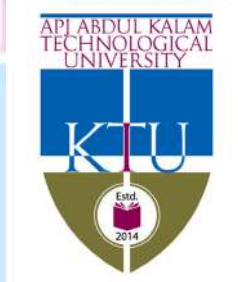


APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY



APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B. Tech. Syllabus



**APJ ABDUL KALAM TECHNOLOGICAL
UNIVERSITY**

**Modified
Syllabus
for
I & II Semester
B. Tech. Degree**

2016

Estd.



2014

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COURSE NO.	COURSE NAME	CREDITS	YEAR OF INTRODUCTION
MA 101	CALCULUS	4	2016
Course Objectives In this course the students are introduced to some basic tools in Mathematics which are useful in modelling and analysing physical phenomena involving continuous changes of variables or parameters. The differential and integral calculus of functions of one or more variables and of vector functions taught in this course have applications across all branches of engineering. This course will also provide basic training in plotting and visualising graphs of functions and intuitively understanding their properties using appropriate software packages.			
Syllabus Single Variable Calculus and Infinite series, Functions of more than one variable, Partial derivatives and its applications, Calculus of vector valued functions, Multiple Integrals.			
Expected outcome At the end of the course the student will be able to (i) check convergence of infinite series (ii) find maxima and minima of functions two variables (iii) find area and volume using multiple integrals (iv) apply calculus of vector valued functions in physical applications and (v) visualize graphs and surfaces using software or otherwise.			
Text Books (1)Anton, Bivens, Davis: Calculus, John Wiley and Sons, 10thed (2)Thomas Jr., G. B., Weir, M. D. and Hass, J. R., Thomas' Calculus, Pearson			
References: 1. Sengar and Singh, Advanced Calculus, Cengage Learning, Ist Edition 2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India edition, 10thed. 3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi. 4. N. P. Bali, Manish Goyal, Engineering Mathematics, Lakshmy Publications 5. D. W. Jordan, P Smith. Mathematical Techniques, Oxford University Press, 4th			

Edition.

6. A C Srivastava, P K Srivastava, Engineering Mathematics Vol 1. PHI Learning Private Limited, New Delhi.

	COURSE NO: MA101	L-T-P:3-1-0	
	COURSE NAME: CALCULUS	CREDITS:4	
MODULE	CONTENT	HRS	END SEM. MARK %
I	Single Variable Calculus and Infinite series (Book I –sec 9.3,9.5,9.6,9.8) Basic ideas of infinite series and convergence - .Geometric series- Harmonic series-Convergence tests-comparison, ratio, root tests (without proof). Alternating series- Leibnitz Test- Absolute convergence, Maclaurins series-Taylor series - radius of convergence. (For practice and submission as assignment only: Sketching, plotting and interpretation of hyperbolic functions using suitable software. Demonstration of convergence of series by software packages)	9	15%
II	Partial derivatives and its applications(Book I –sec. 13.3 to 13.5 and 13.8) Partial derivatives–Partial derivatives of functions of more than two variables - higher order partial derivatives - differentiability, differentials and local linearity - The chain rule – Maxima and Minima of functions of two variables - extreme value theorem (without proof)-relative extrema .	5 4	15%

FIRST INTERNAL EXAM			
III	Calculus of vector valued functions(Book I-12.1,12.2,12.4&12.6,13.6 &13.7) Introduction to vector valued functions-parametric curves in 3-space Limits and continuity – derivatives - tangent lines – derivative of dot and cross product-definite integrals of vector valued functions- unit tangent-normal- velocity-acceleration and speed-Normal and tangential components of acceleration. Directional derivatives and gradients-tangent planes and normal vectors (For practice and submission as assignment only: Graphing parametric curves and surfaces using software packages)	3 3 3	15%
IV	Multiple integrals (Book I-sec. 14.1, 14.2, 14.3, 14.5) Double integrals- Evaluation of double integrals – Double integrals in non-rectangular coordinates- reversing the order of integration- Area calculated as a double integral- Triple integrals(Cartesian co ordinates only)- volume calculated as a triple integral- (applications of results only)	4 2 2 2	15%
SECOND INTERNAL EXAM			
	Topics in vector calculus (Book I-15.1, 15.2, 15.3) Vector and scalar fields- Gradient fields –	2	

V	conservative fields and potential functions –	2	20%
	divergence and curl - the ∇ operator - the Laplacian ∇^2 ,	2	
	Line integrals - work as a line integral-	2	
	independence of path-conservative vector field –	2	
	(For practice and submission as assignment only: graphical representation of vector fields using software packages)		
VI	Topics in vector calculus (continued) (Book I sec., 15.4, 15.5, 15.7, 15.8)		20%
	Green's Theorem (without proof- only for simply connected region in plane),	2	
	surface integrals –	2	
	Divergence Theorem (without proof for evaluating surface integrals) ,	3	
	Stokes' Theorem (without proof for evaluating line integrals)	3	
(All the above theorems are to be taught in regions in the rectangular co ordinate system only)			
END SEMESTER EXAM			

Open source software packages such as gnuplot, maxima, scilab ,geogebra or R may be used as appropriate for practice and assignment problems.

TUTORIALS: Tutorials can be ideally conducted by dividing each class in to three groups. Prepare necessary materials from each module that are to be taught using computer. Use it uniformly to every class.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
PH100	ENGINEERING PHYSICS	3-1-0-4	2016
Course Objectives Most of the engineering disciplines are rooted in Physics. In fact a good engineer is more or less an applied physicist. This course is designed to provide a bridge to the world of technology from the basics of science and to equip the students with skills in scientific inquiry, problem solving, and laboratory techniques.			
Syllabus Harmonic Oscillations: Damped and Forced Harmonic Oscillations. Waves: One Dimensional and Three Dimensional waves, Interference: Interference in thin films (Reflected system) Diffraction: Fraunhofer and Fresnel Diffraction, Grating, Polarization of Light: Double refraction, production and detection of polarized light, Superconductivity: Properties and Applications. Quantum Mechanics: Schrodinger Equations- Formulation and Solution, Operators, Applications. Statistical Mechanics: Microstates and macro states Maxwell - Boltzmann, Bose-Einstein and Fermi Dirac statistics. Fermi level and its significance. Acoustics: Intensity of sound, Reverberation and design concepts, Ultrasonics: Production, Detection and Applications, NDT methods, Lasers: Properties, Working Principles, Practical Lasers. Photonics: Basics of Solid State lighting, Photo detectors, Solar Cells, Fiber Optics.			
Expected outcome Familiarity with the principles of Physics and its significance in engineering systems and technological advances.			
References: • Aruldas, G., Engineering Physics, PHI Ltd. • Beiser, A., Concepts of Modern Physics, McGraw Hill India Ltd. • Bhattacharya and Tandon, Engineering Physics , Oxford India • Brijlal and Subramanyam, A Text Book of Optics, S. Chand & Co. • Dominic and Nahari, A Text Book of Engineering Physics, Owl Books Publishers • Hecht, E., Optics, Pearson Education • Mehta, N., Applied Physics for Engineers, PHI Ltd • Palais, J. C., Fiber Optic Communications, Pearson Education • Pandey, B. K. and Chaturvedi, S., Engineering Physics, Cengage Learning • Philip, J., A Text Book of Engineering Physics, Educational Publishers • Premlet, B., Engineering Physics, Mc GrawHill India Ltd • Sarin, A. and Rewal, A., Engineering Physics, Wiley India Pvt Ltd • Sears and Zemansky, University Physics , Pearson • Vasudeva, A. S., A Text Book of Engineering Physics, S. Chand & Co			

Web:

www.physics.org

www.howstuffworks.com

www.physics.about.com

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Harmonic Oscillations: Differential equation of damped harmonic oscillation, forced harmonic oscillation and their solutions- Resonance, Q factor, Sharpness of resonance- LCR circuit as an electrical analogue of Mechanical Oscillator (Qualitative)	5	15%
	Waves: One dimensional wave - differential equation and solution. Three dimensional waves - Differential equation & its solution. (No derivation) Transverse vibrations of a stretched string.	4	
II	Interference: Coherence. Interference in thin films and wedge shaped films (Reflected system) Newton's rings-measurement of wavelength and refractive index of liquid Interference filters. Antireflection coating.	5	15%
	Diffraction Fresnel and Fraunhofer diffraction. Fraunhofer diffraction at a single slit. Plane transmission grating. Grating equation - measurement of wavelength. Rayleigh's criterion for resolution of grating- Resolving power and dispersive power of grating.	4	
FIRST INTERNAL EXAM			
III	Polarization of Light: Types of polarized light. Double refraction. Nicol Prism. Quarter wave plate and half wave plate. Production and detection of circularly and elliptically polarized light. Induced birefringence- Kerr Cell - Polaroid & applications.	4	15%
	Superconductivity: Superconducting phenomena. Meissner effect. Type-I and Type-II superconductors. BCS theory (qualitative). High temperature superconductors - Applications of superconductors.	5	
IV	Quantum Mechanics: Uncertainty principle and its applications- formulation of Time dependent and Time independent Schrödinger equations- physical meaning of wave function- Energy and momentum Operators-Eigen values and functions- One dimensional infinite square well potential .Quantum mechanical Tunnelling (Qualitative)	6	15%
	Statistical Mechanics: Macrostates and Microstates. Phase space. Basic postulates of Maxwell- Boltzmann, Bose-Einstein and Fermi Dirac	3	

	statistics, Distribution equations in the three cases (no derivation). Fermi Level and its significance.		
SECOND INTERNAL EXAM			
V	Acoustics: Intensity of sound- Loudness-Absorption coefficient - Reverberation and reverberation time- Significance of reverberation time- Sabine's formula (No derivation) -Factors affecting acoustics of a building.	3	20%
	Ultrasonics: Production of ultrasonic waves - Magnetostriction effect and Piezoelectric effect - Magnetostriction oscillator and Piezoelectric oscillator - Detection of ultrasonics - Thermal and piezoelectric methods- Applications of ultrasonics - NDT and medical.	4	
VI	Laser: Properties of Lasers, absorption, spontaneous and stimulated emissions, Population inversion, Einstein's coefficients, Working principle of laser,Optical resonant cavity. Ruby Laser, Helium-Neon Laser, Semiconductor Laser (qualitative). Applications of laser, holography (Recording and reconstruction)	5	20%
	Photonics: Basics of solid state lighting - LED – Photodetectors - photo voltaic cell, junction & avalanche photo diodes, photo transistors, thermal detectors, Solar cells- I-V characteristics - Optic fibre-Principle of propagation-numerical aperture-optic communication system (block diagram) - Industrial, medical and technological applications of optical fibre. Fibre optic sensors - Basics of Intensity modulated and phase modulated sensors.	5	
END SEMESTER EXAM			



Course No.	Course Name	L-T-P-Credits	Year of Introduction
CY100	ENGINEERING CHEMISTRY	3-1-0-4	2016
Course Objectives To enable the students to acquire knowledge in the concepts of chemistry for engineering applications and to familiarize the students with different application oriented topics like new generation engineering materials, storage devices, different instrumental methods etc. And to develop abilities and skills that are relevant to the study and practice of chemistry.			
Syllabus Spectroscopy - Principles and Applications, Electrochemistry - Electrodes, Electrochemical series and applications, Nernst Equation, Potentiometric titration and application, Cells, Instrumental Methods- Thermal Analysis, Chromatography; Conductivity, Chemistry of Engineering Materials, Copolymers, Conducting Polymers, Advanced Polymers, Nano materials, Fuels and Calorific value; Lubricants and their properties, Water Technology - Hardness, Water softening methods, Sewage water Treatment.			
Expected outcome The student will be able to apply the knowledge of chemistry and will be equipped to take up chemistry related topics as part of their project works during higher semester of the course.			
References Books: - Ahad, J., Engineering Chemistry, Jai Publications - Dara, S. S., Engineering Chemistry, S Chand Publishers - Fernandez, A., Engineering Chemistry, Owl Book Publishers, ISBN 9788192863382 - Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishers - Kaurav, Engineering Chemistry with Laboratory Experiments, PHI, ISBN 9788120341746 - Manjooran K. S., Modern Engineering Chemistry, Kannatheri Publication - Seymour, R. B., Introduction to Polymer Chemistry, McGraw Hill - Rath, P., Engineering Chemistry, Cengage Learning, ISBN 9788131526699 - Wiley India, Engineering Chemistry, ISBN 9788126543205			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Spectroscopy: Introduction, Beer Lamberts Law (no derivations)(Numericals)	1	15%
	UV-visible spectroscopy - Principle, Instrumentation and applications	2	
	IR spectroscopy - Principle and applications (Numericals)	2	
	¹ H NMR spectroscopy - Principle, chemical shift - spin - spin splitting and applications including MRI(brief), Spectral Problems	4	
II	Electrochemistry: Different types of electrodes (general) – SHE, Calomel electrode, Glass electrode and determination of E ⁰ using SHE & Calomel	2	15%

	electrode		
	Electrochemical series and its applications.(Numericals)	1	
	Nernst equation - Derivation, application & numericals	2	
	Potentiometric titration - Acid-base and redox titration	2	
	Lithium ion cell and Fuel cell.	1	
FIRST INTERNAL EXAM			
III	Instrumental Methods: Thermal analysis - Principle, instrumentation and applications of TGA and DTA.	3	15%
	Chromatographic methods - Basic principles, column, TLC. Instrumentation and principles of GC and HPLC.	4	
	Conductivity - Measurement of conductivity	1	
IV	Chemistry of Engineering Materials: Copolymers - BS, ABS - Structure and Properties.	1	15%
	Conducting Polymers - Polyaniline, Polypyrrole - Preparation, Structure and Properties.	2	
	OLED – An introduction	1	
	Advanced Polymers – Kevlar, Polybutadiene rubber and silicone rubber: Preparation, Structure and Properties.	2	
	Nanomaterials – Definition, Classification, chemical methods of preparation - hydrolysis and reduction	2	
	Properties and Applications – Carbon Nano Tubes and fullerenes.	1	
SECOND INTERNAL EXAM			
V	Fuels and Lubricants: Fuels - Calorific Value, HCV and LCV - Determination of calorific value of a solid and liquid fuel by Bomb calorimeter - Dulong's formula and Numericals.	3	20%
	Liquid fuel - Petrol and Diesel - Octane number & Cetane number	1	
	Biodiesel - Natural gas.	2	
	Lubricant - Introduction, solid, semisolid and liquid lubricants.	1	
	Properties of lubricants - Viscosity Index, Flash point, Fire point, Cloud point, Pour point and Aniline point.	2	
VI	Water Technology: Types of hardness, Units of hardness, Estimation of Hardness – EDTA method. Numericals based on the above	3	20%
	Water softening methods - Ion exchange process - Principle. Polymer ion exchange.	2	
	Reverse Osmosis - Disinfection method by chlorination and UV	1	
	Dissolved oxygen, BOD and COD.	2	
	Sewage water Treatment - Trickling Filter and UASB process.	1	
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE100	ENGINEERING MECHANICS	3-1-0-4	2016
Course Objectives - To apply the principles of mechanics to practical engineering problems. - To identify appropriate structural system for studying a given problem and isolate it from its environment. - To develop simple mathematical model for engineering problems and carry out static analysis. - To carry out kinematic and kinetic analyses for particles and systems of particles.			
Syllabus Statics: Fundamental concepts and laws of mechanics; Force systems; Principle of moments; Resultant of force and couple systems; Equilibrium of rigid body; Free body diagram; Equilibrium of a rigid body in three dimension; Support reactions; Properties of surfaces and solids - Centroid, Moment of inertia, Polar moment of inertia, Mass moment of inertia, Product of inertia and Principal moment of inertia; Theorems of Pappus – Guldinus; Friction; Principle of virtual work. Dynamics: Rectangular and cylindrical coordinate system; Combined motion of rotation and translation; Newton's second law in rectilinear translation; D' Alembert's principle; Mechanical vibration; Simple harmonic motion; Spring-mass model.			
Expected outcome - Students will be able to apply and demonstrate the concepts of mechanics to practical engineering problems. - Students will be able to determine the properties of planes and solids. - Students will be able to apply fundamental concepts of dynamics to practical problems.			
Text Books: - Shames, I. H., Engineering Mechanics - Statics and Dynamics, Pearson Prentice - Timoshenko, S. & Young D. H., Engineering Mechanics, McGraw Hill			
References Books: - Babu, J., Engineering Mechanics, Pearson Prentice Hall - Beer and Johnson, Vector Mechanics for Engineers - Statics and Dynamics, Tata McGraw Hill Publishing Company Limited - Benjamin J., Engineering Mechanics, Pentex Book Publishers and Distributors - Bhavikkatti, S. S., Engineering Mechanics, New Age International Publishers - Hibbeler, R. C., Engineering Mechanics: Statics and Dynamics, Pearson Prentice Hall - Kumar, K. L., Engineering Mechanics, Tata McGraw Hill Publishing Company Limited - Merriam J. L. and Kraige L. G., Engineering Mechanics – Vol. I and II, John Wiley - Rajasekaran S. and Sankarasubramanian, G., Engineering Mechanics, Vikas Publishing House Private Limited - Tayal, A. K., Engineering Mechanics- Statics and Dynamics, Umesh Publications			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Statics: Fundamental concepts and laws of mechanics – Rigid body – Principle of transmissibility of forces	2	15%
	Coplanar force systems - Moment of a force – Principle of moments	2	
	Resultant of force and couple system	4	
	Equilibrium of rigid body – Free body diagram – Conditions of equilibrium in two dimensions – Two force and three force members.	3	
II	Types of supports – Problems involving point loads and uniformly distributed loads only.	5	15%
	Force systems in space – Degrees of freedom – Free body diagram – Equations of equilibrium – Simple resultant and Equilibrium problems.	4	
FIRST INTERNAL EXAM			
III	Properties of planar surfaces – Centroid and second moment of area (Derivations not required) - Parallel and perpendicular axis theorem – Centroid and Moment of Inertia of composite area.	3	15%
	Polar Moment of Inertia – Radius of gyration – Mass moment of inertia of cylinder and thin disc (No derivations required).	2	
	Product of inertia – Principal Moment of Inertia (conceptual level).	3	
	Theorems of Pappus and Guldinus.	1	
IV	Friction – Characteristics of dry friction – Problems involving friction of ladder, wedges and connected bodies.	6	15%
	Definition of work and virtual work – Principle of virtual work for a system of connection bodies – Problems on determinate beams only.	4	
SECOND INTERNAL EXAM			
V	Dynamics: Rectangular and Cylindrical co-ordinate system	1	20%
	Combined motion of rotation and translation – Concept of instantaneous centre – Motion of connecting rod of piston and crank of a reciprocating pump.	4	
	Rectilinear translation – Newton's second law – D'Alembert's Principle – Application to connected bodies (Problems on motion of lift only).	4	
VI	Mechanical vibrations – Free and forced vibration - Degree of freedom.	1	20%
	Simple harmonic motion – Spring-mass model – Period – Stiffness – Frequency – Simple numerical problems of single degree of freedom.	7	
END SEMESTER EXAM			

Course No:	Course Name	L-T-P Credits	Year of Introduction
BE110	*ENGINEERING GRAPHICS	1-1-3-3	2016
* As this course is practical oriented, the evaluation is different from other lecture based courses. Points to note: (1) End semester examination will be for 50 marks and of 3 hour duration. (2) End semester exam will include all modules except Module IV. (3) 100 marks are allotted for internal evaluation: first internal exam 40 marks, second internal exam 40 marks(CAD Lab Practice) and class exercises 20 marks. (4) The first internal exam will be based on modules I and II and the second internal exam will be a practical exam in CAD based on Module IV alone. Second internal exam may be conducted at the end of the semester.			
Course Objectives To enable the student to effectively communicate basic designs through graphical representations as per standards.			
Syllabus Introduction to Engineering Graphics; Orthographic projections of lines and solids, Isometric projection, Freehand sketching, Introduction to CAD, Sections of solids, Development of surfaces, Perspective projection.			
Expected outcome Upon successful completion of this course, the student would have accomplished the following abilities and skills: 1. Fundamental Engineering Drawing Standards. 2. Dimensioning and preparation of neat drawings and drawing sheets. 3. Interpretation of engineering drawings 4. The features of CAD software			

References Books:

- Agrawal, B. and Agrawal, C. M., Engineering Drawing, Tata McGraw Hill Publishers
- Anilkumar, K. N., Engineering Graphics, Adhyuth Narayan Publishers
- Benjamin, J., Engineering Graphics, Pentex Publishers
- Bhatt, N., D., Engineering Drawing, Charotar Publishing House Pvt Ltd.
- Duff, J. M. and Ross, W. A., Engineering Design and Visualization, Cengage Learning, 2009
- John, K. C., Engineering Graphics, Prentice Hall India Publishers
- Kirstie Plantenberg, Engineering Graphics Essentials with AutoCAD 2016 Instruction, 4th Ed., SDC Publications
- Kulkarni, D. M., Rastogi, A. P. and Sarkar, A. K., Engineering Graphics with AutoCAD, PHI 2009
- Luzadder, W. J. and Duff, J. M., Fundamentals of Engineering Drawing, PHI 1993
- Parthasarathy, N. S., and Murali, V., Engineering Drawing, Oxford University Press
- Varghese, P. I., Engineering Graphics, V I P Publishers
- Venugopal, K., Engineering Drawing & Graphics, New Age International Publishers

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	6 exercises Introduction to Engineering Graphics: Need for engineering drawing. Drawing instruments; BIS code of practice for general engineering drawing. Orthographic projections of points and lines:-Projections of points in different quadrants; Projections of straight lines inclined to one of the reference planes, straight lines inclined to both the planes; True length and inclination of lines with reference planes; Traces of lines.	14	20%

II	12 exercises Orthographic projections of solids:-Projections of simple solids* in simple positions, projections of solids with axis inclined to one of the reference planes and axis inclined to both the reference planes.	11	20%
FIRST INTERNAL EXAM			
III	12 exercises Isometric Projections:-Isometric projections and views of plane figures simple* and truncated simple* solids in simple position including sphere and hemisphere and their combinations. Freehand sketching: Freehand sketching of real objects, conversion of pictorial views into orthographic views and vice versa.	09	20%
IV	6 exercises Introduction to Computer Aided Drafting - familiarizing various coordinate systems and commands used in any standard drafting software - drawing of lines, circle, polygon, arc, ellipse, etc. Creating 2D drawings. Transformations: move, copy, rotate, scale, mirror, offset and array, trim, extend, fillet, chamfer. Dimensioning and text editing. Exercises on basic drafting principles, to create technical drawings. Creation of orthographic views of simple solids from pictorial views. Creation of isometric views of simple solids from orthographic views. Solid modelling and sectioning of solids, extraction of 2D drawings from solid models. (For internal examination only, not for University Examination).	15 (Additional hours are allotted in U slot for CAD practice)	Internal
SECOND INTERNAL EXAM (to be conducted only after finishing CAD Practice.)			
V	9 exercises Sections and developments of solids: - Sections of simple* solids in simple vertical positions with section plane inclined to one of the reference planes - True shapes of sections. Developments of surfaces of these solids.	12	20%

VI	6 exercises Intersection of surfaces: - Intersection of prism in prism and cylinder in cylinder - axis bisecting at right angles only. Perspective projections: - perspective projections of simple* solids.	09	20%
*Triangular, square, pentagonal and hexagonal prisms, pyramids, cones and cylinders.			
END SEMESTER EXAM			

Note:

1. First angle projection is to be followed.
2. CAD Practice is mandatory and shall be conducted in the time slot allotted for U slot in addition to 15 hours allotted for Module IV

Question Paper Pattern: Question Paper shall contain **eight** questions of 10 marks each out of which **five** questions are to be answered as explained below. **The duration of examination is 3 hours.**

Part A: **Three** questions from Modules I & II out of which **two** are to be answered.

Part B: **Five** questions from Modules III, V & VI out of which **three** are to be answered.

The questions are to be answered in A4 size booklet containing grid/plain sheets supplied by the university. Drawing sheets are not needed.

The evaluation of answers shall be based on the correctness of solution, judging the knowledge of student in concepts and principles of Engineering Graphics. Accuracy and neatness shall not be criteria for evaluation.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE101-01	INTRODUCTION TO CIVIL ENGINEERING	2-1-0-3	2016

Course Objectives

1. To provide the students an overview of the profession of Civil Engineering.
2. To give the students an illustration of the use and properties of various building materials and explain the building construction aspects.

Syllabus

Civil Engineering as a profession; General introduction to history of Civil Engineering; types and classification of buildings; setting out of a building; Building materials - Stones, Bricks, Tiles, Cement, Aggregate, Cement mortar, Timber, Steel; Building Construction - Stone Masonry, Brick Masonry, Floors and flooring, Roofs and roof coverings.

Expected outcome

Students will be able to explain the importance of Civil Engineering in the infrastructural development of the society.

1. They will be able to illustrate the types, uses and properties of various building materials.
2. Students will be able to explain the method of construction of different components of a building.

References Books:

- Chen, W. F. and Liew, J. Y. R., (Eds.), The Civil Engineering Handbook, Second Edition, CRC Press (Taylor and Francis)
- Dalal, K. R., Essentials of Civil Engineering, Charotar Publishing House
- Gopi, S., Basic Civil Engineering, Pearson Publishers
- Kandya, A. A., Elements of Civil Engineering, Charotar Publishing house
- Mamlouk, M. S. and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers.
- McKay, W. B. and McKay, J. K., Building Construction Volumes 1 to 4, Pearson India Education Services
- Rangwala, S. C. and Dalal, K. B., Engineering Materials, Charotar Publishing house
- Rangwala, S. C. and Dalal, K. B., Building Construction, Charotar Publishing house

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	General introduction to Civil Engineering - History of Civil Engineering - Relevance of Civil Engineering in the overall infrastructural development of the country.	2	15%
	Types and classification of structures - buildings, towers, chimneys, bridges, dams, retaining walls, water tanks, silos, roads, railways,	3	

	runways and pipelines (Brief description only)		
	Definition and types of buildings as per National Building Code of India (brief description only).	1	
	Selection of site - Components of a building and their functions - Setting out of a building.	2	
II	Stones: Classification of stones - Qualities of good building stones - Quarrying - Dressing - Tests - Specifications - Uses of common building stones.	2	15%
	Bricks: Composition of good brick earth - Classification - Qualities of good bricks - Field and laboratory tests - Specifications.	2	
	Tiles: Classification - Manufacture - Properties - Tests - Specifications	3	
FIRST INTERNAL EXAM			
III	Cement: Basic Ingredients – Manufacturing process - Grades - Properties - Tests - Specifications.	4	15%
	Aggregates: Fine and coarse aggregate - Properties - Uses - Tests.	3	
	Cement Mortar: Types and preparation.	1	
IV	Stone Masonry: Types - Details of Ashlar, Random Rubble, Coarse Rubble and Dry Rubble Masonry.	3	15%
	Brick Masonry: Types - Bond - Introduction to all types of bonds - English bond in detail (1, 1½ and 2 brick walls) - Comparison of stone and brick masonry.	4	
SECOND INTERNAL EXAM			
V	Timber: Properties - Uses - Classification - Seasoning - Defects - Preservation - Tests; Hard board and Particle board - Manufacture and use.	3	20%
	Steel: Structural steel and steel as reinforcement - Types - Properties - Uses - Market forms.	3	
VI	Floors and Flooring materials: Different types and selection of floors and floor coverings.	3	20%
	Roofs and roof coverings: Different types of roofs - Suitability - Types and selection of roofing materials.	3	
END SEMESTER EXAM			

Course No:	Course Name	L-T-P Credits	Year of Introduction
BE101-02	INTRODUCTION TO MECHANICAL ENGINEERING SCIENCES	2-1-0-3	2016
Course Objectives 1. To introduce different disciplines of Mechanical Engineering 2. To kindle interest in Mechanical Engineering 3. To impart basic mechanical engineering principles			
Syllabus Thermodynamics & Power sources, Thermal Engineering, Refrigeration and Air Conditioning, Automobile & Aeronautical Engineering, Engineering Materials and manufacturing.			
Expected Outcome At the end of the course, the students will have exposed to the different areas of Mechanical Engineering; gained idea about nature, scope and applications of Mechanical Engineering principles.			
References Books: • Dossat, R. J., Principles of Refrigeration, PHI • Heywood, J., Internal Combustion Engine Fundamentals, McGraw Hill Publishers • Holman, J. P., Thermodynamics, McGraw Hill Co. • Jain, K. K. and Asthana, R. B., Automobile Engineering, TTTI Bhopal • Jonathan Wickert, Introduction to Mechanical Engineering, Cengage Learning • Kalpakjian, S. and Schmid, S. R., Manufacturing Processes for Engineering Materials, Pearson education • Maines, R., Landmarks in Mechanical Engineering, ASME • Peng, W. W., Principles of Turbomachinery, John Wiley & Sons • Pita, E. G., Air Conditioning Principles & Systems, PHI. • Spalding, D. B. and Cole, E. H., Engineering Thermodynamics, ELBS & Edward Arnold (Pub) Ltd. • Stone, R. and Ball, T. K., Automotive Engineering Fundamentals, SAE International • Sutton, G. P. and Ross, D. M., Rocket Propulsion Elements, John Wiley & Sons • Von Karman, T., Aerodynamics: Selected Topics in the Light of Their Historical Development, Courier Corporation • Online course on Refrigeration & Air conditioning, IIT Kharagpur www.nptel.ac.in			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Thermodynamics: Nature and scope of thermodynamics; Basic concepts ; Laws of thermodynamics- Discovery, Significance & Applications; Qualitative ideas on Entropy, Available energy, Irreversibility, Principle of increase of entropy & Carnot engine; Limitations of Thermodynamics; Sources of power; history of power production; power production in the future.	8	15%
II	Thermal Engineering: Historical development of steam engine, steam turbines, gas turbines and hydraulic turbines; Principle of turbomachinery; History of IC engines; two stroke and four stroke engines-working, applications; Air compressors- types and uses; Principles of Rocket propulsion, chemical rockets, Indian space programme	8	15%
FIRST INTERNAL EXAM			
III	Refrigeration & Air Conditioning: History & scope of refrigeration; applications of refrigeration; Food preservation, refrigerated storage; applications in chemical and process industries; special applications; Air conditioning- Principles & systems; scope of air conditioning; Psychrometric properties of air; Human comfort; comfort standards.	7	15%
IV	Automobile & Aeronautical Engineering: Introduction to an Automobile; history of the automobile; Indian Automobiles; Types of automobiles; Major components and their functions; Manufacturers of motor vehicles in India; Fundamentals of aerodynamics; drag force and lift force; jet engines types and applications.	7	15%
SECOND INTERNAL EXAM			
V	Engineering Materials: Introduction and history of materials; Basic crystallography; metals, alloys, composites, ceramics, polymers; mechanical properties and testing of engineering materials.	5	20%
VI	Manufacturing Engineering :	7	20%

	Methods of manufacturing; casting, forging, rolling, extrusion; machining operations – turning, milling, drilling, grinding, shaping, planing; Joining operations – soldering, brazing & welding; Introduction to CNC machines(elementary idea only); examples of typical products manufactured by above methods.		
END SEMESTER EXAM			

Question Paper Pattern:

Part A: Modules I and II – three questions of 15 marks each – out of which two questions are to be answered.

Part B: Modules III and IV – three questions of 15 marks each – out of which two questions are to be answered.

Part C: Modules V and VI – three questions of 20 marks each – out of which two questions are to be answered.

Each question can have maximum of four subdivisions (a,b,c,d).



Course No.	Course Name	L-T-P Credits	Year of Introduction
BE101-03	INTRODUCTION TO ELECTRICAL ENGINEERING	2-1-0-3	2016
Course Objective The objective of this course is to set a firm and solid foundation in Electrical Engineering with strong analytical skills and conceptual understanding of basic laws and analysis methods in electrical and magnetic circuits.			
Syllabus Fundamental Concepts of Circuit Elements and Circuit variables, Real and Ideal independent voltage and current sources, V-I relations; Basic Circuit Laws, Analysis of resistive circuits, Magnetic Circuits, Electromagnetic Induction; Alternating current fundamentals, Phasor Concepts, Complex representation, Phasor analysis of RL, RC, RLC circuit, admittances; Complex Power, Resonance in series and parallel circuits; Three-phase systems, analysis of balanced and unbalanced star and delta connected loads.			
Expected outcome The course will enable students to learn advanced topics in Electrical Engineering			
References Books: •Bhattacharya, S. K., Basic Electrical & Electronics Engineering, Pearson •Bird, J., Electrical Circuit Theory and Technology, Routledge, Taylor & Francis Group •Edminister, J., Electric Circuits, Schaum's Outline Series, Tata McGraw Hill •Hayt, W. H., Kemmerly, J. E., and Durbin, S. M., Engineering Circuit Analysis, Tata McGraw Hill •Hughes, Electrical and Electronic Technology, Pearson Education •Parker and Smith, Problems in Electrical Engineering, CBS Publishers and Distributors •Sudhakar and Syam Mohan, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill •Suresh Kumar, K. S, Electric Circuits and Networks, Pearson Education			

Course Plan			
Module	Contents	Hours	Sem. Exam. Marks
I	Fundamental Concepts of Circuit Elements and Circuit variables: Electromotive force, potential and voltage. Resistors, Capacitors	1	15%
	Inductors- terminal V-I relations		
	Electromagnetic Induction: Faraday's laws, Lenz's law, statically and dynamically induced EMF, self and mutual inductance, coupling coefficient-energy stored in inductance	2	
	Real and Ideal independent voltage and current sources, V-I relations. Passive sign convention	1	
	Numerical Problems (Module I)	2	
II	Basic Circuit Laws: Kirchhoff's current and voltage laws, analysis of resistive circuits-mesh analysis –super mesh analysis	2	15%
	Node analysis-super node analysis, star delta transformation	2	
	Numerical problems (Module II)	2	
FIRST INTERNAL EXAMINATION			
III	Magnetic Circuits: Magneto motive force, flux, reluctance, permeability -comparison of electric and magnetic circuits, analysis of series magnetic circuits	2	15%
	Parallel magnetic circuits, magnetic circuits with air-gaps.	2	
	Numerical problems (Module III)	2	
IV	Alternating current fundamentals:-Generation of Alternating voltages-waveforms, Frequency, Period, RMS and average values, peak factor and form factor of periodic waveforms (pure sinusoidal) and composite waveforms	3	15%

	Phasor Concepts, Complex representation (exponential, polar and rectangular forms) of sinusoidal voltages and currents phasor diagrams	2	
	Complex impedance - series and parallel impedances and admittances, Phasor analysis of RL, RC, RLC circuits	2	
	Numerical problems. (Module IV)	2	
SECOND INTERNAL EXAMINATION			
V	Complex Power : Concept of Power factor: active , reactive and apparent power	1	20%
	Resonance in series and parallel circuits	2	
	Energy, bandwidth and quality factor, variation of impedance and admittance in series and parallel resonant circuits	2	
	Numerical problems (Module V)	2	
VI	Three phase systems: Star and delta connections, three-phase three wire and three-phase four-wire systems	2	20%
	Analysis of balanced and unbalanced star and delta connected loads	2	
	Power in three-phase circuits. Active and Reactive power measurement by one, two, and three wattmeter methods	2	
	Numerical problems (Module VI)	2	
END SEMESTER EXAMINATION			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE101-04	INTRODUCTION TO ELECTRONICS ENGINEERING	2-1-0-3	2016

Course Objectives

1. To get basic idea about types, specification and common values of passive components
2. To familiarize the working and characteristics of diodes, transistors and MOSFETS
3. To understand working of diodes in circuits and in rectifiers
4. To familiarize some measuring instruments

Syllabus

Evolution and Impact of Electronics, Familiarization of Resistors, Capacitors, Inductors, Transformers and Electro mechanical components, Semiconductors, PN junction diode, Zener diode, LED, photo diode, Bipolar Junction Transistors: Structure, principle of operation, different configurations, load line and operating point, biasing and stabilization, Transistor as amplifier, switch, Junction Field Effect Transistors: Structure, principle of operation, characteristics MOSFET: Structure, principle of operation, characteristics, Principle of operation of Photo transistor, UJT, SCR, Diode circuits and power supplies: Series and parallel diode circuits, Half-wave & full wave rectifiers, capacitor filter, zener voltage regulator, Electronic Measurements and measuring Instruments: Performance parameters, Analog and digital multimeter, CRO, DSO, function generator, Testing of Electronic components.

Expected outcome

Student can identify the active and passive electronic components and can design and setup simple circuits using diodes and transistors. Voltage and currents can be measured and monitored using electronic measuring instruments

References Books:

- Bell, D. A., Electronic Devices and Circuits, Oxford University Press
- Boylestad, R. L. and Nashelsky, L., Electronic Devices and Circuit Theory, Pearson Education
- Kal, S., Basic Electronics: Devices, Circuits and its Fundamentals, PHI Learning
- Millman, J., Halkias, C. and Parikhu, C. D., Integrated Electronics, Tata Mc Graw Hill
- Neaman, D. A., Electronic Circuits Analysis and Design, McGraw Hill
- Sedra, A. S. and Smith, K. C., Microelectronic Circuits, Oxford University Press

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Evolution of Electronics, Impact of Electronics in industry and in society.	1	15%
	Resistors, Capacitors: types, specifications. Standard values, marking, colour coding.	3	
	Inductors and Transformers: types, specifications, Principle of working.	2	

	Electro mechanical components: relays and contactors.	1	
II	Diodes: Intrinsic and extrinsic semiconductors, PN junction diode, barrier potential, V-I characteristics, Effect of temperature. Equivalent circuit of a diode. Piece wise linear model.	3	15%
	Specification parameters of diodes and numbering.	1	
	Zener diode, Varactor diodes, characteristics, working principle of LED, photo diode, solar cell.	3	
FIRST INTERNAL EXAM			
III	Bipolar Junction Transistors: Structure, typical doping, Principle of operation, concept of different configurations. Detailed study of input and output characteristics of common base and common emitter configuration, current gain, comparison of three configurations.	3	15%
	Concept of load line and operating point. Need for biasing and stabilization, voltage divider biasing, Transistor as amplifier, switch, RC coupled amplifier and frequency response	3	
	Specification parameters of transistors and type numbering	1	
IV	Junction Field Effect Transistors: Structure, principle of operation, characteristics, comparison with BJT.	2	15%
	MOSFET: Structure, principle of operation of Enhancement type MOSFET, Current voltage characteristics, Depletion-type MOSFET.	2	
	Principle of operation of Photo transistor, UJT, SCR.	3	
SECOND INTERNAL EXAM			
V	Diode circuits and power supplies: Series and parallel diode circuits, Clippers, Clampers, Voltage multipliers	3	20%
	Half-wave and full wave (including bridge) rectifiers, Derivation of V_{rms} , V_{dc} , ripple factor, peak inverse voltage, rectification efficiency in each case, capacitor filter, working and design of a simple zener voltage regulator. Block diagram description of a DC Power supply, Principle of SMPS	4	
VI	Electronic Measurements and measuring Instruments.	2	20%
	Generalized performance parameters of instruments: error, accuracy, sensitivity, precision and resolution. Principle and block diagram of analog and digital multimeter, Block diagram of CRO, Measurements using CRO, Lissajous patterns, Principle and block diagram of DSO, function generator.	4	
	Testing of Electronic components.	1	
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE101-05	INTRODUCTION TO COMPUTING AND PROBLEM SOLVING	2-1-0-3	2016
Course Objectives - To learn basics of digital computers - To develop problem solving skills - To learn programming and to solve problems using computers			
Syllabus Introduction to digital computer, Introduction to programming languages, Operating systems, Problem Solving strategies, Examples for algorithms and flow charts, Introduction to Python language, functions, parameters and arguments, Boolean Expressions, logical operators and control statements Strings, lists, tuples and dictionaries, operations, Files, introduction to objects, attributes and instances			
Expected outcome - Ability to design algorithmic solution to problems. - Ability to convert algorithms to Python programs. - Ability to design modular Python programs using functions - Ability to design programs with Interactive Input and Output, utilizing arithmetic expression repetitions, decision making, arrays. - Ability to design programs using file Input and Output. - Ability to develop recursive solutions.			
Text Books: - Downey, A. et al., How to think like a Computer Scientist: Learning with Python, John Wiley, 2015 - Goel, A., Computer Fundamentals, Pearson Education - Lambert K. A., Fundamentals of Python - First Programs, Cengage Learning India, 2015 - Rajaraman, V., Computer Basics and C Programming, Prentice-Hall India References Books: - Barry, P., Head First Python, , O' Reilly Publishers - Dromy, R. G., How to solve it by Computer, Pearson India - Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India - Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley, 2015 - Sprankle , M., Problem Solving & Programming Concepts, Pearson India - Venit, S. and Drake, E., Prelude to Programming: Concepts & Design, Pearson India - Zelle, J., Python Programming: An Introduction to Computer Science, Franklin, Beedle & Associates Inc.			

Web links:

- ☐ <https://archive.org/details/MIT6.00SCS11>
- ☐ <https://www.coursera.org/course/pythonlearn>

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to digital computer – Von Neumann concept – A simple model of computer, acquisition of data, storage of data, processing of data, output of processed data. Details of functional units of a computer. Storage – primary storage and secondary storage. <i>(The discussion should focus more on the functionalities of the units and their interaction than on specific hardware details. However, concepts like memory cells and their addressability (need not be binary), registers, inter-connections (buses) have to be introduced at an abstract level. For storage devices – primary and secondary –, various categories have to be introduced along with their distinguishing features. For I-O devices also, various categories are to be introduced. The Von Neumann concept should be effectively introduced. History computers need not be taught. However, students have to be encouraged to read the relevant sections of the text book. Chapters 1 – 4 of 'Goel' may be used to support teaching-learning.)</i> Introduction to programming languages:- types of programming languages - high level language, assembly language and machine language, System software - Operating systems – objectives of operating systems, compiler, assembler and interpreter. <i>(For all the above topics, focus should be more on the concepts, significance and objectives. Chapter 6 and 7 (up to 7.4) of 'Goel' may be used to support the teaching-learning process.)</i>	8	15%
II	Problem Solving strategies – Problem analysis – formal definition of problem – Solution – top- down design – breaking a problem into sub problems- overview of the solution to the sub problems by writing step by step procedure (algorithm) - representation of procedure by flowchart - Implementation of algorithms – use of procedures to achieve modularity. <i>(For this part the instructor has to initially use suitable analogies of real world problems to explain the concepts, before delving into computer-solvable problems.)</i> Examples for algorithms and flow charts - at least 10 problems (starting	8	15%

	with non-numerical examples, and numeric problems like factorial, largest among three numbers, largest among N, Fibonacci etc.; to be introduced with progressive levels of difficulty) must be discussed in detail. (Class assignments and/or tutorials may be used to strengthen understanding of this part. Chapters 4 and 5 of the 'Rajaraman' may be used for the teaching-learning process.)		
FIRST INTERNAL EXAM			
III	Introduction to Python – variables, expressions and statements, evaluation of expressions, precedence, string operations (Note:- the instructor can demonstrate simple programs to the students and encourage them to develop similar ones. In particular, before attempting programs containing functions, the students should be given enough support and time to develop python code containing long sequence of statements for the simple flowcharts developed earlier. This will strengthen the students' understanding of instruction sequencing. Chapters 1 and 2 of 'Downey' have to be covered. Chapter 1 & 2 of 'Lambert' can also be used.) Control statements, Boolean expressions and logical operators, conditional and alternative executions (Note: - Chapter 4 of 'Downey' up to Section 4.9 has to be covered. The instructor should demonstrate each of these concepts with real examples and encourage students to develop as many as possible. Chapter 3 of 'Lambert' can be used for detailed discussion and self-study) Iteration - while statement and tables. (Note: - Chapter 6 of 'Downey' has to be covered. Chapter 3 of 'Lambert' can be used for detailed discussion and self-study.)	8	15%
IV	Functions, calling functions, type conversion and coercion, composition of functions, mathematical functions, user-defined functions, parameters and arguments. (Note: - Chapter 3 of 'Downey' has to be covered. The instructor should demonstrate each aspect of the function with real examples and encourage students to develop their own. Chapter 6 (up to 6.3) of 'Lambert' can be used for detailed discussion and self-study.)	6	15%
SECOND INTERNAL EXAM			
V	Strings and lists – string traversal and comparison with examples. (Note: - Chapter 7 of 'Downey' has to be covered. Section 4.1 of 'Lambert' can be used for detailed discussion and self-study.) List operations with examples (Note: - Chapter 8 of 'Downey' up to Section 8.6 has to be covered. Section 5.1 of 'Lambert' can be used for detailed discussion and self-study.); tuples and dictionaries – operations and examples (Note: -	6	20%

	<i>Chapters 9 & 10 of the third text have to be covered. Section 5.4 of 'Lambert' can be used for detailed discussion and self-study.)</i>		
VI	Files and exceptions - text files, directories (Note: - Chapter 11 of 'Downey' has to be covered) Introduction to classes and objects - attributes, instances (Note: - Chapter 12 of 'Downey' up to Section 12.6 has to be covered)		
END SEMESTER EXAM			



Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE101-06	INTRODUCTION TO CHEMICAL ENGINEERING	2-1-0-3	2016
Course Objectives 1. To instil in students the interest, excitement, and urge to learn the subject of Chemical Engineering 2. To introduce the profession of Chemical Engineering 3. To introduce the purpose of learning important subjects in Chemical Engineering for meeting the requirement of various professional fields in Chemical Engineering.			
Syllabus Introduction to Chemical Engineering, profession, plant operation, Basic concepts of units and equations of state, Overview of unit operations and processes, Modes of heat transfer, chemical reactions, DCDA process, basic concepts of P&I diagram, Introduction to process instrumentation and control, Introduction to safety in chemical process industries, introduction to Environmental Engineering, Challenges of Chemical Engineer, Introduction to novel materials and their development.			
Expected outcome The student will demonstrate the ability to understand the basic concepts of Chemical Engineering			
References Books: • Badger and Banchero, Introduction to Chemical Engineering, McGraw Hill • McCabe, W. L., Smith, J.C. and Harriott, P., Unit Operations in Chemical Engineering, McGraw Hill • Pushpavanam, S., Introduction to Chemical Engineering, PHI Learning Pvt. Ltd. • Smith, R., Chemical Process Design and Integration, Wiley			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Chemical Engineering: history of Chemical Engineering, role of Chemical Engineering– a broad overview; chemical industries in India; introduction to Chemical Engineering profession; introduction to chemical plant operation; process development and process design.	6	15%
II	Basic concepts: units and dimensions, systems of units, conversion and conversion factors of units, concept of mole, weight percent, mole percent, normality, molarity, molality, vapor pressure, partial pressure, concept of ideal gas and equations of state.	7	15%
FIRST INTERNAL EXAM			
III	Overview of unit operations such as distillation, evaporation, absorption,	8	15%

	adsorption, extraction, crystallization, drying, leaching, size separation and size reduction. Overview of unit processes like saponification, polymerization, biodiesel formation and hydrogenation.		
IV	Modes of heat transfer-principles of conduction, convection and radiation, heat exchangers. Fluid flow- laminar and turbulent flow. Introduction to transportation of fluids. Classification of chemical reactions, order of reaction, rate equation, Arrhenius equation, conversion and yield, batch reactor, mixed reactor and plug flow reactor.	8	15%
SECOND INTERNAL EXAM			
V	Block diagram, process flow diagram for DCDA process for Sulphuric acid manufacture, basic concepts of P&I diagram. Introduction to process instrumentation and control: common methodologies of measurements, measuring instruments: thermocouple, venturimeter, U-tube manometer, elements of feedback control loop, introduction to control of a distillation column.	7	20%
VI	Introduction to safety in chemical process industries – basic concepts, Case study: Bhopal gas tragedy. Introduction to Environmental Engineering - basic concepts, Typical wastewater, air and solid waste management system. Case study: Effect of Aerial Spraying of Endosulfan on Residents of Kasargod, Kerala. Challenges of Chemical Engineer –need for sustainable alternatives for processes; products with environment friendly life-cycle. Introduction to novel materials and their development.	6	20%
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE103	INTRODUCTION TO SUSTAINABLE ENGINEERING	2-0-1-3	2016
Course Objectives - To have an increased awareness among students on issues in areas of sustainability - To understand the role of engineering and technology within sustainable development; - To know the methods, tools, and incentives for sustainable product-service system development - To establish a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.			
Syllabus Sustainability- need and concept, challenges, Environment acts and protocols, Global, Regional and Local environmental issues, Natural resources and their pollution, Carbon credits, Zero waste concept ISO 14000, Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Technology and sustainable development, Sustainable urbanization, Industrial Ecology.			
Expected outcome The student will be - Able to understand the different types of environmental pollution problems and their sustainable solutions - Able to work in the area of sustainability for research and education - Having a broader perspective in thinking for sustainable practices by utilizing the engineering knowledge and principles gained from this course			
Reference Books: - Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall. - Bradley, A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning - Environment Impact Assessment Guidelines, Notification of Government of India, 2006 - Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998 - ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System - Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional. - Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).			

- Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios publication

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Sustainability - Introduction, Need and concept of sustainability, Social-environmental and economic sustainability concepts. Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols - Clean Development Mechanism (CDM), Environmental legislations in India - Water Act, Air Act.	L4	15%
	Students may be assigned to do at least one project eg: a) Identifying/assessment of sustainability in your neighbourhood in education, housing, water resources, energy resources, food supplies, land use, environmental protection etc. b) Identify the threats for sustainability in any selected area and explore solutions for the same	P1	
II	Air Pollution, Effects of Air Pollution; Water pollution- sources, Sustainable wastewater treatment, Solid waste - sources, impacts of solid waste, Zero waste concept, 3 R concept. Global environmental issues- Resource degradation, Climate change, Global warming, Ozone layer depletion, Regional and Local Environmental Issues. Carbon credits and carbon trading, carbon foot print.	L6	15%
	Students may be assigned to do at least one project for eg: a) Assessing the pollution status of a small area b) Programmes for enhancing public environmental awareness c) Observe a pond nearby and think about the different measures that can be adopted for its conservation	P3	
FIRST INTERNAL EXAM			
III	Environmental management standards, ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Bio-mimicking, Environment Impact Assessment (EIA) - Procedures of EIA in India.	L4	15%
	Students may be assigned to do at least one project eg: a) Conducting LCA of products (eg. Aluminium cans, PVC bottles, cars etc. or activities (Comparison of land filling and open burning) b) Conducting an EIA study of a small project (eg. Construction of a building)	P2	

IV	Basic concepts of sustainable habitat, Green buildings, green materials for building construction, material selection for sustainable design, green building certification, Methods for increasing energy efficiency of buildings. Sustainable cities, Sustainable transport.	L5	15%
	Students may be assigned to do at least one project eg: a) Consider the design aspects of a sustainable building for your campus b) Explore the different methods that can be adopted for maintaining a sustainable transport system in your city.	P2	
SECOND INTERNAL EXAM			
V	Energy sources: Basic concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans, Geothermal energy.	L5	20%
	Students may be assigned to do at least one project eg: a) Find out the energy savings that can be achieved by the installation of a solar water heater b) Conduct a feasibility study for the installation of wind mills in Kerala	P2	
VI	Green Engineering, Sustainable Urbanisation, industrialisation and poverty reduction; Social and technological change, Industrial Processes: Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis.	L5	20%
	Students may be assigned to do a group project eg: a) Collect details for instances of climate change in your locality b) Find out the carbon credits you can gain by using a sustainable transport system (travelling in a cycle or car pooling from college to home) c) Have a debate on the topics like: Industrial Ecology is a Boon or Bane for Industries?/Are we scaring the people on Climate Change unnecessarily?/Technology enables Development sustainable or the root cause of unsustainability?	P3	
END SEMESTER EXAM			

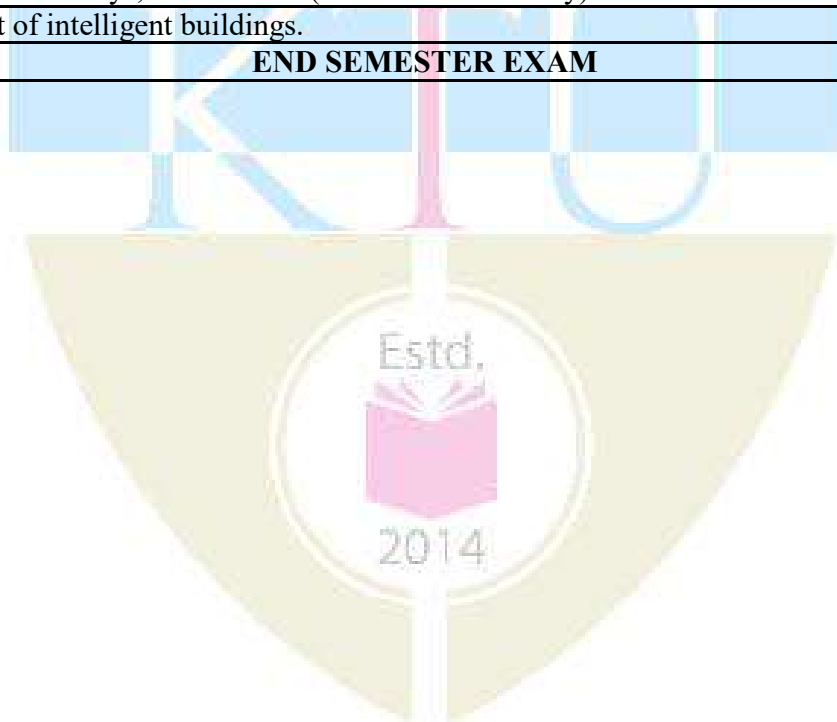
Course No.	Course Name	L-T-P-Credits	Year of Introduction
CE100	BASICS OF CIVIL ENGINEERING	2-1-0-3	2016
Course Objectives			
1. To inculcate the essentials of Civil Engineering field to the students of all branches of Engineering. 2. To provide the students an illustration of the significance of the Civil Engineering Profession in satisfying societal needs.			
Syllabus			
General introduction to Civil Engineering - Introduction to types of buildings, Components of a residential building, Introduction to industrial buildings; Introduction to planning of residential buildings - Simple building plans; Introduction to the various building area terms; Setting out of a building; Surveying – Principles, Objectives, Horizontal measurements with tapes, Ranging; Levelling – Instruments, Reduction of levels; Modern surveying instruments; Building materials – Bricks, cement blocks, Cement, Cement mortar, Steel; Building construction – Foundations, Brick masonry, Roofs, Floors, Decorative finishes, Plastering, Paints and Painting; Basic infrastructure and services – Elevators, Escalators, Ramps, Air conditioning, Sound proofing, Towers, Chimneys, Water Tanks; Intelligent buildings.			
Expected outcome			
1. The students will be able to illustrate the fundamental aspects of Civil Engineering. 2. The students will be able to plan and set out a building. 3. Students will be able to explain the concepts of surveying for making horizontal and vertical measurements. 4. They will able to illustrate the uses of various building materials and explain the method of construction of different components of a building. 5. Students will be able to discuss about various services in a building.			
References Books:			
• Chudley, R., Construction Technology, Vol. I to IV, Longman Group, England • Chudley, R. and Greeno, R., Building Construction Handbook, Addison Wesley, Longman Group, England • Gopi, S., Basic Civil Engineering, Pearson Publishers • Kandya, A. A., Elements of Civil Engineering, Charotar Publishing house • Mamlouk, M. S., and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers			

- McKay, W. B. and McKay, J. K., Building Construction Volumes 1 to 4, Pearson India Education Services
- Minu, S., Basic Civil Engineering, Karunya Publications
- Rangwala, S. C., Essentials of Civil Engineering, Charotar Publishing House
- Rangwala, S. C. and Dalal, K. B., Engineering Materials, Charotar Publishing house
- Rangwala, S. C. and Dalal, K. B., Building Construction, Charotar Publishing house

Course Plan

TECHNOLOGICAL UNIVERSITY			
Module	Contents	Hours	Sem. Exam Marks
I	General Introduction to Civil Engineering - Various disciplines of Civil engineering, Relevance of Civil engineering in the overall infrastructural development of the country.	2	15%
	Introduction to types of buildings as per NBC; Selection of site for buildings.	2	
	Components of a residential building and their functions. Introduction to industrial buildings – office / factory / software development office / power house /electronic equipment service centre (any one related to the branch of study)	2	
	Students have to visit one such building and submit an assignment about the features of any one of the listed building related to their branch (Not included for exam).	1	
II	Building planning - Introduction to planning of residential buildings- Site plan, Orientation of a building, Open space requirements, Position of doors and windows, Size of rooms; Preparation of a scaled sketch of the plan of a single storeyed residential building in a given site plan.	4	15%
	Introduction to the various building area terms - Computation of plinth area / built up area, Floor area / carpet area - for a simple single storeyed building; Setting out of a building.	3	
FIRST INTERNAL EXAM			
III	Surveying - Principles and objectives of surveying;	1	15%
	Horizontal measurements – instruments used – tape, types of tapes; Ranging (direct ranging only) – instruments used for ranging.	3	
	Levelling - Definitions, principles, Instruments (brief discussion only) - Level field book - Reduction of levels - problems on levelling (height of collimation only).	3	
	Modern surveying instruments – Electronic distance meter, digital level, total station, GPS (Brief discussion only).	1	
IV	Building materials - Bricks, cement blocks - Properties and specifications.	2	15%

	Cement – OPC, properties, grades; other types of cement and its uses (in brief).	1	
	Cement mortar – constituents, preparation.	1	
	Concrete – PCC and RCC – grades.	1	
	Steel - Use of steel in building construction, types and market forms.	1	
SECOND INTERNAL EXAM			
V	Building construction – Foundations; Bearing capacity of soil (definition only); Functions of foundations, Types - shallow and deep (sketches only).	2	20%
	Brick masonry – header and stretcher bond, English bonds – Elevation and plan (one brick thick walls only).	2	
	Roofs – functions, types, roofing materials (brief discussion only).	1	
	Floors – functions, types; flooring materials (brief discussion only).	1	
	Decorative finishes – Plastering – Purpose, procedure.	1	
	Paints and Painting – Purpose, types, preparation of surfaces for painting (brief discussion only).	2	
VI	Basic infrastructure and services - Elevators, escalators, ramps, air conditioning, sound proofing (Civil engineering aspects only)	2	20%
	Towers, Chimneys, Water tanks (brief discussion only).	1	
	Concept of intelligent buildings.	2	
END SEMESTER EXAM			



Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME100	BASICS OF MECHANICAL ENGINEERING	2-1-0-3	2016

Course Objectives

To expose the students to the thrust areas in Mechanical Engineering and their relevance by covering the fundamental concepts.

Syllabus

Thermodynamics, laws of thermodynamics, implications, cycles, energy conversion devices, steam and water machines, engines, turbo machines, refrigeration and air conditioning, power transmission devices in automobiles, latest trends, engineering materials and manufacturing processes, types of materials, alloys, shape forming methods, machine tools.

Expected outcome

The student will be able to understand the inter dependence of the thrust areas in Mechanical Engineering and their significance leading to the development of products, processes and systems.

References Books:

- Balachandran, Basic Mechanical Engineering, Owl Books
- Benjamin, J., Basic Mechanical Engineering, Pentex Books
- Clifford, M., Simmons, K. and Shipway, P., An Introduction to Mechanical Engineering Part I - CRC Press
- Crouse, Automobile Engineering, Tata Mc-Graw-Hill, New Delhi
- Gill, Smith and Zuirys, Fundamentals of IC Engines, Oxford and IBH publishing company Pvt. Ltd, New Delhi. Crouse, Automobile Engineering, Tata Mc-Graw-Hill, New Delhi.
- Nag, P. K., Basic and Applied Thermodynamics, Tata McGraw-Hill
- Pravin Kumar, Basic Mechanical Engineering
- Roy and Choudhary, Elements of Mechanical Engineering, Media Promoters & Publishers Pvt. Ltd., Mumbai.
- Sawhney, G. S., Fundamentals of Mechanical Engineering, PHI

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Thermodynamics: Laws of Thermodynamics, significance and Applications of thermodynamics, entropy, Ideal and real gas equations; Analysis of Carnot cycle, Otto cycle, Diesel cycle; Efficiency of these cycles.	7	15%
II	Energy conversion devices: Boilers, Steam turbines, Gas turbines; Working principle of two stroke and four stroke I.C.	7	15%

	Engines (SI and CI), Fuels, CRDI, MPFI, Hybrid Engines, Reciprocating pumps, centrifugal pumps and hydraulic turbines. (Elementary ideas only)		
FIRST INTERNAL EXAM			
III	Refrigeration and Air Conditioning: Vapour compression refrigeration systems, Heat Pump, COP, Study of household refrigerator, Energy Efficiency Rating, Psychrometry, Psychrometric processes, window air conditioner, split air conditioner. Refrigerants and their impact on environment.	7	15%
IV	Automobiles and Power Transmission Devices, Different types of automobiles, types of power units in automobiles; major components and their functions (brief description only); Belts and belt drives; Chain drive; Rope drive; Gears and gear trains; friction clutch (cone and single plate), brakes (types and applications only).	7	15%
SECOND INTERNAL EXAM			
V	Materials and manufacturing processes: Engineering materials, Classification, properties, Alloys and their Applications; Casting, Sheet metal forming, Sheet metal cutting, Forging, Rolling, Extrusion; Metal joining processes - soldering, brazing and welding; Powder metallurgy. (Elementary ideas only).	7	20%
VI	Machine Tools (Basic elements, Working principle and types of operations), Lathe, Drilling Machine, Shaper, planer, slotter, Milling Machine, Grinding machine; Introduction to CNC machines.	7	20%
END SEMESTER EXAM			

Question Paper Pattern:

Part A: Modules I and II – three questions of 15 marks each – out of which two questions are to be answered.

Part B: Modules III and IV – three questions of 15 marks each – out of which two questions are to be answered.

Part C: Modules V and VI – three questions of 20 marks each – out of which two questions are to be answered.

Each question can have maximum of four subdivisions (a,b,c,d).

Course No.	Course Name	L-T-P Credits	Year of Introduction
EE100	BASICS OF ELECTRICAL ENGINEERING	2-1-0-3	2016

Course Objectives

To impart a basic knowledge in Electrical Engineering with an understanding of fundamental concepts.

Syllabus

Elementary concepts of electric circuits, Kirchhoff's laws, constant voltage and current sources, Matrix representation; Magnetic circuits, energy stored in magnetic circuits, Electromagnetic induction, Alternating current fundamentals; AC circuits, phasor representation of alternating quantities- rectangular, polar; Three phase systems, star and delta connection; Generation of power, power transmission and distribution; Transformers, Electric Machines-DC Machines, AC Motors.

Expected outcome

The course will enable the students to gain preliminary knowledge in basic concepts of Electrical Engineering.

References Books:

- Bhattacharya, S. K., Basic Electrical & Electronics Engineering, Pearson
- Bird, J., Electrical Circuit Theory and Technology, Routledge, Taylor & Francis Group
- Del Toro, V., Electrical Engineering Fundamentals, Prentice Hall of India.
- Hayt, W. H., Kemmerly, J. E., and Durbin, S. M., Engineering Circuit Analysis, Tata McGraw Hill
- Hughes, Electrical and Electronic Technology, Pearson Education
- Mehta, V.K. and Mehta, R., Basic Electrical Engineering, S. Chand Publishing
- Parker and Smith, Problems in Electrical Engineering, CBS Publishers and Distributors
- Sudhakar and Syam Mohan, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill
- Suresh Kumar, K. S, Electric Circuits and Networks, Pearson Education

Course Plan

Module	Contents	Hours	Sem. Exam. Marks
I	Elementary concepts of electric circuits: Kirchhoff's laws, constant voltage and current sources-Problems	2	15%
	Formation of network equations by mesh current and node voltage methods-matrix representation-solution of network equations by matrix methods-problems	3	
	star-delta conversion(resistive networks only-derivation is not needed)-problems	1	

II	Magnetic Circuits: MMF, field strength, flux density, reluctance(definition only)-comparison between electric and magnetic circuits	2	15%
	Energy stored in magnetic circuits, magnetic circuits with air gap-Numerical problems on series magnetic circuits	2	
	Electromagnetic Induction: Faraday's laws, lenz's laws- statically induced and dynamically induced emfs-self inductance and mutual inductance, coefficient of coupling (derivation not needed)	2	
FIRST INTERNAL EXAMINATION			
III	Alternating Current fundamentals: Generation of alternating voltages-waveforms, frequency, period, average , RMS values and form factor of periodic waveform(pure sinusoidal)-Numerical Problems	2	15%
	AC Circuits: Phasor representation of alternating quantities-rectangular and polar representation	1	
	Analysis of simple AC circuits: concept of impedance, power and power factor in ac circuits-active, reactive and apparent power	2	
	solution of RL,RC and RLC series circuits-Numerical problems	2	
	Three phase systems: Generation of three phase voltages-advantages of three phase systems, star and delta connection (balanced only), relation between line and phase voltages, line and phase currents	3	
	three phase power measurement by two wattmeter method (derivation is not required) - Numerical problems	1	
IV	Generation of power: Block schematic representation of generating stations- hydroelectric power plants	1	15%
	Block schematic representation of Thermal and nuclear power plants	1	
	Renewable energy sources: solar, wind, tidal and geothermal (Block diagram and working only- No Problems)	1	
	Power transmission: Typical electrical power transmission scheme-need for high voltage transmission-(Derivation is not needed, No Problems)	1	
	Power Distribution: substation equipments, primary and secondary transmission and distribution systems- feeder, service	1	

	mains		
SECOND INTERNAL EXAMINATION			
V	Electric Machines: DC Generator and Motor-Construction-working principle- Back EMF	2	20%
	Types of motor-shunt, series, compound (short and long)-principle of operation of dc motor, applications-numerical problems (voltage -current relations only)	3	
	Transformer: Construction of single phase and three phase Transformers (core type only)-EMF equation and related numerical problems	2	
	Losses and efficiency of transformer for full load –numerical problems (no equivalent circuit)	2	
VI	AC Motors: Three phase induction motor-squirrel cage and slip ring induction motor	1	20%
	Working principle-synchronous speed, slip and related numerical problems. (no equivalent circuit)	1	
	AC Motors: Construction, principles of operation of single phase induction motor (no equivalent circuit)	1	
	Starting methods in single phase induction motors -split phase and capacitor start	2	
END SEMESTER EXAMINATION			

Course No:	Course Name	L-T-P Credits	Year of Introduction
EC100	BASICS OF ELECTRONICS ENGINEERING	2-1-0-3	2016
Course Objectives 1) To get basic idea about types, specification and common values of passive and active components. 2) To familiarize the working of diodes, transistors, MOSFETS and integrated circuits. 3) To understand the working of rectifiers, amplifiers and oscillators. 4) To get a basic idea about measuring instruments 5) To get a fundamental idea of basic communication systems and entertainment electronics			
Syllabus Evolution and Impact of Electronics in industries and in society, Familiarization of Resistors, Capacitors, Inductors, Transformers and Electro mechanical components, PN Junction diode: Structure, Principle of operation, Zener diode, Photo diode, LED, Solar cell, Bipolar Junction Transistors: Structure, Principle of operation, characteristics, Rectifiers and power supplies: Half wave and full wave rectifier, capacitor filter, zener voltage regulator, Amplifiers and Oscillators: common emitter amplifier, feedback, oscillators, RC phase shift oscillator, Analogue Integrated circuits: operational amplifier, inverting and non-inverting amplifier, Electronic Instrumentation: digital multimeter, digital storage oscilloscope, function generator, Radio communication: principle of AM & FM, Super heterodyne receiver, Satellite communication: geo-stationary satellite system, Mobile communication: cellular communications, Optical communication: system, principle of light transmission through fiber, Entertainment Electronics: Cable TV, CCTV system.			
Expected Outcome Student can identify the active and passive electronic components. Student can setup simple circuits using diodes and transistors. Student will get fundamental idea about basic communication systems and entertainment electronics.			
Text Books: • Bell, D. A., Electronic Devices and Circuits, Oxford University Press • Tomasy, W., Advanced Electronic Communication system, PHI Publishers			
References Books: • Boylested, R. L. and Nashelsky, L., Electronic Devices and Circuit Theory, Pearson Education • Frenzel, L. E., Principles of Electronic Communication Systems, Mc Graw Hill • Kennedy, G. and Davis, B., Electronic Communication Systems, Mc Graw Hill			

- Rajendra Prasad, Fundamentals of Electronic Engineering, Cengage Learning

Course Plan

Module	Contents	Hours	Sem. Marks
I	Evolution of Electronics, Impact of Electronics in industry and in society.	1	10%
	Resistors, Capacitors: types, specifications. Standard values, marking, colour coding.	3	
	Inductors and Transformers: types, specifications, Principle of working.	2	
	Electro mechanical components: relays and contactors.	1	
II	PN Junction diode: Intrinsic and extrinsic semiconductors, Principle of operation, V-I characteristics, principle of working of Zener diode, Photo diode, LED and Solar cell.	4	20%
	Bipolar Junction Transistors: PNP and NPN structures, Principle of operation, input and output characteristics of common emitter configuration (npn only).	3	
FIRST INTERNAL EXAM			
III	Rectifiers and power supplies: Block diagram description of a dc power supply ,Half wave and full wave (including bridge) rectifier, capacitor filter, working of simple zener voltage regulator.	4	15%
	Amplifiers and Oscillators: Circuit diagram and working of common emitter amplifier, Block diagram of Public Address system, concepts of feedback, working principles of oscillators, circuit diagram & working of RC phase shift oscillator.	4	
IV	Analogue Integrated circuits: Functional block diagram of operational amplifier, ideal operational amplifier, inverting and non-inverting Amplifier.	3	15%
	Digital ICs: Logic Gates.	1	
	Electronic Instrumentation: Principle and block diagram of digital multimeter, digital storage	2	

	oscilloscope, and function generator.		
SECOND INTERNAL EXAM			
V	Radio communication: principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver.	3	20%
	Satellite communication: concept of geo-stationary Satellite system.	2	
VI	Mobile communication: basic principles of cellular communications, concepts of cells, frequency reuse.	2	20%
	Optical communication: block diagram of the optical communication system, principle of light transmission through fiber, advantages of optical communication systems.	2	
	Entertainment Electronics Technology: Basic principles and block diagram of cable TV, CCTV, DTH system.	2	
END SEMESTER EXAM			

Note: Analysis is not required in this course.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
MA102	DIFFERENTIAL EQUATIONS	3-1-0-4	2016
Course Objectives This course introduces basic ideas of differential equations, both ordinary and partial, which are widely used in the modelling and analysis of a wide range of physical phenomena and has got applications across all branches of engineering. The course also introduces Fourier series which is used by engineers to represent and analyse periodic functions in terms of their frequency components.			
Syllabus Homogeneous linear ordinary differential equation, non-homogeneous linear ordinary differential equations, Fourier series, partial differential equation, one dimensional wave equation, one dimensional heat equation.			
Expected Outcome At the end of the course students will have acquired basic knowledge of differential equations and methods of solving them and their use in analysing typical mechanical or electrical systems. The included set of assignments will familiarise the students with the use of software packages for analysing systems modelled by differential equations.			
TEXT BOOKS • Erwin Kreyszig: Advanced Engineering Mathematics, 10th ed. Wiley • A C Srivastava, P K Srivastava, Engineering Mathematics Vol 2. PHI Learning Private Limited, New Delhi.			
REFERENCES: • Simmons: Differential Equation with Applications and its historical Notes, 2e McGrawHill Education India 2002 • Datta, Mathematical Methods for Science and Engineering. Cengage Learning, 1st. ed • B. S. Grewal. Higher Engineering Mathematics, Khanna Publishers, New Delhi. • N. P. Bali, Manish Goyal. Engineering Mathematics, Lakshmy Publications • D. W. Jordan, P Smith. Mathematical Techniques, Oxford University Press, 4th Edition. • C. Henry Edwards, David. E. Penney. Differential Equations and Boundary Value Problems. Computing and Modelling, 3rd ed. Pearson			

COURSE PLAN			
	COURSE NO: MA102	L-T-P:3-1-0	
	COURSE NAME: DIFFERENTIAL EQUATIONS CONTENT	CREDITS:4	
MODULE		HRS	END SEM. EXAM MARKS (OUT OF 100)
I	HOMOGENEOUS DIFFERENTIAL EQUATIONS (Text Book 1 : Sections 1.7, 2.1, 2.2, 2.6, 3.2) Existence and uniqueness of solutions for initial value problems, Homogenous linear ODEs of second order. Homogenous linear ODEs with constant coefficients, Existence and Uniqueness of solutions Wronskian,	3	17
	Homogenous linear ODEs with constant Coefficients (Higher Order) (For practice and submission as assignment only: Modelling of free oscillations of a mass – spring system)	4	
II	NON-HOMOGENEOUS LINEAR ORDINARY DIFFERENTIAL EQUATIONS (Text Book 2: Sections 1.2.7 to 1.2.14) The particular Integral (P.I.), Working rule for P.I. when $g(x)$ is X^m , To find P.I. when $g(x) = e^{ax}.V_1(x)$, Working rule for P.I. when $g(x) = x.V(x)$, Homogeneous Linear Equations, PI of Homogenous equations	7	17
	Legendre's Linear equations	2	
	Method of variation of parameters for finding PIs	3	
	(For practice and submission as assignments only: Modelling forced oscillations, resonance, electric circuits)		
FIRST INTERNAL EXAM			
III	FOURIER SERIES (Text Book 2 - Sections 4.1,4.2,4.3,4.4) Periodic functions ,Orthogonally of Sine and Cosine functions (Statement only), Fourier series and Euler's formulas	3	17
	Fourier cosine series and Fourier sine series (Fourier series of even and Odd functions)	3	
	Half range expansions (All results without proof)	3	

	(For practice and submission as assignment only: Plots of partial sums of Fourier series and demonstrations of convergence using plotting software)		
IV	PARTIAL DIFFERENTIAL EQUATIONS (Text Book 2 : Sections : 5.1, 5.1.1, 5.1.2, 5.1.5, 5.2.6- 5.2.10) Introduction to partial differential equations , formation of PDE, Solutions of first order PDE(Linear only) Lagrange's Method Linear PDE with constant coefficients , Solutions of Linear Homogenous PDE with constant coefficients , Shorter method for finding PI when $g(x,y)=f(ax+by)$, Method of finding PI when $g(x,y) = x^m y^n$, method of find PI when $g(x,y)=e^{ax+by} V(x,y)$	3 3 6	17
SECOND INTERNAL EXAM			
V	ONE DIMENSIONAL WAVE EQUATION (Text Book 2: Sections :6.1-- 6.4) Method of separation of variables The wave Equation Vibrations of a stretched string Solutions of one dimensional wave equation using method of separation of variables and problems	2 1 1 4	16
VI	ONE DIMENSIONAL HEAT EQUATION (Text Book 2: sections 6.7, 6.8 ,6.9, 6.9.1 ,6.9.2) The equation of Heat conduction One dimensional Heat transfer equation. Solutions of One Dimensional Heat transfer equation, A long insulated rod with ends at zero temperatures, A long insulated rod with ends at non zero temperatures	1 1 6	16
END SEMESTER EXAM			

TUTORIALS: Tutorials can be ideally conducted by dividing each class into three groups. Prepare necessary materials from each module that can be practiced using computer software. Use them uniformly in every class.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE102	DESIGN AND ENGINEERING	2-0-2-3	2016
Course Objectives The purpose of this course is:- 1. To excite the student on creative design and its significance; 2. To make the student aware of the processes involved in design; 3. To make the student understand the interesting interaction of various segments of humanities, sciences and engineering in the evolution of a design; 4. To get an exposure as to how to engineer a design.			
Syllabus Design and its objectives; Role of science, engineering and technology in design; Engineering as a business proposition; Creative design and the Design Process; Design evaluation and communication of designs; Design for function and strength; Material selection and design detailing; Role of standards in design Engineering the design; Design for "X"; Product centered and user centered design; Aesthetics and ergonomics; Concepts of value engineering, concurrent engineering and reverse engineering in design; Culture based design; Modular design; Design optimization needs; User interface; Intelligent and autonomous products; Internet of things; Advanced products and human psychology; Life cycle design; Product and its environment; Design as a marketing tool; Products and IPR; Product liability.			
Expected outcome The student will be:- • Able to appreciate the different elements involved in good designs and to apply them in practice when called for. • Aware of the product oriented and user oriented aspects that make the design a success. • Will be capable to think of innovative designs incorporating different segments of knowledge gained in the course; • Students will have a broader perspective of design covering function, cost, environmental sensitivity, safety and other factors other than engineering analysis.			
References Books: • Balmer, R. T., Keat, W. D., Wise, G., and Kosky, P., Exploring Engineering, Third Edition; An Introduction to Engineering and Design - [Part 3 - Chapters 17 to 27], ISBN-13: 978-0124158917 ISBN-10: 0124158919 • Dym, C. L., Little, P. and Orwin, E. J., Engineering Design - A Project based introduction - Wiley, ISBN-978-1-118-32458-5 • Eastman, C. M. (Ed.), Design for X Concurrent engineering imperatives, 1996, XI, 489 p. ISBN 978-94-011-3985-4 Springer • Haik, Y. And Shahin, M. T., Engineering Design Process, Cengage Learning, ISBN-13: 978-0-495-66816-9 • Pahl, G., Beitz, W., Feldhusen, J. and Grote, K. H., Engineering Design: A Systematic Approach, 3rd ed. 2007, XXI, 617p., ISBN 978-1-84628-319-2 • Dieter and Schmidt, Engineering Design, McGraw Hill Education(India) Edition 2013			

- Voland, G., Engineering by Design, ISBN 978-93-325-3505-3, Pearson India

Web pages:

1. E-Book (Free download): <http://opim.wharton.upenn.edu/~ulrich/designbook.html>
2. http://www2.warwick.ac.uk/fac/sci/wmg/fmssc/modules/modulelist/peuss/designforx/design_for_x_notes_section_5.pdf

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Design and its objectives; Design constraints, Design functions, Design means and Design from; Role of Science, Engineering and Technology in design; Engineering as a business proposition; Functional and Strength Designs. Design form, function and strength;	L2	15%
	How to initiate creative designs? Initiating the thinking process for designing a product of daily use. Need identification; Problem Statement; Market survey- customer requirements; Design attributes and objectives; Ideation; Brain storming approaches; arriving at solutions; Closing on to the Design needs.	L3	
	An Exercise in the process of design initiation. A simple problem is to be taken up to examine different solutions- Ceiling fan? Group Presentation and discussion.	P4	
II	Design process- Different stages in design and their significance; Defining the design space; Analogies and "thinking outside of the box"; Quality function deployment-meeting what the customer wants; Evaluation and choosing of a design.	L2	15%
	Design Communication; Realization of the concept into a configuration, drawing and model. Concept of "Complex is Simple". Design for function and strength. Design detailing- Material selection, Design visualisation- Solid modelling; Detailed 2D drawings; Tolerancing; Use of standard items in design; Research needs in design; Energy needs of the design, both in its realization and in the applications.	L3	
	An exercise in the detailed design of two products (Stapler/ door/clock)	P4	
FIRST INTERNAL EXAM			
III	Prototyping- rapid prototyping; testing and evaluation of design; Design modifications; Freezing the design; Cost analysis.	L2	15%
	Engineering the design – From prototype to product. Planning; Scheduling; Supply chains; inventory; handling;	L3	

	manufacturing/construction operations; storage; packaging; shipping; marketing; feed-back on design.		
	List out the standards organizations. Prepare a list of standard items used in any engineering specialization. Develop any design with over 50% standard items as parts.	P4	
IV	Design for "X"; covering quality, reliability, safety, manufacturing/construction, assembly, maintenance, logistics, handling; disassembly; recycling; re-engineering etc. List out the design requirements(x) for designing a rocket shell of 3 meter diameter and 8 meter length.	L4	15%
	Design mineral water bottles that could be packed compactly for transportation.	P4	
SECOND INTERNAL EXAM			
V	Product centred and user centred design. Product centred attributes and user centred attributes. Bringing the two closer. Example: Smart phone. Aesthetics and ergonomics.	L2	20%
	Value engineering, Concurrent engineering, Reverse engineering in design; Culture based design; Architectural designs; Motifs and cultural background; Tradition and design; Study the evolution of Wet grinders; Printed motifs; Role of colours in design.	L4	
	Make sharp corners and change them to smooth curves-check the acceptance. Examine the possibility of value addition for an existing product.	P6	
VI	Modular design; Design optimization; Intelligent and autonomous products; User interfaces; communication between products; autonomous products; internet of things; human psychology and the advanced products. Design as a marketing tool; Intellectual Property rights – Trade secret; patent; copy-right; trademarks; product liability.	L3	20%
	Group presentation of any such products covering all aspects that could make or mar it.	P6	
END SEMESTER EXAM			

Evaluation Scheme:

First internal exam – closed book exam – 25 marks

Second internal exam – open book exam – 25 marks

Assignment/projects – 50 marks (iv) End semester exam – open book exam – 50 marks (2 hours duration – conducted by the University)

First Test: Marks: 25 Closed Book;

Questions may cover:-

Topics covered in the lectures.

How to arrive at the design details for a specific need gap given.

Sketching the design of a product that is to meet the given user requirements.

Second Test: Marks: 25 Open Book:

Students are permitted to bring in class notes, own notes, text books and other books (Maximum 3/4 books) for the test. Access to internet and mobile phones is NOT permitted.

Assignments: Marks: 20 Two assignments are to be given (10 marks each). These assignments are to cover specific design/s, sketching of the design, and a short but well written write-up on the design.

Projects: Marks: 30 Two mini projects are to be assigned. One is to be a group project and the other an individual one. A group of 3 or 4 students can take up the group project. Each project is to be evaluated for 15 marks.

The Group Project is to be done in the practical hours given for the course. Projects including the group projects are to be evaluated based on individual presentations and answers to the questions raised. These presentations could be done during the practical hours.

Question Paper Pattern for End Semester Examination (Open Book)

Part A – Eight questions of each 5 marks, out of which **six** questions are to be answered.

Part B – Three questions of each 10 marks, out of which **two** questions are to be answered.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
PH110	ENGINEERING PHYSICS LAB	0-0-2-1	2016

Course Objectives

This course is designed (i) to impart practical knowledge about some of the phenomena they have studied in the Engineering Physics course and (ii) to develop the experimental skills of the students.

List of Exercises / Experiments (Minimum of 8 mandatory)

Basics

1. Study of application of Cathode Ray Oscilloscope (CRO) for Frequency and Amplitude measurements. Lissajous figures (useful for different types of polarized light.)
2. Temperature measurement – Thermocouple
3. Measurement of strain using strain gauge and Wheatstones bridge.

Waves, Oscillations and Ultrasonics

4. Wave length and velocity measurement of ultrasonic waves in a liquid using ultrasonic diffractometer.
5. The LCR Circuit – Forced and damped harmonic oscillations.
6. Melde's string apparatus. Measurement of frequency in the transverse and longitudinal mode.

Interference

7. Wave length measurement of a monochromatic source of light using Newton's Rings method.
8. Determination of refractive index of a liquid using Newton's Rings apparatus.
9. Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.

Diffraction

10. To determine the slit or pinhole width.
11. To measure wavelength using a millimeter scale as a grating.
12. Determination the wavelength of He-Ne laser or any standard laser using diffraction grating.
13. To determine the wavelength of monochromatic light using grating.
14. Determination of dispersive power and resolving power of a plane transmission grating.

Polarisation

15. Kerr Effect - To demonstrate the Kerr effect in nitrobenzene solution and to measure the light intensity as a function of voltage across the Kerr cell using photo detector.
16. To measure the light intensity of plane polarised light as a function of the analyzer position.
17. Laurent's Half Shade Polarimeter -To observe the rotation of the plane of polarization of monochromatic light by sugar solution and hence to determine the concentration of solution of optically active substance.

Laser & Photonics

18. To determine the speed of light in air using laser.
19. Calculate the numerical aperture and study the losses that occur in optical fiber cable.
20. Determination of the particle size of lycopodium powder.
21. I-V characteristics of solar cell
22. To measure Planck's constant using photo electric cell.
23. Measurement of wavelength of laser using grating.

Reference Books:

- Avadhanulu, M. N., Dani, A. A. and Pokley, P. M., Experiments in Engineering Physics, S. Chand & Co.
- Gupta, S. K., Engineering Physics Practicals, Krishna Prakashan Pvt. Ltd.
- Koser, A. A., Practical Engineering Physics, Nakoda Publishers and Printers India Ltd
- Rao, B. S. and Krishna, K. V., Engineering Physics Practicals, Laxmi Publications
- Sasikumar, P. R. Practical Physics, PHI.

Website:

- <http://www.indosawedu.com>

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CY 110	ENGINEERING CHEMISTRY LAB	0-0-2-1	2016
List of Exercises / Experiments (Minimum of 8 mandatory) 1. Estimation of Total Hardness – EDTA method. 2. Estimation of Iron in Iron ore. 3. Estimation of Copper in Brass. 4. Estimation of dissolved oxygen by Winklers method. 5. Estimation of chloride in water. 6. Preparation of Urea formaldehyde and Phenol-formaldehyde resin. 7. Determination of Flash point and Fire point of oil by Pensky Martin Apparatus. 8. Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} in solution. 9. Determination of molar absorptivity of a compound other than Fe^{3+}. 10. Analysis of IR spectra of any three organic compounds. 11. Analysis of ^1H NMR spectra of any three organic compounds. 12. Calibration of pH meter and determination of pH of a solution. 13. Verification of Nernst equation for electrochemical cell. 14. Potentiometric titrations: acid – base and redox titrations 15. Conductivity measurements of salt solutions. 16. Flame photometric estimation of Na^+ to find out the salinity in sand.			
Expected outcome The student will be able to apply and demonstrate the theoretical concepts of Engineering Chemistry.			
References: • Practical Engineering Chemistry Lab Manual, Owl book publishers			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CE110	CIVIL ENGINEERING WORKSHOP	0-0-2-1	2016

List of Exercises / Experiments (Minimum of 8 mandatory)

(For Civil Engineering Branch)

Setting out of a building: The student should set out a building (single room only) as per the given building plan using tape only.

Setting out of a building: The student should set out a building (single room only) as per the given building plan using tape and cross staff.

Construct a wall of height 50 cm and wall thickness 1½ bricks using English bond (No mortar required) - corner portion – length of side walls 60 cm.

Construct a wall of height 50 cm and wall thickness 2 bricks using English bond (No mortar required) - corner portion – length of side walls 60 cm.

Compute the area and/or volume of various features of a building/structure such as door and window size, number of bricks required to construct a wall of a building, diameter of bars used in windows etc. – To create an awareness of measurements and units (use tape or other simple measuring instruments like vernier caliper, screw gauge etc.).

Testing of building materials: The student should do the compression testing of any three construction materials and compare the strength (brick, hollow block, laterite block, cement concrete cube, stone block, and so on).

Computation of Centre of gravity and Moment of inertia of a given rolled steel section by actual measurements.

Introduction to simple plumbing and sanitary fittings.

Home assignment 1: Preparation of a building model - The students in batches should prepare and submit a building model for a given plinth area in a given site plan constrained by a boundary wall. The minimum requirements of a residential building viz., drawing cum dining room, one bed room and a kitchen should be included. The concept of an energy efficient building should also be included in the model.

Home assignment 2: Report preparation -The student should collect the construction details of any one unique Civil Engineering structure, prepare and submit a detailed report with neat illustrations.

Home assignment 3: Report preparation - The students should collect samples of building materials, prepare and submit a detailed report including their market rates.

(For braches other than Civil Engineering)

Setting out of a building: The student should set out a building (single room only) as per the given building plan using tape only.

Setting out of a building: The student should set out a building (single room only) as per the

given building plan using tape and cross staff.

Building area computation: The student should prepare a rough sketch of a given single storeyed building and by taking linear measurements compute plinth area and carpet area of the given building.

Construct a wall of at least a height of 500mm and wall thickness 1brick using English bond (No mortar required) - corner portion – length of side walls at least 600mm.

Compute the area and/or volume of various features of a building/structure such as door and window size, number of bricks required to construct a wall of a building, diameter of bars used in windows etc. – To create an awareness of measurements and units (use tape or other simple measuring instruments like vernier calipers, screw gauge etc.).

Horizontal measurements: Find the area of an irregular polygon set out on the field.

Vertical measurements: Find the level difference between any two points.

Computation of Centre of gravity and Moment of inertia of a given rolled steel section by sketching and measurements.

Home assignment 1: Preparation of a building model - The students in batches should prepare and submit a building model for a given plinth area in a given site plan constrained by a boundary wall. The minimum requirements of a residential building viz., drawing cum dining room, one bed room and a kitchen should be included. The concept of an energy efficient building should also be included in the model.

Home assignment 2: Report preparation - The student should collect the construction details of an industrial building related to their branch of study, prepare and submit a detailed report with neat illustrations.

Home assignment 3: Report preparation - The students should collect samples of building materials, prepare and submit a detailed report about their market rates.

Estd.



2014

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME110	MECHANICAL ENGINEERING WORKSHOP	0-0-2-1	2016

Course Objectives

Introduction to manufacturing processes and applications. Familiarization of various tools, measuring devices, practices and machines used in various workshop sections.

List of Exercises / Experiments (Minimum of 8 mandatory)

Sl. No.	Name of Shop floor	Exercises	No of sessions
1	General	Studies of mechanical tools, components and their applications: (a) Tools: screw drivers, spanners, Allen keys, cutting pliers etc. And accessories (b) Components: Bearings, seals, O-rings, circlips, keys etc.	1
2	Carpentry	Any one model from the following: 1. T-Lap joint 2. Cross lap joint 3. Dovetail joint 4. Mortise joint	2
3	Smithy	(a) Demonstrating the forgability of different materials (MS, Al, Alloy steel and Cast steel) in cold and hot states. (b) Observing the qualitative differences in the hardness of these materials (c) Determining the shape and dimensional variations of Al test specimen due to forging under different states by visual inspection and measurements	2
4	Foundry	Any one exercise from the following 1. Bench moulding 2. Floor moulding 3. Core making	2
5	Sheet metal	Any one exercise from the following Making 1. Cylindrical 2. Conical 3. Prismatic shaped jobs from sheet metal	2
6	Welding	Any one exercise from the following Making joints using Electric arc welding. Bead formation in horizontal, vertical and overhead positions	2
7	Fitting and Assembly	Filing exercise and any one of the following exercises Disassembling and reassembling of 1. Cylinder piston assembly 2. Tail stock assembly 3. Time piece/clock 4. Bicycle or any machine.	2
8	Machines	Demonstration and applications of Drilling machine, Grinding machine, Shaping machine, Milling machine and lathe	2

Course No.	Course Name	L-T-P-Credits	Year of Introduction
EE110	ELECTRICAL ENGINEERING WORKSHOP	0-0-2-1	2016

Course Objectives

The objective of this course is to familiarize the students with commonly used components, accessories and measuring equipment in Electrical installations. The course also provides hands on experience in setting up of simple wiring circuits.

List of Exercises / Experiments (Minimum of 8 mandatory)

1. Identify different types of cables/wires and switches and their uses.
2. Identify different types of fuses & fuse carriers, MCB and ELCB, MCCB with ratings and usage.
3. Wiring of simple light circuit for controlling light/fan point (PVC conduit wiring).
4. Wiring of light/fan circuit using Two way switches (Staircase wiring)
5. Wiring of fluorescent lamps and light sockets (6 A)
6. Wiring of Power circuit for controlling power device (16A socket)
7. Godown wiring / Tunnel wiring
8. Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, Main switch and Energy meter.
9. Measurement of voltage, current and power in single phase circuit using voltmeter, ammeter and wattmeter. Calculate the power factor of the circuit.
10. Wiring of backup power supply including inverter, battery and load for domestic installations.
11. Demonstration and measurement of power consumption of electric iron, mixer grinder, single phase pump, exhaust fan, etc.
12. Energy meter reading and tariff calculation.

Expected outcome

1. Familiarity with supply arrangements and their limitations, knowledge of standard voltages and their tolerances, safety aspects of electrical systems and importance of protective measures in wiring systems.
2. Knowledge about the types of wires, cables and other accessories used in wiring. Creating awareness of energy conservation in electrical systems.
3. Students should be able to wire simple lighting circuits for domestic buildings, distinguish between light and power circuits.
4. To measure electrical circuit parameters and current, voltage and power in a circuit.
5. Familiarity with backup power supply in domestic installation.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
EC110	ELECTRONICS ENGINEERING WORKSHOP	0-0-2-1	2016

Course Objectives

This course gives the basic introduction of electronic hardware systems and provides hands-on training with familiarization, identification, testing, assembling, dismantling, fabrication and repairing such systems by making use of the various tools and instruments available in the Electronics Workshop.

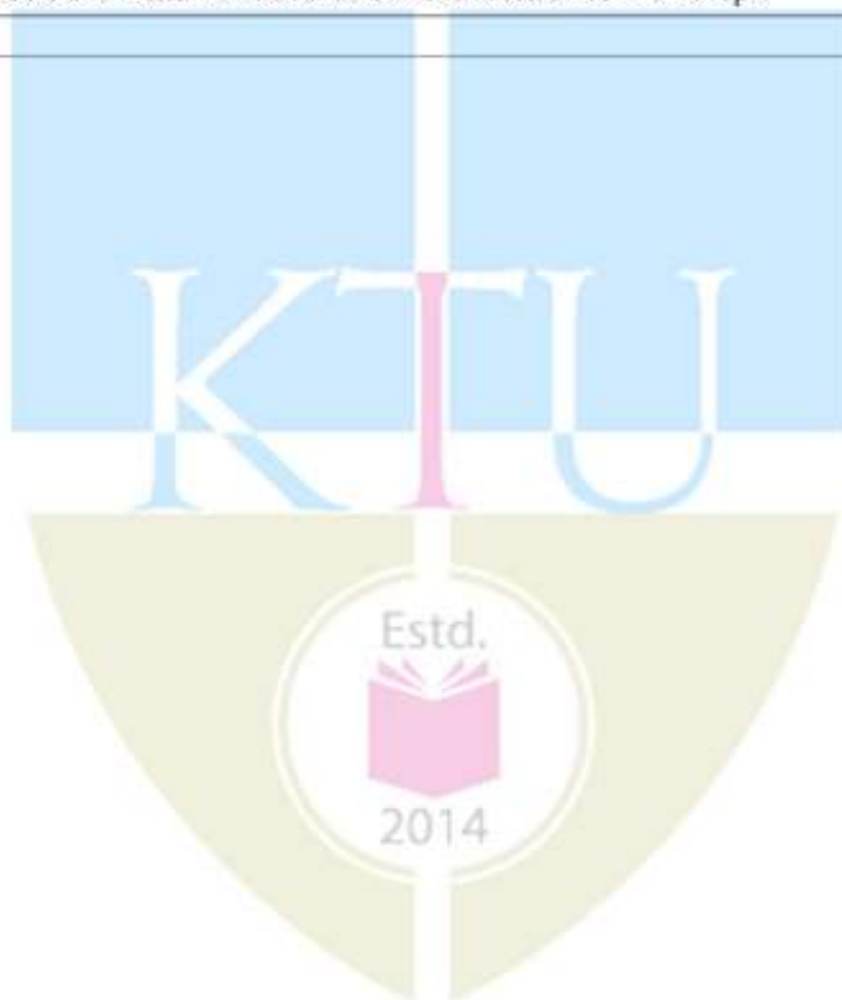
List of Exercises / Experiments (Minimum of 8 mandatory)

1. Familiarization/Identification of electronic components with specification (Functionality, type, size, colour coding, package, symbol, cost etc. [Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink etc.]
2. Drawing of electronic circuit diagrams using BIS/IEEE symbols and introduction to EDA tools, Interpret data sheets of discrete components and IC's, Estimation and costing.
3. Familiarization/Application of testing instruments and commonly used tools. [Multimeter, Function generator, Power supply, CRO etc.] [Soldering iron, De-soldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de-soldering station etc.]
4. Testing of electronic components [Resistor, Capacitor, Diode, Transistor, UJT and JFET using multimeter.]
5. Inter-connection methods and soldering practice. [Bread board, Wrapping, Crimping, Soldering - types - selection of materials and safety precautions, soldering practice in connectors and general purpose PCB, Crimping.]
6. Printed circuit boards (PCB) [Types, Single sided, Double sided, PTH, Processing methods, Design and fabrication of a single sided PCB for a simple circuit with manual etching (Ferric chloride) and drilling.]
7. Assembling of electronic circuit/system on general purpose PCB, test and show the functioning(**Any Four circuits**)
 1. Fixed voltage power supply with transformer, rectifier diode, capacitor filter, zener/IC regulator.
 2. LED blinking circuit using a stable multi-vibrator with transistor BC 107.
 3. Square wave generation using IC 555 timer in IC base.
 4. Sine wave generation using IC 741 OP-AMP in IC base.
 5. RC coupled amplifier with transistor BC 107.
 6. AND and NAND gates in diode transistor logic.
8. Familiarization of electronic systems (**Any three systems**)

1. Setting up of a PA system with different microphones, loud speakers, mixer etc.
2. Assembling and dismantling of desktop computer/laptop/mobile phones.
3. Coil/Transformer winding.
4. Identify the subsystems of TV, DTH, CCTV, Cable TV, CRO, Function generator etc.
5. Screen printing and PCB pattern transfer
6. Soldering & de-soldering of SMD using hot air soldering station.
7. Introduction to robotics- Familiarization of components (motor, sensors, battery etc.) used in robotics and assembling of simple robotic configurations.

Expected outcome

Student can identify the active and passive electronic components. Student gets hands-on assembling, testing, assembling, dismantling, fabrication and repairing systems by making use of the various tools and instruments available in the Electronics Workshop.



Course No.	Course Name	L-T-P-Credits	Year of Introduction
CS110	COMPUTER SCIENCE WORKSHOP	0-0-2-1	2016

Course Objectives

1. To familiarize students with basic hardware and software tools
2. To implement algorithms studied in the course Introduction to Computing & Problem Solving.
3. To learn the implementation of control structures, Iterations and recursive functions, Lists, Tuples and Dictionaries.
4. To implement operations of files.
5. To implement a small micro project using Python

List of Exercises / Experiments (Minimum of 8 mandatory)

List of Exercises:

Introduction: Familiarization of hardware components of a desktop computer (motherboard, cards, memory, slots, power, cables etc.) Familiarization of Operating systems and various tools, particularly those for scientific computing, open source tools etc.

Programming exercises in Python based on the course Introduction To Computing and Problem Solving (BE 101-05). The exercises may include programs using the following concepts–

1. Decision making, branching and looping

1. Variables , Expressions & Conditional statements
2. Iteration statements (While , For etc.)

2. Function & Function calls

1. Function calls, Math functions
2. Parameters and arguments
3. Adding new functions, Recursion

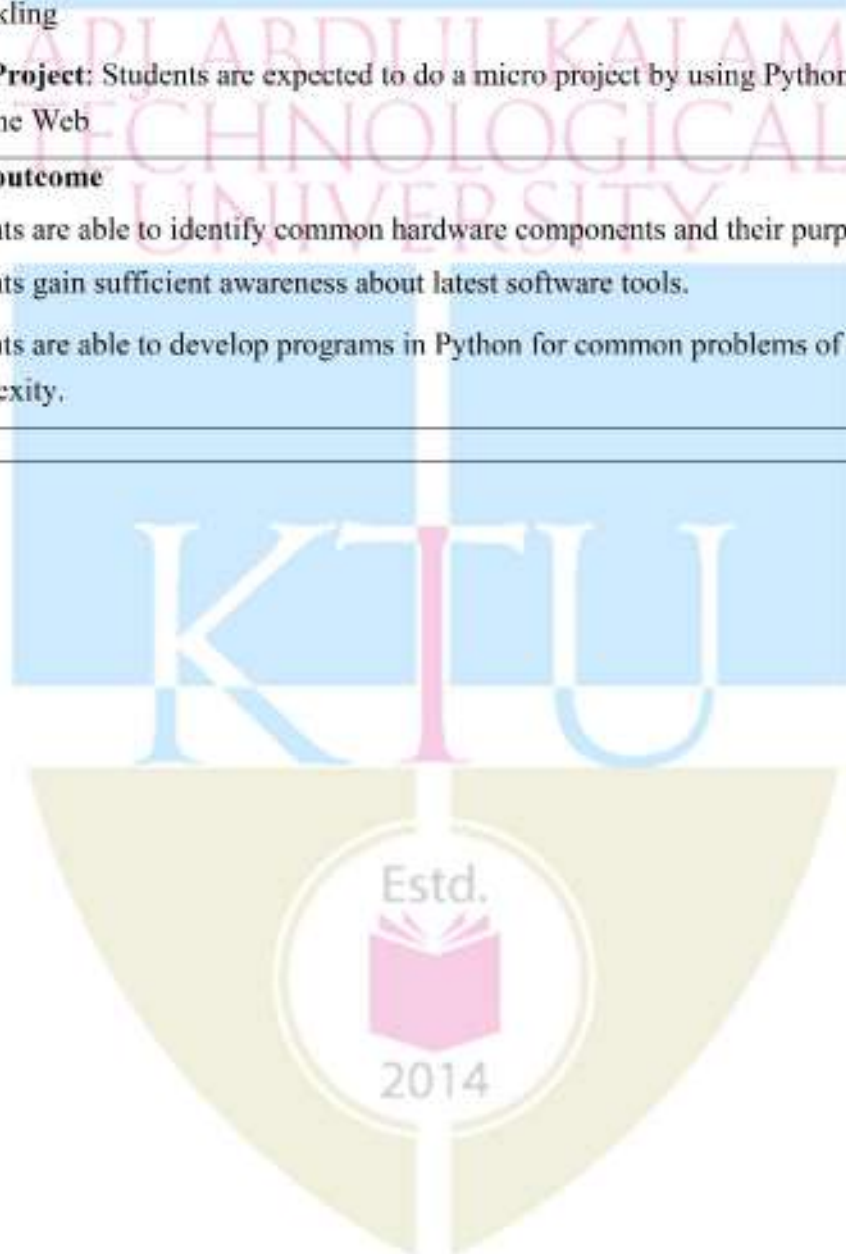
3. Strings

1. String traversal
2. String searching, Comparison
3. Other important String methods

4. Lists, Tuples and Dictionaries

1. Traversing List, List Operations

2. Creation of Dictionary and Operations 3. Lists and Tuples
5. Files and Operations 1. Files - defining, opening/closing, operations 2. Pickling
6. Micro Project: Students are expected to do a micro project by using Python, preferably related to the Web
Expected outcome 1. Students are able to identify common hardware components and their purpose 2. Students gain sufficient awareness about latest software tools. 3. Students are able to develop programs in Python for common problems of reasonable complexity.



Course No:	Course Name	L-T-P-Credits	Year of Introduction
CH110	CHEMICAL ENGINEERING WORKSHOP	0-0-2-1	2016
Course Objectives To impart in students the basic knowledge in chemical engineering through simple experiments and demonstrations.			
List of Exercises / Experiments (Minimum of 8 mandatory) 1. Preparation of soap 2. Determination of flash and fire point 3. Preparation of Biodiesel 4. Specific gravity measurement 5. Fabrication of FRP laminates/ Study of filtration equipments 6. Study of distillation column 7. Study of absorption column 8. Study of heat exchanger 9. Study of size reduction equipment 10. Preparation of Pigment			
Expected outcome Students will have a thorough understanding of the basic concepts that they learn in the theory paper “Introduction to Chemical Engineering”.			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CS100	Computer Programming	2-1-0	2016

Course Objectives

To understand the fundamental concept of C programming and use it in problem solving.

Syllabus

Introduction to C language; Operators and expressions; Sorting and searching; Pointers; Memory allocation; Stacks and Queues.

Course Outcomes

1. Identify appropriate C language constructs to solve problems.
2. Analyze problems, identify subtasks and implement them as functions/procedures.
3. Implement algorithms using efficient C-programming techniques.
4. Explain the concept of file system for handling data storage and apply it for solving problems
5. Apply sorting & searching techniques to solve application programs.

References

1. Rajaraman V., Computer Basics and Programming in C, PHI.
2. Anita Goel and Ajay Mittal, Computer fundamentals and Programming in C., Pearson.
3. Gottfried B.S., Programming with C, Schaum Series, Tata McGraw Hill.
4. Horowitz and Sahni, Fundamentals of data structures - Computer Science Press.
5. Gary J. Bronson, ANSI C Programming, CENGAGE Learning India.
6. Stewart Venit and Elizabeth Drake, Prelude to Programming – Concepts & Design, Pearson.
7. Dromy R.G., How to Solve it by Computer, Pearson.
8. Kernighan and Ritchie D.M., The C. Programming Language, PHI.

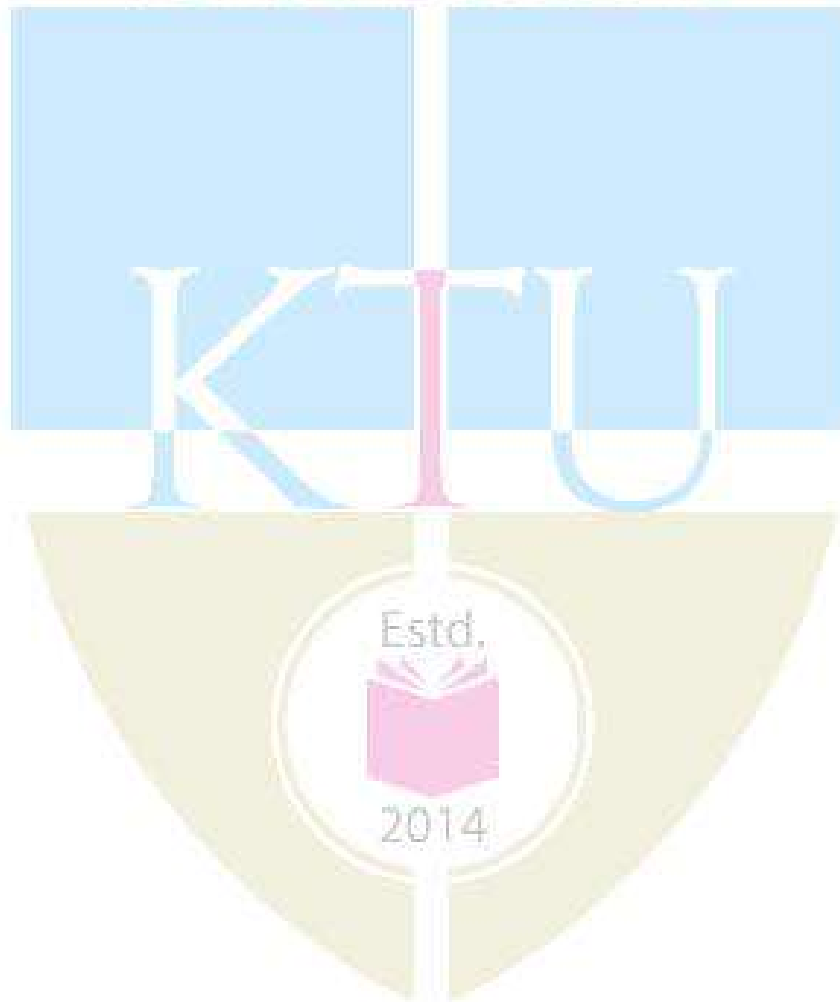
COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks;%
I	Introduction to C Language: Preprocessor directives, header files, data types and qualifiers. Operators and expressions. Data input and output, control statements.	7	15%

II	Arrays and strings- example programs. Two dimensional arrays - matrix operations. Structure, union and enumerated data type.	8	15%
III	Pointers: Array of pointers, structures and pointers. Example programs using pointers and structures.	7	15%
FIRST INTERNAL EXAM			
IV	Functions – function definition and function prototype. Function call by value and call by reference. Pointer to a function –. Recursive functions.	7	15%
SECOND INTERNAL EXAM			
V	Sorting and Searching : Bubble sort, Selection sort, Linear Search and Binary search. Scope rules Storage classes. Bit-wise operations.	6	20%
VI	Data files – formatted, unformatted and text files. Command line arguments – examples.	7	20%
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
110	Computer Programming Lab		2016
Course Objective: • To implement algorithms studied in the course Computer Programming • To learn the implementation of control structures, Iterations and recursive functions. • To implement operations on different types of files.			
List of Exercises / Experiments (For Computer Science and Engineering Branch)			
The exercises may include the Programs using the following concepts. 1. Decision making, branching and looping - if, if else statements - switch, goto statements - while, do, for statements 2. Arrays and strings - one-dimensional, two-dimensional, multidimensional arrays - reading/writing strings - operations on strings - string handling 3. Functions - user defined functions - function calls, arguments & return values - nesting of functions - recursive functions - passing arrays and strings to functions 4. Structures and unions - copying and comparing structure variables - arrays of structures - arrays within structures - structures with in structures - structures and functions - unions 5. Pointers - pointers and arrays - pointers and character strings - array of pointers - pointers and functions - pointers and structures 6. Files, memory allocation, bit-level programming - files -defining, opening/closing, input - output operations - command line arguments - memory allocation functions			
Course Outcome Students will be able to analyse a problem, find appropriate programming language construct should be used and implement C program for the problem.			

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC201	NETWORK THEORY	3-1-0-4	2016
Prerequisite: Nil			
Course objectives:			
- To make the students capable of analyzing any linear time invariant electrical network. - To study time domain, phasor and Laplace transform methods of linear circuit analysis. - To study the transient response of networks subject to test signals. - To develop understanding of the concept of resonance, coupled circuits and two port networks.			
Syllabus:			
Circuit variables and Circuit elements, Kirchhoff's laws, Network topology, Mesh and node analysis of network, Laplace transform, Inverse Laplace transform, Solution of differential equations by using Laplace transforms, Transient analysis of RL, RC, and RLC networks, Network functions for the single port and two ports, Parameters of two-port network, Resonance, Coupled circuits			
Expected outcome:			
At the end of the course students will be able to analyze the linear time invariant electrical circuits.			
Text Books			
1. Ravish R., Network Analysis and Synthesis, 2/e, McGraw-Hill, 2015. 2. Valkenburg V., Network Analysis, 3/e, PHI, 2011.			
References:			
1. Sudhakar A, S. P. Shyammohan, Circuits and Networks- Analysis and Synthesis, 5/e, McGraw-Hill, 2015. 2. Choudhary R., Networks and Systems, 2/e, New Age International, 2013. 3. Franklin F. Kuo, Network Analysis and Synthesis, 2/e, Wiley India, 2012. 4. Pandey S. K., Fundamentals of Network Analysis and Synthesis, 1/e, S. Chand, 2012. 5. Edminister, Electric Circuits – Schaum's Outline Series, McGraw-Hill, 2009.			
Course Plan			
Module	Course content (48 hrs)	Hours	Sem. Exam Marks
I	Introduction to circuit variables and circuit elements, Review of Kirchhoff's Laws, Independent and dependent Sources, Source transformations	3	15
	Network topology, Network graphs, Trees, Incidence matrix, Tie-set matrix and Cut-set matrix	2	
	Solution methods applied to dc and phasor circuits: Mesh and node analysis of network containing independent and dependent sources	3	
II	Network theorems applied to dc and phasor circuits: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Millman's theorem, Maximum power transfer theorem	6	15

	Laplace transform, properties Laplace Transforms and inverse Laplace transform of common functions, Important theorems: Time shifting theorem, Frequency shifting theorem, Time differentiation theorem, Time integration theorem, s domain differentiation theorem, s domain integration theorem, Initial value theorem, Final value theorem	4	
FIRST INTERNAL EXAM			
III	Partial Fraction expansions for inverse Laplace transforms, Solution of differential equations using Laplace transforms	3	15
	Transformation of basic signals and circuits into s-domain	2	
	Transient analysis of RL, RC, and RLC networks with impulse, step, pulse, exponential and sinusoidal inputs	3	
	Analysis of networks with transformed impedance and dependent sources.	3	
IV	Network functions for the single port and two ports, properties of driving point and transfer functions, Poles and Zeros of network functions, Significance of Poles and Zeros	3	15
	Time domain response from pole zero plot, Impulse Response	1	
	Network functions in the sinusoidal steady state, Magnitude and Phase response	3	
SECOND INTERNAL EXAM			
V	Parameters of two port network: impedance, admittance, transmission and hybrid parameters, Interrelationship among parameter sets	5	20
	Series and parallel connections of two port networks	2	
	Reciprocal and Symmetrical two port network	2	
	Characteristic impedance, Image impedance and propagation constant (derivation not required)	2	
VI	Resonance: Series resonance, bandwidth, Q factor and Selectivity, Parallel resonance	3	20
	Coupled circuits: single tuned and double tuned circuits, dot convention, coefficient of coupling, Analysis of coupled circuits	4	
END SEMESTER EXAM			

Question Paper Pattern

The question paper consists of three parts. Part A covers modules I and II, Part B covers modules III and IV and Part C covers modules V and VI. Each part has three questions. Each question can have a maximum of four subparts. Among the three questions one will be a compulsory question covering both the modules and the remaining two questions will be as one question from each module, of which one is to be answered. Mark pattern is according to the syllabus with maximum 30% for theory and 70% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC203	SOLID STATE DEVICES	3-1-0-4	2016
Prerequisite: Nil			
Course objectives: - To provide an insight into the basic semiconductor concepts - To provide a sound understanding of current semiconductor devices and technology to appreciate its applications to electronics circuits and systems			
Syllabus: Elemental and compound semiconductors, Fermi-Dirac distribution, Equilibrium and steady state conditions: Equilibrium concentration of electrons and holes, Temperature dependence of carrier concentration, Carrier transport in semiconductors, High field effects, Hall effect, Excess carriers in semiconductors, PN junctions, contact potential, electrical field, potential and charge density at the junction, energy band diagram, minority carrier distribution, ideal diode equation, electron and hole component of current in forward biased pn junction, piecewise linear model of a diode, effect of temperature on VI characteristics, Diode capacitances, electrical breakdown in pn junctions, Tunnel Diode, Metal semiconductor contacts, bipolar junction transistor, metal insulator semiconductor devices, MOSFET, FinFET			
Expected outcome: The students should have a good knowledge in semiconductor theory and electronic devices.			
Text Books: - Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson, 6/e, 2010 - Achuthan, K N Bhat, Fundamentals of Semiconductor Devices, 1e, McGraw Hill, 2015			
References: - Tyagi M.S., Introduction to Semiconductor Materials and Devices, Wiley India, 5/e, 2008 - Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005 - Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012 - Pierret, Semiconductor Devices Fundamentals, Pearson, 2006 - Rita John, Solid State Devices, McGraw-Hill, 2014 - Bhattacharya .Sharma, Solid State Electronic Devices, Oxford University Press, 2012 - Dasgupta and Dasgupta, Semiconductor Devices : Modelling and Technology (PHI)			
Course Plan			
Module	Course content (48hrs)	Hours	Sem. Exam Marks
I	Elemental and compound semiconductors, Fermi-Dirac distribution, Equilibrium and steady state conditions, Equilibrium concentration of electrons and holes, Temperature dependence of carrier concentration	4	15
	Carrier transport in semiconductors, drift, conductivity and mobility, variation of mobility with temperature and doping, High Field Effects, Hall effect	5	
II	Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi Fermi levels, diffusion, Einstein relations, Continuity equations, Diffusion length, Gradient of quasi Fermi level	9	15
FIRST INTERNAL EXAM			

III	PN junctions : Contact potential, Electrical Field, Potential and Charge density at the junction, Energy band diagram, Minority carrier distribution, Ideal diode equation, Electron and hole component of current in forward biased p-n junction, piecewise linear model of a diode effect of temperature on V-I characteristics	9	15
IV	Diode capacitances, switching transients, Electrical Breakdown in PN junctions, Zener and avalanche break down (abrupt PN junctions only), Tunnel Diode basics only, Metal Semiconductor contacts, Ohmic and Rectifying Contacts, current voltage characteristics	9	15
SECOND INTERNAL EXAM			
V	Bipolar junction transistor , current components, Minority carrier distributions, basic parameters, Evaluation of terminal currents (based on physical dimensions), Transistor action, Base width modulation	9	20
VI	Metal Insulator semiconductor devices: The ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, work function difference, interface charge, threshold voltage MOSFET: Output characteristics, transfer characteristics, sub threshold characteristics, MOSFET scaling (basic concepts)	9	20
	FinFET-structure and operation	1	
END SEMESTER EXAM			

Question Paper Pattern

The question paper consists of three parts. Part A covers modules I and II, Part B covers modules III and IV and Part C covers modules V and VI. Each part has three questions. Each question can have a maximum of four subparts. Among the three questions one will be a compulsory question covering both the modules and the remaining two questions will be as one question from each module, of which one is to be answered. Mark pattern is according to the syllabus with maximum 70 % for theory, derivation, proof and 30% for logical/numerical problems.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC204	ANALOG INTEGRATED CIRCUITS	4-0-0-4	2016
Prerequisite: Nil			
Course Objectives - To equip the students with a sound understanding of fundamental concepts of operational amplifiers - To understand the wide range of applications of operational amplifiers - To introduce special function integrated circuits - To introduce the basic concepts and types of data converters			
Syllabus Differential amplifier configurations, Operational amplifiers, Block diagram, Ideal op-amp parameters, Effect of finite open loop gain, bandwidth and slew rate on circuit performance, op-amp applications-linear and nonlinear, Active filters, Specialized ICs and their applications, Monolithic Voltage Regulators - types and its applications, Data converters - specifications and types.			
Expected outcome . The students will - have a thorough understanding of operational amplifiers - be able to design circuits using operational amplifiers for various applications			
Text Book: - Franco S., Design with Operational Amplifiers and Analog Integrated Circuits, 3/e, Tata McGraw Hill, 2008 - Salivahanan S. ,V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008			
References: - Botkar K. R., Integrated Circuits, 10/e, Khanna Publishers, 2010 - C.G. Clayton, Operational Amplifiers, Butterworth & Company Publ. Ltd. Elsevier, 1971 - David A. Bell, Operational Amplifiers & Linear ICs, Oxford University Press, 2nd edition, 2010 - Gayakwad R. A., Op-Amps and Linear Integrated Circuits, Prentice Hall, 4/e, 2010 - R.F. Coughlin & Fredrick Driscoll, Operational Amplifiers & Linear Integrated Circuits, 6th Edition, PHI,2001 - Roy D. C. and S. B. Jain, Linear Integrated Circuits, New Age International, 3/e, 2010 - Sedra A. S. and K. C. Smith, Microelectronic Circuits, 6/e, Oxford University Press, 2013			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Differential amplifiers: Differential amplifier configurations using BJT, Large and small signal operations, Input resistance, Voltage gain, CMRR, Non-ideal characteristics of differential amplifier. Frequency response of differential amplifiers, Current sources, Active load, Concept of current mirror circuits, Wilson current mirror circuits (Analysis using hybrid 'pi' model only).	6	15%
	Operational amplifiers: Introduction, Block diagram, Ideal op-amp parameters, Equivalent circuit, Voltage transfer curve, Open loop op-amp configurations, Effect of finite open loop gain, Bandwidth and slew rate on circuit performance	5	
II	Op-amp with negative feedback: Introduction, Feedback	3	15%

	configurations, Voltage series feedback, Voltage shunt feedback, Properties of practical op-amp.		
	Op-amp applications: Inverting and non inverting amplifier, DC and AC amplifiers, Summing, Scaling and averaging amplifiers, Instrumentation amplifier.	4	
FIRST INTERNAL EXAMINATION			
III	Op-amp applications: Voltage to current converter, Current to voltage converter, Integrator, Differentiator, Precision rectifiers, Log and antilog amplifier, Phase shift and Wien bridge oscillators	7	15%
IV	Astable and monostable multivibrators, Triangular and saw tooth wave generators, Comparators, Zero crossing detector, Schmitt trigger	5	15%
	Active filters: Advantages, First and second order low pass, High pass, Band pass and band reject filters, Design of filters using Butterworth approximations	5	
SECOND INTERNAL EXAMINATION			
V	Specialized ICs and its applications: Timer IC 555 : Astable and monostable operations, applications. Analog Multipliers: Introduction, Gilbert multiplier cell. Voltage Controlled Oscillator IC AD633 and their applications.	3	20%
	Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL for AM & FM detection and Frequency multiplication, Frequency division, Frequency synthesizing.	4	
	Monolithic Voltage Regulators - Fixed voltage regulators, 78XX and 79XX series, Adjustable voltage regulators, IC 723 – Low voltage and high voltage configurations, Current boosting, Current limiting, Short circuit and Fold-back protection.	4	
VI	Data Converters: D/A converter, Specifications, Weighted resistor type, R-2R Ladder type.	3	20%
	A/D Converters: Specifications, Classification, Flash type, Counter ramp type, Successive approximation type, Single slope type, Dual slope type, Sample-and-hold circuits.	5	
END SEMESTER EXAM			

Assignment

1. Explain the importance of frequency compensated networks in opamps and the commonly used compensation techniques.
2. Write short notes on commercially available integrated circuits (Opamp, ADC, DAC, VCO, Analog multiplier, PLL) with pin outs and their important features

Question Paper Pattern

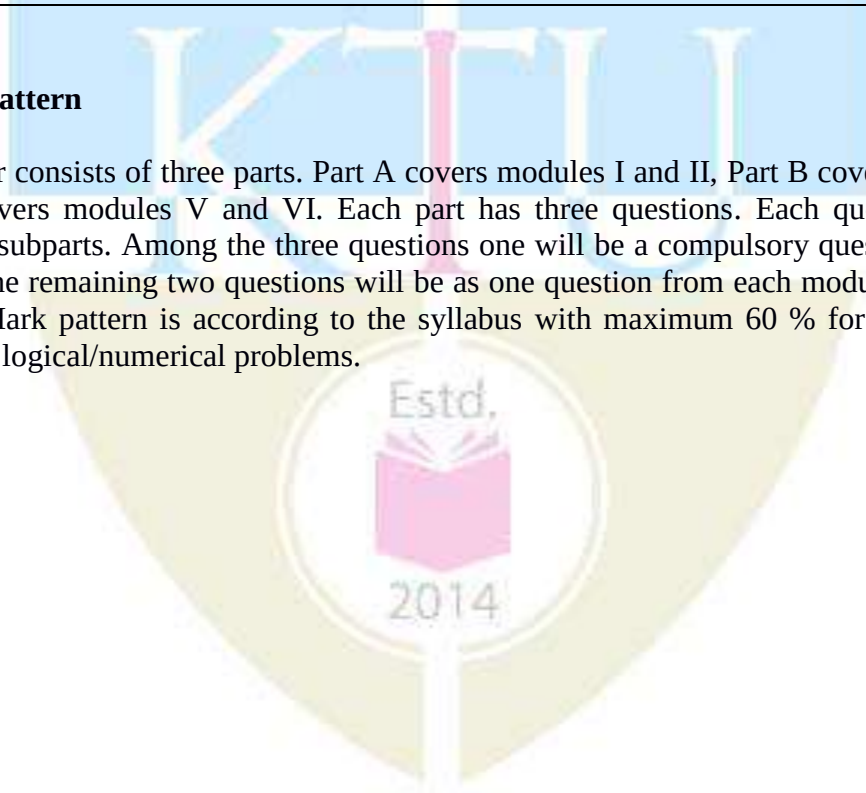
The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions, which may have maximum four subdivisions. Among the three questions, one will be a compulsory question covering both modules and the remaining from each module, of which, one to be answered. Part A & Part B questions shall carry 15 marks each and Part C questions shall carry 20 marks each with maximum 60% for theory and 40% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC205	ELECTRONIC CIRCUITS	3-1-0-4	2016
Prerequisite: Nil			
Course objectives: To develop the skill of analysis and design of various analog circuits using discrete electronic devices as per the specifications.			
Syllabus: High pass and low pass RC circuits, Differentiator, Integrator, Analysis of BJT biasing circuits, small signal analysis of transistor configurations using small signal hybrid π model, low frequency and high frequency analysis of BJT amplifiers, Cascade amplifiers, Wide band amplifiers, Feedback amplifiers, Oscillators, Tuned amplifiers, Power amplifiers, Sweep circuits and multivibrators, transistor voltage regulator, DC analysis of MOSFET circuits, small signal equivalent circuit, Small signal analysis of MOSFET amplifier circuits, Analysis of multistage MOSFET amplifiers			
Expected outcome: At the end of the course, students will be able to analyse and design the different electronic circuits using discrete electronic components.			
Text Books: - Sedra A. S. and K. C. Smith, Microelectronic Circuits, 6/e, Oxford University Press, 2013 - Millman J. and C. Halkias, Integrated Electronics, 2/e, McGraw-Hill, 2010			
References: - Neamen D., Electronic Circuits - Analysis and Design, 3/e, TMH, 2007 - Rashid M. H., Microelectronic Circuits - Analysis and Design, Cengage Learning, 2/e, 2011 - Spencer R. R. and M. S. Ghausi, Introduction to Electronic Circuit Design, Pearson, 2003 - Razavi B., Fundamentals of Microelectronics, Wiley, 2015			
Course Plan			
Module	Course content (48 hrs)	Hours	Sem. Exam Marks
I	RC Circuits: Response of high pass and low pass RC circuits to sine, step, pulse and square wave inputs, Differentiator, Integrator	5	15
	BJT biasing circuits: Types, Q point, Bias stability, Stability factors, RC coupled amplifier and effect of various components, Concept of DC and AC load lines, Fixing of operating point, Classification of amplifiers	5	
II	Small signal analysis of CE, CB and CC configurations using small signal hybrid π model (gain, input and output impedance). Small signal analysis of BJT amplifier circuits, Cascade amplifier	7	15
FIRST INTERNAL EXAM			
III	High frequency equivalent circuits of BJT, Short circuit current gain, cutoff frequency, Miller effect, Analysis of high frequency response of CE, CB and CC amplifiers	4	15
	Wide band amplifier: Broad banding techniques, low frequency and high frequency compensation, Cascode amplifier.	4	
IV	Feedback amplifiers: Effect of positive and negative feedback on gain, frequency response and distortion, Feedback topologies and	3	15

	its effect on input and output impedance, Feedback amplifier circuits in each feedback topologies (no analysis required)		
	Oscillators & Tuned Amplifiers: Classification of oscillators, Barkhausen criterion, Analysis of RC phase shift and Wien bridge oscillators, Working of Hartley, Colpitts and Crystal oscillators; Tuned amplifiers, synchronous and stagger tuning	6	
SECOND INTERNAL EXAM			
V	Power amplifiers: Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, efficiency and distortion, Transformer-less class B and Class AB power amplifiers, Class C power amplifier (no analysis required)	6	20
	Switching Circuits: Simple sweep circuit, Bootstrap sweep circuit, Astable, Bistable, and Monostable multivibrators, Schmitt Trigger	5	
VI	Transistor based voltage regulator: Design and analysis of shunt and series voltage regulator, load and line regulation, Short circuit protection	4	20
	MOSFET amplifiers: Biasing of MOSFET amplifier, DC analysis of single stage MOSFET amplifier, small signal equivalent circuit. Small signal voltage and current gain, input and output impedances of CS configuration, MOSFET Cascade amplifier	5	
END SEMESTER EXAM			

Question Paper Pattern

The question paper consists of three parts. Part A covers modules I and II, Part B covers modules III and IV and Part C covers modules V and VI. Each part has three questions. Each question can have a maximum of four subparts. Among the three questions one will be a compulsory question covering both the modules and the remaining two questions will be as one question from each module, of which one is to be answered. Mark pattern is according to the syllabus with maximum 60 % for theory, derivation, proof and 40% for logical/numerical problems.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC207	LOGIC CIRCUIT DESIGN	3-0-0-3	2016
Prerequisite: Nil			
Course objectives:			
- To work with a positional number systems and numeric representations - To introduce basic postulates of Boolean algebra and show the correlation between Boolean expression - To outline the formal procedures for the analysis and design of combinational circuits and sequential circuits - To study the fundamentals of HDL - To design and implement combinational circuits using basic programmable blocks - To design and implement synchronous sequential circuits			
Syllabus:			
Positional Number Systems, Boolean algebra, Combinational Logic, HDL concepts ,Digital ICs, Programmable Logic Devices, Sequential Logic, Sequential Circuits			
Expected outcome:			
The student should able to:			
1. Compare various positional number systems and binary codes			
2. Apply Boolean algebra in logic circuit design			
3. Design combinational and sequential circuits			
4. Design and implement digital systems using basic programmable blocks			
5. Formulate various digital systems using HDL			
Text Books:			
1. Donald D Givone, Digital Principles and Design, Tata McGraw Hill, 2003 2. John F Wakerly, Digital Design Principles and Practices, Pearson Prentice Hall, 2007			
References:			
1. Ronald J Tocci, Digital Systems, Pearson Education, 11 th edition, 2010 2. Thomas L Floyd, Digital Fundamentals, Pearson Education, 8 th edition 2009 3. Moris Mano, Digital Design, Prentice Hall of India, 3 rd edition, 2002 4. John M Yarbrough, Digital Logic Applications and Design, Cenage learning, 2009 5. David Money Harris, Sarah L Harris, Digital Design and Computer Architecture, Morgan Kaufmann – Elsevier, 2009			
Course Plan			
Module	Course content (42 hrs)	Hours	Sem. Exam Marks
I	Number systems- decimal, binary, octal, hexa decimal, base conversion	2	15
	1's and 2's complement, signed number representation Binary arithmetic, binary subtraction using 2's complement	2	
	Binary codes (grey, BCD and Excess-3), Error detection and correcting codes : Parity(odd, even), Hamming code (7,4), Alphanumeric codes : ASCII	2	
II	Logic expressions, Boolean laws, Duality, De Morgan's law, Logic functions and gates	2	15
	Canonical forms: SOP, POS, Realisation of logic expressions using K-	2	

	map (2,3,4 variables)		
	Design of combinational circuits – adder, subtractor, 4 bit adder/subtractor, BCD adder, MUX, DEMUX, Decoder,BCD to 7 segment decoder, Encoder, Priority encoder, Comparator (2/3 bits)	4	
FIRST INTERNAL EXAM			
III	Introduction to HDL : Logic descriptions using HDL, basics of modeling (only for assignments)	2	0
	Logic families and its characteristics: Logic levels, propagation delay, fan in, fan out, noise immunity , power dissipation, TTL subfamilies	1	
	NAND in TTL (totem pole, open collector and tri-state), CMOS:NAND, NOR, and NOT in CMOS, Comparison of logic families (TTL,ECL,CMOS) in terms of fan-in, fan-out, supply voltage, propagation delay, logic voltage and current levels, power dissipation and noise margin	2	
	Programmable Logic devices - ROM, PLA, PAL, implementation of simple circuits using PLA	2	
IV	Sequential circuits - latch, flip flop (SR, JK, T, D), master slave JK FF, conversion of FFs, excitation table and characteristic equations	3	15
	Asynchronous and synchronous counter design, mod N counters, random sequence generator	5	
SECOND INTERNAL EXAM			
V	Shift Registers - SIPO, SISO, PISO, PIPO, Shift registers with parallel LOAD/SHIFT Shift register counter - Ring Counter and Johnson Counter	3	20
	Mealy and Moore models, state machine ,notations, state diagram, state table, transition table, excitation table, state equations	3	
VI	Construction of state diagram – up down counter, sequence detector	3	20
	Synchronous sequential circuit design - State equivalence	2	
	State reduction – equivalence classes, implication chart	2	
END SEMESTER EXAM			

Assignments:

1. Simple combinational circuit design using MUX, DEMUX, PLA & PAL
2. HDL simulation of circuits like simple ALU, up-down counter, linear feedback shift register, sequence generator

Question Paper Pattern

The question paper consists of three parts. Part A covers modules I and II, Part B covers modules III and IV and Part C covers modules V and VI. Each part has three questions. Each question has a maximum of four subparts. Among the three questions one will be a compulsory question covering both the modules and the remaining two questions will be as one question from each module, of which one is to be answered. Mark pattern is according to the syllabus with maximum 50 % for theory, derivation, proof and 50% for logical/numerical problems.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC230	LOGIC CIRCUIT DESIGN LAB	0-0-3-1	2016
Prerequisite: EC207 Logic circuit design			
Course objectives: - To study the working of standard digital ICs and basic building blocks - To design and implement combinational circuits - To design and implement sequential circuits			
List of Experiments: -(Minimum 12 experiments are to be done) - Realization of functions using basic and universal gates (SOP and POS forms). - Design and Realization of half /full adder and subtractor using basic gates and universal gates. 4 bit adder/subtractor and BCD adder using 7483. 2/3 bit binary comparator. - Binary to Gray and Gray to Binary converters. - Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates - Asynchronous Counter: Realization of 4-bit counter - Asynchronous Counter: Realization of Mod-N counters. - Asynchronous Counter:3 bit up/down counter - Synchronous Counter: Realization of 4-bit up/down counter. - Synchronous Counter: Realization of Mod-N counters. - Synchronous Counter:3 bit up/down counter - Shift Register: Study of shift right, SIPO, SISO, PIPO, PISO (using FF & 7495) - Ring counter and Johnson Counter. (using FF & 7495) - Realization of counters using IC's (7490, 7492, 7493). - Multiplexers and De-multiplexers using gates and ICs. (74150, 74154), - Realization of combinational circuits using MUX & DEMUX. - Random sequence generator. - LED Display: Use of BCD to 7 Segment decoder / driver chip to drive LED display - Static and Dynamic Characteristic of NAND gate (MOS/TTL)			
Expected outcome:			
The student should be able to:			
- Design and demonstrate functioning of various combination circuits - Design and demonstrate functioning of various sequential circuits - Function effectively as an individual and in a team to accomplish the given task			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC231	Electronic Devices & Circuits Lab	0-0-3-1	2016
Prerequisite: Should have registered for EC205 Electronic circuits			
Course objectives:			
- To study the working of analog electronic circuits. - To design and implement analog circuits as per the specifications using discrete electronic components.			
List of Experiments: (12 Mandatory Experiments) - VI Characteristics of rectifier and zener diodes - RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response) - Clipping and clamping circuits (Transients and transfer characteristics) - Fullwave Rectifier -with and without filter- ripple factor and regulation - Simple Zener voltage regulator (load and line regulation) - Characteristics of BJT in CE configuration and evaluation of parameters - Characteristics of MOSFET in CS configuration and evaluation of parameters - RC coupled CE amplifier - frequency response characteristics - MOSFET amplifier (CS) - frequency response characteristics - Cascade amplifier – gain and frequency response - Cascode amplifier -frequency response - Feedback amplifiers (current series, voltage series) - gain and frequency response - Low frequency oscillators –RC phaseshift, Wien bridge, - High frequency oscillators –Colpitt's and Hartley - Power amplifiers (transformer less) - Class B and Class AB - Transistor series voltage regulator (load and line regulation) - Tuned amplifier - frequency response - Bootstrap sweep circuit - Multivibrators -Astable, Monostable and Bistable - Schmitt trigger			
Expected outcome:			
The student should able to: - Design and demonstrate functioning of various discrete analog circuits. - Function effectively as an individual and in a team to accomplish the given task.			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC232	ANALOG INTEGRATED CIRCUITS LAB	0-0-3-1	2016
Prerequisite: ..Should have registered for EC204 Analog Integrated Circuits			
Course objectives: - To acquire skills in designing and testing analog integrated circuits - To expose the students to a variety of practical circuits using various analog ICs.			
List of Experiments: (Minimum 12 experiments are to be done) 1. Familiarization of Operational amplifiers - Inverting and Non inverting amplifiers, frequency response, Adder, Integrator, comparators. 2. Measurement of Op-Amp parameters. 3. Difference Amplifier and Instrumentation amplifier. 4. Schmitt trigger circuit using Op –Amps. 5. Astable and Monostable multivibrator using Op -Amps. 6. Timer IC NE555 7. Triangular and square wave generators using Op- Amps. 8. Wien bridge oscillator using Op-Amp - without & with amplitude stabilization. 9. RC Phase shift Oscillator. 10. Precision rectifiers using Op-Amp. 11. Active second order filters using Op-Amp (LPF, HPF, BPF and BSF). 12. Notch filters to eliminate the 50Hz power line frequency. 13. IC voltage regulators. 14. A/D converters- counter ramp and flash type. 15. D/A Converters- ladder circuit. 16. Study of PLL IC: free running frequency lock range capture range			
Expected outcome:			
The student should able to:			
1. Design and demonstrate functioning of various analog circuits 2. Students will be able to analyze and design various applications of analog circuits.			

Course code	Course name	L-T-P-Credits	Year of Introduction
AE301	CONTROL SYSTEM	3-1-0-4	2016
PREREQUISITE : Nil			
Course objectives - To familiarize the modelling of linear time invariant systems and their responses in time and frequency domain. - To learn state space techniques			
Syllabus Mathematical model of systems – transfer function – block diagram -System analysis-time domain analysis- stability of linear systems -frequency domain analysis- state variable analysis –state diagram.			
Expected outcome At the end of the semester students will be able to understand and analyse the different behaviour of system performances.			
Text Books - I J Nagrath and M. Gopal, Control Systems Engineering, New Age International Publishers, New Delhi, 1997 M. Gopal, Digital Control and State Variable Methods, 2 nd ed., Tata McGraw Hill, New Delhi, 2003			
Reference Books G. J. Thaler, Automatic Control Systems, Jaico Publishing House, Mumbai, 2005 K. Ogata, Modern Control Engineering, 4th ed., Pearson Education, Delhi, 2002 B. C. Kuo, Automatic Control Systems, 7th ed., Prentice Hall of India, New Delhi, 1995 R. C. Dorf and R. H. Bishop, Modern Control Systems, 10th ed., Pearson Education, Delhi, 2004			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	System Analysis: Systems, subsystems, and stochastic and deterministic systems - Principles of automatic control -Open loop and closed loop systems -Principles of superposition and homogeneity-Transfer Function Approach: Mathematical models of physical systems and transfer function approach - Impulse response and transfer function -Determination of transfer functions for simple electrical, mechanical, electromechanical, hydraulic and pneumatic systems - Analogous systems -Multiple-input multiple-output systems: Block diagram algebra - block diagram reduction -Signal flow graphs -Mason's gain formula.	8	15%
II	Time Domain Analysis: Standard test signals -Response of systems to standard test signals –Step response of second order systems -Time domain specifications (of second order system) -Steady state response -Steady state error -Static and dynamic error coefficients -Zero input and zero state response	8	15%
FIRST INTERNAL EXAMINATION			
III	Stability of linear systems -absolute stability -relative stability	8	15%

	-Hurwitz and Routh stability criterion -Root locus method - construction of root locus -root contours -root sensitivity to gain k -effect of poles and zeros and their locations on the root locus.		
IV	Frequency Domain Analysis: Frequency response representation -Frequency domain specifications -Correlation between time and frequency response -Polar plots - Logarithmic plots -Bode plots – All pass, minimum-phase and non-minimum-phase systems -Transportation lag - Stability in frequency domain -Nyquist stability criterion - Stability from polar and bode plot -Gain margin and phase margin -relative stability -M-N circles -Nichols chart.	9	15%
SECOND INTERNAL EXAMINATION			
V	State Variable Analysis: Concepts of state, state variables, state vector and state space -State model of continuous time systems Transformation of state variable -Derivation of transfer function from state model -invariance property	9	20%
VI	State diagram -State variable from transfer function -bush or companion form -controllable canonical form - observable canonical form -Jordan canonical form -Diagonalization-State transition matrix -computation of state transition matrix by Laplace transform, Cayley-Hamilton theorem -Controllability and observability of a system. (proof not required)	10	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE302	PROCESS CONTROL	4-0-0-4	2016
Prerequisite : Nil			
Course objectives - To introduce the principles of various control and instrumentation components and strategies applied in a process control system. - To Basics of Principals of Sensors and Transducers, Control System Component and Process Loop Control			
Syllabus Process characteristics - Types of processes- Analysis of Control Loop- Analysis of Flow Control- Feedback Control- Multi Loop & Nonlinear Systems-Concept of Multivariable Control- Intelligent Controllers			
Expected outcome At the end of the semester students will be able to understand and analyse the different behaviour of process control system performances.			
Text Books - B.Wayne Bequette, <i>Process Control: Modeling, Design and Simulation</i>, PHI - Donald Eckman – <i>Automatic Process Control</i>, Wiley Eastern Limited - F.G.Shinskey, <i>Process control Systems</i>, TMH			
Reference Books - B.G.Liptak, <i>Handbook of Instrumentation -Process control</i>, Chilton - Considine, <i>Process Instrumentation and control Handbook</i>, 5th Ed., McGraw Hill - Krishna Kant, <i>Computer Based Industrial Control</i>, PHI - Murrill, <i>Applications concepts of Process control</i>, ISA - Murrill, <i>Fundamentals of Process Control</i>, ISA - Stephanopoulos George, <i>Chemical Process Control</i>, PHI - T.J.Ross <i>Fuzzy Logic with Engineering Applications</i>, John Wiley & Sons, 2004 - Thomas E Marlin - <i>Process Control- Designing processes and Control Systems for Dynamic performance</i>, McGraw-Hill International Editions			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Process characteristics: Incentives for process control, Process Variables types and selection criteria,, Process degree of freedom, The period of Oscillation and Damping, Characteristics of physical System: Resistance, Capacitive and Combination of both. Elements of Process Dynamics, Types of processes- Dead time, Single /multi capacity, self-Regulating /non self-regulating, Interacting /non interacting, Linear/non-linear, and Selection of control action for them. Study of Liquid Processes, Gas Processes, Flow Processes, Thermal Processes in respect to above concepts	9	15%
II	Analysis of Control Loop: Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain, Linearizing an equal percentage valve, Variable pressure drop. Analysis of Flow Control, Pressure Control, Liquid level Control, Temperature control, SLPC-	8	15%

	features, faceplate, functions, MLPC- features, faceplate, functions, SLPC and MLPC comparison. Scaling: types of scaling, examples of scaling		
FIRST INTERNAL EXAMINATION			
III	Feedback Control: Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control. Factors in Controller Tuning, Determining Tuning Constants for Good Control Performance, Correlations for tuning Constants, Fine Tuning of the controller tuning Constants.	8	15%
IV	Multi Loop & Nonlinear Systems: Cascade control, Feed forward control, feedback-feed forward control, Ratio control, Selective Control , Split range control- Basic principles, Design Criteria , Performance, Controller Algorithm and Tuning, Implementation issues, Examples and any special features of the individual loop and industrial applications. Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance.	9	15%
SECOND INTERNAL EXAMINATION			
V	Multivariable Control: Concept of Multivariable Control: Interactions and its effects, Modelling and transfer functions, Influence of Interaction o the possibility of feedback control, important effects on Multivariable system behaviour Relative Gain Array, effect of Interaction on stability and tuning of Multi Loop Control system. Multi Loop control Performance through: Loop Paring, tuning, Enhancement through Decoupling, Single Loop Enhancements.	10	20%
VI	Intelligent Controllers: Step analysis method for finding first, second and multiple time constants and dead time. Model Based controllers: Internal Model control, Smith predictor, optimal controller, Model Predictive controller, Dynamic matrix controller (DMC). Self Tuning Controller. Fuzzy logic systems and Fuzzy controllers, Introduction, Basic Concepts of Fuzzy Logic, Fuzzy Sets, Fuzzy Relation, Fuzzy Graphs, and Fuzzy Arithmetic, Fuzzy If-Then Rules, Fuzzy Logic Applications, Neuro-Fuzzy Artificial Neural networks and ANN controller.	10	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

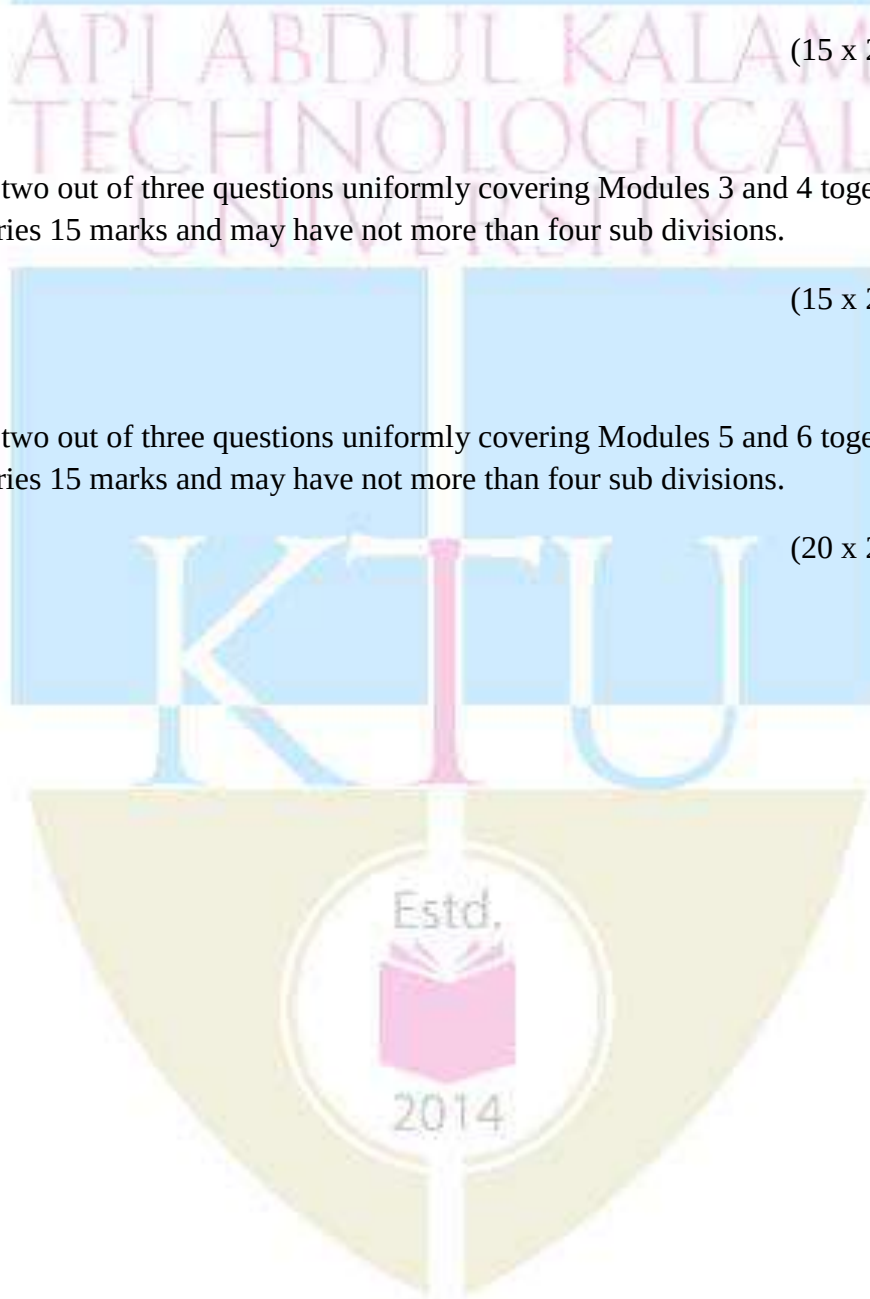
Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)



Course code	Course name	L-T-P-Credits	Year of Introduction
AE303	ELECTRICAL MEASUREMENTS AND MEASURING INSTRUMENTS	3-0-0-3	2016
Prerequisite: Nil			
Course objectives To impart knowledge on different types of measuring techniques using electrical and electronic measurement system.			
Syllabus General Principles of Measurements- Calibration of Meters- Errors in Measurement and its Analysis- Essentials of indicating instruments- Moving Iron, Dynamo Meter- D.C bridges- A.C bridges-Series and shunt type ohm meter- Electronic measurements- Analog and digital multimeters- Waveform analyzing instruments: Distortion meter- Spectrum analyser- Magnetic Measurements- Data Acquisition systems.			
Expected outcome The students will be able - To learn the use of different types of analogue meters for measuring electrical quantities such as current, voltage, power energy power factor and frequency. - To learn the principle of working and applications of electronic measuring devices.			
Text Books - Baldwin, C.T., "Fundamentals of electrical measurements" – Lyall Book Depot, New Delhi, 1973. - David.A.Bell, "Electronic Instrumentation and Measurements", 2nd Edition, Prentice Hall, New Jersey, 1994. - Golding, E.W. and Widdis, F.C., "Electrical Measurements and Measuring Instruments" A.H.Wheeler and Co, 5th Edition, 1993.			
Reference Books - Cooper, W.D. and Helfric, A.D., "Electronic Instrumentation and Measurement Techniques" Prentice Hall of India, 1991. - Kalsi.H.S., "Electronic Instrumentation", Tata McGraw Hill, New Delhi, 1995 - Pattanabis, "Sensors and Transducers", 2nd Edition, Prentice Hall India Pvt. Ltd., 2003. - Waldemar Nawrocki, "Measurement Systems and Sensors", Artech House, 2005			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	General Principles of Measurements: Absolute and Working Standards- Calibration of Meters- Qualities of Measurements- Accuracy, precision, sensitivity, resolution, loading effect. - Characteristics - Errors in Measurement and its Analysis	6	15%
II	Essentials of indicating instruments- deflecting, damping, controlling torques- Moving Coil , Moving Iron, Dynamo Meter, Induction, Thermal, Electrostatic and Rectifier Type meter; Shunts and Multipliers-Variety Types of Galvanometers- Accuracy class.	7	15%
FIRST INTERNAL EXAMINATION			
III	DC Bridges: Introduction, sources & detectors for DC bridge,	7	15%

	general equation for bridge at balance. Wheatstone and Kelvin's double bridge, Carry Foster Slide Wire Bridge – Bridge Current Limitations.		
IV	AC bridges: Introduction, sources & detectors for a.c bridge, general equation for bridge at balance. Maxwell's Inductance & Maxwell's Inductance-Capacitance Bridge, Anderson bridge, Measurements of capacitance using Schering Bridge. Potentiometers: General principle, Modern forms of dc potentiometers, standardization, Vernier dial principle, AC potentiometers – coordinate and polar types, application of dc and ac potentiometers	8	15%
SECOND INTERNAL EXAMINATION			
V	Cathode ray oscilloscope (review), Special purpose oscilloscopes- delayed time base, analog storage, sampling oscilloscopes. Digital storage oscilloscopes-DSO applications. Method of measuring voltage, current, phase, frequency and period using CRO, DSO. Graphic Recording Instruments: strip chart recorder, X-Y recorder, Plotter, liquid crystal display (LCD).	7	20%
VI	Waveform analysing instruments: Distortion meter, Spectrum analyser, Digital spectrum analyser, Q meter, Watthour meter, Power-factor meter, Instrument transformers, Thermocouple instruments, Peak response voltmeter, True RMS meter	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE304	INDUSTRIAL INSTRUMENTATION	3-0-0-3	2016
Prerequisite : Nil			
Course Objective - To equip the students with the basic knowledge of Pressure, Temperature, flow, level, Density and viscosity measurements. - To understand the construction and working of measuring instruments			
Syllabus Temperature measurement- Pressure measurement- Measurement of viscosity- Flow measurement- Anemometers- Target flow meters- Level measurement			
Expected outcome The students will be able to - grasp the working of different types of instruments for measurement of mechanical quantities - choose appropriate instruments for measurement of mechanical quantities			
Text Books - Doebelin E.O, “<i>Measurement Systems: Application and Design</i>”, 4th Edition, McGraw Hill, New York, 2003. - Patranabis D, “<i>Principles of Industrial Instrumentation</i>”, 2nd Edition, Tata McGraw Hill, New Delhi, 1997. - Spitzer D. W., <i>Flow measurement</i>, ISA press, New York, 1998			
Reference Books - Andrew W.G, “<i>Applied Instrumentation in Process Industries – A survey</i>”, Vol I & Vol II, Gulf Publishing Company, Houston, 2001. - Douglas M. Considine, “<i>Process / Industrial Instruments & Controls Handbook</i>”, 5th Edition, McGraw Hill, Singapore, 1999. - Liptak B.G, “<i>Process Measurement and Analysis</i>”, 4th Edition, Chilton Book Company, Radnor, Pennsylvania, 2003. - Noltingk B.E., “<i>Instrumentation Reference Book</i>”, 2nd Edition, Butterworth Heinemann, 1995.			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Temperature measurement: Resistance temperature detector (RTD), principle and types, construction requirements for industry, measuring circuits. Thermistors, principle and sensor types, manufacturing techniques, measuring circuits, linearization methods and applications. Pneumatic and suction pyrometers, integrated circuit sensors, diode type sensors, ultrasonic thermometers, Johnson noise thermometer, fluidic sensors, spectroscopic temperature measurements, thermograph, temperature switches and thermostats.	7	15%
II	Pressure measurement basics, mechanical type instruments, electromechanical type, low pressure measurement, related accessories, pressure measuring standards, selection and application. Transmitter definition, classification, pneumatic	7	15%

	transmitter-force balance type, torque balance type, two wire and four wire transmitters, I/P and P/I converters.		
FIRST INTERNAL EXAMINATION			
III	Measurement of viscosity: definitions, units, Newtonian and Newtonian behaviour, measurement of viscosity using laboratory viscometers, industrial viscometers. Viscometer selection and application. Measurement of density, definitions, units, liquid density measurement, gas densitometers, its application and selection.	7	15%
IV	Flow measurement: Introduction, definitions and units, classification of flow meters, pitot tubes, positive displacement liquid meters and provers, positive displacement gas flow meters, variable area flow meters.	6	15%
SECOND INTERNAL EXAMINATION			
V	Anemometers: Hot wire/hot film anemometer, laser Doppler anemometer (LDA), electromagnetic flow meter, turbine and other rotary element flow meters, ultrasonic flow meters, doppler flow meters, cross correlation flow meters, vortex flow meters. Measurement of mass flow rate: radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine Coriolis, gyroscopic and heat transfer type mass flow meters. Target flow meters: V-cone flow meters purge flow regulators, flow switches, flow meter calibration concepts, flow meter selection and application.	8	20%
VI	Level measurement: introduction, float level devices, displacer level devices, rotating paddle switches, diaphragm and differential pressure detectors, resistance, capacitance and RF probes, radiation, conductivity, field effect, thermal, ultrasonic, microwave level switches, radar and vibrating type level sensors. Level sensor selection and application.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE305	MICROPROCESSORS & MICROCONTROLLERS	3-0-0-3	2016
Prerequisite: Nil			
Course Objective - To expose the features of advanced microprocessors like 8086, 80386, and Pentium processors - To introduce the architecture, programming, and interfacing of the microcontroller 8051			
Syllabus Intel 8086 - Assembler directives and operators - 8086 hardware design - Multi-processor configuration - Memory (RAM and ROM) interfacing - 8087 co-processor architecture and configuration - Introduction to 80386 - Superscalar architecture - 8051 Microcontroller - Assembly Language programming in 8051.			
Expected outcome At the end of the semester students will be - familiar with microprocessors and microcontrollers - able to study the processor architecture, assembly language, memory management, interfacing etc.			
Text Books - A K Ray and K M Bhurchandi, , Advanced Microprocessors and Peripherals, Tata McGraw Hill, 2006 - D V Hall, Microprocessors and Interfacing: Programming and Hardware, 2nd ed., Tata McGraw Hill, 1999. - M A Mazidi and J. G. Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, Delhi, 2004 - Ramani Kalpathi and Ganesh Raja, Microcontrollers and Applications, Pearson Education, 2010			
Reference Books - B Brey, The Intel Microprocessors, 8086/8088, 80186, 80286, 80386 and 80486 architecture, Programming and interfacing, 6th ed., Prentice Hall of India, New Delhi, 2003 - K J Ayala, The 8051 Microcontroller- Architecture, Programming and applications, Thomson Delmar Publishers Inc., India reprint Penram - Y C Liu and G A Gibson, Microcomputer system: The 8086/8088 family, 2nd ed., Prentice Hall of India, New Delhi, 1986			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Intel 8086, format:, Assembler directives and operators, Assembly process, Linking and relocation, stacks, procedures, interrupt routines, macros.	7	15%
II	8086 hardware design - Bus structure, bus buffering and latching, system bus timing with diagram, Minimum and maximum mode configurations of 8086, Multi-processor configuration, 8087 co-processor architecture and configuration, Memory (RAM and ROM) interfacing, memory	8	15%

	address decoding.		
FIRST INTERNAL EXAMINATION			
III	8087 co-processor architecture and configuration, Memory (RAM and ROM) interfacing, memory address decoding	6	15%
IV	Introduction to 80386 – Memory management unit – Descriptors, selectors, description tables and TSS – Real and protected mode – Memory paging – Pentium processor -Special features of the Pentium processor – Branch prediction logic– Superscalar architecture, microprocessors - state of the art	7	15%
SECOND INTERNAL EXAMINATION			
V	8051 Microcontroller: Overview of 8051 family, architecture of 8051, Program counter, ROM space in 8051, data types and directives, flags and PSW register, register bank and stack, Addressing modes. Instruction set Arithmetic instructions JUMP, LOOP,CALL instructions, time delay generations.	7	20%
VI	Assembly Language programming in 8051 (some simple programs): programs using arithmetic and logic instructions, single bit instructions and programs, Timer/counter programming, 8051 serial communication programming, programming timer interrupts. Interfacing with Stepper motor, keyboard, DAC, external memory.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year Of Introduction
AE306	Digital Signal Processing	3-0-0-3	2016
Prerequisite : Nil			
Course Objective To introduce the basic concepts and techniques for processing signals on a Computer.			
Syllabus Discrete-time and digital signals- DFT and the FFT- Z-transform- FIR Filters- IIR Filters- Filter Realization- Computer architectures for signal processing.			
Expected outcome The students will be familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.			
Text Books - Chen, C.T., “<i>Digital Signal Processing: Spectral Computation & Filter Design</i>”, Oxford Univ. Press, 2001 - Ifeachor, E.C., & Jervis, B.W., “<i>Digital Signal Processing: A Practical Approach</i>”, 2/e, Pearson Education Asia, 2002. - Proakis, J.G. & Manolakis, D.G., “<i>Digital Signal Processing: Principles, Algorithms, & Applications</i>”, 3/e Prentice Hall of India, 1996.			
Reference Books: - Embree, P.M., & Danieli, D., “<i>C++ Algorithms for Digital Signal Processing</i>”, 2/e, Prentice Hall Upper Saddle River, NJ, 1999. - McClellan, J.H., Schafer, R.W., & Yoder, M.A., “<i>DSP First: A Multimedia Approach</i>”, Prentice Hall Upper Saddle River, NJ, 1998 - Mitra, S.K., “<i>Digital Signal Processing: A Computer-Based Approach</i>”, McGraw Hill, NY, 1998			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Signal Processing Fundamentals: Discrete-time and digital signals, A/D, D/A conversion and Nyquist rate, Frequency aliasing due to sampling, Need for anti-aliasing filters. Discrete Time Fourier transform and frequency spectra, Spectral computation, Computational complexity of the DFT and the FFT, Algorithmic development and computational advantages of the FFT, Inverse FFT, Implementation of the FFT, Correlation of discrete-time signals.	7	15%
II	Discrete-time systems, Difference equations and the Z-transform, Analysis of discrete-time LTIL systems, Stability and Jury's test.	6	15%
FIRST INTERNAL EXAMINATION			
III	FIR Filters: Ideal digital filters, Realizability and filter specifications, Classification of linear phase FIR filters, Design using direct truncation, window methods and frequency sampling, Least-squares optimal FIR filters,	7	15%

	Minimax optimal FIR filters, Design of digital differentiators and Hilbert transformers, comparison of design methods.		
IV	IIR Filters: Design of analogue prototype filters, Analog frequency transformations, Impulse invariance method and digital frequency transformations, Bilinear transformation, Analog prototype to digital transformations, Difficulties in direct IIR filter design, Comparisons with FIR filters.	7	15%
SECOND INTERNAL EXAMINATION			
V	Filter Realization: Structures for FIR filters, Structures for IIR filters, State-space analysis and filter structures, Fixed point and floating-point representation of numbers, Errors resulting from rounding and truncating, Quantization effects of filter coefficients, Round-off effects of digital filters.	7	20%
VI	DSP Processors: Computer architectures for signal processing – Harvard architecture and pipelining, General purpose digital signal processors, Selection of DSPs, Implementation of DSP algorithms on a general purpose DSP, Special purpose hardware – hardware digital filters and hardware FFT processors, Evaluation boards for real-time DSP.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE307	SIGNALS AND SYSTEMS	3-0-0-3	2016
Prerequisite : Nil			
Course Objective - To impart the basic concepts of continuous and discrete signals and systems - To develop understanding about frequency domain approaches used for analysis of continuous and discrete time signals and systems. - To establish the importance of z-transform and its properties for analyzing discrete time signals and systems			
Syllabus Introduction to signals and systems - Classification of signals - Properties of systems - Representation of LTI systems - Continuous & Discrete Time LTI systems - Frequency response of LTI - Continuous Time Fourier Series - Discrete Time Fourier Transform - Laplace Transform – Causality and stability- Z Transform- Determining the frequency response from poles and zeros.			
Expected outcome The students are expected to: - Have an advanced knowledge in continuous and discrete signals and systems - Have knowledge in z-transform			
Text Books - Haykin S. & Veen B.V., <i>Signals & Systems</i>, John Wiley - Oppenheim A.V., Willsky A.S. & Nawab S.H., <i>Signals and Systems</i>, Tata McGraw Hill - Taylor F.H., <i>Principles of Signals & Systems</i>, McGraw Hill			
References - Bracewell R.N., <i>Fourier Transform & Its Applications</i>, McGraw Hill - Haykin S., <i>Communication Systems</i>, John Wiley - Lathi B.P., <i>Modern Digital & Analog Communication Systems</i>, Oxford University Press - Papoulis A., <i>Fourier Integral & Its Applications</i>, McGraw Hill			
Course Plan			
Module	Contents	Hours	Semester exam marks
I	Introduction to signals and systems - Classification of signals - Basic operations on signals – Elementary signals - Concept of system - Properties of systems - Stability, invertability, time invariance - Linearity - Causality - Memory - Time domain description - Convolution - Impulse response.	7	15%
II	Representation of LTI systems - Differential equation and difference equation representations of LTI systems ,Continuous Time LTI systems and Convolution Integral, Discrete Time LTI systems and linear convolution.	6	15%
FIRST INTERNAL EXAMINATION			

III	Frequency response of LTI systems - Correlation theory of deterministic signals - Condition for distortionless transmission through an LTI system - Transmission of a rectangular pulse through an ideal low pass filter - Hilbert transform – Sampling and reconstruction	8	15%
IV	Frequency Domain Representation of Continuous Time Signals- Continuous Time Fourier Series: Convergence. Continuous Time Fourier Transform: Properties. Frequency Domain Representation of Discrete Time Signals- Discrete Time Fourier Transform: Properties, Sampling Theorem, aliasing, reconstruction filter, sampling of band pass signals. Fourier Series Representation of Discrete Time Periodic Signals.	7	15%
SECOND INTERNAL EXAMINATION			
V	Laplace Transform – ROC – Inverse transform – properties – Analysis of Continuous LTI systems using Laplace Transform – unilateral Laplace Transform. Relation between Fourier and Laplace Transforms. Laplace transform analysis of systems - Relation between the transfer function and differential equation - Causality and stability - Inverse system - Determining the frequency response from poles and zeros	7	20%
VI	Z Transform - Definition - Properties of the region of convergence - Properties of the Z transform - Analysis of LTI systems - Relating the transfer function and difference equation - Stability and causality - Inverse systems - Determining the frequency response from poles and zeros	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE308	ADVANCED MICROPROCESSORS	3-0-0-3	2016
Prerequisite: AE305 Microprocessors & microcontrollers			
Course Objective - To familiarise the importance and applications of advance microprocessor - To understand architecture of ARM processor - To understand instruction set of ARM processor			
Syllabus Need of advance microprocessors- RISC and CISC- ARM Architecture and Programmers Model- ARM Instruction set- C Programming for ARM- Memory management units- Advanced Microprocessor Bus Architecture.			
Expected outcome The students will have good idea about ARM processor and its application.			
Text Books - Andrew N. Sloss, Dominic Symes, Chris Wright <i>ARM System Developer's Guide, Designing and Optimizing System Software</i>, Elsevier - Muhammad Ali Mazidi, <i>ARM Assembly Language Programming & Architecture</i>, Kindle edition - Steve Furber <i>ARM System-on-chip Architecture</i>, 2nd Edition, , Pearson publication - William Hohl and Christopher Hinds, <i>ARM Assembly Language, Fundamentals and Techniques</i>, 2nd edition, CRC Press.			
Reference Books - Douglas V.Hall, "<i>Microprocessors and Interfacing</i>", Tata McGraw Hill, II Edition 2006 - Mohamed Rafiquzzaman, "<i>Microprocessors and Microcomputer Based System Design</i>", II Edition, CRC Press, 2007			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Introduction: Need of advance microprocessors, Difference between RISC and CISC, RISC Design philosophy, ARM Design Philosophy, History of ARM microprocessor, ARM processor family, Development of ARM architecture.	7	15%
II	The ARM Architecture and Programmers Model : The Acorn RISC Machine, ARM Core data flow model, Architectural inheritance, The ARM7TDMI programmer's model: General purpose registers, CPSR, SPSR, ARM memory map, data format, load and store Architecture, Core extensions, Architecture revisions, ARM development tool.	7	15%
FIRST INTERNAL EXAMINATION			
III	ARM Instruction set: Data processing instructions, Arithmetic and logical instructions, Rotate and barrel shifter, Branch instructions, Load and store instructions, Software interrupt instructions, Program status register instructions,	8	15%

	Conditional execution, Multiple register load and store instructions, Stack instructions, Thumb instruction set, advantage of thumb instructions, Assembler rules and directives, Assembly language programs for shifting of data, factorial calculation, swapping register contents, moving values between integer and floating point registers		
IV	C Programming for ARM: Overview of C compiler and optimization, Basic C data types, C Looping structures, Register allocations, function calls, pointer aliasing, structure arrangement, bit fields, unaligned data and Endianness, Division, floating point, Inline functions and inline assembly, Portability issues. C programs for General purpose I/O, general purpose timer, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC.	7	15%
SECOND INTERNAL EXAMINATION			
V	Memory management units: Moving from memory protection unit (MPU) to memory management unit (MMU), Working of virtual memory, Multitasking, Memory organization in virtual memory system, Page tables, Translation look aside buffer, Caches and write Buffer, Fast context switch extension.	7	20%
VI	Advanced Microprocessor Bus Architecture (AMBA) Bus System, User peripherals, Exception handling in ARM, ARM optimization Techniques.	6	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year Of Introduction
AE312	POWER ELECTRONICS	3-0-0-3	2016
Prerequisite : Nil			
Course Objective To introduce various power semiconductor devices and converters used in industrial applications.			
Syllabus Power semiconductor devices- Controlled rectifiers- DC choppers- DC to AC converters- DC and AC power supplies- Advanced control of power electronic circuits			
Expected outcome At the end of the semester students will have idea regarding power semiconductor devices, controlled rectifiers, DC chopper, DC to AC converters, DC and AC power supplies and advanced control of power electronic circuits.			
Text Books M. H. Rashid, <i>Power Electronics: Circuits, Devices and Applications</i>, 3rd ed., Pearson Education, Delhi, 2002 N. Mohan, T. M. Underland, and W. P. Robbins, <i>Power Electronics: Converter, Applications and Design</i>, John Wiley & Sons, New York P. S. Bimbhra, <i>Power Electronics</i>, Khanna Publishers, New Delhi, 2002.			
Reference Books G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K. Sinha, <i>Thyristorised Power Controllers</i>, NewAge International Publishers, New Delhi, 1996			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Power semiconductor devices: Power diodes-types, power transistors, thyristor family, SCRs, Triac, GTOs, power MOSFETs, IGBTs, MCTs-static and dynamic characteristics, protection circuits, series and parallel connections, turn-on characteristics, turn off characteristics	7	15%
II	Controlled rectifiers- single phase and three phase converters-power factor improvements-design of converter circuits-AC voltage controllers-single phase and three phase-cyclo converters-single phase and three phase, design of AC voltage controller circuits.	7	15%
FIRST INTERNAL EXAMINATION			
III	DC choppers – principle of step down and step up operations – step down chopper with RL load, Classes of chopper, MOSFET/IGBT choppers.	6	15%
IV	DC to AC converters: Thyristor inverters, McMurray-McMurray Bedford inverter, current source inverter, voltage control waveform control, inverters using devices other than thyristors, vector control of induction motors.	7	15%

SECOND INTERNAL EXAMINATION			
V	DC and AC power supplies: Switched mode, resonant, bi-directional and multistage conversions, buck, boost, buck boost regulators. UPS-block diagram, types. Drive requirements and design of simple drive circuits for power BJT, MOSFET and IGBT.	9	20%
VI	Advanced control of power electronic circuits using microprocessors, microcontrollers, isolation amplifier circuits, synchronization circuits.	6	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE331	MICROPROCESSORS & MICROCONTROLLERS LAB	0-0-3-1	2016
Prerequisite : AE305 Microprocessors & Microcontrollers			
Course objectives - To write ALP for arithmetic and logical operations in 8086 and 8051 - To differentiate Serial and Parallel Interface - To interface different I/Os with Microprocessors			
List of Experiments (Out of 18 experiments minimum 12 experiments are compulsory) 8086 Programs using kits : 1. Basic arithmetic and Logical operations 2. Move a data block without overlap 3. Separating Odd and Even numbers 4. Code conversion, decimal arithmetic and Matrix operations. 5. Program for sorting an array 6. Program for string manipulation 7. Floating point operations and searching. Peripherals and Interfacing Experiments 8. Stepper motor control. 9. Serial interface and Parallel interface 10. A/D and D/A interface and Waveform Generation 8051 Experiments using kits : 11. Basic arithmetic and Logical operations 12. Square and Cube program, Find 2's complement of a number 13. Unpacked BCD to ASCII 14. Program to verify Timer/Counter in 8051 15. Program and verify interrupt handling in 8051 16. UART operation in 8051 17. Communication between 8051 kit and PC 18. Interfacing LCD to 8051.			
Expected outcomes At the end of the semester students are expected to be familiar with the operations in 8086 and 8051.			

Course code	Course name	L-T-P-Credits	Year of introduction
AE332	PROCESS CONTROL LAB	0-0-3-1	2016
Prerequisite : AE302 Process control			
Course Objective - To provide experience on control of various industrial processes using different control paradigms - To provide experience in development of virtual instrumentation systems for industry applications - To introduce few novel control strategies based on artificial neural networks, fuzzy logic, digital control algorithm, etc.			
LIST OF EXPERIMENTS: (Minimum 12 experiments are to be done) 1 .ON-OFF controller with and without neutral zone-level control, flow control 2. Temperature control using P, PI, PD, and PID controllers–Study of output response 3. Flow control using P, PI, PD, and PID controllers–Study of output response 4. Liquid level control using P, PI, PD, and PID controllers–Study of output response 5. Pressure control using P, PI, PD, and PID controllers–Study of output response 6.Control valve characteristics 7. Controller tuning for various processes – using Ziegler-Nichols rule 8. Controller tuning for various processes – using Cohen and Coon rule 9.Controller Tuning – Simulation 10.Block diagram simulation of a complex control system 11Study of feed-forward, cascade, and ratio controls 12.Data Logger 13. PC based control of robotic actions 14. Simulation of Artificial Neural Networks –use any software 15.Simulation of Heat Exchanger Temperature Control 16. Interface of DCS with PLC/SCADA using protocol/fieldbus			
Expected outcome The students will be familiar with the concept of process controllers			

Course code	Course name	L-T-P-Credits	Year of introduction
AE334	POWER ELECTRONICS LAB	0-0-3-1	2016
Prerequisite : AE312 Power Electronics			
Course Objective - To familiarise the characteristics of power semiconductor devices - To provide experience on design, testing, and analysis of few power electronic circuits - To expose simulation of power electronic circuits			
Course Plan			
LIST OF EXPERIMENTS: (Minimum 12 experiments are to be done) - SCR characteristics - Triac and Diac characteristics - Phase controlled rectifier-resistance triggering - Phase controlled rectifier- UJT triggering - Chopper circuits - MOSFET characteristics - Simple DC to AC inverter circuit - Driven DC to AC inverter using MOSFET & IC - IGBT characteristics - Inverter circuit using IGBT - Digital triggering circuit for phase controlled rectifiers - Application of ICS: PWM IC TL 494, optocoupler IC -MCT2E - DC motor speed control – Using digital logic circuits/microprocessor/PC - AC motor speed control – Using digital logic circuits/microprocessor/PC - Simulation of power electronic converter and inverter circuits using software like MATLAB,PSPIC - SCR turn-off circuits using (i) LC circuit (ii) Auxiliary Commutation. - AC voltage controller using Triac – Diac combination. - Generation of firing signals for Thyristor/Triac using digital Circuit/ Microprocessor.			
Expected outcome At the end of the semester students will be familiar with the concept of power semiconductor device, power electronics circuits etc			

Course code	Course name	L-T-P-Credits	Year of Introduction
AE362	INDUSTRIAL PSYCHOLOGY	3-0-0-3	2016
Prerequisite: Nil			
Course objectives - To introduce major topics and sub-specialties including critical theory and research findings that have served to define the field of Industrial / Organizational (I/O) psychology - To increase understanding of the complicated systems of individual and group psychological processes involved in the world of work - To connect the basic principles of I/O Psychology to Personnel and Human Resources management within organizations - To allow participants to explore ways in which individual career choices and work-life success can be improved through the benefits of I/O Psychology			
Syllabus Introduction to Industrial and Organizational Psychology – Leadership - Development of Human Resources - Consumer Psychology - Decision making			
Expected outcome After completing the course the students will be able to: - Demonstrate fundamental knowledge about need and scope of I/O Psychology - Be aware of the brief history and various related fields of I/O Psychology - Learn about employee motivation, job satisfaction and leadership styles. - Understand the concept of organizational culture and learn the various types and functions of organizational culture - Comprehend the concept of Job analysis and be aware about the various methods of Job analysis. - Learn about the process of employee selection and understand the various methods of selection process with special emphasis on psychological testing. - Demonstrate knowledge about the processes of training and performance appraisal - Understand the meaning of consumer behaviour and the decision making process of the consumer. Level of Basic knowledge of psychological concepts and principles			
Text Books - Aswathappa K (2008) Human Resource Management (fifth edition), Tata McGraw Hill - Blum & Naylor (1982) Industrial Psychology. Its theoretical & social foundations, CBS Publications. - Singh N. (2011). Industrial Psychology. Tata McGraw hill Education private limited.			
References - Aamodt.M G (2016) Industrial/Organizational Psychology: An applied Approach (8th edition), Cengage Learning - Miner J B (1992) Industrial/Organizational Psychology. N Y: McGraw Hill - Robbins, S. P. (2010). Organizational behaviour. Tata McGraw Hill publications. - Schiffman, L G & Wisenblit, J. (2010). Consumer behaviour. Pearson publications. - Schultz, D. P., & Schultz, E. S. (2008). Psychology and Work today. New York: Mac Milan publishing company.			
Course Plan			

Module	Contents	Hours	Semester Exam Marks
I	Introduction to Industrial and Organizational Psychology: Introduction to industrial psychology, Definition, scope, major influences, goals, key forces, and fundamental concepts, History of industrial psychology, Major Fields of I/O Psychology, scientific management.	6	15%
II	Individual in Workplace : Motivation- Definition, Types, Theory-Maslow's and Herzberg, Job satisfaction- Definition, Factors affecting Job Satisfaction, Consequences, Leadership - Definition, Leadership Styles, Approaches to Leadership, Organizational Culture -Definition, Levels, Characteristics, Types, Functions	7	15%
FIRST INTERNAL EXAMINATION			
III	Development of Human Resources: Job Analysis- Definition, Purpose, Types, Process, Methods, Recent Developments Recruitment and Selection- Nature and objectives, Sources- Internal and External, Process, Definition and steps in selection process Performance Management- Definition, Scope, Process, Tools Training and Development- Meaning and nature, Objectives, Methods- on the job and off the job	7	15%
IV	Introduction to Consumer Psychology: Definition, Scope, Marketing concept. Market Segmentation- consumer rooted, consumption specific, and brand experience as segmentation bases. Targeting- criteria for effective targeting; Positioning and repositioning	7	15%
SECOND INTERNAL EXAMINATION			
V	Consumer Decision Making : Levels of Decision making, Views of consumer decision making, Model of consumer decision making: Input – marketing efforts, socio cultural environment. Process – psychological field, need recognition, pre-purchase search, Evaluation of alternatives Output – Purchase behavior and post purchase evaluation.	8	20%
VI	Performance management: Training & Development: Work environment & engineering psychology – fatigue, boredom, accidents & safety, Job analysis, Recruitment & Selection, Reliability & Validity of recruitment tests.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

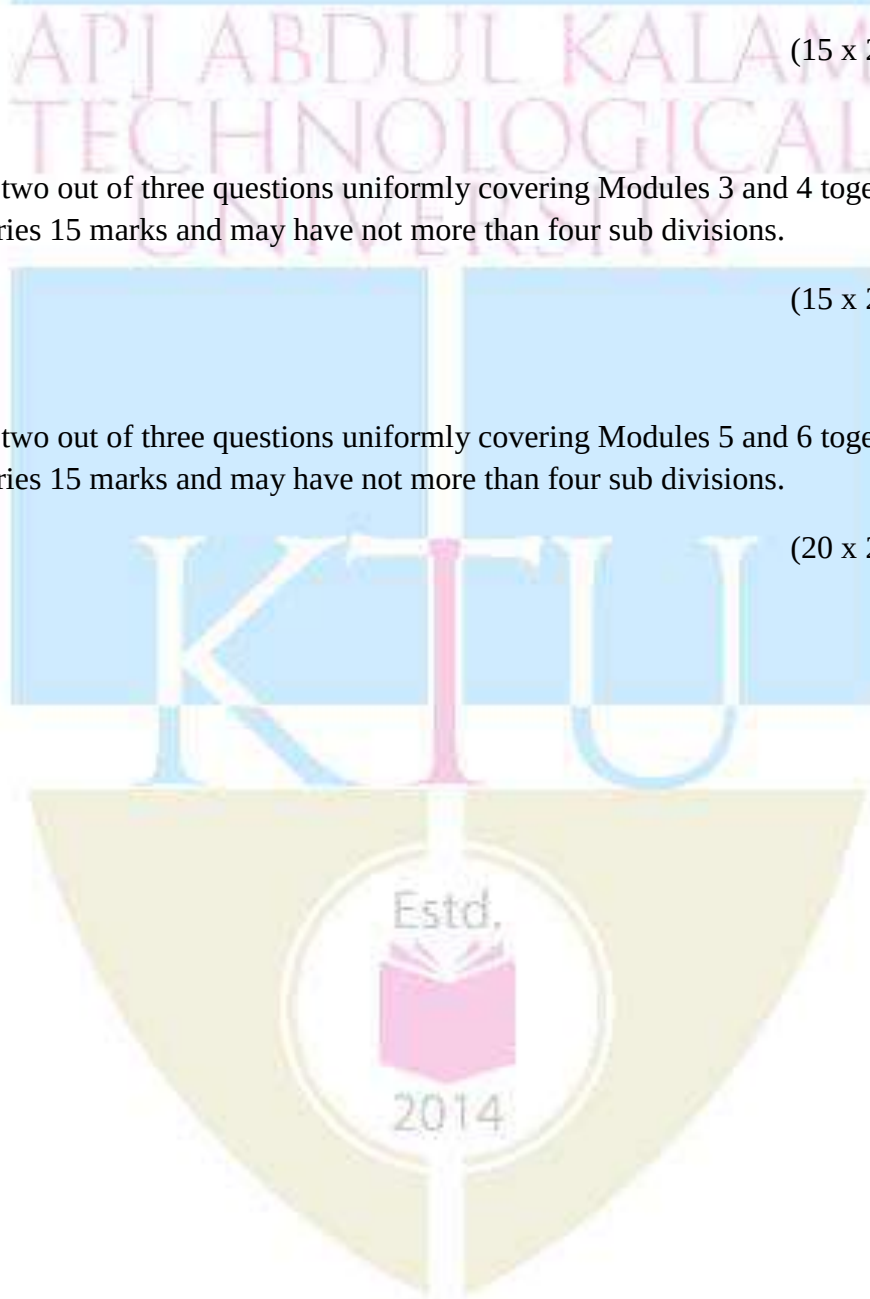
Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)



Course code	Course name	L-T-P-Credits	Year of introduction
AE363	VLSI CIRCUIT DESIGN	3-0-0-3	2016
Prerequisite : Nil			
Course Objective - To bring circuits and system views on design together. - To understand the design of digital VLSI circuits for hardware design.			
Syllabus Fundamental considerations in IC processing - NMOS IC technology - CMOS IC technology - BiCMOS IC technology- The MOS device- capacitance of MOS structure – characteristics- Second order MOS device effects- pass transistors and transmission gates -The basic inverter using NMOS- Basic NAND, NOR circuits - The CMOS inverter, - pseudo CMOS- Layout design of static MOS circuits –Stick Diagram –Fabrication-- Combinational circuits- Timing issues in VLSI system design.			
Expected outcome The students will be able - to learn layout, stick diagrams, fabrication steps , static and switching characteristics of inverters - to design digital system using MOS circuits.			
Text Books - Douglas A. Pucknell & Kamran Eshraghian, <i>Basic VLSI Design</i>, PHI. - Jan M. Rabaey, A. Chandrakasan, B. Nikolic, <i>Digital Integrated Circuits- A Design perspective</i>, 2/e, Pearson education. - Sung-Mo Kang, Yusuf Leblebici, <i>CMOS Digital Integrated Circuits Analysis and Design</i>, Tata Mc-Graw-Hill			
References - Charles H Roth Jr – <i>Fundamentals of Logic Design</i> 4 Ed, Jaico Publishers - Mead & Conway , <i>Introduction to VLSI System Design</i>-Addison Wesley - S M Sze, <i>VLSI Technology</i>, PHI - Wayne Wolf: <i>Modern VLSI Design Systems on Chip</i>-Pearson Education, 2nd ed., - Weste and Eshraghian, <i>Principles of CMOS VLSI Design</i>, A Systems Perspective,2/e, Pearson Education.			
Course Plan			
Module	Contents	Hours	Semester exam marks
I	VLSI process integration: - fundamental considerations in IC processing - NMOS IC technology - CMOS IC technology - BiCMOS IC technology - GaAs technology. Ion implantation in IC fabrication.	6	15%
II	The MOS device: (n - channel & p- channel) - capacitance of MOS structure - accumulation, depletion and inversion, threshold voltage, current equations - characteristics, channel pinch-off. Second order MOS device effects: short-channel effect, narrow width effect, sub-threshold current, device saturation characteristics.	6	15%
FIRST INTERNAL EXAMINATION			
III	Switch logic- pass transistors and transmission gates, Gate logic-The basic inverter using NMOS-circuit – current	8	20%

	equations - pull up to pull down ratio- transfer characteristics- Alternate forms of pull up. Basic NAND, NOR circuits. The CMOS inverter, characteristics – NAND, NOR and compound circuits using CMOS. Other forms of CMOS logic: pseudo CMOS, CMOS domino logic, n-p logic.		
IV	Layout design of static MOS circuits – Layout rules - general principles & steps of lay-out design - use of stick diagrams - design rules - Layout examples of NAND and NOR-Fabrication.	7	15%
SECOND INTERNAL EXAMINATION			
V	Combinational circuits - clocked sequential circuit - drivers for bus lines. Scaling of MOS circuits: scaling models and scaling factors for device parameters.	7	15%
VI	Timing issues in VLSI system design: timing classification- synchronous timing basics – skew and jitter-latch based clocking- self timed circuit design - self timed logic, completion signal generation, self-timed signalling– synchronizers and arbiters	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

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(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE364	MEMS/NEMS	3-0-0-3	2016
Prerequisite : Nil			
Course objectives - To introduce the concept of MEMS and Microsystems. - To understand the diverse technological and functional approaches and applications - To provide an insight of micro sensors, actuators and micro fluidics.			
Syllabus Microsystems - Micro Manufacturing Techniques - Micro Actuators - Micro Sensors - Micro/Nano Fluids - Microsystem Design and Packaging			
Expected outcome On completion of the course, the students will be able to - Become familiar with micro fabrication techniques - Assess whether using a MEMS based solution is the relevant and best approach - Select the most suitable manufacturing process and strategies for micro fabrication			
Text Book Maluf, Nadim "An introduction to Microelectromechanical Systems Engineering" "AR Tech house, Boston 2000.			
Reference Books: - Mohamed Gad – el – Hak "MEMS Handbook" Edited CRC Press 2002 - Sabrie Solomon "Sensors Handbook", Mc Graw Hill, 1998 - Marc F Madou, " Fundamentals of micro fabrication," CRC Press 2002 2nd Edition - Francis E.H Tay and W. O. Choong, "Micro fluidics and bio MEMS application" IEEE Press New York 1997 - Trimmer William S, "Micromachinics and MEMS", IEEE Press, New York 1997			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Foundation in Microsystems : Review of microelectronics manufacture and introduction to MEMS- Overview of microsystems technology, Laws of scaling- The multi-disciplinary nature of MEMS- Survey of materials central to micro engineering- Applications of MEMS in various industries	6	15%
II	Micro Manufacturing Techniques : Photolithography- Film deposition, Etching Processes-Bulk micro machining, silicon surface micro machining	6	15%
FIRST INTERNAL EXAMINATION			
III	Micro Actuators : Energy conversion and force generation- Electromagnetic Actuators, Reluctance motors, piezoelectric actuators, bi-metal-actuator Friction and wear	7	20%
IV	Micro Sensors : Transducer principles-Signal detection and signal processing-Mechanical and physical sensors- Acceleration sensor, pressure sensor, Sensor arrays.	7	15%

SECOND INTERNAL EXAMINATION			
V	Introduction to Micro/Nano Fluids : Fundamentals of micro fluidics- Micro pump – introduction – Types - Mechanical Micro pump – Non mechanical micro pumps, Actuating Principles, Design rules for micro pump – modeling and simulation, Verification and testing – Applications	8	20%
VI	Microsystem Design and Packaging : Design considerations-Mechanical Design, Process design, Realization of MEMS components using Intellisuite. Micro system packaging-Packing Technologies-Assembly of Microsystems- Reliability in MEMS.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE366	EMBEDDED SYSTEM DESIGN	3-0-0-3	2016
Prerequisite : Nil			
Course objectives To impart the basic functions and structure of embedded systems Outcomes.			
Syllabus Embedded Systems Vs General Computing Systems - Purpose of Embedded Systems - Core of the Embedded System – Memory - Embedded Firmware - RTOS Based Embedded System Design - Task Communication - Task Synchronization - Programming concepts of Embedded programming in C Program - Concepts of embedded programming in C++ – Real time operating systems Definitions of process.			
Expected outcome At the end of the semester students will be able to understand the basic concepts & applications of embedded systems.			
Text Books - Shibu K.V, <i>Introduction to Embedded Systems</i>, Mc Graw Hill - Wayne Wolf, <i>Computers as Components: Principles of Embedded Computing System Design</i> – Harcourt India, Morgan Kaufman Publishers, First Indian Reprint 2001			
Reference Books - David E. Simon <i>An Embedded Software Primer</i>, Pearson Education. - Frank Vahid and Tony Givargis, <i>Embedded System Design – A unified Hardware / Software Introduction</i>, John Wiley, 2002. - Lyla B Das, <i>Embedded Systems An Integrated Approach</i>, Pearson, 2013 - Rajkamal, <i>Embedded Systems Architecture, Programming and Design</i>, TATA McGraw-Hill, First reprint Oct. 2003			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	6	15%
II	Typical Embedded System: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: On board and External Communication Interfaces.	7	15%
FIRST INTERNAL EXAMINATION			
III	Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.	7	15%

IV	RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.	7	15%
SECOND INTERNAL EXAMINATION			
V	Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication /Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.	7	20%
VI	Programming concepts of Embedded programming in C Program Elements, Macros and functions - Use of Pointers - NULL Pointers - Use of Function Calls – Multiple function calls in a Cyclic Order in the Main Function Pointers – Function Queues and Interrupt Service Routines Queues Pointers – Concepts of embedded programming in C++ – Cross compiler – Optimization of memory codes. Real time operating systems Definitions of process, tasks and threads.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE368	PLASTIC ENGINEERING	3-0-0-3	2016
Prerequisite: Nil			
Course objectives - To give the concept of plastic engineering and their standards. - To understand the diverse technological and functional approaches and applications - To provide an insight of testing, identification and quality control.			
Syllabus Engineering Plastics- Concept of testing & identification of plastics- Test methods and standards for bio-degradable plastics - Recycling technologies for bio degradable plastics - Inspection and quality control of moulds - Environmental consideration			
Expected outcome On completion of the course, the students will - become familiar with testing methods and standards of plastic. - be able to test the quality control of different modules. - be able to identify how to engineer along with the environmental consideration.			
Text Books - Cyril Donaldson, George H.Lecain, V C Goold, Tool Design, TATA McGraw Hill,1998. - Fred W. Billmeyer, Jr., Text Book of Polymer Science, John Wiley & Sons, Singapore,1994. - G.J.L. Griffin, Chemistry and Technology of Biodegradable Polymers, Blackie Academic Professional, 1994.			
Reference Books: - Abraham J. Domb, Joseph Kost & David M.Wiseman, Handbook of Biodegradable polymers, CRC Press - Dominick V. Rosato, DonaldV. Rosato, Injection Molding Hand Book, CBC Publishers&Distributors,1987 - Gerald Scott & Dan Gilad, Degradable Polymers-Principles & Applications, Chapman & Hall, 1995. - Gordon L. Robertson, Food Packaging Principles and Practice, Marcel Dekker, Inc., New York 1993. - IrwinI Rubin, Injection Molding Theory and Practice, Wisely Inter science Publication, 1972. - Louis T. Manzione, Plastic Packaging of Microelectronic Devices, Van Nostrand Reinhold, New York, 1990. - Plastics Engineering Hand Book of the Society of the Plastics Industry Inc.,Van Nostrand Reinhold Company, 1945. - Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons Inc., New York, 1998.			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Engineering Plastics : Sources and Manufacture of raw materials, Methods of Manufacture of Polymer, General Properties and applications of Acrylonitrile Butadiene	8	15%

	Styrene -Polyamides (PA-6,PA-66,PA-6,10,PA-11&12) – Polycarbonates – Poly acetal & Copolymers - Thermoplastic Polyesters (PET&PBT) Poly phenylene oxide – Poly sulfones Fluoropolymers (PVF,PVDF,PTFE,PCTFE) - Thermoplastic Polyurethane.		
II	Concept of testing & identification of plastics : Basic concepts of testing - Specification and Standards - National and International Standards - Test specimen preparation - Pre-conditioning and test atmosphere. Identification of plastics by simple tests - Visual examination - Density - Melting point - Solubility test - Flame test - Chemical tests.	8	15%
FIRST INTERNAL EXAMINATION			
III	Test methods and standards for bio-degradable plastics: Plastics – criteria used in evaluation of biodegradable plastics – description of current Test methods – Scanning test for ready biodegradability – Test for inherent biodegradability – Test for simulation studies – Other methods for assessing polymer biodegradability	6	15%
IV	Recycling technologies for bio degradable plastics: Conventional recycling – Degradable complicate recycling – reprocessing polyethylene starch/film scrap – Economics in in-plant recycling	6	
SECOND INTERNAL EXAMINATION			
V	Inspection and quality control of moulds : Introduction to Tool Room measuring instruments – Vernier– Micrometer – Height Gauge–Slip Gauge–Dial Gauge–Measuring tapers and angles–CMM	7	20%
VI	Environmental consideration: Plastic waste – Classification, Segregation, Sorting and Waste Management viz. source reduction, reuse/repair, recycling related to packaging films and constrainers. Pollutants an outline – Chloro Fluoro Carbon (CFC), Dioxin Life cycle assessment: A case study	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

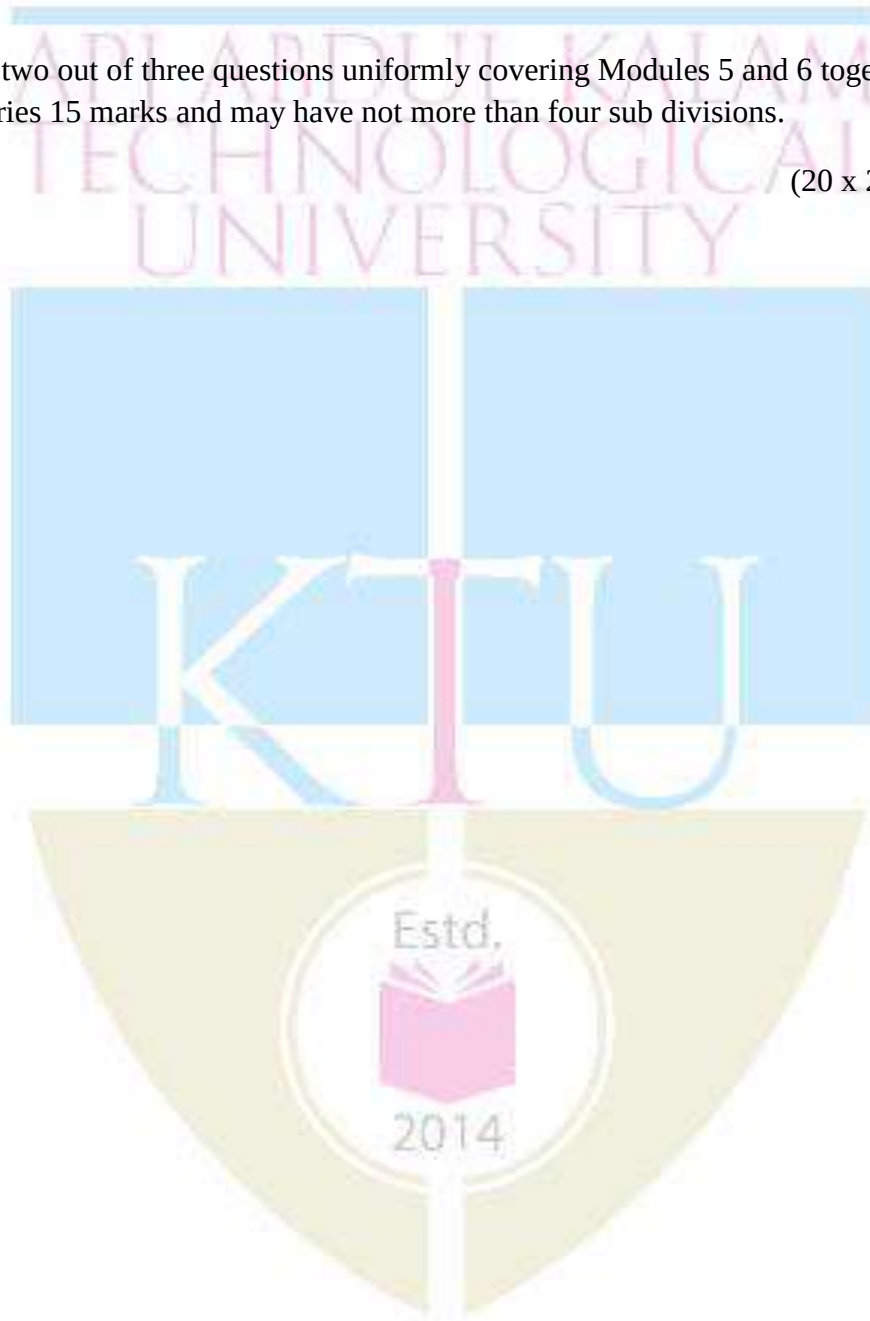
Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)



Course code	Course name	L-T-P-Credits	Year of Introduction
EE337	ELECTRICAL ENGINEERING LAB	0-0-3-1	2016
Prerequisite : EE216 Electrical Engineering			
Course objectives - To study the performance characteristics of dc and ac machines and transformers. - To familiarize various electrical measurement methods			
Experiments - Plot open circuit characteristics of DC shunt generator for rated speed - Predetermine O.C.C. for other speeds - Determine critical field resistance for different speeds - Load test on DC shunt generator - Plot external characteristics - Deduce internal Characteristics - Load test on DC series motor - Plot the performance characteristics - OC and SC tests on single phase transformer - Determine equivalent circuit parameters - Predetermine efficiency and regulation at various loads and different power factors - verify for unity power factor with a load test - Load test on 3 phase cage induction motor - Plot performance curves - Resistance measurement using (a) Wheatstone's bridge (b) Kelvin's double bridge - Measurement of self-inductance, mutual inductance and coupling coefficient of (a) Transformer windings (b) air cored coil - Power measurement in 3 phase circuit - Two wattmeter method - Extension of ranges of ammeter and voltmeter using shunt and series resistances - Calibration of Single phase energy meter by direct loading			
Expected outcomes At the end of the semester students are expected to be familiar with the working and characteristics of DC and AC machines.etc			

Course code	Course name	L-T-P-Credits	Year of Introduction
AE361	VIRTUAL INSTRUMENT DESIGN	3-0-0-3	2016
Prerequisite : Nil			
Course objectives - To review background information required for studying virtual instrumentation. - To study the basic building blocks of virtual instrumentation. - To study the various graphical programming environment in virtual instrumentation. - To study few applications in virtual instrumentation.			
Syllabus Review of digital instrumentation - Fundamentals of virtual instrumentation - VI programming techniques - Data acquisition - VI Chassis requirements - Graphical programming environment - Analysis tools and simple applications			
Expected outcome The students will gain knowledge in virtual instrumentation and some of its applications.			
Text Books - Peter W. Gofton, 'Understanding Serial Communications', Sybex International. - Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2003. S. Gupta and J.P Gupta, 'PC Interfacing for Data Acquisition and Process Control', Instrument society of America, 1994.			
Reference Books - Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw Hill Professional Publishing, 2006. - Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newness, 2000. WEB RESOURCES: www.ni.com			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Review of digital instrumentation: - Representation of analog signals in the digital domain – Review of quantization in amplitude and time axes, sample and hold, sampling theorem, ADC and DAC.	6	15%
II	Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.	7	15%
FIRST INTERNAL EXAMINATION			
III	VI programming techniques: VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.	7	15%

IV	Data acquisition basics: Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.	6	15%
SECOND INTERNAL EXAMINATION			
V	VI Chassis requirements. Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.	8	20%
VI	VI toolsets, Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE401	LOGIC & DISTRIBUTED CONTROL SYSTEM	4-0-0-4	2016
Prerequisite: AE301 Control system			
Course objectives - To give an introductory knowledge about PLC and the programming languages. - To give basic knowledge in the architecture and local control unit of distributed control system. - To give adequate information in the interfaces used in DCS. - To give basic knowledge about Computer Controlled Systems.			
Syllabus Programmable Logic Controller - Architecture of PLC - Design of PLC - PLC Basic Functions - Applications Of PLC - Instructions in PLC - PLC programming methods as per IEC 61131 – SCADA - Distributed Control System - Architectures - Interfaces In DCS - Process Safety & Safety Management System - Risk Terminologies - Instrumented System.			
Expected outcome At the end of the course, students will be able to : - Understand the basics of PLC and PLC Programming - Know the whereabouts of implementation of SCADA - Reproduce the working of Distributed Control System - Perform the implementation of DCS - Recognise the safety procedures to be maintained in an industry			
Text Books - John. W. Webb Ronald A Reis - Programmable Logic Controllers - Principles and Applications, Fourth edition, Prentice Hall Inc., New Jersey, 1998. - Michael P. Lukas, 'Distributed Control Systems', Van Nostrand Reinhold Co., Canada, 1986 - Petruzella, 'Industrial Electronics', McGraw Hill, Second edition, 1997.			
Reference Books - Krishna Kant – Computer based Industrial Control, Prentice Hall, New Delhi, 1997. - Thomas A. Hughes, 'Programmable Logic Controllers', ISA press, 2007.			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Programmable Logic Controller : Evolution of PLC's, Components of PLC, Advantages over relay logic, Architecture of PLC, Programming devices, Discrete and Analog I/O modules, Programming languages, Ladder diagram, Programming timers and counters, Design of PLC, Definition of PLC, , overview of PLC systems, input/output modules, power supplies, isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions: PLC Basic Functions: Register basics, timer functions, counter functions.	9	15%
II	Applications Of PLC : Instructions in PLC	9	15%

	Program control instructions, math instructions, sequencer instructions, Use of PCas PLC, Application of PLC, Case study of bottle filling system, PLC programming methods as per IEC 61131, Developing programs using Sequential Function Chart, Functional Block Diagram, Analog control using PLC (PID controller configuration), Interfacing PLC to SCADA/DCS using communication link (RS232, RS485) , Protocols (Modbus ASCII/RTU) and OPC, Development stages involved for PLC based automation systems.		
FIRST INTERNAL EXAMINATION			
III	Computer Controlled Systems: Basic building blocks of Computer controlled systems, SCADA, Data Acquisition System, Supervisory Control, Direct digital Control.	7	15%
IV	Distributed Control System : DCS - Architectures, Comparison, Local control unit, Process interfacing issues, Communication facilities. Distributed Control System Basics: DCS introduction, Various function Blocks, DCS components/block diagram, DCS Architecture of different makes, comparison of these architectures with automation pyramid, DCS specification, latest trend and developments, DCS support to Enterprise Resources Planning (ERP), performance criteria for DCS and other automation tools.	10	15%
SECOND INTERNAL EXAMINATION			
V	Interfaces In Dcs : Operator interfaces, Low level and high level operator interfaces, Operator displays, Engineering interfaces, Low level and high level engineering interfaces, General purpose computers in DCS, DCS detail Engineering, configuration and programming, functions including database management, reporting, alarm management, diagnosis.	9	20%
VI	Process Safety & Safety Management System : Process safety and Safety Management Systems: Introduction to process safety, risk, risk terminologies, consequence and risk, risk measurement, Process Hazard Analysis (PHA), Hazard and operability study (HaZOp), Safety Integrity Level (SIL), Introduction to IEC61511 standard for Functional safety, protection layers, Safety Instrumented System:	10	20%

	function, architecture, safety life cycle, Application of safety system.		
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

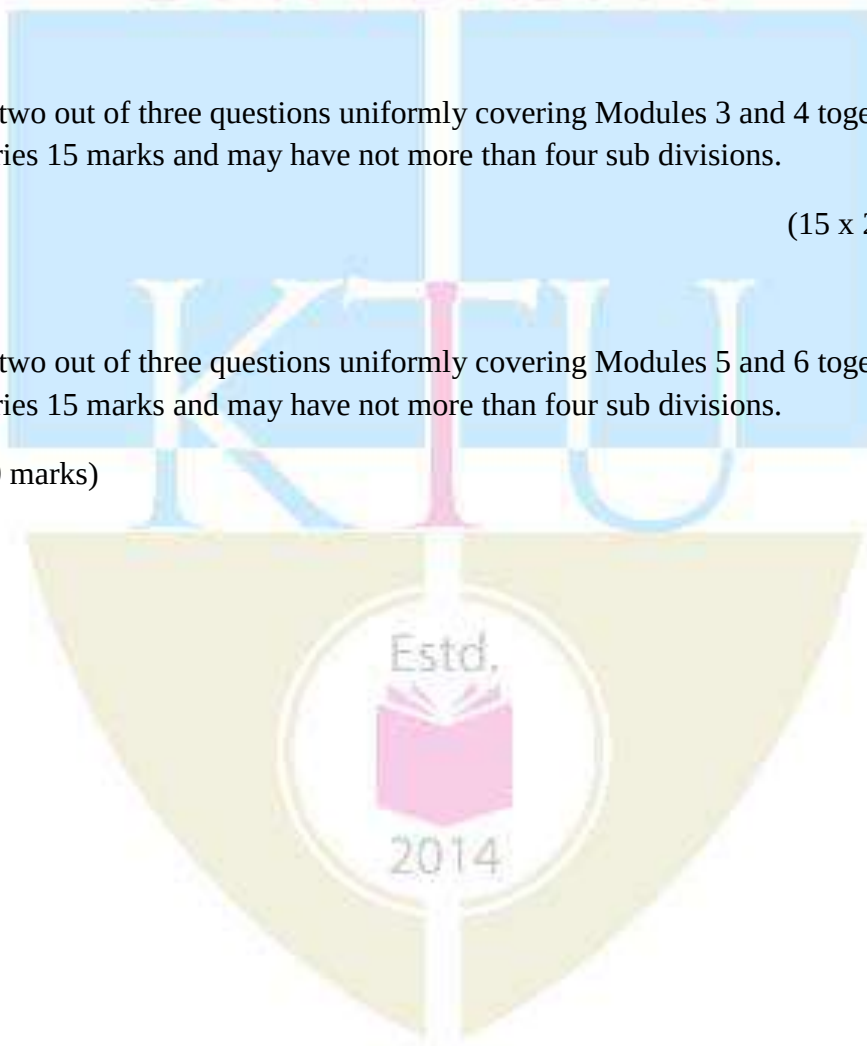
Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)



Course code	Course name	L-T-P-Credits	Year of Introduction
AE402	ANALYTICAL INSTRUMENTATION	3-0-0-3	2016
Prerequisite : Nil			
Course objectives - To review background information required for studying virtual instrumentation. - To study the basic building blocks of virtual instrumentation. - To study the various graphical programming environment in virtual instrumentation. - To study a few applications in virtual instrumentation.			
Syllabus Fundamentals of analytical instruments –Classification of instrumental techniques - Electromagnetic radiation- Electromagnetic spectrum- Absorption spectroscopy - Ultra violet and visible absorption spectroscopy - Colorimeters/ photometers - Spectro photometers - Infra red spectroscopy - Atomic absorption spectrophotometers - Fluorescence spectroscopy - Raman spectrometer - Mass spectrometer - Nuclear Magnetic Resonance spectroscopy - Electron spectroscopy - X- Ray spectrometers - Chromatographic process – Classification - Gas chromatography - Liquid Chromatography - High pressure Liquid Chromatography - Industrial Gas analysers - Gas analysers - Blood PH measurement – Thin film technology for gas sensors- Thermal Sensors.			
Expected outcome At the end of the semester students will be able to obtain comprehensive knowledge in analytical instrumentation and some of its applications.			
Text Books - Skoog, Holler, Nieman, “Principles of Instrumental Analysis”, Thomson books-cole publications, 5th edition. - Willard, Merritt, Dean, Settle , “Instrumental Methods of Analysis”, CBS Publishers & Distributors, New Delhi, Seventh edition.			
Reference Books - Galen W. Ewing, “Instrumental Methods of Chemical Analysis”, , McGraw-Hill Book Company, Fifth edition. R. S. Khandpur , “Handbook of Analytical Instruments”, , Tata McGraw–Hill Publications, 3rd edition. - Robert D. Braun, “Introduction to Instrumental Analysis”, , McGraw-Hill Book Company			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Introduction to Analytical Instrumentation: Fundamentals of analytical instruments: Elements of an analytical instrument – PC based analytical instruments –Classification of instrumental techniques. Electromagnetic radiation- Electromagnetic spectrum- Laws relating to absorption of radiation. Absorption spectroscopy: Absorption instruments – Radiation sources- Optical filters- Monochromators- Detectors. Ultra violet and visible absorption spectroscopy.	6	15%
II	Colorimeters/ photometers: Single beam and double beam filter photometer – Spectro photometers: Single beam and	7	15%

	double beam spectro photo meters- Infra red spectroscopy: Basic components- Radiation sources- Monochromators- Detectors. Flame Photometry: Principle and constructional details of flame photometer- Emission system – Optical system – Detectors. Atomic absorption spectrophotometers: Theoretical concepts, Instrumentation: Radiation sources - Burners and flames - Plasma excitation sources - Optical and electronic system.		
FIRST INTERNAL EXAMINATION			
III	Fluorescence spectroscopy: Principle of fluorescence – Measurement of fluorescence – Single beam and double beam filter fluorimeter- Ratio fluorimeter. Spectro fluorimeters. Raman spectrometer- Basic theory-Photo acoustic spectroscopy- Photo thermal spectroscopy. Mass spectrometer: Principle of operation- Magnetic deflection mass spectrometers- Components of a mass spectrometer – Inductively coupled plasma mass spectrometer.	7	15%
IV	Nuclear Magnetic Resonance spectroscopy: Basic principle – Constructional details of NMR spectrometer – Nuclear radiation detectors. Electron Spin Resonance spectrometer: Basic ESR spectrometer – Electron spectroscopy: Instrumentation for electron spectroscopy. X- Ray spectrometers: X – ray spectrum –Instrumentation for x –ray spectrometry. X-ray diffractometers- X-ray absorption meters- X- ray fluorescence spectrometry.	7	15%
SECOND INTERNAL EXAMINATION			
V	Chromatography: Chromatographic process – Classification- Terms in chromatography- Gas chromatography: Block diagram- Principle - Constructional details – Column details- GC detectors. Liquid Chromatography: Types of liquid chromatography- High pressure Liquid Chromatography (HPLC): Principle- Constructional details.	7	20%
VI	Industrial Gas analyzers- pH meters- Conductivity meters - Dissolved oxygen meters- Sodium analyser– Gas analysers- Paramagnetic oxygen analyser – CO analysers – Flue gas analysers- Blood PH measurement – Thin film technology for gas sensors- Basic concepts. Measurement techniques and application of gas sensors. Thermal Sensors:- Radiation Sensors, Mechanical Sensors and Bio-Chemical sensors.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

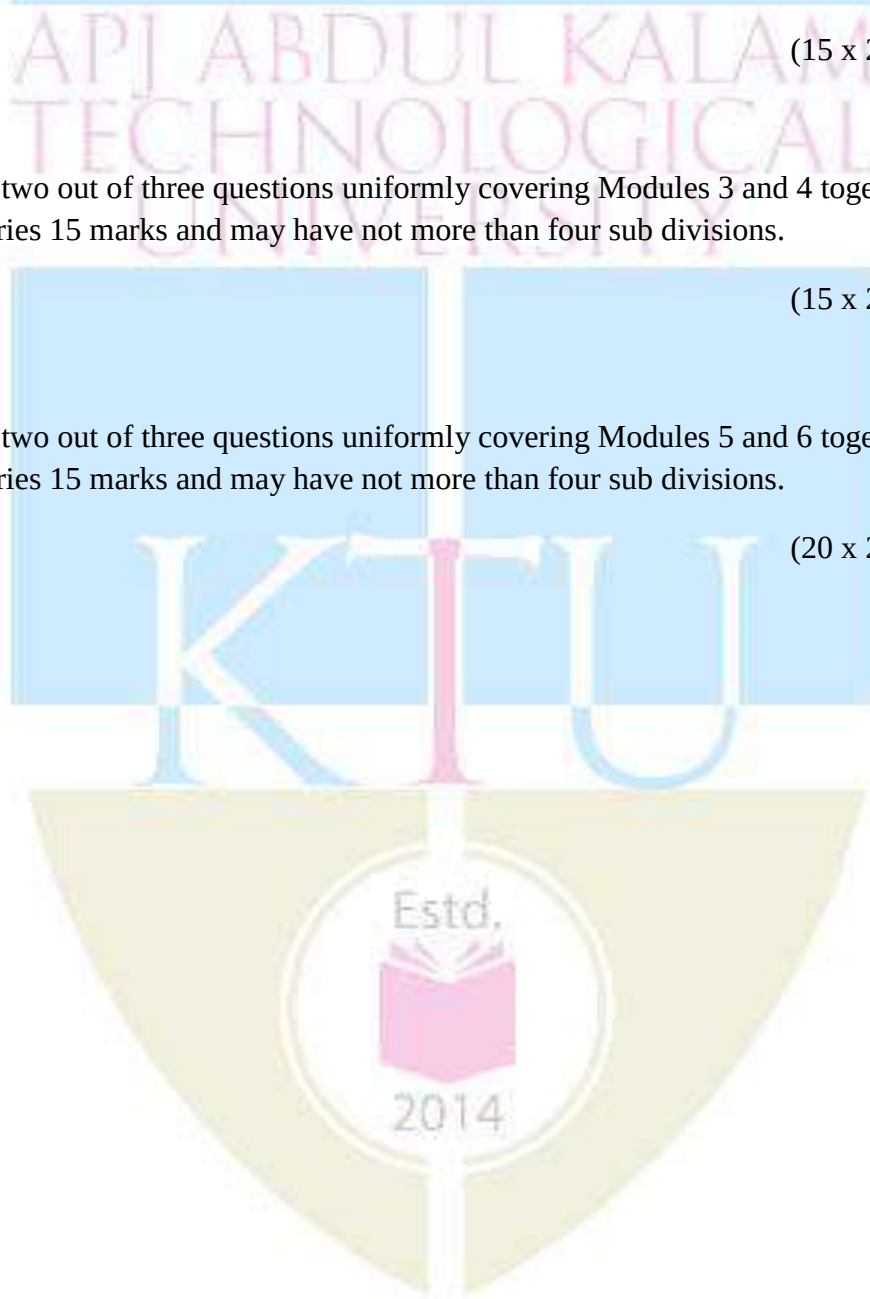
Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)



Course code	Course name	L-T-P-Credits	Year of Introduction
AE405	ADVANCED CONTROL THEORY	3-0-0-3	2016
Prerequisite: AE301 Control system			
Course objectives - To study the basic theory required for solving complex control problems. - To do analysis and modelling of systems and signals.			
Syllabus Concept of state space - Linear time varying system - Non-linear system - Describing function analysis -Lyapunov stability analysis – Controllability- Observability - Z- Transform - Discrete root locus.			
Expected outcome At the end of the semester students will have comprehensive knowledge in advanced control theory.			
Text Books/Reference books C. D. Johnson, <i>Process Control Instrumentation Technology</i>, 7th ed., Prentice Hall of India, New Delhi, 2003 - K.Ogata “<i>Discrete Time Control Systems</i>” , 1996, PHI. - K.Ogata “<i>Modern Control Engineering</i>” , 1996, PHI. M. Gopal, “<i>Modern Control System Theory</i>”,New Age International Publishers, 2nd edition,1996 - Madangopal “<i>Digital control and state variables methods</i>” 1997, PHI. R. C. Dorf and R. H. Bishop, <i>Modern Control Systems</i>, 8th ed., Pearson Education, Delhi, 2004			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Concept of state space-state space representation of system, solution of time invariant state equation- state transition matrix. Linear time varying system. Discrete system state space representation and solution.	6	15%
II	Non-linear system, types of non-linearity, singular point, non-linear system stability analysis- phase plane technique, construction of phase trajectories, isocline method.	6	15%
FIRST INTERNAL EXAMINATION			
III	Describing function analysis : Basic concepts, derivation of describing functions for common non-linearities Describing function analysis of non-linear systems – Conditions for stability – Stability of oscillations.	7	15%
IV	Lyapunov stability analysis- definition of stability, instability and asymptotic stability. Lyapunov stability theorems. Stability analysis of simple linear systems.	7	15%
SECOND INTERNAL EXAMINATION			

V	MIMO systems-controllability- Observability- Effect of pole-zero cancellation, Practical examples-controllable and uncontrollable systems-observable and unobservable systems. Optimal control system-definition- design using state variable feedback and error squared performance indices.	8	20%
VI	Z- Transform and digital control system- Z-transfer function- block diagram- signal flow graph- discrete root locus.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE407	DIGITAL CONTROL SYSTEM	3-0-0-3	2016
Prerequisite : AE301 Control system			
Course objectives - To study the stability analysis of digital control system - To equip the basic knowledge of digital process control design			
Syllabus Discrete Data Control Systems - Signal conversion & processing - Z-transform- inverse Z-transform - Digital control systems- Pulse transfer function - Stability tests Frequency domain analysis of discrete systems - State space representation - Controllability and Observability -			
Expected outcome At the end of the semester Students will have knowledge of digital process control design.			
Text Books B. C. Kuo , “<i>Digital control systems</i>” (Second Edition) , Oxford University Press, 2007 K. Ogatta, “<i>Discrete Time control systems</i> ”, 2nd ed. (PHI),1995 M. Gopal, “<i>Digital Control systems and state variable methods</i>”, Tata McGraw Hill.			
Reference - John Dorsey , “<i>Continuous & Discrete Control Systems</i> “, (MGH). - Nagrath & Gopal , “<i>Control System Engineering</i>” (Wiley Eastern).			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Introduction: Basic Elements of discrete data control systems, advantages of discrete data control systems, examples. Signal conversion & processing: Digital signals & coding, data conversion & quantization, sample and hold devices, Mathematical modeling of the sampling process; Data reconstruction and filtering of sampled signals: Zero order hold, first order Hold and polygonal hold.	6	15%
II	Review of Z transform. z transform and inverse z transform . Relationship between s- plane and z- plane- Difference equation . Solution by recursion and z- transform.	6	15%
FIRST INTERNAL EXAMINATION			
III	Digital control systems- Pulse transfer function . z transform analysis of closed loop open loop systems- Modified z- transfer function- Stability of linear digital control systems	8	20%
IV	Stability tests- Steady state error analysis- Root loci - Frequency domain analysis- Bode plots- Gain margin and	8	20%

	phase margin		
SECOND INTERNAL EXAMINATION			
V	Review of state space techniques to continuous data systems, state space representation of discrete time systems- Transfer function from state space model-various canonical forms- conversion of transfer function model to state space model-characteristics equation- solution to discrete state equations.	7	15%
VI	Controllability and Observability - Response between sampling instants using state variable approach-Pole placement using state feedback . Dynamic output feedback- Effects of finite wordlength on controllability and closed loop pole placement-	7	15%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE409	OPTICAL INSTRUMENTATION	3-0-0-3	2016
Prerequisite : Nil			
Course objectives - To understand the basic concepts of fiber optics. - To study optical communication and optical instruments. - To provide basic knowledge in Laser and its application.			
Syllabus Principle of Optical fiber - Numerical aperture - Types of optical fibers - Optical sources- Optical detectors - Fibre optic sensors - Different types of modulators – Interferometers - Interference filters - Optical spectrum analyzer - Lasers - Population inversion - Semiconductor lasers - Laser Doppler Anemometry - Medical application of lasers.			
Expected outcome At the end of the semester the students will have knowledge of optical fiber and optical instrumentation techniques.			
Text Books/Reference books G. Keiser, “Optical Fibre Communication”, McGraw Hill, 1995. - J.Wilson and J.F.B.Hawkes , “Optoelectronics: An Introduction”, Prentice Hall of India. - John F. Ready, “Industrial Applications of Lasers”, Academic Press, 1978. - John M. Senior, “Optical Fiber Communications-Principles and Practice”, Pearson Education Limited. - K.Thygarajan and A.K.Ghatak , “Lasers: Theory and Applications “, Plenum Press. - O.Svelto , “ Principles of Lasers “ ,Plenum Press.			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Principle of Optical fiber – Acceptance angle and acceptance cone –Numerical aperture – V-number – Types of optical fibers (Material, Refractive index and mode) – properties- Optical sources-Optical detectors. Optical fiber production and fabrication.	6	15%
II	Fibre optic sensors – Fibre optic instrumentation system for measurement of fibre characteristics – Different types of modulators – Interferometric method for measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain – fiber optic gyroscope. Source coupling- Fiber connection-Splicing Techniques.	8	15%
FIRST INTERNAL EXAMINATION			
III	Interferometers – Fabry – perot and Michelson interferometers – Interference filters – Interferometric method of measurement – Interference filters – Interferometric method of measurement of optical components – Optical spectrum analyzer.	7	15%

IV	Lasers – Principles of operation – Einstein relations – Population inversion – Optical feedback – laser modes – Classes of laser – Solid state, gas and liquid dye lasers– Semiconductor lasers – Q-switching and mode locking – Properties of laser light.	6	15%
SECOND INTERNAL EXAMINATION			
V	Laser applications: Laser for measurement of distance, length, atmospheric effect and pollutants-Laser Doppler Anemometry (LDA) - Material processing: Laser heating, Melting, Scribing, Trimming, Welding.	8	20%
VI	Medical application of lasers- Laser and Tissue interaction-Laser diagnosis-Laser instruments for microsurgery, Removal of tumors of vocal chords, Brain surgery, dermatology, Oncology and Ophthalmology.	7	15%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE431	CONTROL SYSTEM AND SIGNAL PROCESSING LAB	0-0-3-1	2016
Prerequisite : AE301 & AE306			
Course objective To give hands on experience in various digital Signal Processing techniques using TMS 320C6X family processors and in control system analysis using MATLAB.			
List of Experiments CONTROL SYSTEM LAB using MATLAB - Familiarization of MATLAB commands used in control system design - Representation of system in MATLAB: state space representation & transfer function representation - Stability analysis using Bode plot, root locus & their pole-zero-gain representation. - Implementation of Ziegler- Nicholas/ Cohen-coon tuning method for 1st order system. - Analysis of a closed loop system. - Implementation of PID control using both m-file and Simulink. - Pole placement technique applied to stabilize a system. - Realization of a compensator design. - Modelling and analysis of a first order system. - Modelling of an unstable system (inverted pendulum, ball & plate system etc.) PC Based Control - PLC programming: familiarization of instruction set. - PLC programming: simulation of process control. - SCADA interface. - Familiarization of Distributed Control System (DCS) with different process stations pressure, flow and level. LabVIEW based Virtual Instrumentation - Getting started with LabVIEW: Basic operations, controls, indicators, and simple Programming structures. - Debugging a VI and sub-VI. - Familiarization of DAQ card. SIGNAL PROCESSING LAB - Familiarization of signal processing commands used in MATLAB Software. - Developing elementary signal function modules (m-files) for unit impulse, step, exponent and ramp sequence. - Generating continuous and discrete time sequences. - Carrying out mathematical operations on signals. - Response of LTI system described by difference and differential equation. - Developing a program for computing inverse Z-Transform. - Developing program for finding magnitude & phase response of LTI System - Developing program for computing DFT & IDFT. - Developing a program for computing circular convolution. - Design of filter: FIR, IIR, ECG Signal filter (can be done as 3 separate experiments).			
Expected outcome At the end of the semester students are expected to be familiar with the basic signal processing & control system techniques.			

Course code	Course name	L-T-P-Credits	Year of Introduction
AE461	ARM SYSTEM ARCHITECTURE	3-0-0-3	2016
Prerequisite : Nil			
Course objectives To introduce the concepts of embedded processors and ARM based development.			
Syllabus Embedded Computers - Embedded System Design - ARM Architecture - Instruction Set - ARM Processor –Assembly programming - Component Interfacing - ARM interfacing programs - Peripherals In ARM Processors - Peripherals and their control - ARM tools and Peripherals - Arm Procedure Call Standard - Example C program.			
Expected outcome At the end of the semester students must be able to obtain comprehensive knowledge in embedded processors and ARM based system.			
Text Books - Steve Furber, “<i>ARM system on Chip Architecture</i>”, 2nd Edition, Addison Wesley Publishers, 2013 - Wayne Wolf, “<i>Computers as Components Principles of Embedded Computing System Design</i>”, Morgan Kaufman Publishers, 2001			
Reference Books: - David Seal, “<i>ARM Architecture Reference Manual</i>”, 2nd Edition, Addison Wesley Publishers, 2001 - Frank Vahid and Tony. D.Givargis, “<i>Embedded System Design - A Unified Hardware/Software Introduction</i>”, John Wiley Sons, 2000.			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Embedded Computers – Characteristics of Embedded Computing Applications–Challenges in Embedded Computing. Embedded System Design –Process Requirements – Specification	6	15%
II	ARM Architecture: The ARM Instruction Set Architecture. Bus structure and the peripherals. Register set, Exception modes, Software Interrupt.	6	15%
FIRST INTERNAL EXAMINATION			
III	ARM Processor – Memory organization and processor initialization [start up code]. Load store instruction set. Assembly programming using Assemblers, Linkers, Loaders and Debuggers. Component Interfacing – Designing with Microprocessor Development and Debugging – Design Example Alarm Clock	8	15%
IV	ARM interfacing programs: GPIO, Timers, Counters, PWM, ADC. Application coding examples: Measurement and control of time, frequency velocity acceleration, power	8	15%

	control and touch monitoring		
SECOND INTERNAL EXAMINATION			
V	Peripherals In ARM Processors: ARM / THUMB architecture. Program structure to Supervisor, Kernel, and User modes. Peripherals and their control: GPIO, Timers, Counters, PWM, ADC and serial communication channels.	7	20%
VI	ARM tools and Peripherals: ARM Development Environment, Arm Procedure Call Standard (APCS), Example C program.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE463	AEROSPACE & NAVIGATION INSTRUMENTS	3-0-0-3	2016
Prerequisite : Nil			
Course Objective - To introduce the basics of aerospace engineering - To impart ideas on aircraft and navigation instruments			
Syllabus History of aviation and space flight - - basics of aerodynamics - Airplane performance- Introduction to turbojet and turbofan engines- Basic engine instruments- Aircraft compass- Air speed indicator- GPS and GNSS- Introduction to guidance, navigation and avionics- Introduction to navigation and guidance instrumentation- MEMS gyroscopes and accelerometers.			
Expected outcome At the end of semester, the students will - be familiar with the basics of aerospace engg and navigation - have an idea about the instrumentation used in aerospace engineering			
Text Books - Nagaraja.M.S, Elements of electronic navigation, Tata McGraw Hill - Pallet.E.H.J , Aircraft instruments- Principles and applications, Pitman Pub			
Reference books - Ernest O Doebelin, Dhanesh N Manik , Measurement Systems-Application and Design, 5th Edition, Tata McGraw Hill, 2007 - Jewel B Barlow, William H. Rae, Jr. , Alan Pope , Low-Speed Wind Tunnel Testing, , John Wiley, Third Edition, 1999 - Marcel J. Sidi, Spacecraft Dynamics and Control-A Practical Engineering Approach, , Cambridge University Press, 1997.			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	History of aviation and space flight- anatomy of airplane and space vehicle with emphasis on control surfaces- airfoil nomenclature- basics of aerodynamics to illustrate lift and drag- types of drag – finite wings – swept wings –flaps.	6	15%
II	Airplane performance- thrust –power- rate of climb absolute and service ceiling- range and endurance. Introduction to turbojet and turbofan engines. Space vehicle trajectories- Kepler’s laws- rocket engines, propellants and staging. (Introductory treatment of the above topics is only expected, no detailed derivations)	8	15%
FIRST INTERNAL EXAMINATION			
III	Basic engine instruments- Capacitive fuel content- Gauges. Standard atmosphere- Altimeters Aneroid and radio	6	15%

	altimeters.		
IV	Aircraft compass- Remote indicating magnetic compass- Rate of climb indicator- Pitot static system- Air speed indicator- Mach meters- Integrated flight instruments	6	15%
SECOND INTERNAL EXAMINATION			
V	GPS and GNSS, - Automatic Pilots- Aircraft flight simulation instrumentation Introduction to guidance, navigation and avionics- Radio navigational aids- automatic direction finder VHF- Phase-Comparison direction finder.	8	20%
VI	Introduction to navigation and guidance instrumentation- Principle, construction and applications of inertial sensors- Gyroscope and accelerometers- Ring laser gyroscope- Fibre optic gyroscope, MEMS gyroscopes and accelerometers.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year Of Introduction
AE464	NON-LINEAR CONTROL SYSTEM	3-0-0-3	2016
Prerequisite : AE301 Control system			
Course objectives - To familiarize the modelling of simple mechanical systems. - To analyse stability of nonlinear control systems			
Syllabus Linear vs non-linear system - Common Nonlinearities in control systems - mass spring system - method of isoclines- phase plane analysis of linear systems- phase plane analysis of non-linear systems- bendixon theorems - Describing Function Fundamentals -Describing functions of common nonlinearities - Concepts of Stability- Linearization and Local Stability - Lyapunov's Direct Method - Generation of Lyapunov functions -Popov's stability criterion - Non-Linear control system design-stabilisation problems-tracking problems - Issues in constructing non-linear controllers- available methods of non-linear control design.			
Expected outcome At the end of the semester students must be able to understand and analyse the different behaviour of system performances and Stability technique.			
Text Books - Jean Jacques Slotine and Weiping Li , “Applied Nonlinear Control”, Prentice Hall Inc., 1991. H. K. Khalil., “Nonlinear Systems”, Pearson Education, 3rd Ed. - M Gopal “Digital Control and State Variable Methods”, Tata McGraw-Hill Ltd, New Delhi, 2003. - Nagoor Kani, “Advanced Control System”, Rba Publications			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Introduction: Linear vs non-linear system- non-linear systems and equilibrium points- non-linear system behavior-examples-Common Nonlinearities in control systems-Autonomous and non-autonomous systems-modelling of simple pendulum- mass spring system-analysis and design of nonlinear system.	7	15%
II	Phase Plane Analysis: Singular points-construction of phase portraits- method of isoclines- phase plane analysis of linear systems- phase plane analysis of non-linear systems- local behaviour of non-linear systems-limit cycles- Stability- poincare- bendixon theorems.	7	15%
FIRST INTERNAL EXAMINATION			
III	Describing Function: Describing Function Fundamentals - Describing functions of common nonlinearities-hysteris, backlash, relay, deadzone, saturation and combined effects-stability analysis and limit cycles.	7	15%
IV	Stability of nonlinear systems-Lyapunov theory (review)- autonomous and non-autonomous systems equilibrium points, Stability in the sense of Lyapunov, asymptotic stability and exponential stability, Linearization and local	7	15%

	stability, Lyapunov's direct method, positive definite functions and Lyapunov functions, Lyapunov theorem for local stability and global stability		
SECOND INTERNAL EXAMINATION			
V	Analysis based on Lyapunov's direct method-LTI systems-Krasovskii's method, Variable gradient method for constructing Lyapunov functions-simple examples, Popov's stability criterion. Stability of non-autonomous systems (basic concepts only)- Lyapunov's direct method – simple problems.	7	20%
VI	Non-Linear control system design-stabilisation problems-tracking problems-relations between stabilization and tracking problems-desired behaviour of nonlinear systems-Issues in constructing non-linear controllers- available methods of non-linear control design.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE465	INFORMATION SECURITY	3-0-0-3	2016
Prerequisite : Nil			
Course Objective - To understand the threat models and the basic types of authentication mechanisms - To analyse cryptographic techniques, protocols, formats, and standards. - To analyse different log files and understand Cyber laws to recover and secure the data.			
Syllabus Introduction to security and services-Cryptography- Securing the systems-Network security topics-Network perimeter security-Computer forensics and Cyber laws			
Expected outcome At the end of the semester students will be able - to apply cryptographic algorithms to avoid data accessing by unauthorized users - to implement security algorithms as per the need of organization.			
Text Books - Bruce Schneier, “<i>Applied Cryptography</i>”, Second Edition, John Wiley & Sons, 1996 - Charlie Kaufman, Radia Perlman, and Mike Speciner, “<i>Network Security: Private Communication in a Public World</i>”, 2nd Edition, Prentice Hall, 2002. - Rick Lehtinen, G. T. Gangemi, SR., “<i>Computer Security Basics</i>”, Second Edition, O'Reilly Pubs, June 2006.			
Reference Books: - Marije, “<i>Computer Forensics and Cyber Crime</i>”: An Introduction, Prentice Hall, 2004. - Stephen Northcutt, Karen Kent, and Lenny Zeltser, “<i>Inside Network Perimeter Security</i>”, Sams Publications, 200 - William Stallings, “<i>Cryptography and Network Security</i>”, Fourth Edition, Prentice Hall, 2005			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Introduction to security and services, vulnerabilities and countermeasures, malicious code, goals of security-prevention, detection, and recovery.	6	15%
II	Cryptography-Types of encryption, confidentiality using symmetric encryption, PKI, RSA, Key management, Diffie- Hellman, ECC, CA, etc., authentication protocols.	6	15%
FIRST INTERNAL EXAMINATION			
III	Securing the systems-Network security protocols: SSL, IPSEC, Kerberos, X.509 Authentication service, Electronic mail security S/MIME, Application security- SSL, PGP, SET.	7	15%

IV	Network security topics: Network layer security – IPSec – overview, IP and IPv6, IPSec Protocols: AH and ESP, Tunnel Mode and transport mode. Internet Key exchange Protocol- IPSec cookies.	7	15%
SECOND INTERNAL EXAMINATION			
V	Network perimeter security-Secured router configuration, firewall, design principles, trusted systems, VPN, IDS, IPS penetration testing, NAT.	8	20%
VI	Computer forensics and Cyber laws- data recovery, security policies and procedures, Security lifestyle management, security audit, managed security services.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE466	INDUSTRIAL ROBOTICS	3-0-0-3	2016
Prerequisite : Nil			
Course Objective - To familiarise automation and brief history of robot and applications. - To study the kinematics of robots. - To give knowledge about robot end effectors and their design. 4. To learn about Robot Programming methods & Languages of robot.			
Syllabus Automation and Robotics-configuration of robots-introduction to manipulator kinematics-Basic control system models-Robot actuation and feedback components- General considerations in robot material handling- Robot Programming and AI -Robot cell layouts - robot cycle time analysis			
Expected outcome The students will - be equipped with the automation and brief history of robot and applications. - be familiarized with the kinematic motions of robot. - have good knowledge about robot end effectors and their design concepts.			
Text Books Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, " <i>Robotic Engineering - An Integrated Approach</i> ", Prentice Hall India, 2002			
Reference books: - Deb S.R., "<i>Robotics Technology and Flexible Automation</i> ", Tata McGraw-Hill, Publishing Co., Ltd., 1994. - K.S. Fu., R.C.Gonzalez, C.S.G.Lee, "<i>Robotics Control Sensing</i> ", Vision and Intelligence, McGraw Hill International Edition, 1987. - Mikell P. Groover, Mitchell Weiss, "<i>Industrial Robotics, Technology, Programming and Applications</i> ", McGraw Hill International Editions, 1st Edition, 2000			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Automation and Robotics, Robot anatomy, configuration of robots, joint notation schemes, work volume, introduction to manipulator kinematics, position representation, forward and reverse transformations of a 2- DOF arm, a 3- DOF arm in two dimension , a 4 – DOF arm in three dimension, homogeneous transformations in robot kinematics, D-H notations, solving kinematics equations, introduction to robot arm dynamics.	7	15%
II	Basic control system models, slew motion, joint – interpolated motion and straight line motion, controllers like on/off, proportional, integral, proportional plus integral, proportional plus derivative, proportional plus integral plus derivative.	7	15%

FIRST INTERNAL EXAMINATION			
III	Robot actuation and feedback components position and velocity sensors, actuators and power transmission devices, mechanical grippers , vacuum cups, magnetic grippers, pneumatic, electric , hydraulic and mechanical methods of power and control signals to end effectors.	7	15%
IV	General considerations in robot material handling, material transfer applications, pick and place operations, palletizing and related operations, machine loading and unloading, die casting, plastic molding, forging, machining operations, stamping press operations using robots.	7	15%
SECOND INTERNAL EXAMINATION			
V	Robot Programming and AI: Methods - Languages - Computer control and Robot Software -VAL Language – Trajectory Planning, Basic robot motions - Point to point control & continuous path control and interpolations AI – Basics – Goals-AI Techniques – AI & Robotics.	7	20%
VI	Robot cell layouts , multiple robots and machine interface, other considerations in work cell design, work cell control, interlocks, error detection and recovery, work cell controller, robot cycle time analysis.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE467	CMOS CIRCUIT DESIGN	3-0-0-3	2016
Prerequisite: EC204 Analog integrated circuits			
Course objectives - To give ideas about basic amplifiers, current Mirrors and Differential Amplifiers - To impart idea of static and switching characteristics of the CMOS Inverter - To study the operation of pass transistor logic and transmission gates - To analyse Operational Amplifiers on its design and stability factors - To familiarise different types of Memory and its decoder Circuits			
Syllabus Review of single stage MOS Amplifiers - current Mirrors - Differential Amplifiers - CMOS Inverter - Sequential Logic Circuits- Different CMOS Flip flop - MOS Operational Amplifiers- Stability and frequency compensation in Op amps - Design of a two stage Op amp - CMOS Circuit and Logic Design - Arithmetic Circuits in CMOS VLSI - Low power design - Designing Memory and Array Structures- Designing Combinational Logic Gates in CMOS.			
Expected outcome At the end of the semester students will be able to obtain comprehensive knowledge in CMOS Circuit Design.			
Text Books - Douglas A. Pucknell and K. Eshragian., “<i>Basic VLSI Design</i>” 3 rd Edition. PHI, 2000. - John P. Uyemura, “<i>Introduction to VLSI Circuits and Systems</i>”, John Wiley & Sons 2002 - Kesshab K. Parhi, “<i>VLSI DIGITAL SIGNAL PROCESSING SYSTEMS</i>”, John Wiley & Sons 2002 - Neil. H.E. Weste and K. Eshragian, “<i>Principles of CMOS VLSI Design</i>”. 2 nd Edition. Addison-Wesley , 2000. R. Jacob Baker, Harry W. Li., & David K. Boyce., “<i>CMOS Circuit Design</i>”, 3 rd Indian reprint, PHI, 2000.			
References - Jan M. Rabaey and et al, “<i>DIGITAL INTEGRATED CIRCUITS</i>”, Pearson Edn. Inc. 2003 - Kang & Leblebgi “<i>CMOS Digital IC Circuit Analysis & Design</i>”- McGraw Hill, 2003 - Weste and Eshraghian, “<i>Principles of CMOS VLSI design</i>” Addison-Wesley, 2002			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Review of single stage MOS Amplifiers CS, CD, CG and cascode Amplifiers . Design of current Mirrors, Wilson current mirrors and Widlar current mirrors. Band gap voltage reference Differential Amplifiers: MOS Load Current Source, Current Mirror, Cascade Load.	6	15%
II	CMOS Inverter-Static Characteristics, Derivation for VTH,	7	15%

	V _{IL} and V _{IH} Switching Characteristics and Calculation of delay times Sequential Logic Circuits- Different CMOS Flip flops Theory of operation and Circuits of Pass transistor Logic and transmission gate.		
FIRST INTERNAL EXAMINATION			
III	MOS Operational Amplifiers, Cascode and Folded Cascode opamps . Stability and frequency compensation in Op amps. Design of a two stage Op amp DRAM, SRAM, Sense Amplifiers, Design of Row and Column Decoders Flash Memory- NOR and NAND Flash Memory Cell	7	15%
IV	CMOS Circuit and Logic Design-CMOS Logic structures. Advanced techniques in CMOS Logic Circuits-Mirror circuits, Pseudo NMOS, Tri-state circuits, Clocked CMOS, Dynamic CMOS Logic circuits, Dual Rail Logic Networks.	7	15%
SECOND INTERNAL EXAMINATION			
V	Arithmetic Circuits in CMOS VLSI-Bit Adder Circuits, Ripple Carry Adder, Carry Look Ahead Adders, Other High speed adders-Multiplexer based fast binary adders, Multipliers-Parallel multiplier, Wallace Tree and Dadda multiplier, Low power design- Scaling Versus Power consumption, Power reduction techniques.	8	20%
VI	Designing Memory and Array Structures - Memory classification, Memory Core - Read Only Memories, Non-volatile Read Write Memories, Read Write Memories, Content - Addressable or Associative Memories, Memory Peripheral Circuits - Address Decoders, Sense Amplifiers, Designing Combinational Logic Gates in CMOS.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

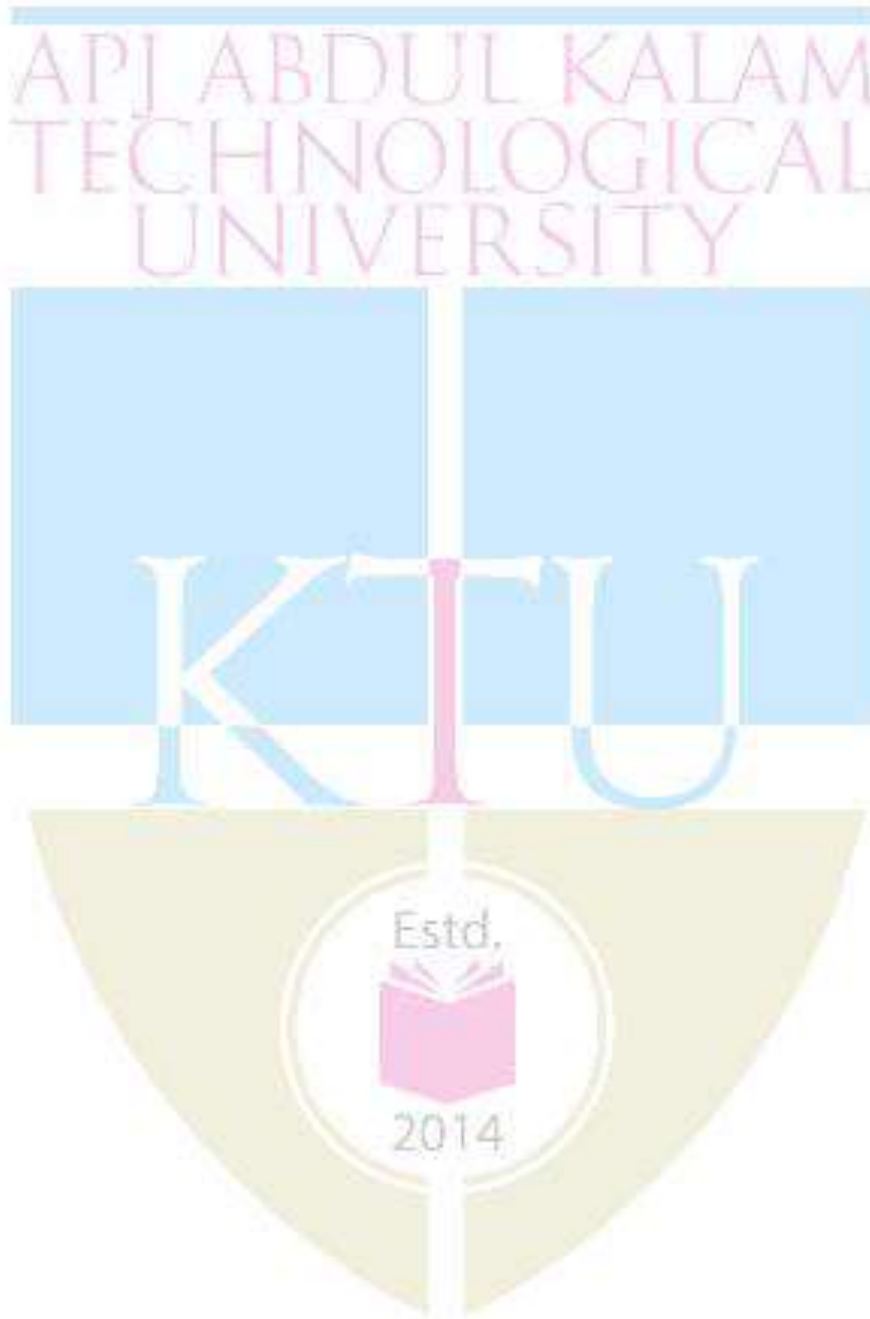
Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)



Course code	Course name	L-T-P-Credits	Year of Introduction
AE468	NANO ELECTRONICS	3-0-0-3	2016
Course objectives - To impart the basic concepts of nanotechnology - To develop understanding about application of nanomaterials.			
Syllabus Introduction to nanotechnology and Nano electronics- fabrication of nano materials- Introduction to characterization tools of nano materials- basic properties of 2d semiconductor nanostructures- The concept of super lattices Kronig - Penney model of super lattice- Nanoelectronic devices and systems- Nanocomposites- nanofillers			
Expected outcome At the end of the semester students will have good idea regarding nano electronics and their various applications.			
Text books - J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda “<i>Nanotechnology for Microelectronics and optoelectronics</i>”, Elsevier, 2006. - W.R. Fahrner, “<i>Nanotechnology and Nanoelctronics</i>”, Springer, 2005			
Reference books - Chattopadhyay, Banerjee, “<i>Introduction to Nanoscience & Technology</i>”, PHI 2009 - Diwanand and Bharadwaj, “<i>Nanoelectronics</i>”, Pentagon Press Delhi 2006 - Goser, P. Glosekotter, J. Dienstuhl, “<i>Nanoelectronics and nanosystems</i>”, Springer 2004. - Poole, “<i>Introduction to Nanotechnology</i>”, John Wiley 2006 - Pulikel M. Ajayan, “<i>Nanocomposite science and technology</i>”, Wiley-VCH 2005 - Supriyo Dutta, “<i>Quantum Transport- Atom to transistor</i>”, Cambridge University Press, 2005. T. Pradeep, “<i>Nano the Essentials</i>”, TMH, 2007.			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Introduction to nanotechnology and Nano electronics, Impacts, Limitations of conventional microelectronics. Introduction to methods of fabrication of nano materials- different approaches. fabrication of nano-layers -Physical Vapor Deposition, Chemical Vapor Deposition, Epitaxy, Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide. Fabrication of nanoparticle- grinding with iron balls, laser ablation, reduction methods, sol gel, self-assembly.	7	15%
II	Introduction to characterization tools of nano materials- principle of operation of STM, AFM, SEM, TEM, XRD, PL & UV instruments. Mesoscopic Physics and Nanotechnologies - trends in Microelectronics and Optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Quantum wells, wires and dots, Density of states and dimensionality .	6	15%
FIRST INTERNAL EXAMINATION			
III	The physics of low dimensional structures - basic properties	7	15%

	of two dimensional semiconductor nanostructures, square quantum wells of finite depth, parabolic and triangular quantum wells, quantum wires and quantum dots. Semiconductor quantum nanostructures and super lattices – MOSFET structures, Heterojunctions, Quantum wells, modulation doped quantum wells, multiple quantum wells.		
IV	The concept of super lattices Kronig - Penney model of super lattice. Transport of charge in Nanostructures under Electric field - parallel transport, perpendicular transport, quantum transport in nanostructures. Transport of charge in magnetic field and quantum Hall effect - Effect of magnetic field on a crystal, the Aharonov-Bohm effect, the Shubnikov-de Hass effect, the quantum Hall effect.	7	15%
SECOND INTERNAL EXAMINATION			
V	Nanoelectronic devices and systems - MODFETS, heterojunction bipolar transistors, resonant tunnel effect, RTD, RTT, hot electron transistors, Coulomb blockade effect and single electron transistor, CNT transistors, heterostructure semiconductor laser, quantum well laser, quantum dot LED, quantum dot laser, vertical cavity surface emitting laser, quantum well optical modulator, quantum well sub band photo detectors, Infrared detector, Nano switches, principle of NEMS..	8	20%
VI	Nanocomposites, nanofillers, high performance materials, polymer nanocomposites, nanoclays, nanowires, nanotubes, nanoclusters etc. Smart materials, self-assembly of materials, safety issues with nanoscale powders.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

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Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE472	PETROLEUM ENGINEERING	3-0-0-3	2016
Prerequisite : Nil			
Course objectives - To impart the basic concepts of petroleum production, testing etc. - To impart idea on Health Safety and Environment in Petroleum Industry. - To update with the latest trends in Petroleum Engineering.			
Syllabus Refinery products - Coking and thermal process - Catalytic Cracking - Coring and core analysis - Reservoir fluid properties - Reserve estimation & techniques - Well equipments - Well servicing & Workover operations - Field processing of oil & gas - Production system analysis & optimization - Nodal system analysis - LNG value chain - Lubricating oil blending stocks petrochemical feedstocks - Evaluation of CBL/VDL, USIT, SFT, RFT. - Production logging tools, principles, limitations and applications. - Cost Evaluation - Latest trends in Petroleum Engineering.			
Expected outcome At the end of the semester students will be able - To gain advanced knowledge in petroleum engineering - To get knowledge in industrial safety and cost evaluation			
Text Books - A.Lucas Hurley , Modern Petroleum Technology Upstream Vol I Edition 2002. - A.G. Lucas Hurley , Modern Petroleum Technology Downstream Vol II Edition 2002. - J.CH Garry , Hardward G.E and M.J.Kaiser, Petroleum Refining : Technology and economics CRC Press V Edition			
Course Plan			
Module	Contents	Hours	Semester Exam Marks
I	Refinery products – Refinery Feeds – Crude distillation – Coking and thermal process : Classification and description of some common rocks with special reference to clastic and nonclastic reservoir rocks. Origin, migration and accumulation of Petroleum. Petroleum exploration methods.	6	15%
II	Catalytic Cracking - Catalytical hydro cracking – Hydro processing and Reused processing hydro treating. Petrophysical properties of reservoir rocks. Coring and core analysis. Reservoir fluid properties. Phase behavior of hydrocarbon system. Flow of fluids through porous media. Water and gas coning.	6	15%
FIRST INTERNAL EXAMINATION			
III	Well equipments. Well completion techniques. Well production problems and mitigation. Well servicing & Workover operations. Workover & completion fluids. Formation damage. Well stimulation techniques. Artificial lift techniques. Field processing of oil & gas. Storage and transportation of petroleum and petroleum products. Metering and measurements oil & gas.	7	15%

IV	Production system analysis & optimization. Production testing. Multiphase flow in tubing and flow-lines. Nodal system analysis. Pressure vessels, storage tanks, shell and tube heat exchangers, pumps and compressors, LNG value chain.	7	15%
SECOND INTERNAL EXAMINATION			
V	Lubricating oil blending stocks petrochemical feedstocks. Evaluation of petro physical of sub-surface formations: Principles applications, advantages and disadvantages of SP, resistivity, radioactive, acoustic logs and types of tools used. Evaluation of CBL/VDL, USIT, SFT, RFT. Production logging tools, principles, limitations and applications.	8	20%
VI	Special type of logging tools. Casing inspection tools (principles, applications and limitations), Formations micro scanner (FMS), NMR logging principles. Standard log interpretation methods. Cross-plotting methods. Cost Evaluation – Economic evaluation of petroleum reused and refineries. Latest trends in Petroleum Engineering: Coal bed methane, shale gas, oil shale, gas hydrate, and heavy oil.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks:100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.

(15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO201	AIRCRAFT BASICS AND CONTROLS	2-1-0-3	2016
Prerequisite: Nil			
Course Objectives To introduce the concepts of flying, International Standard Atmosphere, Structural aspects of Airplanes, systems, instruments and power plants used in airplanes.			
Syllabus Developments in Aerodynamics, Materials, Structures and Propulsion. Physical properties and structure of the atmosphere, temperature, pressure and altitude relationships. General types of construction – aerofoil – aircraft components – control – aircraft engines – rockets - helicopter			
Expected Outcome The students will be able to - Know the basics of aircraft. - Identify suitable materials and Power plants for aircraft. - Perform basic calculations of lift, drag and moment.			
Text Books: - Anderson, J.D., “Introduction to Flight”, McGraw-Hill, 1995. - A.C. Kermode, Flight without Formulae References: - Kermode, A.C., “Mechanics of Flight”, Himalayan Book, 1997. - Rotocraft Flying Hand Book- FAA H-8083-21, FAA, U.S DEPARTMENT OF TRANSPORTATION. - Aviation Maintenance Technician Hand Book-Power plant – Volume – I &II , FAA, Shroff Publications, New Delhi.			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	History of Flights - Balloon flight	1	15%
	Ornithopters	1	
	Early airplanes by wright brothers, biplanes and monoplanes	2	
	Developments in aerodynamics, materials, structures and propulsion over the years	2	
II	Physical properties and structure of the atmosphere, temperature, pressure and altitude relationships	2	15%
	Newton’s law of motions applied to aeronautics - evolution of lift, drag and moment	2	
	Aerofoils, mach number, maneuvers. aerodynamic forces on aircraft	2	

	Classification of NACA Aerofoils, aspect ratio, wing loading, centre of pressure and aerodynamic centre - aerofoil characteristics- lift, drag curves.	2	
FIRST INTERNAL EXAM			
III	Different types of flight vehicles, classifications.	1	15%
	Components of an airplane and their functions.	1	
	Wing and Landing gear configurations.	2	
	Conventional control, powered control, basic instruments for flying - typical systems for control actuation.	3	
IV	General types of construction, Truss, monocoque & semi-monocoque	3	15%
	Typical wing structure	2	
	metallic and non-metallic materials	1	
	Use of aluminum alloy, titanium, stainless-steel and composite materials.	1	
SECOND INTERNAL EXAM			
V	Basic ideas about piston, turboprop and jet engines	1	20%
	use of propeller and jets for thrust production -comparative merits,	2	
	Propeller - Operating Principle , Propeller classifications, Forces acting on a propeller	2	
	Principles of operation of rocket, types of rockets.	2	
VI	Basic Helicopter Aerodynamics	2	20%
	Basic Helicopter Components and their functions.	2	
	Types of rotor heads. Control mechanisms	2	
	Hovering and Autorotation	1	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100,

Exam Duration:3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO202	AERODYNAMICS - I	3-1-0-4	2016
Prerequisite: Nil			
Course Objectives - To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics. - To make the student understand the concept of vorticity, irrotationality, theory of airfoils and wing sections. - To introduce the basics of viscous flow			
Syllabus Basics of fluid Mechanics-methodology of conformal transformation- Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energy thickness, shape parameter			
Expected Outcome The students will have - an ability to apply airfoil theory to predict air foil performance - a knowledge of incompressible flow - an exposure to Boundary layer theory			
Text Books: - Houghton, E.L., and Caruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989. - Anderson, J.D., "Fundamentals of Aerodynamics", McGraw Hill Book Co., 1999 References: - Milne Thomson, L.H., "Theoretical Aerodynamics", Macmillan, 1985 - John J Bertin., "Aerodynamics for Engineers", Pearson Education Inc, 2002 - Clancey, L J., "Aerodynamics", Pitman, 1986 - Kuethe, A.M and Chow, C.Y, "Foundations of Aerodynamics", Fifth Edition, John Wiley & Sons, 2000.			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Euler equation	2	15%
	incompressible Bernoulli's equation	2	
	circulation and vorticity	2	
	Green's lemma and Stoke's theorem	2	
II	Barotropic flow, Kelvin's theorem	2	15%
	streamline, stream function, irrotational flow	3	
	potential function, equipotential line	2	

	Elementary flows and their combinations.	4	
FIRST INTERNAL EXAM			
III	Ideal Flow over a circular cylinder,	2	15%
	D'Alembert's paradox, magnus effect,.	2	
	Kutta Jukowski's theorem, starting vortex, Kutta condition	3	
	real flow over smooth and rough cylinders	2	
IV	Cauchy-Riemann relations, complex potential,	2	15%
	methodology of conformal transformation,	2	
	Kutta Jukowski transformation and its applications	2	
	thin airfoil theory and its applications.	2	
SECOND INTERNAL EXAM			
V	Vortex filament	2	20%
	Biot and Savart law,	2	
	bound vortex and trailing vortex, horse shoe vortex,	2	
	Lifting line theory and its limitations.	2	
VI	Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energy thickness, shape parameter,	2	20%
	boundary layer equations for a steady, two dimensional incompressible flow,	2	
	boundary layer growth over a flat plate, critical Reynolds number	4	
	Blasius solution, basics of turbulent flow.	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO204	AIRCRAFT STRUCTURES -1	4-0-0-4	2016
Prerequisite : Nil			
Course Objectives - To provide an understanding on the linear static analysis of determinate and indeterminate aircraft structural components. - To understand the design process using different failure theories.			
Syllabus Plane truss analysis – Strain energy -Energy theorems- Euler's column curve – beam columns -Ductile and brittle materials – Theories of failure - Thermal stresses – Creep & Fatigue			
Expected Outcome The students will be able to - perform linear static analysis of determinate and indeterminate aircraft structural components - design a component using different theories of failure			
Text Books: - Timoshenko and Gere, "Mechanics of Materials", Tata McGraw Hill, 1993. - Megson T M G, "Aircraft Structures for Engineering students" Elsevier , 2007 References: - Donaldson, B.K., "Analysis of Aircraft Structures - An Introduction", McGraw Hill, 1993. - Bruhn E F, "Analysis and Design of Flight Vehicle Structures", Tri-State Off-set Company, USA,1985 - Peery, D.J. and Azar,J.J., "Aircraft Structures", Ed.2, McGraw – Hill, N.Y, 1999.			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Plane truss analysis – method of joints – method of sections – method of shear	2	15%
	3-D trusses	2	
	principle of super position	2	
	Clapeyron's 3 moment equation and moment distribution method for indeterminate beams.	3	
II	Strain Energy in axial loadings.	2	15%
	Strain Energy in bending	2	
	Strain Energy in torsion and shear loadings.	2	
	Castigliano's theorems and their applications	2	

FIRST INTERNAL EXAM			
III	Energy theorems	2	15%
	dummy load & unit load methods	2	
	energy methods applied to statically determinate and indeterminate beams,	2	
	energy methods applied to frames, rings & trusses	2	
IV	Euler's column curve – inelastic buckling	2	15%
	effect of initial curvature – the South well plot – columns with eccentricity	2	
	use of energy methods – theory of beam columns	2	
	beam columns with different end conditions – stresses in beam columns.	3	
SECOND INTERNAL EXAM			
V	Ductile and brittle materials	2	20%
	maximum principal stress theory - maximum principal strain theory - maximum shear stress theory	2	
	distortion energy theory	2	
	octahedral shear stress theory.	2	
VI	Thermal stresses	2	20%
	impact loading	2	
	Fatigue – Creep	2	
	Stress Relaxation	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO206	PROPULSION -1	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives - To introduce basic concepts and salient features of engine components of jet propelled engines which are operated in atmosphere. - To familiarize advanced jet propulsion methods like hypersonic propulsion.			
Syllabus Piston engines – Gas turbine engines – thrust augmentation –inlets – nozzles -thrust reversal-combustion chamber - axial flow compressor- centrifugal compressor – axial flow turbine – ram jet engine – performance characteristics of GT engines.			
Expected Outcome The students will be able to - identify the engine components of jet propelled engines - know the details of advanced Jet propulsion and hypersonic propulsion			
Text Books: - Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999. - James Award, "Aerospace Propulsion System" References: - Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Longman, 1989. - Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985. - Rolls Royce, "Jet Engine", 5th Edition, Rolls Royce Technical Publications, 2005. - Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 1999.			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Operating principles of piston engines – thermal efficiency calculations – classification of piston engines.	1	15%
	Propeller geometry, types, material for propellers, selection of propellers.	1	
	Propeller theories Ideal Momentum and Blade element, Numerical problems on the performance of propellers using propeller charts.	2	
	Illustration of working of gas turbine engine-the thrust equation.	1	
	Factors affecting thrust – effect of pressure, velocity and temperature	2	

	changes of air entering compressor – methods of thrust augmentation.		
II	Internal flow and Stall in subsonic inlets.	1	15%
	Relation between minimum area ratio and external deceleration ratio, Diffuser performance.	1	
	Supersonic inlets – starting problem on supersonic inlets, shock swallowing by area variation.	1	
	Real flow in nozzles and nozzle efficiency – losses in nozzles – equilibrium flow and frozen flow in nozzles- two phase flow in nozzles.	1	
	Ejector and variable area nozzles - interaction of nozzle flow with adjacent surfaces, Thrust reversal.	1	
	Classification of combustion chambers – combustion chamber performance.	1	
	Effect of operating variables on performance – flame stabilization.	1	
FIRST INTERNAL EXAM			
III	Principle of operation of axial flow compressor.	1	15%
	Work done and pressure rise – velocity diagrams.	2	
	Degree of reaction – free vortex and constant reaction designs of axial flow compressor.	2	
	Performance characteristics of axial flow compressors– stage efficiency calculations - cascade testing.	2	
IV	Principle of operation of centrifugal compressor.	1	15%
	Work done and pressure rise – velocity diagrams – degree of reaction.	3	
	Performance characteristics of centrifugal compressors	1	
	Stage efficiency calculations.	2	
SECOND INTERNAL EXAM			
V	Principle of operation of axial flow turbines– limitations of radial flow turbines- Work done and pressure rise.	2	20%
	Velocity diagrams – degree of reaction – free vortex and constant nozzle angle designs.	2	
	Performance characteristics of axial flow turbine– turbine blade cooling methods.	1	
	Stage efficiency calculations – basic blade profile design considerations – matching of compressor and turbine.	2	
VI	Operating principle of ramjet engine.	1	20%
	Various components of ramjet engines and their efficiencies.	1	
	Combustion in ramjet engine – critical, subcritical and supercritical	2	

	modes of operation -ramjet engine and its performance characteristics.		
	Sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets.	2	
	Characteristics of turboprop, turbofan and turbojet – performance characteristics.	1	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100, Time: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

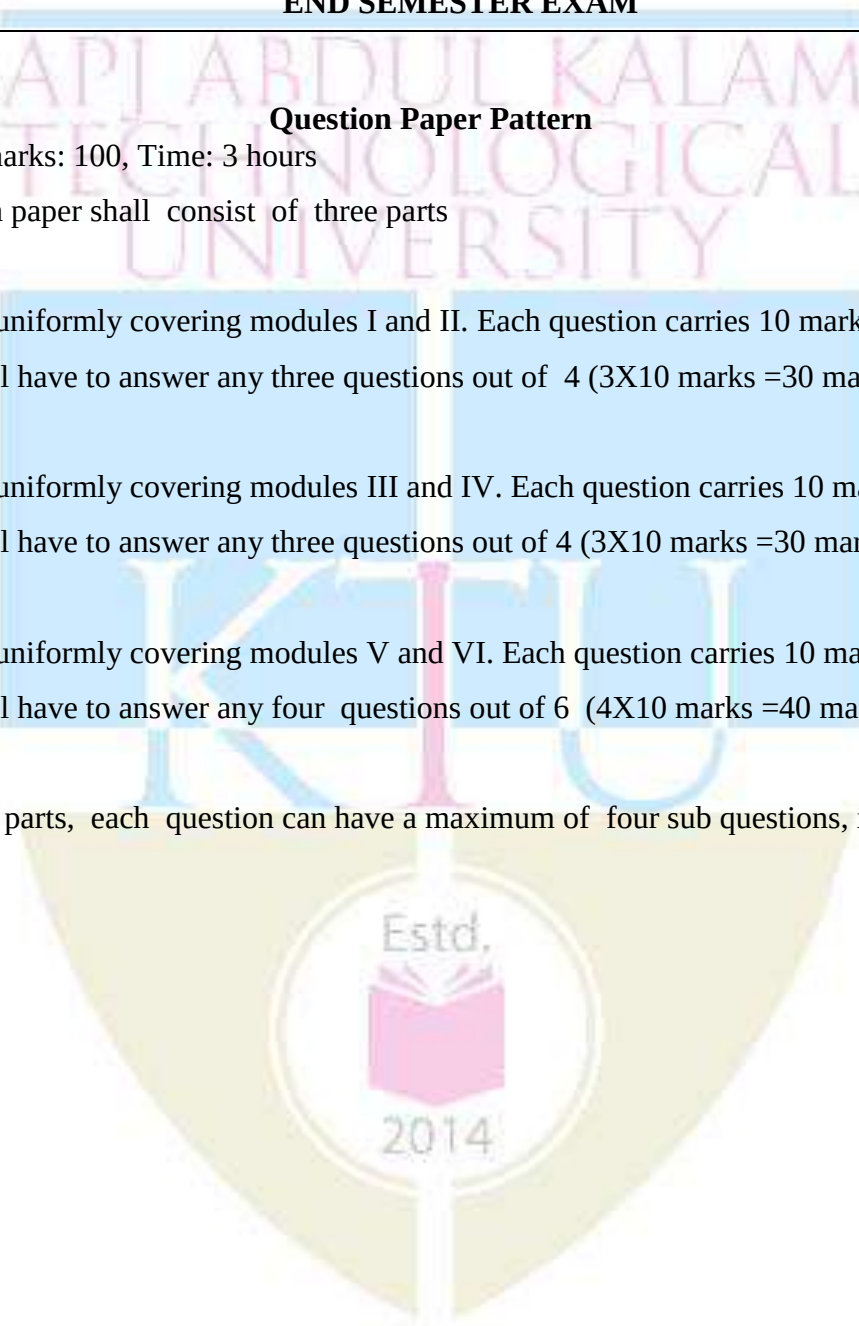
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
AO208	AIRCRAFT MATERIALS AND PROCESSES	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: To study types of materials and mechanical behavior of materials for aircraft applications			
Syllabus Structure of solid materials - mechanical properties -Ferrous, non-ferrous, aluminium, titanium, copper and magnesium alloys - Non-Metallic Materials -Composite materials -Metal working process-heat treatment -corrosion – high temperature materials – super alloys.			
Expected Outcome The students will be able to - Understand role of corrosion and heat treatment processes of aircraft materials - Know the usage of composite materials in aircraft component design. - Know the use of high temperature materials in space applications - Familiarize the different types of metal working processes.			
Text Books: - Titterton.G., "Aircraft Materials and Processes", V Edition, Pitman Publishing Co., 1995. - Advanced Composites –Cindy Forema			
References: - Martin, J.W., "Engineering Materials, Their properties and Applications", Wykedham Publications (London) Ltd., 1987. - Van Vlack.L.H., "Materials Science for Engineers", Addison Wesley, 1985. - Airframe and Power plant Mechanics-General Hand Book-FAA Himalayan Book House , New Delhi.			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Structure of solid materials – Atomic structure of materials – crystal structure	2	15%
	millier indices – density – packing factor – space lattices	1	
	x-ray diffraction – imperfection in crystals	2	
	Mechanical properties of materials - physical metallurgy - general requirements of materials for aerospace applications	2	
	Structural Metals – Ferrous aircraft metals and alloys	2	
	Non-Ferrous Aircraft metals and Alloys	2	

II	Aluminum and Aluminum alloys, Titanium and Titanium Alloys	2	15%
	Copper and Copper Alloys Magnesium and Magnesium alloys.	2	
FIRST INTERNAL EXAM			
III	Non-Metallic Materials - Wood, Fabrics ,Plastics , Transparent materials Rubber and Synthetic rubber	1	15%
	Composite materials - Introduction	2	
	Reinforcing Fibers, Matrix materials	2	
	Core materials& manufacturing of composites.	2	
IV	Metal working process	1	15%
	Cold working and Hot working	1	
	Heat Treatment-Hardening, Tempering, Annealing, Normalizing, Case hardening	2	
	Machining Process-Turning, Taper Turning, Milling, Shaping, Grinding. Thread Cutting . Sheet Metal Rolling	1	
SECOND INTERNAL EXAM			
V	Types of corrosion	1	20%
	Effect of corrosion on Mechanical properties, Stress corrosion	2	
	Factors affecting corrosion	2	
	Corrosion resistant materials used in for space vehicles.	2	
VI	Classification, production and characteristics of high temperature materials – methods and testing	2	20%
	determination of mechanical and thermal properties of materials at elevated temperatures	2	
	application of these materials in thermal protection systems of aerospace vehicles	1	
	super alloys – high temperature material characterization.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO232	AERODYNAMICS AND FLIGHT MECHANICS LAB	0-0-3-1	2016
Prerequisite: AO202 Aerodynamics - I			
List of Experiments (Minimum 12 are mandatory)			
1. Calibration of a subsonic Wind tunnel. 2. Determination of Lift, Drag, Side force. (Symmetrical Aerofoil & Cambered Aerofoil) 3. Determination of Moments acting on Symmetric / Cambered Aerofoil. 4. Pressure distribution over a smooth and rough circular cylinder. 5. Pressure distribution over a symmetric and cambered Aerofoil 6. Flow visualization studies in Aerofoil. 7. Flow visualization studies in Cylinder, Flat Plates. 8. Flow visualization studies in various models (Aircraft, Cars etc.) 9. Flow visualization using Hele-shaw apparatus. 10. Practical investigation of longitudinal stability & control of the aircraft to demonstrate behaviour during take off, level flight & climb. 11. Determination of the effect of speed on attitude for level flight & stall. 12. Measurement of the lift curve for the wing up to & beyond stall. 13. Determination of neutral stability & plot trim curves. 14. Demonstration of phugoid motion in terms of altitude. 15. Demonstration of short period oscillation due to sudden disturbance by the change of incidence. 16. Determination of Mach No. of supersonic waves using Wind Tunnel. 17. Study of flow visualization by SCHLIEREN Method. 18. Plotting the pressure distribution over various models using supersonic wind tunnel.			
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
AO234	CAD LAB	0-0-3-1	2016
Prerequisite : Nil			
List of Experiments/Exercises			
1. Design and drafting of riveted joints 2. Design and drafting of welded joints. 3. Design and drafting control components - cam 4. Design and drafting control components - bell crank 5. Design and drafting control components- gear 6. Design and drafting control components push-pull rod 7. Three view diagram of a typical aircraft 8. Layout of typical wing structure. 9. Layout of typical fuselage structure. 10. Layout of control system 11. Layout of aircraft landing gear 12. Design of Airfoils (NACA airfoils)			
END SEMESTER EXAM			

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO301	AERODYNAMICS - II	3-1-0-4	2016
Prerequisite: AO201 Aerodynamics -I			
Course Objectives - To introduce the concepts of compressibility, - To make the student understand the theory behind the formation of shocks and expansion fans in Supersonic flows.			
Syllabus Compressibility, Governing equations for steady one dimensional flow, Operating characteristics of nozzles, Introduction to hypersonic flows, Normal shock relations, Moving normal shock waves, Rayleigh flow, Fanno flow, Expansion waves, Potential equation for 2-dimensional compressible flow, Method of characteristics, Critical Mach number, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Shock-expansion theory			
Expected Outcome The students will - Understand the characteristics of fluid flows - Gain knowledge on shock phenomenon and shock waves. - Understand fluid flow characteristics over wings, airfoils and airplanes.			
Text Books: - Anderson, J. D, "Modern Compressible Flow", McGraw-Hill & Co., 2002. - Rathakrishnan., E, "Gas Dynamics", Prentice Hall of India, 2004.			
Data Book (Approved for use in the examination): - Rathakrishnan E, Gas Tables, Orient Blackswan Private Limited - New Delhi (2013) - S M Yahya, Gas Tables for Compressible Flow Calculations, New Age International Publishing, 2012			
References: - Oosthuizen,P.H., &Carscallen,W.E., "Compressible Fluid Flow", McGraw- Hill & Co.,1997 - Shapiro, A. H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982. - Zucrow, M. J. and Anderson, J. D., "Elements of Gas Dynamics", McGraw- Hill & Co., 1989.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Compressibility, Continuity, Momentum and energy equations for steady one dimensional flow, Compressible Bernoulli's equation	4	15%
	velocity relation, Mach cone, Mach angle,	2	
	Operating characteristics of nozzles- introduction to hypersonic flows.	3	
II	Normal shock relations, Prandtl's relation, Hugoniot equation	3	15%
	Rayleigh Supersonic Pitot tube equation,	3	

	Moving normal shock waves.	3	
	Area- Mach number relation	1	
FIRST INTERNAL EXAMINATION			
III	Shock Polar, Reflection of oblique shocks, left running and right running waves	3	15%
	Interaction of oblique shock waves, introduction to slip line	2	
	Introduction to boundary layer interaction	2	
	compression corner effect – incident shock interaction.	2	
IV	Rayleigh flow, Fanno flow (simple numerical examples)	4	15%
	Expansion waves, Prandtl-Meyer expansion	2	
	Maximum turning angle	2	
	Simple and non-simple regions.	1	
SECOND INTERNAL EXAMINATION			
V	Critical Mach number, drag divergence Mach number, Shock Stall	3	20%
	Supercritical Airfoil Sections, Transonic area rule	3	
	Swept wing, Airfoils for supersonic flows supersonic wings	3	
VI	Lift, drag, Pitching moment and Center of pressure for supersonic profiles,	3	20%
	Shock-expansion theory, wave drag	3	
	Design considerations for supersonic aircraft- aerodynamic heating.	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO302	PROPULSION - II	4-0-0-4	2016
Prerequisite : AO206 Propulsion - I			
Course Objectives - To impart knowledge in non-air-breathing and hypersonic propulsion methods - To familiarise various propulsion technologies associated with space launch vehicles, missiles and space probes..			
Syllabus Hypersonic air breathing propulsion- Supersonic combustion - chemical rocket propulsion - Flight performance - Air augmented rockets - Pulse rocket motors -Static testing of rockets & instrumentation, safety considerations- solid propellant rockets - liquid propellant rockets - Combustion instability - Cryogenic engines - hybrid rocket propulsion - electric propulsion techniques- Nuclear rocket propulsion - Propellant less Propulsion concept, Photon rocket, beamed energy propulsion, solar sail.			
Expected Outcome The students will be able to - Understand Hypersonic propulsion systems - Know the applications and principles of liquid and solid-liquid propulsion systems - Exposed to non-conventional propulsion in rocketry..			
Text Books: - Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988. - Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.			
References: - Hieter and Pratt, "Hypersonic Air Breathing Propulsion", AIAA Education Series, 1994 - Thomas A Ward, "Aerospace Propulsion System" , Wiley, 2010			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion.	3	15%
	Salient features of scramjet engine and its applications for hypersonic vehicles – problems associated with supersonic combustion.	2	
	Engine/airframe integration aspects of hypersonic vehicles – various types scramjet combustors – fuel injection schemes in scramjet combustors.	3	
	One dimensional model for supersonic combustion using method of influence coefficients.	2	

II	Operating principle – specific impulse of a rocket.	1	15%
	Internal ballistics – performance considerations of rockets – types of igniters.	3	
	Preliminary concepts in nozzle-less propulsion – air augmented rockets – pulse rocket motors.	2	
	Static testing of rockets & instrumentation –safety considerations.	4	
FIRST INTERNAL EXAM			
III	Salient features of solid propellant rockets – selection criteria of solid propellants.	2	15%
	Estimation of solid propellant adiabatic flame temperature - propellant grain design considerations.	2	
	Erosive burning in solid propellant rockets – combustion instability – strand burner and T-burner.	3	
	Applications and advantages of solid propellant rockets.	1	
IV	Salient features of liquid propellant rockets – selection of liquid propellants – various feed systems and injectors for liquid propellant rockets.	3	15%
	Thrust control and cooling in liquid propellant rockets and the associated heat transfer problems.	3	
	Combustion instability in liquid propellant rockets.	2	
	Problems associated with operation of cryogenic engines.	3	
SECOND INTERNAL EXAM			
V	Introduction to hybrid rocket propulsion.	1	20%
	Standard and reverse hybrid systems.	2	
	Combustion mechanism in hybrid propellant rockets.	3	
	Applications and limitations.	2	
VI	Electric rocket propulsion– types of electric propulsion techniques - Ion propulsion.	3	20%
	Nuclear rocket –comparison of performance of these propulsion systems with chemical rocket propulsion systems.	3	
	Future applications of electric propulsion systems.	2	
	Solar sail.	1	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO303	AIRCRAFT STRUCTURES - II	3-0-0-3	2016
Prerequisite: AO204 Aircraft Structures -I			
Course Objectives - To provide various methods for analysis of aircraft wings and fuselage. - To provide the behavior of major aircraft structural components.			
Syllabus Bending of symmetric and unsymmetric beams -Thin walled beams - Bredt - Batho theory, - Bending of thin plates – Loads on an aircraft - Bending moment distribution over the aircraft - Shear flow in thin-webbed beams with non-parallel flanges - Complete tension field beam, Semi-tension field beam theory.			
Expected Outcome The students will be able to i. analyse the aircraft wings and fuselage ii. demonstrate the behavior of major aircraft structural components.			
Text Books: 1. Bruhn. E.H., "Analysis and Design of Flight Vehicles Structures", Tri-state off-set Company, USA,1985 2. Megson T M G , "Aircraft Structures for Engineering Students", Elsevier Ltd, 2007 3. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw – Hill, N.Y., 1999			
References: 1. Howard D Curtis, "Fundamentals of Aircraft Structural Analysis", WCB-McGraw Hill, 1997 2. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw Hill, 1993.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Bending of symmetric beams subject to skew loads	2	15%
	Bending stresses in beams of unsymmetrical sections	2	
	Generalized ‘k’ method,	2	
	Neutral axis method, and principal axis method	2	
II	Thin walled beams – concept of shear flow	1	15%
	Shear flow distribution in symmetrical, unsymmetrical thin-walled sections	2	
	The shear center and its determination	2	
	Structural idealization – shear flow variation in idealized sections.	3	
FIRST INTERNAL EXAMINATION			

III	Bredt - Batho theory	1	15%
	Single-cell and multi-cell tubes subject to torsion	2	
	Shear flow distribution in thin-walled single & multi-cell structures subject to combined bending torsion – with walls effective and ineffective in bending	3	
	Shear center of closed sections.	1	
IV	Bending of thin plates – rectangular sheets under compression	1	15%
	Local buckling stress of thin walled section	2	
	Crippling strength estimation – thin-walled column strength	2	
	Load carrying capacity of sheet stiffener panels – effective width.	2	
SECOND INTERNAL EXAMINATION			
V	Loads on an aircraft – v-n diagram	1	20%
	Shear force distribution over the aircraft wing and fuselage	2	
	Bending moment distribution over the aircraft wing and fuselage	2	
VI	Shear flow in thin-webbed beams with parallel flanges	2	20%
	Shear flow in thin-webbed beams with non-parallel flanges	1	
	Complete tension field beams	1	
	Semi-tension field beam theory	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

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Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO304	VIBRATION AND AEROELASTICITY	3-0-0-3	2016
Prerequisite :Nil			
Course Objectives To study the dynamic behavior of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces			
Syllabus Simple harmonic motion -Free and forced vibrations- Vibration measuring instruments - Static and Dynamic couplings - Eigen value problems -Hamilton's principle- Lagrangean equation and application – Vibration of elastic bodies- Vibration of strings- Longitudinal, Lateral and Torsional vibrations – Rayleigh's and Holzer methods - Transverse vibrations of strings - Aero elastic instabilities			
Expected Outcome The students will i. Gain knowledge on vibration ii. Be able to define and predict the motion of vibrating body. iii. Get an idea of Aeroelasticity.			
Text Books: - Fung Y.C., "An Introduction to the Theory of Aeroelasticity" – John Wiley & Sons, New York, 1995. - Timoshenko S., "Vibration Problems in Engineering"– John Wiley and Sons, New York, 1993. - V P Singh, Mechanical Vibrations, Dhanpat Rai & Co (P) Ltd			
Reference: - Bisplinghoff R.L., Ashley H and Hoffman R.L., "Aeroelasticity" – Addison Wesley Publication, New York, 1983. - Scanlan R.H. & Rosenbaum R., "Introduction to the study of Aircraft Vibration & Flutter", John Wiley and Sons, New York, 1982. - Tongue. B. H., "Principles of Vibration", Oxford University Press, 2000. - Tse. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations", – Prentice Hall, New York, 1984.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Simple harmonic motion – Terminologies.	1	15%
	Newton's Law. D' Alembert's principle.	1	
	Energy Methods	3	
II	Free vibrations, numerical problems	3	15%
	Damped vibrations, numerical problems	3	

	Forced Vibrations, with and without damping – support excitation	2	
FIRST INTERNAL EXAM			
III	Two degrees of freedom systems – Static and Dynamic couplings vibration absorber.	2	15%
	Principal co- ordinates, Principal modes and orthogonal condition – Eigen value problems.	3	
	Hamilton’s principle– Vibration of elastic bodies.	3	
	Vibration of strings- Longitudinal, Lateral and Torsional vibrations.	2	
IV	Rayleigh’s Methods to find natural frequencies.	3	15%
	Holzer Methods to find natural frequencies.	3	
SECOND INTERNAL EXAM			
V	Transverse vibrations of strings.	1	20%
	Longitudinal, Lateral and Torsional vibrations.	1	
	Approximate methods for calculating natural frequencies.	3	
VI	Concepts – Coupling.	2	20%
	Aero elastic instabilities and their prevention.	2	
	Basic ideas on wing divergence, loss and reversal of aileron control.	2	
	Flutter and its prevention.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
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Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO305	FLIGHT MECHANICS	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives			
To understand the behavior of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.			
Syllabus			
Measurement of speed - Streamlined and bluff bodies- Drag -Straight and level flight-Gliding and Climbing flight- Range and Endurance- Aero foil geometry, characteristics and symbols- Lift, drag and L/D ratio devices- Take off and landing performance, turning performance-V-n diagram- Static and dynamic stability- aerodynamic balancing- Aircraft equations of motion- stability derivatives			
Expected Outcome			
The students will be able to analyze the behavior of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.			
Text Books:			
1. Houghton, E.L., and Caruthers, N.B., Aerodynamics for engineering students, Edward Arnold Publishers, 1988. 2. Perkins C.D., &Hage, R.E. Airplane performance, stability and control, Wiley Toppan, 1974.			
References:			
1. Babister, A.W. Aircraft stability and response, Pergamon Press, 1980. 2. Clancey,L.J. Aerodynamics, Pitman, 1986. 3. Kuethe, A.M., and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons, 1982. 4. McCormic, B.W., Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995. 5. Nelson, R.C. Flight Stability & Automatic Control, McGraw-Hill, 1989.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Measurement of speed& Mach number	1	15%
	True, Indicated and Equivalent air speed, Streamlined and bluff bodies	2	
	Various Types of drag in airplanes, drag polar curve	3	
	Methods of drag reduction of airplanes.	2	
II	Aero foil characteristics and symbols.	3	15%
	Fundamental equation for lift and drag and L/D ratio	2	
	Shape and dimension of aero foil Aspect ratio of its effects. Mean aerodynamic chord and airflow control devices	3	
FIRST INTERNAL EXAMINATION			
III	Straight and level flight, thrust required and available	1	15%
	Power required and available, Effect of altitude on thrust and power	3	
	Conditions for minimum drag and minimum power required	2	
	Gliding and Climbing flight, Range and Endurance.	4	
IV	Take off and landing performance	2	15%

	Turning performance, horizontal and vertical turn	2	
	Pull up and pull down, maximum turn rate	1	
	V-n diagram	1	
SECOND INTERNAL EXAMINATION			
V	Degrees of freedom of a system, static and dynamic stability, static longitudinal stability	2	20%
	Contribution of individual components, neutral point, static margin, Hinge moment, Elevator control effectiveness	3	
	Aircraft equations of motion, stability derivatives, stability quartic, Phugoid motion	2	
VI	Yaw and side slip, Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory	2	20%
	Aileron reversal, weather cock stability, directional control, rudder requirements, dorsal fin	2	
	Dutch roll, spiral and directional divergence, autorotation and spin(descriptive)	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

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Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO306	AVIONICS AND CONTROL SYSTEMS	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives - To introduce the basic of avionics and its need for civil and military aircrafts - To impart knowledge about the avionic architecture and various avionics data buses - To gain more knowledge on various avionics subsystems employed in modern aircrafts.			
Syllabus Introduction to digital computer and memories – Avionics - Avionics system architecture - Data buses - display technology- Civil and Military Electrical Power requirement standards- Radio navigation - Inertial Navigation Systems (INS)- Inertial sensors, Satellite navigation systems, GPS- Air data quantities- Mach warning, Altitude warning. Auto pilot -Fiber optic cables and their characteristics, -Avionics fiber optic data busses-Multiplexing schemes for onboard avionics- Fiber optic gyro.			
Expected Outcome The students will be able to - Build Digital avionics architecture and various displays. - Design Navigation system - Design and perform analysis on air system.			
Text Books: - Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004 - Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996.			
Reference: - Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989. - Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993. - Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000 - S.C.Gupta, "Optoelectronic devices and Systems", Prentice Hall of India, New Delhi, 2005.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Need for avionics in civil and military aircraft and space systems.	1	15%
	Integrated avionics and weapon systems.	1	
	Typical avionics subsystems, design, technologies.	2	
	Introduction to digital computer and memories.	2	
	Avionics system architecture.	1	15%

II	Data buses - MIL-STD-1553B.	3	
	ARINC – 429.	2	
	ARINC – 629	4	
FIRST INTERNAL EXAM			
III	Trends in display technology, Alphanumeric displays, character displays etc.	2	15%
	Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS.	1	
	Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit.	3	
	Civil and Military Electrical Power requirement standards.	1	
IV	Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS.	1	15%
	Inertial Navigation Systems (INS).	2	
	Inertial sensors, INS block diagram.	2	
	Satellite navigation systems – GPS.	2	
SECOND INTERNAL EXAM			
V	Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature.	1	20%
	Mach warning, Altitude warning.	1	
	Auto pilot – Basic principles.	1	
	Longitudinal and lateral auto pilot.	2	
VI	Types of Fiber optic cables and their characteristics, fiber optic sources and detectors.	2	20%
	Avionics fiber optic data busses: IEEE std 1393, MIL STD 1773 etc.	1	
	Multiplexing schemes for onboard avionics,	1	
	Fiber optic gyro.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

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Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO307	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives To impart the basic concepts of aircraft general engineering and maintenance practices.			
Syllabus Aircraft Weight and Balance - Aircraft station Numbers -Aircraft Hardware- Fluid lines and Fittings- American and British Systems for Identification- Hand Tools- Lay out and Measuring tools - Aircraft metal structure Repair - Inspection Fundamentals- Aircraft logs, Publications, Bulletins, Various Manuals, Type Certificate data sheet-ATA Specifications, Engine Starting Procedures, Piston Turbo Prop and Turbo Jet Engines, Aircraft Fuelling Procedures- Aircraft Tie down, Towing and Taxing of Aircraft, Jacking of Aircraft			
Expected Outcome The students will gain the concepts of aircraft general engineering and maintenance practices.			
Text Books: - Kroes Watkins Delp, Aircraft Maintenance and Repair, McGraw Hill, New York, 1993. - Airframe and Power plant Mechanics-General Hand Book-FAA Himalayan Book House, New Delhi.			
References: - Aviation Maintenance Technician Hand Book-Airframe Vol -I and II, FAA, Shroff Publishers & Distributors ,New Delhi. - Civil Aircraft inspection procedures-CAP 459-Vol.I & II, Sterling Book house, Mumbai. - Lalit Gupta , Aircraft General Engineering Practices, ,Himalayan Book house, New Delhi			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Aircraft Weight and Balance - Purpose, Theory of Weight and Balance	1	15%
	Terminology - The Datum, C.G, Maximum Weight, Empty Weight, Useful load, Zero fuel weight	1	
	Aircraft weighing procedure - Control Surface Balancing - Rigging checks	2	
	Structural Alignment, Cable tension, Control surface travel - Aircraft Station Numbers	2	
II	Aircraft Hardware-Aircraft Bolts and Nuts, Washers, Aircraft Screws, Control cables, Turn Buckles, Rivets	1	15%
	Fluid lines And Fittings-Flexible Hose, Rubber Hose, Rigid tubes	3	
	Identification of Fluid Lines	2	
	Plumbing Connectors. American and British Systems for Identification.	4	

FIRST INTERNAL EXAMINATION			
III	Hand Tools-Pliers, Wrenches, Torque Wrenches, Snips	2	15%
	Files, Reamers, Drills, Taps and Dies, Screw Drivers	1	
	Lay out and Measuring tools, rules, Combination set	3	
	Precision Instruments-Micrometer, Vernier caliper, Telescopic gauge, Vernier height gauge.	1	
IV	Aircraft metal structure Repair - Riveting, Installation of Rivets, riveting procedure, Rivet Lay out.	2	15%
	Sheet metal Bending, Tube Bending and Flaring - Cable Splicing & Swaging,	2	
	Wire Locking Welding-Oxy Acetylene, Electric Arc Welding	2	
	MIG, TIG, plasma welding	1	
SECOND INTERNAL EXAMINATION			
V	Inspection Fundamentals-, Special Inspections-Hard Landing Inspection	1	20%
	Severe turbulence inspection	1	
	Aircraft logs, Publications, Bulletins	1	
	Various Manuals, Type Certificate data sheet-ATA Specifications	2	
VI	Engine Starting Procedures	2	20%
	Piston Turbo Prop and Turbo Jet Engines	1	
	Aircraft Fuelling Procedures- Aircraft Tie down, Towing and Taxing of Aircraft	1	
	Jacking of Aircraft	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO309	EXPERIMENTAL STRESS ANALYSIS	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives To study the various experimental techniques involved for measuring displacements, stresses, strains in structural components.			
Syllabus Principles of measurements – Extensometers - Capacitance gauges, Laser displacement sensors- electrical resistance strain gauges - static and dynamic strain measurements - strain indicators- Rosette analysis- stress gauges- load cells- Two-dimensional photo elasticity- Transmission photo elasticity- polariscopes - Introduction to three-dimensional photo elasticity -Relation between stresses in coating and specimen-Fundamentals of NDT			
Expected Outcome The students will acquire knowledge about - Stress and strain measurements in loaded components. - The usage of strain gauges and photo elastic techniques of measurement. - Use of NDT in stress analysis			
Text Books: - Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw Hill Inc., New York 1998. - Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1996. - Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and RaMachandra, K., "Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984.			
References: - Durelli. A.J., "Applied Stress Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1970 - Hetenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972. - Max Mark Frocht, "Photo Elasticity", John Wiley and Sons Inc., New York, 1968 - Pollock A.A., Acoustic Emission in Acoustics and Vibration Progress, Ed. Stephens R.W.B., Chapman and Hall, 1993. - Ramesh, K., Digital Photoelasticity, Springer, New York, 2000			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Principles of measurements, Accuracy, Sensitivity and range of measurements	1	15%
	Mechanical and Optical extensometers and their uses, Advantages and disadvantages	2	
	Acoustical and Electrical extensometers and their uses, Advantages and disadvantages	2	
	Capacitance gauges.	1	
II	Principle of operation of electrical resistance strain gauges and requirements, Types and their uses.	2	15%
	Materials for strain gauges	1	

	Calibration and temperature compensation, cross sensitivity	2	
FIRST INTERNAL EXAMINATION			
III	Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements	1	15%
	Rosette analysis – Numerical Problems	4	
	strain indicators	1	
	Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements	2	
IV	Two-dimensional photo elasticity, Photo elastic materials	2	15%
	Concept of light - photo elastic effects	1	
	Stress optic law, Transmission photo elasticity	3	
	plane and circular polariscopes.	1	
SECOND INTERNAL EXAMINATION			
V	Interpretation of fringe pattern	1	20%
	Calibration of photo elastic materials	2	
	Compensation and separation techniques	2	
	Moire method of strain analysis.	2	
	Introduction to three-dimensional photo elasticity	2	
VI	Fundamentals of NDT	2	20%
	Acoustic Emission Technique	2	
	Radiography, Thermography, Ultrasonic Testing	2	
	Eddy Current testing, Fluorescent Penetrant Testing	1	
	Introduction to brittle coating	1	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

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Part A

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Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO331	AIRFRAME PRODUCTION AND MAINTENANCE LAB	0-0-3-1	2016
Course Objectives To give training on riveting, patchwork, welding and carpentry			
List of experiments - Aircraft wood gluing-single scarf joint - Aircraft wood gluing-double scarf joint - Study on MIG, TIG & PLASMA welding of aircraft components - Welded single & double V-joints. - Fabric Patch repair - Riveted patch repairs. - Tube bending and flaring - Sheet metal forming. - Preparation of glass epoxy of composite laminates and specimens. - Determination of elastic constants of composite specimens. - Plain Turning operation on Lathe. - Plain Milling Exercise. - TIG welding practice of basic joints - MIG welding practice of basic joints - PLASMA welding practice of basic joints			
Expected Outcome The students will get hands on experience in doing minor works in airframe production and maintenance.			
END SEMESTER EXAM			



Course code	Course Name	L-T-P-Credits	Year of Introduction
AO332	PROPULSION LAB	0-0-3-1	2016
Course Objectives To carryout experiments in IC Engines, propeller, turbine blades etc.			
List of Experiments 1. Performance test on a 4-stroke engine. 2. Valve timing of a 4 – stroke engine 3. Port timing of a 2 stroke engine. 4. COP test on a Vapour compression refrigeration test rig 5. Velocity profiles of wall jets. 6. Velocity profiles of free jets. 7. Wall Pressure distribution and measurements in nozzles. 8. Study of Forced / Free Convection. 9. Determination of Propeller Thrust and Performance. 10. Determination of effectiveness of heat exchanger. 11. Flame stabilization studies using conical flame holders. 12. Cascade testing of compressor and turbine blades. 13. Study of piston engines used in aircraft. 14. Study of Jet Engines used in aircraft. 15. Determination of calorific value of a fuel.			
Expected outcome The students will be able to do simple experiments in propulsion area			
END SEMESTER EXAM			

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO333	AIRCRAFT STRUCTURAL ANALYSIS LAB	0-0-3-1	2016
Prerequisite:			
Course Objectives To impart practical experience on static and dynamic analysis of aircraft structural components			
List of Experiments			
- Constant strength Beams - Buckling of columns - Unsymmetrical Bending of Beams - Shear Center Location for Open Section - Shear Center Location for Closed Section - Flexibility Matrix for Cantilever Beam - Combined Loading - Wagner beam - Stress / Strain Measurement on pressurized thin walled tubes of various materials using strain gauges. - Stress / Strain Measurement on flat plate and cylindrical rod with axial loads using strain gauges. - Stress / Strain Measurement on hollow cylindrical rod with torsional load using strain gauges. - Vibration damping test – Longitudinal - Vibration damping test – Torsional - Stress / Strain Measurement using strain rosette – Star and Delta Connected - Verification of stress optic law using photo elasticity.			
Expected Outcome The students will be able to do experiments to analyse static and dynamic behaviour of aircraft structural components			
END SEMESTER EXAM			

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO464	AEROSPACE GUIDANCE AND CONTROL	3-0-0-3	2016
Course Objectives The students will have an exposure on various topics such as 6-DOF equations of motion, autopilots and augmentation systems and missile guidance systems and will be able to deploy these skills effectively in the design of control for aerospace systems.			
Syllabus Introduction to Guidance and control-Need for automatic flight control systems-Displacement Autopilot-Damping of the Dutch Roll			
Expected outcome The students will be able to - Appreciate how complex aerospace vehicles navigate in air and space - Analyze the control systems which assist in maneuvering these vehicles			
Text Books: - R.P.G Collinson, “Introduction to Avionics Systems”, Springer; 3rd ed. edition, 2011 - Tewari, A.“Advanced Control of Aircraft, Spacecraft and Rockets”, John Wiley & Sons, Ltd, Chichester, UK, 2011			
References: - BernadEtikin,’Dynamic of flight stability and control’, John Wiley, 1972. - Blake Lock, J.H ‘Automatic control of Aircraft and missiles ‘, John Wiley Sons, New York, 1990. - Collinson R.P.G, ‘Introduction to Avionics’, Chapman and Hall, India, 1996. - Garnel.P. &East.D.J, ‘Guided Weapon control systems’, Pergamon Press, Oxford, 1977. - Nelson R.C ‘Flight stability & Automatic Control’, McGraw Hill, 1989. New York, 1992. - Stevens B.L & Lewis F.L, ‘Aircraft control & simulation’, John Wiley Sons,			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Guidance and control - definition,	3	15%
	Historical background	2	
II	Need for automatic flight control systems	1	15%
	Stability augmentation systems,	2	
	control augmentation systems,.	2	
	Gain scheduling concepts	2	
FIRST INTERNAL EXAMINATION			
III	Displacement Autopilot-	2	
	Pitch Orientation Control system, Acceleration Control System,	2	

	Glide Slope Coupler and Automatic Flare Control and Flight path stabilization	2	15%
	Longitudinal control law design using back stepping algorithm.	2	
IV	Damping of the Dutch Roll,	2	15%
	Methods of Obtaining Coordination,	2	
	Yaw Orientation Control system, turn compensation,	2	
	Automatic lateral Beam Guidance	2	
SECOND INTERNAL EXAMINATION			
V	Introduction to Fly-by-wire flight control systems	2	20%
	Lateral control law design using back stepping algorithm.	2	
VI	Operating principles and design of guidance laws, homing guidance laws- short range	2	20%
	Medium range and BVR missiles,	2	
	Launch Vehicle- Introduction, Mission requirements,	2	
	Implicit guidance schemes, Explicit guidance, Q guidance schemes.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO465	INDUSTRIAL AERODYNAMICS	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives			
To familiarize non-aeronautical uses of aerodynamics in road vehicles, buildings and problems of flow induced vibrations.			
Syllabus			
Atmospheric circulation - Turbulence profiles -Boundary layers and separation--Power requirements and drag coefficients of automobiles - effects of cut back angle-aerodynamics of trains. - Horizontal and vertical axis machines- Betz coefficient aerodynamics of low rise and tall buildings-building codes - ventilation and architectural aerodynamics- Vortex shedding lock& effects of Reynolds number on wake formation in turbulent flows – wind galloping - oscillation of tall structures and launch vehicles -stall flutter.			
Expected Outcome			
The students will be able to apply principles of aerodynamics in the design of vehicles, buildings, launch vehicles etc.			
Text Books:			
1. Blevins R.D “Flow Induced Vibrations”, Van Nostrand, 1990 2. Calvert N.G “Wind Power Principles”, Charles Griffin & Co London, 1979 3. Sachs P “Wind Forces in Engineering”, Pergamon Press, 1988 4. Scorer R.S “Environmental Aerodynamics”, Ellis Harwood Ltd, England, 1978 5. Sovran, M(ed) “Aerodynamic drag mechanism of bluff bodies and road vehicles”, Plenum Press, N.Y, 1978			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Atmospheric circulation	1	15%
	Local winds-Terrain types	2	
	Mean velocity profiles	2	
	Power law and logarithm law- wind speeds	2	
II	Turbulence profiles	2	15%
	Roughness parameters	3	
	simulation techniques in wind tunnels	3	
FIRST INTERNAL EXAM			
III	Boundary layers and separation-Two-dimensional wake and vortex formation-	2	15%

	Strouhal and Reynolds numbers-Separation and reattachment	2	
	Power requirements and drag coefficients of automobiles	3	
	Effects of cut back angle-aerodynamics of trains.	1	
IV	Horizontal and vertical axis machines-energy density of different rotors	2	15%
	Power coefficient	2	
	Betz coefficient by momentum theory	2	
SECOND INTERNAL EXAM			
V	Pressure distribution on low rise buildings-wind forces on buildings	2	20%
	Environmental winds in city block	2	
	special problems of tall buildings-building codes	1	
	ventilation and architectural aerodynamics	2	
VI	Vortex shedding	2	20%
	lock & effects of Reynolds number on wake formation in turbulent flows -	2	
	across wind galloping-wake galloping-along wind galloping of circular cables		
	oscillation of tall structures and launch vehicles under wind loads-stall flutter.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO466	AIRCRAFT RULES AND REGULATIONS	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives To grasp the civil air rules and regulation which are being followed by Directorate General of Civil Aviation.			
Syllabus C.A.R.- M –Continuing Airworthiness Requirements -C.A.R series ‘B’ -C.A.R series ‘C’-C.A.R series ‘F’-C.A.R series ‘H’-C.A.R series ‘I’-C.A.R series ‘R’			
Expected outcome The students will be able to - know whether an aircraft is airworthy or not - prepare important documents like emergency check list, cockpit check list and deficiency list - record, monitor, investigate and report about the defects in an aircraft - decide on the inspection and maintenance procedures and schedules - know the procedure of approval for aircraft manufacturing and maintenance industries - know about the aircraft registration process and procedures to obtain licenses for engines, aircrafts			
Text Books: - Civil Aviation Requirements with latest Amendments (section 2 airworthiness)”- published by DGCA, The English Book Store,17-1,Connaught circus, New Delhi - CAR –M ,CAR-66,CAR-145 with latest Amendments Issued By DGCA, India.			
References: - Aircraft Manual (India), The English book store 17-1. Connaught circus ,New Delhi - Advisory circulars from DGCA 2003.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	C.A.R.- M –Continuing Airworthiness Requirements	1	15%
	Responsibilities of Owner , Continuing airworthiness tasks , Aircraft Maintenance program , Reliability program	1	
	Continuing Airworthiness Record System, Approval Requirements of Maintenance Organizations	2	
	Aircraft and Component Certificate of Release to Service	2	
II	C.A.R series ‘B’ – Minimum Equipment List	1	15%
	C.A.R series ‘C’-Defect Recording ,Reporting ,Investigation, Rectification ,and Analysis	2	
	CAR-145 – Approval of Maintenance Organizations-Facility	2	

	Requirements , Personnel Requirements		
	Acceptance of Components ,Certification of Maintenance	3	
FIRST INTERNAL EXAMINATION			
III	C.A.R series ‘F’- Part I-Procedures Relating To Registration And Deregistration of Aircraft.	2	15%
	Part-III-Issue/Validation and Renewal Of Certificate Of Airworthiness.	1	
	C.A.R series ‘H’-Part-II- Aircraft fuelling Procedures ,	3	
	Part-III- Aviation Fuel at Airport-Storage Handling and Quality Control	1	
IV	C.A.R series ‘I’- Part I-Aircraft Instruments Overhaul And Periodical Inspections.	1	15%
	Part-V & VI – Flight Data Recorders and Cockpit Voice Recorders.	2	
	C.A.R series ‘R’-Part I- Aircraft Radio Equipment.-	2	
	Part II – Installation of Communication, Navigation and Radar Equipment.	2	
SECOND INTERNAL EXAMINATION			
V	CAR-66 - Licensing Of Aircraft Maintenance Engineers	1	20%
	License Categories , Aircraft Groups , Eligibility , Privileges ,	1	
	Basic Knowledge Requirements ,	1	
	Basic Experience Requirements.	2	
VI	C.A.R.series ‘S’-Part II – Fixation of calendar period for determining overhaul life of Reciprocating Engines.	2	20%
	C.A.R. series ‘X’-Part II-Weight and Balance control of Aircraft.	1	
	-Part VI- Aircraft Log Books-	1	
	Part VII- Documents to be carried on board by Indian Registered Aircraft.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
AO467	OPTIMIZATION METHODS IN AIRCRAFT DESIGN	3-0-0-3	2016
Prerequisite : Nil			
Course Objective To understand the use of optimisation methods in the design of aircraft.			
Syllabus Phases of Aircraft Design - Design Examples. -Airfoil Selection – wing loading- Initial Sizing of Aircraft - Configuration Layout and Loft -linear programming (LP) problem -Simplex algorithm - Piecewise linear approximation of a nonlinear function - Multi objective optimization – Weighted and constrained methods; Multi level optimization - Direct and indirect search methods - Evolutionary algorithms for optimization and search - Applications in aerospace engineering			
Expected Outcome The students will be able to - do the design calculations of various types of aircraft - create optimum designs			
Text Books: - D.P. Raymer, Aircraft Design: A Conceptual Approach, AIAA Education Series, 2006 - G.N. Vanderplaats: Numerical Optimization Techniques For Engineering Design, McGraw Hill, 1984 - H.A. Taha,"OperationsResearch:An Introduction", 5th Edition, Macmillan, New York, 1992. - S.S. Rao,"Engineering Optimization: Theory and Practice", New Age International Pvt. Ltd., New Delhi, 2000.			
References G. Hadley,"Linear programming", Narosa Publishing House, New Delhi, 1990 J. Nocedal, S.J. Wright, Numerical Optimization, Springer 1999 K. Deb,"Optimization for Engineering Design Algorithms and Examples",Prentice-Hall of India Pvt. Ltd., New Delhi, 1995. - K.Srinivasa Raju and D. Nagesh Kumar, "Multi criterion Analysis in Engineering and Management", PHI Learning Pvt. Ltd., New Delhi, India, ISBN 978-81-203-3976-7, pp.288, 2010. R. Baldick: Applied Optimization, Cambridge University Press, 2006			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction - Phases of Aircraft Design -	1	15%
	Aircraft Conceptual Design Process - Takeoff-Weight Buildup -	2	

	Empty-Weight Estimation - Fuel-Fraction Estimation	2	
	Takeoff-Weight Calculation - Design Examples.	2	
II	Airfoil Selection - Wing Geometry	2	15%
	Biplane Wings - Tail Geometry and Arrangement	3	
	Thrust-to-Weight Ratio - Wing Loading	2	
	Selection of Thrust-to-Weight and Wing Loading	4	
	FIRST INTERNAL EXAM		
III	Initial Sizing of Aircraft	2	15%
	Rubber Engine Sizing – Fixed Engine Sizing	2	
	Geometry Sizing	3	
	Control Surface Sizing	1	
IV	Configuration Layout and Loft - End Products of Configuration Layout -	2	15%
	Conic Lofting - Conic Fuselage Development - Flat-Wrap Fuselage Lofting - Circle-to-Square Adapter	2	
	Fuselage Loft Verification - Wing/Tail Layout and Loft	2	
	Aircraft Layout Procedures- Wetted Area Determination - Volume Determination	2	
SECOND INTERNAL EXAM			
V	Standard form of linear programming (LP) problem; Canonical form of LP problem	1	20%
	Assumptions in LP Models; Elementary operations - Graphical method for two variable optimization problem; Examples	1	
	Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion	1	
	Minimization versus maximization problems	2	
VI	Piecewise linear approximation of a nonlinear function	2	20%
	Multi objective optimization – Weighted and constrained methods; Multi level optimization	1	
	Direct and indirect search methods	1	
	Evolutionary algorithms for optimization and search - Applications in aerospace engineering	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P Credits	Year of Introduction
AO468	AIRFRAME MAINTENANCE AND REPAIR	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives To study the maintenance aspect of airframe systems and rectification of snags			
Syllabus Equipment used in welding shop and their maintenance -N.D.T. Testing -Inspection and Repair of composite components –Pneumatic Power System Maintenance.			
Expected outcome The students will be able to i. know the welding process of aircraft structural components. ii. know the maintenance and repair process of plastics and composites in Aircraft. iii. understand the jacking, assembly and rigging process of aircraft iv. get an understanding of hydraulic and pneumatic system in aircraft. v. acquaint with the safety practices in aircraft.			
Text Books: 1. KROES, WATKINS, DELP, “Aircraft Maintenance and Repair”, McGraw-Hill, New York, 1992 2. “Aviation Maintenance Technician Hand Book - Airframe Vol.I& II”, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi.			
References: 1. LARRY REITHMEIR, “Aircraft Repair Manual”, Palamar Books, Marquette, 1992. 2. BRIMM D.J. BOGGES H.E., “Aircraft Maintenance”, Pitman Publishing corp. New York, 1940 3. Civil Aircraft inspection Procedures-CAP 459-Vol.I & II, Sterling Book house ,Mumbai.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Equipment used in welding shop and their maintenance – Ensuring quality welds	1	15%
	Welding jigs and fixtures – Soldering and brazing.	1	
	Inspection of damage – Classification – Repair or replacement – Sheet metal inspection	2	
	N.D.T. Testing – Riveted repair design, Damage investigation – reverse technology.	2	
II	Review of types of plastics used in airplanes	1	15%
	– Maintenance and repair of plastic components – Repair of cracks, holes etc., various repair schemes – Scopes.	3	
	Inspection and Repair of composite components	2	
	Special precautions – Autoclaves.	2	
FIRST INTERNAL EXAMINATION			

III	Inspection and maintenance of Hydraulic system – sampling	2	15%
	Flushing , Draining - Routine maintenance	2	
	Pneumatic Power System Maintenance.	3	
IV	Inspection and maintenance of landing gear systems.	2	15%
	Bleeding of Shock Struts ,Aircraft wheel inspection	2	
	Brake Inspection and Servicing , Bleeding of Brake System	2	
	Inspection and maintenance of air-conditioning and pressurization system	2	
SECOND INTERNAL EXAMINATION			
V	Installation and maintenance of Instruments – handling – Testing – Inspection	1	20%
	. Inspection and maintenance of auxiliary systems – Fire protection systems	1	
	Ice protection system – Rain removal system	1	
	Position and warning system – Auxiliary Power Units (APUs)	2	
VI	Hazardous materials storage and handling	2	20%
	Aircraft furnishing practices – Equipment.	2	
	Trouble shooting - Theory and practices.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO472	AIR TRANSPORTATION AND AIRLINE MANAGEMENT	3-0-0-3	2016
Course Objectives - To introduce air transportation, various organizations involved and the administrative structure in aviation. - To accustom the economic parameters in an aviation industry. - To introduce to the processes involved in airline scheduling. - To familiarize the technologies used in aircraft maintenance			
Syllabus History of Aviation- Development of Air transportation in India- Layout of an Airport & Ground Handling - Airport & Aircraft Security - Airport planning-Operational area and Terminal planning, design, and operation.			
Expected outcome The student will be able to i. understand the procedures in an aviation industry or organization. ii. decide on the size of the fleet, crew and their management. iii. decide on the scheduling of fleet according to the requirements iv. determine the schedule for inspection and maintenance.			
Text Books: 1. James Reason and Alan Hobbs, Managing Maintenance Error, Ashgate Publishing Ltd. 2. Manoj S. Patankar and James C. Taylor, Risk Management and Error Reduction in Aviation Maintenance, Ashgate Publishing Ltd. 3. P.S.Senguttuvan, Fundamentals of Airport Transport Management, McGraw Hill 2003			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	History of Aviation- Development of Air transportation in India	1	15%
	Major players in Airline Industry-SWOT analysis in Airline Industry	1	
	Market potential of Indian Airline Industry—Current challenges in Airline Industry	2	
	Completion in Airline Industry-IATA & ICAO	2	
II	Layout of an Airport & Ground Handling - Airport & Aircraft Security	1	15%
	Managerial Operations - Airline Catering & Various Bodies	3	
	Handling of Unaccompanied minors and Disabled Passengers	2	
	Handling of Stretcher Passengers and Human Remains	4	
FIRST INTERNAL EXAMINATION			
III	Airport planning-Operational area and Terminal planning, design, and operation	2	

	Airport operations-Airport functions-Organization structure of Airline and Airports sectors-	1	15%
	Airport authorities-Global and Indian scenario of Airport management – DGCA –AAI.	3	
IV	International trends-Emerging Indian scenario-PPP- Public Private Participation in Indian Airports-	1	15%
	Environmental regulations-Private participation in International developments-	2	
	Environment regulations-Regulatory issues-	2	
	Meteorological services for Aviation-Airport fees, rates, and charges	2	
SECOND INTERNAL EXAMINATION			
V	Airline Terminal Management-Flight Information Counter/Reservation and Ticketing-Check In/Issue of Boarding pass-Customs and Immigration formalities	1	20%
	Co-ordination-Security Clearance-Baggage and -Handling of Unaccompanied minors and Disabled Passengers	1	
	Handling of Stretcher Passengers and Human Remains	1	
	Handling of CIP,VIP& VVIP-Co-ordination of Supporting Agencies /Departments.	2	
VI	Concept of Logistics- Role of Ware Housing-trend in material handling	2	20%
	Global Supply Chain-Quality concept and Total Quality Management-improving Logistic performance	1	
	Air Cargo Concept- Cargo Handling-Booking of Perishable Cargo and Live Animals- Industry Relation	1	
	Type of Air Cargo-Air Cargo Tariff, ratios and Charges-Airway Bill, Function, Purpose, Validation	2	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO482	FLIGHT AGAINST GRAVITY	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives To introduce the basic concepts of aerospace engineering and the current developments in the field.			
Syllabus: History of aeronautics – helicopters – aircraft propulsion – aircraft configurations – Atmosphere and atmospheric flight – space flight – aircraft structures and materials – rockets.			
Text Book: Anderson, J.D., “Introduction to Flight”, McGraw-Hill, 1995.			
Reference: Kermode, A.C., “Flight without Formulae”, McGraw-Hill, 1997.			
Syllabus & Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Historical Developments in Aeronautical Activities: Early air vehicles: Balloons, Biplanes and Monoplanes	3	15%
	Helicopters; Developments in aerodynamics, aircraft materials, aircraft structures & aircraft propulsion.	3	
II	Aircraft Configurations: Different types of flight vehicles and their classifications;	2	15%
	Components of fixed wing airplane and their functions;	2	
	Airfoils, wings and other shapes.	2	
FIRST INTERNAL EXAMINATION			
III	Principles of Atmospheric Flight: Physical properties and structure of the atmosphere:	3	15%
	The Standard Atmosphere, Temperature, Pressure and Altitude relationships, Mach number	2	
	Evolution of theory of lift and drag, Maneuvers, Concepts of stability and control.	3	
IV	Introduction to Space Flight: Introduction to basic concepts, the upper atmosphere	3	15%
	Space vehicle trajectories-some basic concepts, Kepler’s Laws of planetary motion.	3	
SECOND INTERNAL EXAMINATION			
V	Introduction to airplane structures and materials : General types of construction, Monocoque, semi-monocoque.	3	20%
	Typical wing and fuselage structure. Metallic and non-metallic materials	2	
	Use of aluminium alloy, titanium, stainless steel and composite materials.	2	
VI	Power plants used in airplanes : Basic ideas about piston, turboprop and jet engines.	3	20%

	Comparative merits, Principles of operation of rocket, types of rockets and typical applications,	3	
	Exploration into space.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

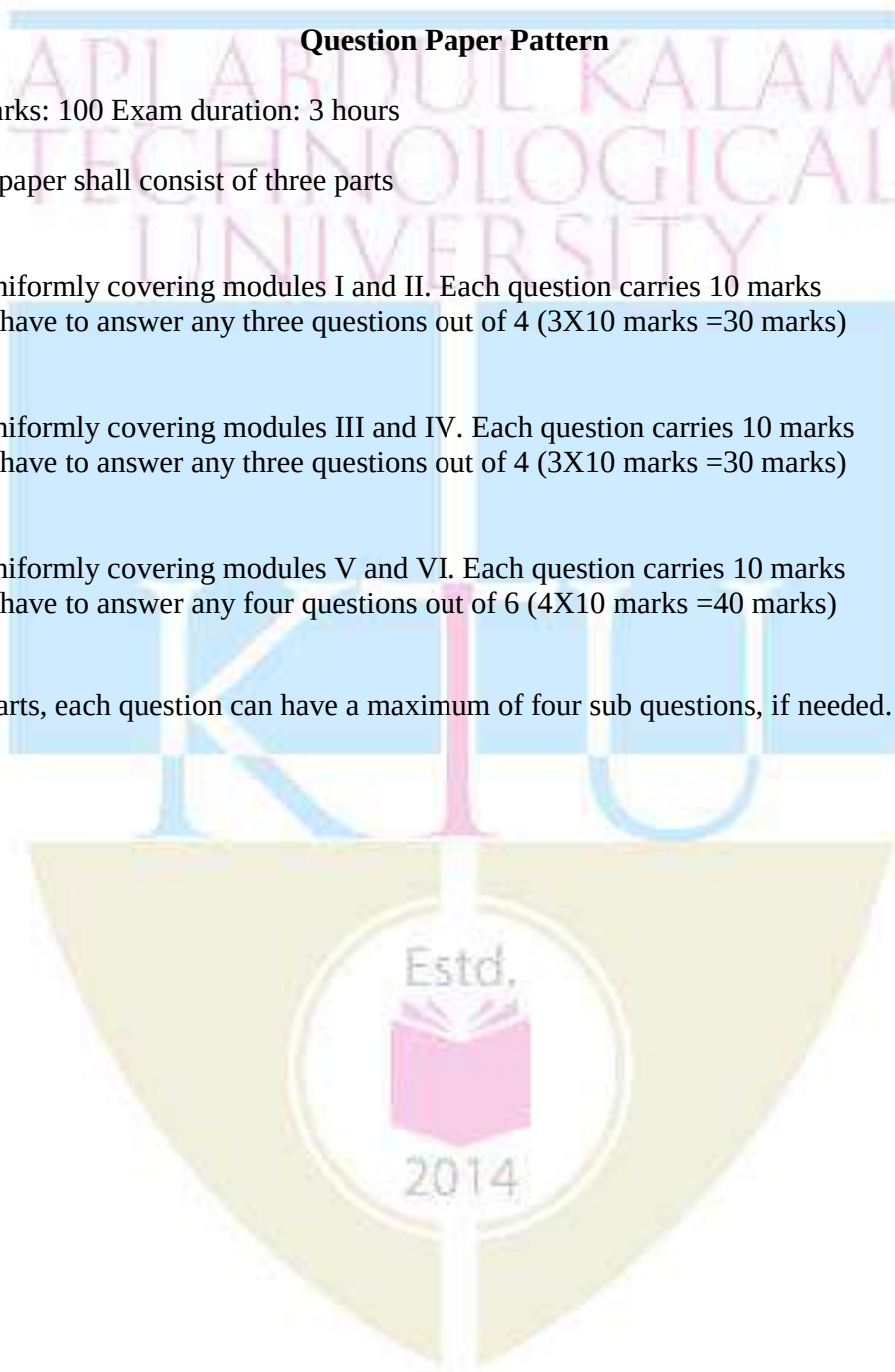
Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course No.	Course Name	L-T-P – Credits	Year of Introduction
CE201	MECHANICS OF SOLIDS	3-1-0-4	2016
Pre requisite: BE 100 Engineering Mechanics			
Course Objectives: To enable the students to calculate stresses and strains generated in material due to external loads for various types of loading conditions			
Syllabus: Concept of stress. Concept of strain. Stress-strain relations. Calculating internal forces (Normal force, shear force and bending moment diagrams) Behavior of axially loaded members. Behavior of members subjected to bending moments. Behavior of circular members subjected to Torsion. Shear stresses in beams. Transformation of plane stresses. Mohr circle. Concept of design of beams. Buckling of columns. Indeterminacy.			
Expected outcome . 1. Ability to calculate internal forces in members subject to axial loads, shear, torsion and bending and plot their distributions 2. Ability to calculate normal, shear, torsion and bending stresses and strains 3. Ability to transform the state of stress at a point and determine the principal and maximum shear stresses using equations as well as the Mohr's circle 4. Understanding of column buckling and ability to calculate critical load and stress			
Text Books: 1. Timoshenko , Strength of Materials Vol. I & Vol. II , CBS Publishers & Distributers, New Delhi 2. Rattan, Strength of Materials 2e McGraw Hill Education India 2011			
Data Book (Approved for use in the examination): Nil			
References: 1. Crandall, An Introduction to Mechanics of Solids 3e McGraw Hill Education India 2014 2. Egor P Popov , Mechanics of solids, Prentice Hall of India, New Delhi 3. M.L. Gambhir, Fundamentals of structural Mechanics and analysis, Prentice Hall India 4. Stephen H Crandall, N C Dahi, Thomas J L, M S Sivakumar, an introduction to Mechanics of Solids , McGraw hill Education, 3rd edition 5. Cheng, Statics and Strength of Materials 2e McGraw Hill Education India 2013 6. Hearn E.J., <i>Mechanics of Materials</i>, Pergamon Press, Oxford 7. Nash W A, Strength of Materials (SIE) (Schaum's Outline Series) 5e McGraw Hill Education India 2010 8. Rajput R.K. Strength of Materials, S.Chand&company Ltd., New Delhi 9. James M Gere & Stephen P Timoshenko , Mechanics of Materials , CBS Publishers & Distributers, New Delhi 10. Punmia B. C., A. K. Jain and A. K. Jain, Mechanics of Materials, Laxmi Publications(P) Ltd, New Delhi			

<i>Course Plan</i>			
Module	Contents	Hours	Sem. Exam Marks
I	Review of Statics Types of external loads - internal stresses - normal and shear stresses - strain - Hooke's law - working stress - stress strain diagrams - Poisson's ratio - relationship between elastic constants	9	15%
II	Elongation of bars of constant and varying sections – statically indeterminate problems in tension and compression – Temperature effects – strain energy and complementary energy-strain energy due to tension, compression and shear	9	15%
FIRST INTERNAL EXAMINATION			
III	Bending Moment & Shear force: Different types of beams-various types of loading –Relationship connecting intensity of loading , shearing force and bending moment- shear force and bending moment diagrams for cantilever beams and Simply supported beams for different types of loading.	9	15%
IV	Stresses in beams of symmetrical cross sections: Theory of simple bending –assumptions and limitations – Normal stresses in beams- Moment of resistance - beams of uniform strength - beams of two materials – strain energy due to bending - shearing stresses in beams.	9	15%
SECOND INTERNAL EXAMINATION			
V	Analysis of stress and strain on oblique sections: Stress on inclined planes for axial and biaxial stress fields - principal stresses - Mohr's circle of stress Thin and Thick Cylinders: Stresses in thin cylinders – thick cylinders - Lamé's equation – stresses in thick cylinders due to internal and external pressures Torsion: Torsion of solid and hollow circular shafts.-Pure shear- strain energy in pure shear and torsion. Springs: Close coiled and open coiled helical springs.	9	20%
VI	Deflection of statically determinate beams: Differential equation of the elastic curve - Method of successive integration, Macaulay's method, Method of superposition, moment area method. Theory of columns: Direct and bending stresses in short columns- Kern of a section. Buckling and stability-Euler's buckling/crippling load for columns with different end conditions- Rankine's formula	11	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks: 100

Exam Duration: 3 Hrs

The question paper shall have three parts.

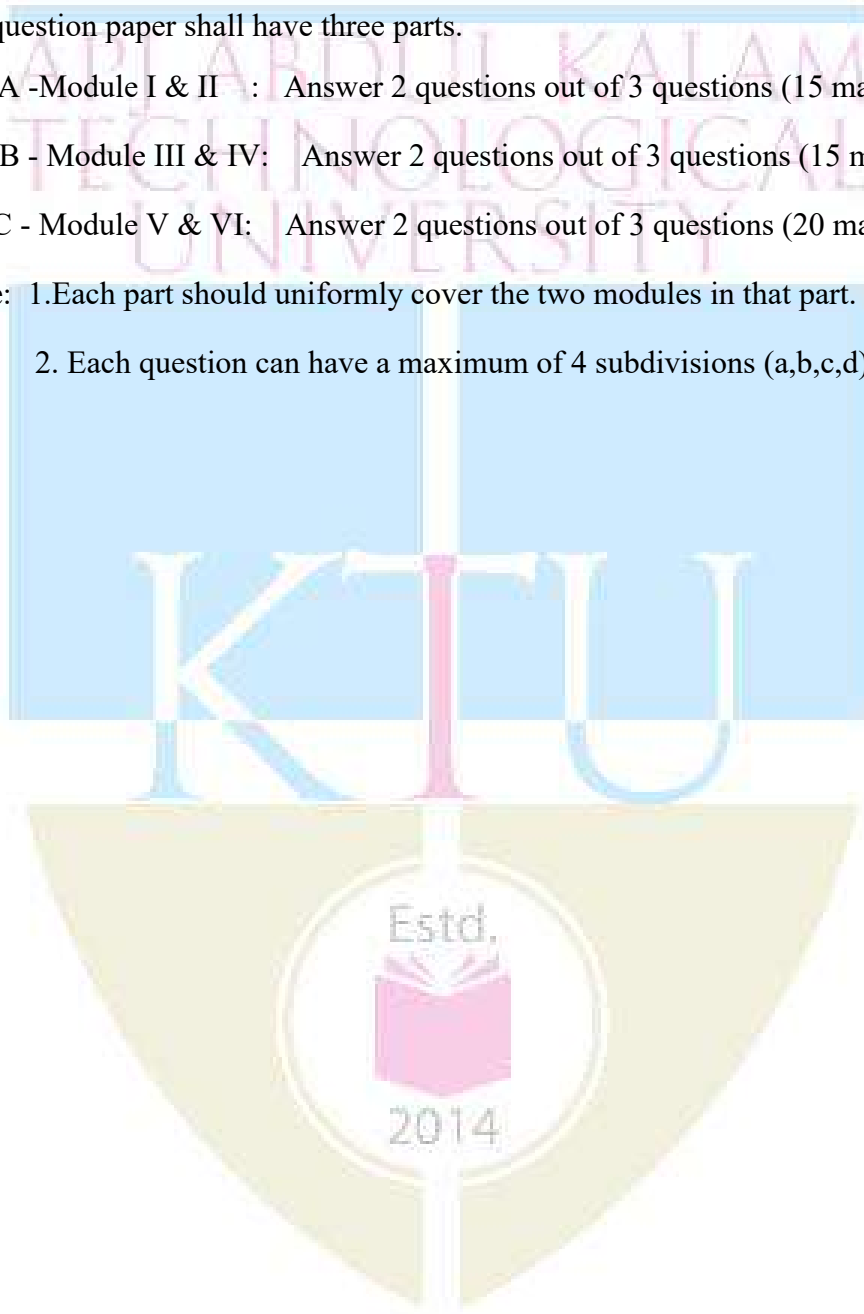
Part A -Module I & II : Answer 2 questions out of 3 questions (15 marks each)

Part B - Module III & IV: Answer 2 questions out of 3 questions (15 marks each)

Part C - Module V & VI: Answer 2 questions out of 3 questions (20 marks each)

Note: 1.Each part should uniformly cover the two modules in that part.

2. Each question can have a maximum of 4 subdivisions (a,b,c,d), if needed.



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE202	STRUCTURAL ANALYSIS -I	3-1-0-4	2016

Prerequisite: CE201 Mechanics of Solids

Course objectives:

- To equip the students with the comprehensive methods of structural analysis with emphasis on analysis of elementary structures.

Syllabus :

Truss analysis, Displacement response of statically determinate structural systems using energy methods, Principle of virtual work, Statically indeterminate structures, Strain Energy methods, Moving loads and influence lines, Cables and Suspension bridges, Arches.

Expected Outcomes:

The students will be able to

- analyse trusses and study displacement response of statically determinate structural systems using energy methods:
- apply unit load method and strain energy method for determination of deflection of statically determinate beams, frames & pin jointed trusses
- analyse statically indeterminate structures using strain energy method and method of consistent deformation
- know about moving loads and influence lines
- know about Statically determinate and indeterminate suspension bridges and arches

Text Books:

- Gere and Timoshenko, Mechanics of materials, CBS. Publishers
- Kenneth Leet, Chia M Uang & Anne M Gilbert., Fundamentals of Structural Analysis, McGraw Hill
- R.Vaidyanathan and P.Perumal, Comprehensive Structural Analysis Volume I & II, Laxmi Publications (P) Ltd
- Wang C.K., Intermediate Structural Analysis, McGraw Hill

References:

- Aslam Kassimali., Structural Analysis, Cenage Learning
- Chandramouli P N, Structural Analysis I –Analysis of Statically Determinate Structures, Yes DeePublishing Pvt Ltd., Chennai, Tamil Nadu.
- DevdasMenon, Structural Analysis, Narosa Publications
- Hibbeler., Structural Analysis, Pearson Education
- Kinney S., Indeterminate Structural Analysis, Oxford & IBH
- M.L. Gambhir, Fundamentals of structural Mechanics and analysis, Printice Hall India
- Reddy C.S., Indeterminate Structural Analysis, Tata McGraw Hill
- Timoshenko S.P. & Young D.H., Theory of Structures, McGraw Hill

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks
I	TRUSS ANALYSIS: Analysis of determinate truss-Methods of	8	15%

	joints and sections (Numerical problems) Elastic theorems and energy principles - strain energy due to axial load, bending moment, shear and torsion - strain energy method, Castigliano's method for deflection (Derivations only)		
II	Principle of virtual work – Unit load method-Betti's theorem – Maxwell's law of reciprocal deflections - principle of least work - application of unit load method and strain energy method for determination of deflection of statically determinate beams, frames - pin jointed trusses (simple numerical problems) Concepts of temperature effects and lack of fit.(No numerical problems) Statically indeterminate structures: Degree of static and kinematic indeterminacies – Introduction to force and displacement method(step by step procedure)	9	15%
FIRST INTERNAL EXAMINATION			
III	Strain Energy methods: Analysis of beams, frames and trusses with internal and external redundancy – (Simple problems with maximum two redundants) Concepts of effect of prestrain, lack of fit, temperature changes and support settlement.(No numerical problems) Method of Consistent deformations: Analysis of beams frames and trusses with internal and external redundancy(Simple problems with maximum two redundants) Concepts of effect of prestrain, lack of fit, temperature changes and support settlement.(No numerical problems)	9	15%
IV	Moving loads and influence lines. Introduction to moving loads - concept of influence lines - influence lines for reaction, shear force and bending moment in simply supported beams and over hanging beams - analysis for different types of moving loads - single concentrated load - several concentrated loads, uniformly distributed load on shorter and longer than the span.	10	15%
SECOND INTERNAL EXAMINATION			
V	Cables: Analysis of forces in cables under concentrated and uniformly distributed loads - Anchor Cables Suspension Bridges : Un-stiffened suspension bridges, maximum tension in the suspension cable and backstays, pressure on towers.	10	20%
VI	Arches : Theory of arches - Eddy's theorem - analysis of three hinged arches-Support reactions-normal thrust and Radial shear at any section of a parabolic and segmental arch due to simple cases of loading. Moving loads on three hinged arches (simple problems)	10	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination) :

Maximum Marks :100

Exam Duration: 3 Hrs

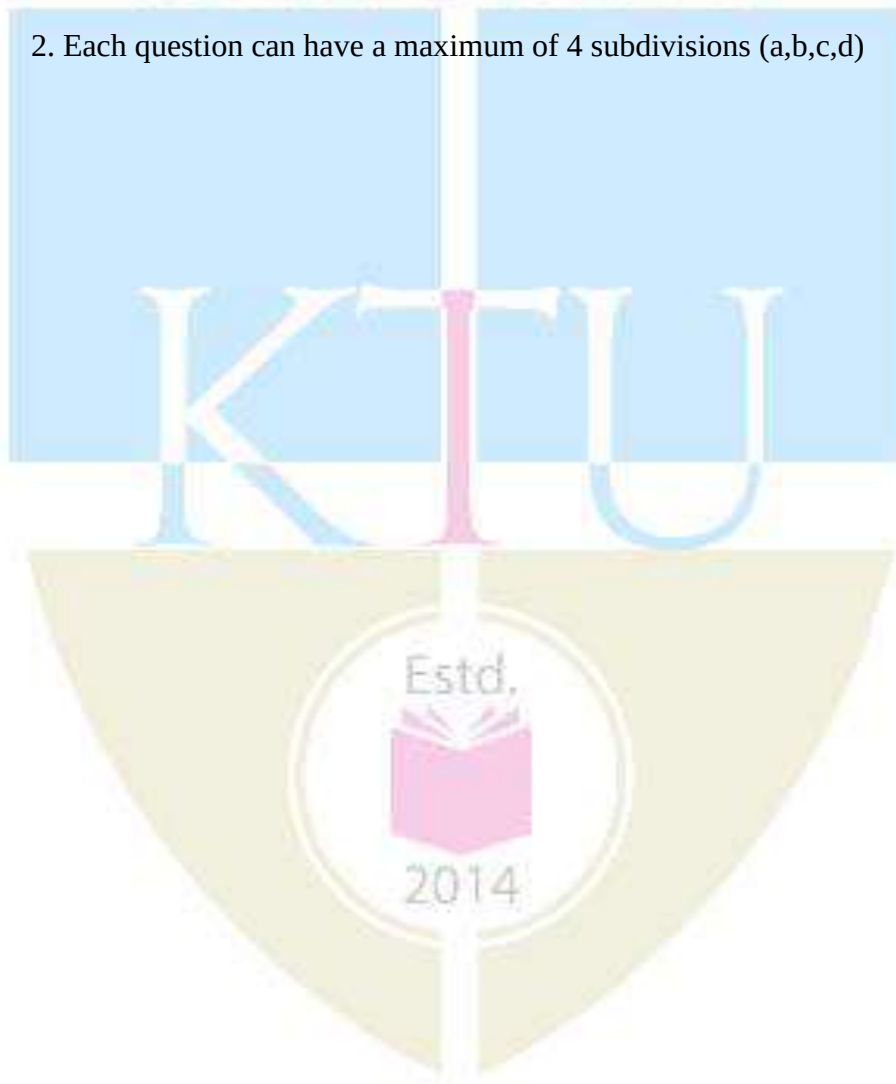
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI: 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE203	FLUID MECHANICS - I	3-1-0-4	2016

Pre requisite : Nil

Course Objectives

1. To understand the basic properties of the fluid, fluid statics, kinematics, and fluid dynamics so as to analyse and appreciate the complexities involved in solving the fluid flow problems.
2. To give an introduction to the fundamentals of fluid flow and its behavior so as to equip the students to learn related subjects and their applications in the higher semesters.
3. To develop the skill for applying the fluid statics, kinematics and dynamics of fluid flow concepts for solving civil engineering problems.

Syllabus

Fluid Statics, Fluid pressure, Buoyancy and floatation, Fluid Kinematics, Dynamics of fluid flow, Flow through orifice and notches, Flow through pipes, Boundary layer, Drag and lift on Immersed bodies

Course Outcomes:

1. Students will be able to get a basic knowledge of fluids in static, kinematic and dynamic equilibrium, so as to solve real life problems in fluid mechanics.
2. Students will gain the knowledge of the applicability of physical laws in addressing problems in hydraulics.

Text Books

1. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002.
2. Subramanya K., Theory and Applications of Fluid Mechanics, Tata McGraw-Hill, 1993.

References

1. Streeter.V.L. Fluid Mechanics, Mc Graw Hill Publishers.
2. Bruce R Munson, Donald F Young . Fundamentals of Fluid Mechanics, John Wiley & sons, 2011.
3. Jain A. K., Fluid Mechanics, Khanna Publishers, Delhi, 1996.
4. Joseph Katz, Introductory Fluid Mechanics, Cambridge University Press, 2015
5. Arora.K.R. Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, 2005.
6. Narasimhan S., A First Course in Fluid Mechanics, University Press (India) Pvt. Ltd., 2006.
7. Frank.M.White, Fluid Mechanics, Mc Graw Hill, 2013.
8. Mohanty.A.K. Fluid Mechanics, Prentice Hall, New Delhi, 2011
9. Narayana Pillai,N. Principles of Fluid Mechanics and Fluid Machines, University Press, 2011.
10. Kumar.D.N. Fluid Mechanics and Fluid power Engineering, S.K.Kataria & sons, 2013.

COURSE PLAN			
Module	Contents	Hours	Sem. Exam Marks %
I	Fluid properties - density – specific gravity - surface tension and capillarity - vapour pressure - viscosity and compressibility - Classification of Fluids (No questions to be asked) . Fluid statics: Fluid pressure, variation of pressure in a fluid, measurement of pressure using manometers- simple manometers, differential manometers, Pressure head. Forces on immersed plane and curved surfaces. Pressure distribution diagram for vertical surfaces, Practical application of total pressure (spillway gates). Buoyancy and Floatation: Buoyant force, stability of floating and submerged bodies, metacentre and metacentric height, Analytical and experimental determination of metacentric height.	8	15
II	Kinematics of fluid flow: Methods of describing fluid motion, Lagrangian and Eulerian methods, Types of fluid flow: steady and unsteady flow, uniform and non-uniform flow, one, two and three dimensional flow, laminar and turbulent flow, rotational and irrotational flow. Types of flow lines: stream line, path line, streak lines, conservation of mass, equation of continuity in one, two and three dimensions, (Derivation in Cartesian co-ordinate system only) Velocity & Acceleration of fluid particle, convective and local acceleration, Deformation of fluid elements: circulation and vorticity, velocity potential, stream function, equipotential lines, flow net, uses of flow net; Vortex motion, free and forced vortex (no problems).	8	15
FIRST INTERNAL EXAMINATION			
III	Dynamic of fluid flow: Euler's equation of motion and integration of Euler's equation of motion along a streamline. Bernoulli's Equation, Energy correction factors, Applications of Bernoulli's equation : Pitot tube, Venturimeter and orifice meter. Momentum Principle- Steady flow momentum equation- Momentum correction factor, Force computation on a pipe bend	8	15
IV	Flow through orifices: Different types of orifices, Flow over a sharp edged orifice, Hydraulic coefficients – Experimental determination of these	8	15

	coefficients, flow through large rectangular orifice, Flow through submerged orifices, flow under variable heads, time of emptying. Flow over weirs: flow over rectangular, triangular and trapezoidal sharp crested weir, Cipolletti weir, Broad crested weir, Submerged weirs, Proportional weir.		
SECOND INTERNAL EXAMINATION			
V	Flow through pipes: Viscous flow - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen Poiseuille's Eqn) - Hydraulic and energy gradient - flow through pipes - Darcy -Weisbach's equation - pipe roughness -friction factor- Moody's diagram- Major and minor losses of flow in pipes - Pipes in series and in parallel.	12	20
VI	Boundary layer theory-no slip condition, boundary layer thickness, boundary layer growth over long thin plate, laminar, turbulent boundary layer, laminar sub layer, Momentum integral equation of boundary layer (no derivation), Blasius boundary layer equations for laminar and turbulent boundary layer. Drag and lift on Immersed bodies-Pressure drag and friction drag, profile drag, Drag and lift co-efficient-computation of drag on a flat plate. Separation of boundary layer and control.	12	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks: 100

Exam Duration: 3 Hrs

The question paper shall have three parts.

Part A - Module I & II : Answer 2 questions out of 3 questions (15 marks each)

Part B - Module III & IV: Answer 2 questions out of 3 questions (15 marks each)

Part C - Module V & VI: Answer 2 questions out of 3 questions (20 marks each)

Note: 1.Each part should uniformly cover the two modules in that part.

2. Each question can have a maximum of 4 subdivisions (a,b,c,d), if needed.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE204	CONSTRUCTION TECHNOLOGY	4-0-0-4	2016

Prerequisite : Nil

Course objectives:

- To study details regarding properties and testing of building materials,
- To study details regarding the construction of building components
- To study properties of concrete and concrete mix design
- To impart the basic concepts in functional requirements of building and building services.
- To develop understanding about framed construction and building failures

Syllabus:

Construction Materials –. Timber -Mortar – Iron and Steel –. Structural steel – Modern materials. Concrete–Admixtures –Making of concrete -Properties of concrete– mix proportioning
 Building construction - foundations -Introduction to Cost-effective construction –Masonry – Lintels and arches –Floors and flooring –
 Roofs and roof coverings -Doors, windows and ventilators -Finishing works. Tall Buildings – steel and concrete frame –prefabricated construction – slip form construction. Vertical transportation – Stairs –Elevators – Escalators –ramps.
 - Building failures and Retrofitting–failures in RCC and Steel structures– Foundation failure-

Expected Outcomes:

The students will be able to

- understand construction materials, their components and manufacturing process
- know the properties of concrete and different mix design methods
- understand the details regarding the construction of building components
- analyse and apply learning of materials, structure, servicing and construction of masonry domestic buildings.
- define and describe the concepts and design criteria of tall framed and load bearing buildings.

Text books

1. Arora and Bindra, Building construction, Dhanpath Rai and Sons.
2. Punmia B. C, Building construction. Laxmi Publications
3. Rangwala S C., Engineering Materials, Charotar Publishers
4. Shetty M.S., Concrete Technology, S. Chand & company.

Reference Books

1. Adler R, Vertical Transportation for Building, American Elsevier Pub.
2. G C Sahu & Joygopal Jena., Building Materials and construction, McGraw Hill Education
3. Gambhir M L, Concrete Technology, Tata McGrawHill.
4. Krishna Raju N, Design of Concrete Mixes, CBS publishers.
5. Mcking T.M, Building Failures, Applied Science Pub.
6. National Building Code.
7. Neville A.M. and Brooks.J.J, Concrete Technology, Pearson Education.
8. Smith P & Julian W. Building services, Applied Science Pub.
9. Tall building systems & concepts, Monograph on planning and design of Tall building,

COURSE PLAN			
Module	Contents	Hours	Sem. Exam Marks
I	Properties of masonry materials – review of specifications; Mortar – Types – Sand – properties – uses. Timber products: properties and uses of plywood, fibre board, particle board. Iron and Steel –Reinforcing steel – types – specifications. Structural steel – specifications Miscellaneous materials (only properties, classifications and their use in construction industry): Glass, Plastics, A.C. Sheets, Bitumen, Adhesives, Aluminium	9	15%
II	Concrete – Aggregates – Mechanical & Physical properties and tests – Grading requirements – Water quality for concrete – Admixtures – types and uses – plasticizers – accelerators – retarders –water reducing agents Making of concrete - batching – mixing – types of mixers – transportation – placing – compacting – curing Properties of concrete – fresh concrete – workability – segregation and bleeding - factors affecting workability & strength – tests on workability – tests for strength of concrete in compression, tension & flexure Concrete quality control – statistical analysis of results – standard deviation –acceptance criteria – mix proportioning (B.I.S method) – nominal mixes.	9	15%
FIRST INTERNAL EXAMINATION			
III	Building construction - Preliminary considerations for shallow and deep foundations Masonry – Types of stone masonry – composite walls - cavity walls and partition walls -Construction details and features – scaffoldings Introduction to Cost-effective construction - principles of filler slab and rat-trap bond masonry	9	15%
IV	Lintels and arches – types and construction details. Floors and flooring – different types of floors and floor coverings Roofs and roof coverings – different types of roofs – suitability – types and uses of roofing materials Doors, windows and ventilators – Types and construction details Finishing works – Plastering, pointing, white washing, colour washing, distempering, painting. Methods of providing DPC. Termite proofing	9	15%
SECOND INTERNAL EXAMINATION			

V	Tall Buildings – Framed building – steel and concrete frame – structural systems –erection of steel work–concrete framed construction– formwork – construction and expansion. joints Introduction to prefabricated construction – slip form construction Vertical transportation: Stairs – types - layout and planning- Elevators – types – terminology – passenger, service and goods elevators – handling capacity - arrangement and positioning of lifts – Escalators – features –use of ramps	10	20%
VI	Building failures – General reasons – classification – Causes of failures in RCC and Steel structures, Failure due to Fire, Wind and Earthquakes. Foundation failure – failures by alteration, improper maintenance, overloading. Retrofitting of structural components - beams, columns and slabs	10	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination):

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE205	ENGINEERING GEOLOGY	3-0-1-4	2016

Prerequisite: NIL

Course Objectives

Awareness about earth resources and processes to be considered in various facets of civil engineering

1. Appreciation of surface of earth as the fundamental foundation structure and the natural phenomena that influence its stability

Syllabus :

Relevance of geology in Civil Engineering. Subdivisions of Geology. Interior of the earth. Weathering, its engineering significance and laboratory tests used in civil engineering. Soil profile. Hydrogeology-occurrence of groundwater, Types of aquifers and their properties. Engineering significance of subsurface water in construction. Methods to control of subsurface water. Minerals- Properties that affect the strength of minerals. Physical properties and chemical composition of common rock forming minerals
Earth quakes- in relation to internal structure of earth and plate tectonics
Types of rocks. Brief account of selected rocks. Rock features that influence the strength of rocks as construction material. Rock types of Kerala. Engineering properties of rocks.
Attitude of geological structures- strike and dip. Deformation structures and their engineering significance. Geological factors considered in the construction of engineering structures.
Introduction to natural hazards and their management. Coastal Processes and protection strategies. Soil erosion and conservation measures.

Expected Outcomes:

1. The course would help the student to understand of the factors that determine the stability of earth's surface
2. The student would comprehend better the earth resources used as building materials

Text Books / References:

1. Duggal, SK, Rawal, N and Pandey, HK (2014) Engineering Geology, McGraw Hill Education, New Delhi
2. Garg, SK (2012) Introduction to Physical and Engineering Geology, Khanna Publishers, New Delhi
3. Gokhale, KVGK (2010) Principles of Engineering Geology, BS Publications, Hyderabad
4. Kanithi V (2012) Engineering Geology, Universities Press (India) Ltd., Hyderabad
5. Singh, P (2004) Engineering and General Geology, S. K. Kataria and Sons, New Delhi
6. Bennison, GM, Olver, PA and Moseley, KA (2013) An introduction to geological structures and maps, Routledge, London
7. Gokhale, NW (1987) Manual of geological maps, CBS Publishers, New Delhi

COURSE PLAN			
Module	Contents	Hours	End Sem.Exam Marks %
I	Relevance of geology in Civil Engineering. Subdivisions of Geology. Weathering, types and its engineering significance. Laboratory tests used in civil engineering for assessing intensity of weathering. Engineering classification of weathered rock masses. Soil profile. Geological classification of soils.	8	15
II	Hydrogeology-occurrence of groundwater, Types of aquifers, permeability / hydraulic conductivity. Engineering significance of subsurface water-problems created in construction, as an erosional agent. Methods to control of subsurface water-barriers and liners, drains and wells.(Resistivity survey of groundwater may be demonstrated)	11	15
FIRST INTERNAL EXAMINATION			
III	Minerals- Properties that affect the strength of minerals. Physical properties and chemical composition of following minerals -quartz, feldspars (orthoclase and plagioclase), micas (biotite and muscovite), amphibole (hornblende), pyroxene (augite and hypersthene), gypsum, calcite, clay minerals (kaolinite), their chemical formulae. Earth quakes- in relation to internal structure of earth and plate tectonics	8	15
IV	Rocks as aggregates of minerals. Basic concepts-igneous, sedimentary and metamorphic rocks, Brief account of following rocks- granite, basalt, sandstone, limestone, shale, marble and quartzite. Rock features that influence the strength of rocks as construction material-concepts of lineation and foliation-schistosity and gneissosity. Rock types of Kerala. Brief account of engineering properties of rocks used as construction material (building and foundation) and road aggregates. Assessment of these properties.(Students should be taught to identify common rock forming minerals and common rocks based on their physical properties).	10	15
SECOND INTERNAL EXAMINATION			
V	Attitude of geological structures- strike and dip. Brunton compass. Deformation structures and	11	20

	their engineering significance- folds, faults and joints. Geological factors considered in the construction of dams and reservoirs, tunnels. (Simple exercises based on geological/topographic maps for determination of dip, apparent dip and thickness of lithological beds and preparation of geological cross sections should be performed. The students should be instructed in handling clinometer/Brunton compass to determine strike and dip)		
VI	Introduction to natural hazards-Mass movements (Landslides), floods, their common management strategies. Coastal Processes- waves, currents and landforms. Types of coastal protection strategies. Soil erosion- causes and types and soil conservation measures.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100

Exam Duration: 3 Hrs

The question paper shall have three parts.

Part A -Module I & II : Answer 2 questions out of 3 questions (15 marks each)

Part B - Module III & IV: Answer 2 questions out of 3 questions (15 marks each)

Part C - Module V & VI : Answer 2 questions out of 3 questions (20 marks each)

Note : 1.Each part should uniformly cover the two modules in that part.

2. Each question can have a maximum of 4 subdivisions (a,b,c,d), if needed.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE206	FLUID MECHANICS -II	3-0-0-3	2016

Prerequisite : CE203 Fluid Mechanics I

Course objectives

- To study the Basic principles and laws governing fluid flow to open channel flow including hydraulic jump & gradually varied flow.
- To understand basic modeling laws in fluid mechanics and dimensional analysis.
- To apply the fundamental theories of fluid mechanics for the analysis and design of hydraulic machines

Syllabus

Hydraulic machines, Turbines, Pumps, Open channel flow, uniform flow, Hydraulic Jump, Gradually varied flow, Dimensional analysis and model testing.

Expected Outcome

The students will

- become capable of analysing open channel flows & designing open channels.
- get an insight into the working of hydraulic machines.
- become capable of studying advanced topics such as design of hydraulic structures.

Text Books:

1. Kumar D.S., Fluid Mechanics and Fluid power Engineering, S. K. Kataria & Sons, New Delhi, 2013
2. Modi P. N. and S. M. Seth, Hydraulics and Fluid Mechanics (Including Hydraulic Machines), Standard Book House, New Delhi, 2013.
3. Narayana Pillai,N. Principles of Fluid Mechanics and Fluid Machines, University Press, 2011.

References:

1. Arora.K.R. Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, 2005.
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2010.
3. C S P Ojha, P N Chandramouli and R Brendtsson, Fluid Mechanics and Machinery, Oxford University Press , India , New Delhi
4. Hanif Choudhary, Open channel flow, Prentice Hall, 2010
5. Jain A. K., Fluid Mechanics, Khanna Publishers, Delhi, 1996.
6. Subramanya K., Open Channel Hydraulics, Tata McGraw Hill, 2009.
7. Ven Te Chow, Open channel Hydraulics, 2009.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks
I	Hydraulic Machines - Impulse momentum principle, impact of jets, force of a jet on fixed and moving vanes. Turbines- classification and comparison of velocity triangles for Pelton wheel and reaction turbines (Francis and Kaplan), work done and efficiency, specific speed, draft tube- different types, penstock, surge tank - types, cavitation in turbines (Concepts only).	7	15%

II	Pumps- classification of pumps - Centrifugal pumps- types, work done, efficiency, minimum speed, velocity triangle for pumps, specific speed, priming, limitation of suction lift, net positive suction head, cavitation in centrifugal pump (Concepts only).	7	15%
FIRST INTERNAL EXAMINATION			
III	Introduction : Open channel flow and its relevance in Civil Engineering , Comparison of open channel flow and pipe flow . Flow in open channels-types of channels, types of flow, geometric elements of channel section, velocity distribution in open channels, uniform flow in channels, Chezy's equation, Kutter's and Manning's formula, Most economic section for rectangular and trapezoidal channels. Condition for maximum discharge and maximum velocity through circular channels, computations for uniform flow, normal depth, conveyance of a channel section, section factor for uniform flow.	6	15%
IV	Specific energy, critical depth, discharge diagram, Computation of critical flow, Section factor for critical flow. Specific force, conjugate or sequent depths, hydraulic jump, expression for sequent depths and energy loss for a hydraulic jump in horizontal rectangular channels, types of jump, length of jump, height of jump, uses of hydraulic jump.	6	15%
SECOND INTERNAL EXAMINATION			
V	Gradually varied flow - dynamic equation for gradually varied flow, different forms of dynamic equation, Approximation for a wide rectangular channel, classification of surface profiles, Backwater and drawdown curves, characteristics of surface profiles in prismatic (Rectangular and trapezoidal only). Computation of length of surface profiles, direct step method. Design of lined open channels : trapezoidal cross-sections only	8	20%
VI	Dimensional analysis and model studies - dimensions, dimensional homogeneity, methods of dimensional analysis, Rayleigh method, Buckingham method, dimensionless numbers, Similitude - geometric, kinematic and dynamic similarities. Model laws - Reynold's and Froude model laws, scale ratios, types of models, Concepts of distorted and undistorted models.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination) :

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI: 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE207	SURVEYING	3-0-0-3	2016

Prerequisite : Nil

Course objectives:

- To introduce the principle of surveying
- To impart awareness on the various fields of surveying and types of instruments
- To understand the various methods of surveying and computations

Syllabus: Basics of Surveying, Levelling and Contouring, Area and Volume Computation, Theodolite Survey, Mass Diagram, Triangulation, Theory of Errors, Electronic Distance Measurement, Total Station Survey

Course Outcomes: After successful completion of the course, the students will possess knowledge on the basics of surveying and different methods of surveying

Text Books :

1. Prof. T.P.Kenetkar & Prof.S.V.Kulkarni - Surveying and Levelling , Pune Vidyarthi Griha Prakashan,2004
2. N N Basak, Surveying and Levelling, Mc GrawHill Education

References :

1. R.Agor - A Text book of Surveying and Levelling, Khanna Publishers, 2005
2. C. Venkatramaiah, Textbook of Surveying, Universities Press (India) Private Limited 2011
3. James M Andersen, Edward M Mikhail, Surveying Theory and Practice, McGraw Hill Education
4. Dr. B.C.Punmia , Ashok Kumar Jain & Arun Kumar Jain - Surveying , Laxmi publications (P)Ltd , 2005
5. S.K.Duggal - Surveying Vol. I, Tata Mc Graw Hill Ltd ,Reprint 2015.

COURSE PLAN			
Module	Contents	Hours	Sem.Exam Marks %
I	Introduction to Surveying- Principles, Linear, angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines, Local attraction, Declination, Dip, Latitude and Departure, Methods of orientation, Principle of resection	7	15
II	Levelling: Principles of levelling- Dumpy level- booking and reducing levels, Methods- simple, differential, reciprocal leveling, profile levelling and cross sectioning. Digital and Auto Level, Errors in levelling Contouring: Characteristics, methods, uses.	7	15
FIRST INTERNAL EXAMINATION			
III	Area and Volume: Various methods of computation. Theodolite survey: Instruments, Measurement of horizontal and vertical angle. Mass diagram: Construction, Characteristics and Uses.	6	15
IV	Triangulation: Triangulation figures, Strength of figure, Triangulation stations, Inter visibility of stations, Towers and signals – Satellite Stations and reduction to centre.	8	15
SECOND INTERNAL EXAMINATION			
V	Theory of Errors – Types, theory of least squares, Weighting of observations, Most probable value, Application of weighting, Computation of indirectly observed quantities - method of normal equations.	8	20
VI	Electromagnetic distance measurement (EDM) – Principle of EDM, Modulation, Types of EDM instruments, Distomat Total Station – Parts of a Total Station – Accessories – Advantages and Applications, Introduction to Astronomical terms, Field Procedure for total station survey, Errors in Total Station Survey.	6	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam) :

Maximum Marks :100

Exam Duration: 3 Hrs

The question paper shall have three parts.

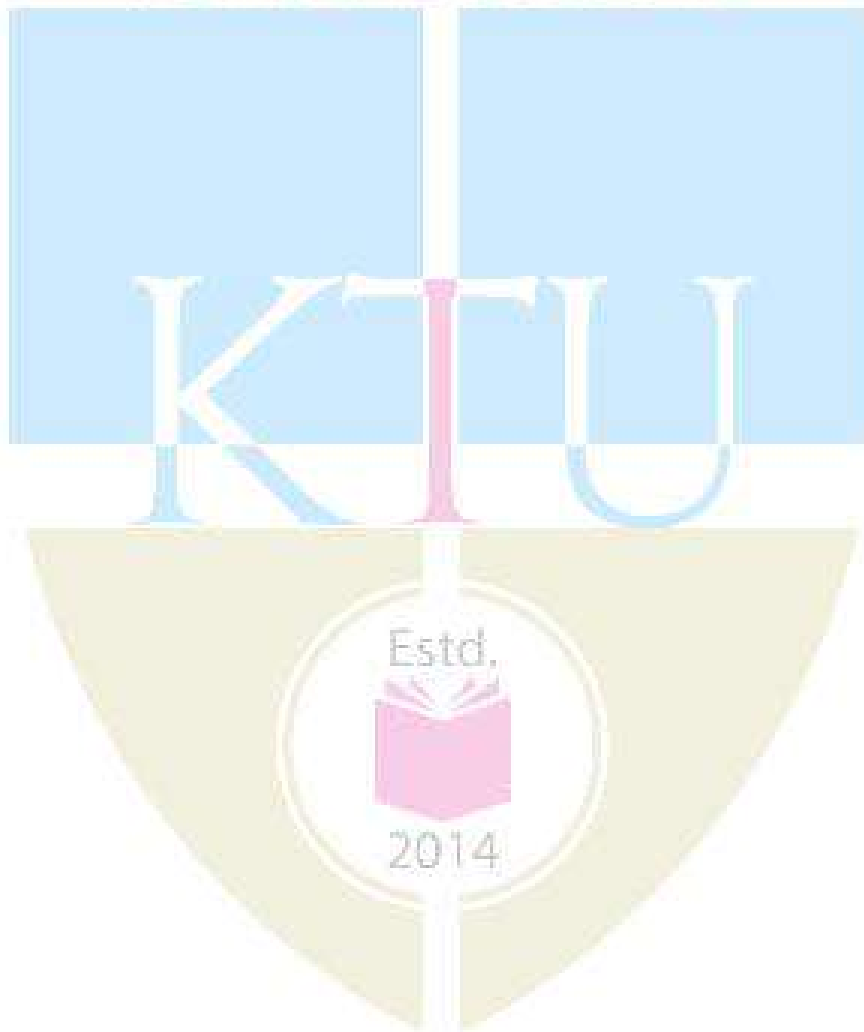
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should uniformly cover the two modules in that part.

2. Each question can have a maximum of 4 subdivisions (a,b,c,d), if needed



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE208	GEOTECHNICAL ENGINEERING I	3-0-0 -3	2016
Prerequisite : CE 205 Engineering Geology			
Course objectives: - To impart to the fundamentals of Soil Mechanics principles; - To provide knowledge about the basic, index and engineering properties of soils.			
Syllabus: Major soil deposits of India, Basic soil properties, Relationship between basic soil properties, Index properties-Sieve analysis, Hydrometer analysis, Atterberg Limits and Relative density, Soil classification, Permeability of soils, Principle of effective stress, Quick sand condition, Critical hydraulic gradient, Shear strength of soils, Mohr-Coulomb failure criterion, Different types of shear tests, Liquefaction of soils, Compressibility and Consolidation, Void ratio versus pressure relationship, Normally consolidated, under consolidated and over consolidated states, Estimation of magnitude of settlement, Terzaghi's theory of one-dimensional consolidation, Coefficient of consolidation, Stability of finite slopes, Swedish Circle Method- Friction circle method, use of Stability, Compaction of soils, light and heavy compaction tests, Control of compaction			
Expected Outcomes: The students will be able to - understand the basic principles governing soil behavior. - understand the procedure, applicability and limitations of various soil testing methods.			
Text Books: - Das B. M., Principles of Geotechnical Engineering, Cengage India Pvt. Ltd., 2010. - Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.			
References: - A V Narasimha Rao and C Venkatramaiah, Numerical Problems, Examples and Objective questions in Geotechnical Engineering, Universities Press (India) Ltd., 2000 - Arora K. R., Geotechnical Engineering, Standard Publishers, 2006. - Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Kindersley(India) Pvt. Ltd., 2013 - Taylor D.W., Fundamentals of Soil Mechanics, Asia Publishing House, 1948. - Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967. - Venkatramaiah, Geotechnical Engg, Universities Press, 2000.			

COURSE PLAN			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to soil mechanics -Major soil deposits of India Basic soil properties - Void ratio, porosity, degree of saturation, air content, percentage air voids, moisture content, specific gravity, unit weight - Relationship between basic soil properties – Sensitivity – Thixotropy - numerical problems	6	15%
II	Index properties - Sieve analysis – Well graded, poorly graded and gap graded soils - Stoke's law - Hydrometer analysis (no derivation required for percentage finer and diameter) - numerical problems- – Relative density Consistency-Atterberg Limits - Practical Applications - numerical problems I.S. classification of soils.	6	15%
FIRST INTERNAL EXAMINATION			
III	Permeability of soils - Darcy's law – Factors affecting permeability - Practical Applications - Constant head and falling head permeability tests - Average permeability of stratified deposits (no derivation required) - numerical problems. Principle of effective stress - Total, neutral and effective stress variation diagrams - Quick sand condition - Critical hydraulic gradient - - numerical problems– Definition of phreatic line and exit gradient	7	15%
IV	Shear strength of soils- Practical Applications - Mohr-Coulomb failure criterion – Mohr circle method for determination of principal planes and stresses- numerical problems – relationship between shear parameters and principal stresses [no derivation required} Brief discussion of direct shear test, tri-axial compression test, vane shear test and unconfined compression test – Applicability - numerical problems -UU and CD tests [Brief discussion only]	7	15%
SECOND INTERNAL EXAMINATION			
V	Compressibility and Consolidation - Void ratio versus pressure relationship - Coefficient of compressibility and volume compressibility – Compression index Practical Applications - Change in void ratio method - Height of solids method - Normally consolidated, under consolidated and over consolidated states - Estimation of pre consolidation pressure - Practical Applications - Estimation of magnitude of settlement of normally consolidated clays - Numerical problems Terzaghi's theory of one-dimensional consolidation(no derivation required) - average degree of consolidation – Time	8	20%

	factor - Coefficient of consolidation - Practical Applications - Square root of time and logarithm of time fitting methods - Numerical problems		
VI	Stability of finite slopes - Toe failure, base failure, slip failure - Swedish Circle Method- Friction circle method- Factor of safety with respect to cohesion and angle of internal friction - Stability number - Stability charts. Compaction of soils - Standard Proctor, Modified Proctor, I.S. light & Heavy Compaction Tests – OMC - Zero Air voids line - Control of compaction - numerical problems	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination):

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)



Course No.	Course Name	L-T-P-Credits	Year of Introduction
CE230	MATERIAL TESTING LAB	0-0-3-1	2016
Course Objectives: 1. To provide knowledge on mechanical behaviour of materials 2. To acquaint with the experimental methods to determine the mechanical properties of materials.			
Syllabus List of experiments: 1. Tension test on mild steel/ tor-steel/ high strength steel and cast iron using Universal Testing Machine and extensometers. 2. Tests on springs (Open and closed coiled) 3. Torsion pendulum (mild steel, aluminium and brass wires) 4. Hardness test (Brinell, Vickers and Rockwell) 5. Impact test (Izod and Charpy) 6. Torsion test on mild steel rods. 7. Shear test on mild steel rods. 8. Fatigue test – Study of testing machine. 9. Bending test on wooden beams. 10. Strut test (Column buckling experiment) 11. Verification of Clerk Maxwell's law of reciprocal deflection and determination of Young's modulus of steel. 12. Photo elastic methods for stress measurements. 13. Jominy hardenability test 14. Measurement using strain gauges 15. Determination of moment of inertia of rotating bodies Note: A minimum of 10 experiments are mandatory.			
Expected outcome: At the end of the course the students will be able to 1. Acquire the knowledge on mechanical behaviour of materials 2. Conduct experiments determine the mechanical properties of materials.			
References Books: 1. G E Dieter. Mechanical Metallurgy, McGraw Hill,2013 2. Dally J W, Railey W P, Experimental Stress analysis , McGraw Hill,1991 3. Baldev Raj, Jayakumar T, Thavasimuthu M., Practical Non destructive testing, Narosa Book Distributors,2015			

Course No.	Course Name	L-T-P - Credits	Year of Introduction
CE231	CIVIL ENGINEERING DRAFTING LAB	0-0-3-1	2016
Prerequisite : BE 110 - Engineering Graphics			
Course Objectives : 1. To introduce the fundamentals of Civil Engineering drawing. 2. To understand the principles of planning 3. To learn drafting of buildings. 4. To impart knowledge on drafting software such as AutoCAD.			
List of Exercises : (at least 10 exercises / plates are mandatory) 1. Paneled Doors 2. Glazed Windows and Ventilators in wood 3. Steel windows 4. Roof truss in steel sections 5. Reinforced concrete staircase 6. Residential buildings with flat roof 7. Residential buildings with tiled roof 8. Preparation of site plan and service plans as per building rules 9. Building Services (for single and two storied buildings only). Septic tanks and soak pit detailed drawing 10. Two storied and multi storied buildings 11. Public buildings like office, dispensary, post office, bank etc. 12. Industrial buildings with trusses			
Expected outcome. To accomplish the abilities/skills for the following. 1. To understand the drawings of various components of buildings 2. Preparation of building drawings. 3. Interpretation of building drawings. 4. Use of a drafting software.			
Text Books: 1. National Building Code of India. 2. Kerala Municipal Building Rules. 3. Dr. Balagopal T.S. Prabhu, Building Drawing and Detailing, Spades Publishers, Calicut 4. AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, USA References: 1. Shah, M.G., Kale, C. M. and Patki, S.Y. Building Drawing With An Intergrated Approach to Built Environment, Tata McGraw Hill Publishing Company Limited, New Delhi			

Points to note:

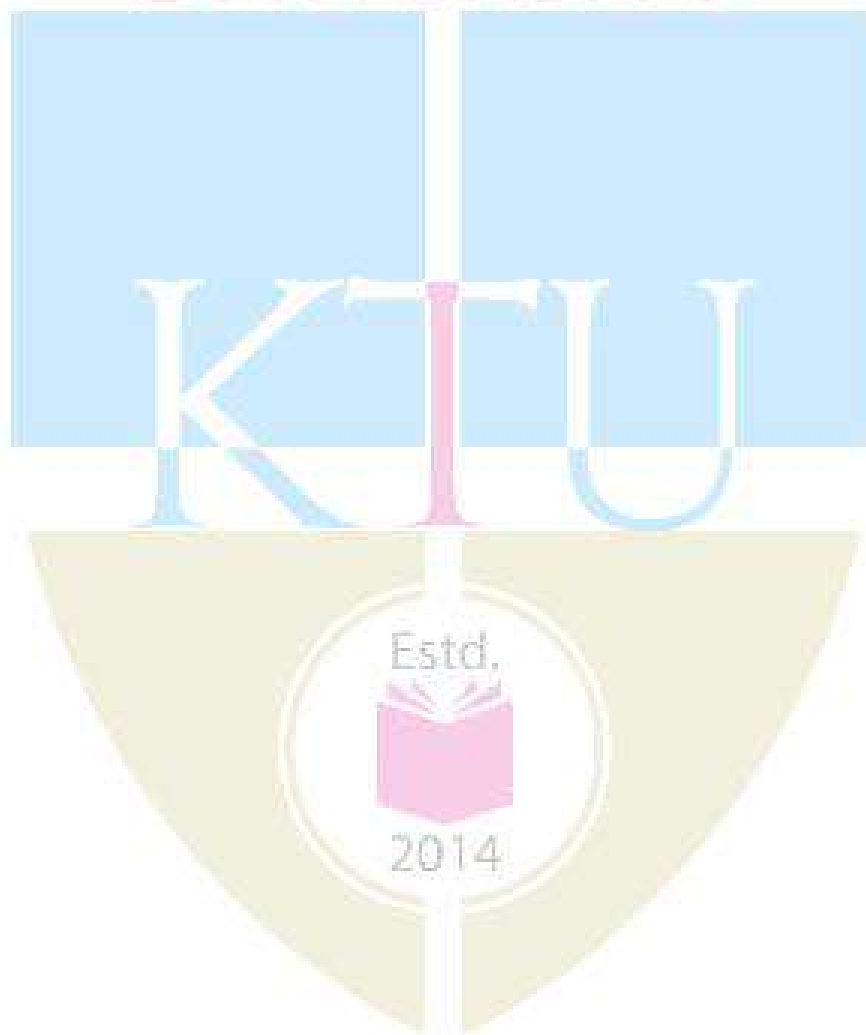
1. Equal weightage to be given for manual drafting and drafting using computer aided drafting software.
2. Evaluation of drawing, along with a viva-voce, to be done at the end of every day class.

Internal Continuous Evaluation - 100 marks

Best 10 plates - 60 marks

Viva-voce - 10 marks

Final Examination - 30 marks



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE232	MATERIAL TESTING LAB -I	0-0-3-1	2016

Prerequisite : CE201 Mechanics of Solids

Course objectives:

The experimental work involved in this laboratory should make the student understand the fundamental modes of loading of the structures and also make measurements of loads, displacements and strains. Relating these quantities, the student should be able to obtain the strength of the material and stiffness properties of structural elements.

Course Outcomes:

The students will be able to undertake the testing of materials when subjected to different types of loading.

List of Experiments: (10 Experiments mandatory)

1. Tension test on Structural Materials: Mild Steel and Tor steel (HYSD bars) (Universal Testing machine and suitable extensometer)
2. Shear test on mild steel rod (Compression Testing Machine and Shear Shackle)
3. Bending test on mild steel (I sections) (Universal Testing Machine)
4. Torsion test on Mild steel circular bars (Torsion Testing Machine)
5. Torsion test on Steel/Copper/ Aluminum wires
 - a. Using Torsion Pendulum with Central disk
 - b. Using Torsion Pendulum with distributed Mass
6. Impact test
 - a. Izod test (Impact Testing Machine)
 - b. Charpy test (Impact Testing Machine)
7. Hardness test
 - a. Brinell Hardness test (Brinell Hardness Testing Machine)
 - b. Rockwell Hardness test (Rockwell Hardness Testing Machine)
 - c. Vickers Hardness test (Vickers Hardness Testing Machine)
8. Test On Springs
 - a. Open coil (Spring Testing Machine)
 - b. Close coil (Spring Testing Machine)
9. Bending Test on Timber (Universal Testing Machine and dial Gauge)
10. Bend & Rebend test on M S Rods
11. Verification of Clerk Maxwells Theorem
12. Demonstration of Fatigue Test
13. Study/demonstration of Strain Gauges and load cells

Books/Manuals /References:-

1. Testing of Engineering Materials by George E Troxell, Harmer E Davis, G Hauck, McGraw-Hill, New York
2. Testing of Metallic Materials by Prof. A V K Suryanaraya, Prentice Hall, India, Pvt Ltd.
3. Mechanical Behavior of Materials, by N Dowling, Prentice Hall, 1993.

Internal Continuous Evaluation - 100 marks

Record/output (Average) - 60 marks Viva-voce (Average) - 10 marks

Final practical exam – 30 marks

Course No.	Course Name	L-T-P - Credits	Year of Introduction
CE233	SURVEYING LAB	0-0-3-1	2016
Prerequisite : Nil			
Course Objectives: <			

Internal Continuous Evaluation - 100 marks

Record/output (Average) - 60 marks

Viva-voce (Average) - 10 marks

Final practical examination – 30 marks

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE234	FLUID MECHANICS LABORATORY	0-0-3-1	2016

Prerequisite : CE203 Fluid Mechanics- I

Course objectives

1. Students should be able to verify the principles studied in theory by performing the experiments in laboratory

Expected Outcome

1. The students will be able to understand the different flow measurement equipment's and their procedures.
2. The students will be able to analyze the performance characteristics pumps/turbines.
3. Able to develop the skill of experimentation techniques for the study of flow phenomena in channels/pipes.

List of Experiments (Minimum 12 nos. mandatory)

1. Study of taps, valves, pipe fittings, gauges, pitot tubes, water meters and current meters.
2. Calibration of Pressure gauges
3. Determination of metacentric height and radius of gyration of floating bodies.
4. Verification of Bernoulli's theorem
5. Hydraulic coefficients of orifices and mouth pieces under constant head method and time of emptying method.
6. Calibration of Venturimeter.
7. Calibration of Orifice meter
8. Calibration of water meter.
9. Calibration of rectangular and triangular notches.
10. Time of Emptying : unsteady flow
11. Determination of Darcy's and Chezy's constant for pipe flow.
12. Determination of Chezy's constant and Manning's number for open channel flow.
13. Plotting Specific Energy Curves in Open Channel flow
14. Study of Parameters of Hydraulic Jump in Open channel Flow.
15. Determination of friction co-efficient in pipes
16. Determination of loss co-efficient for pipe fittings

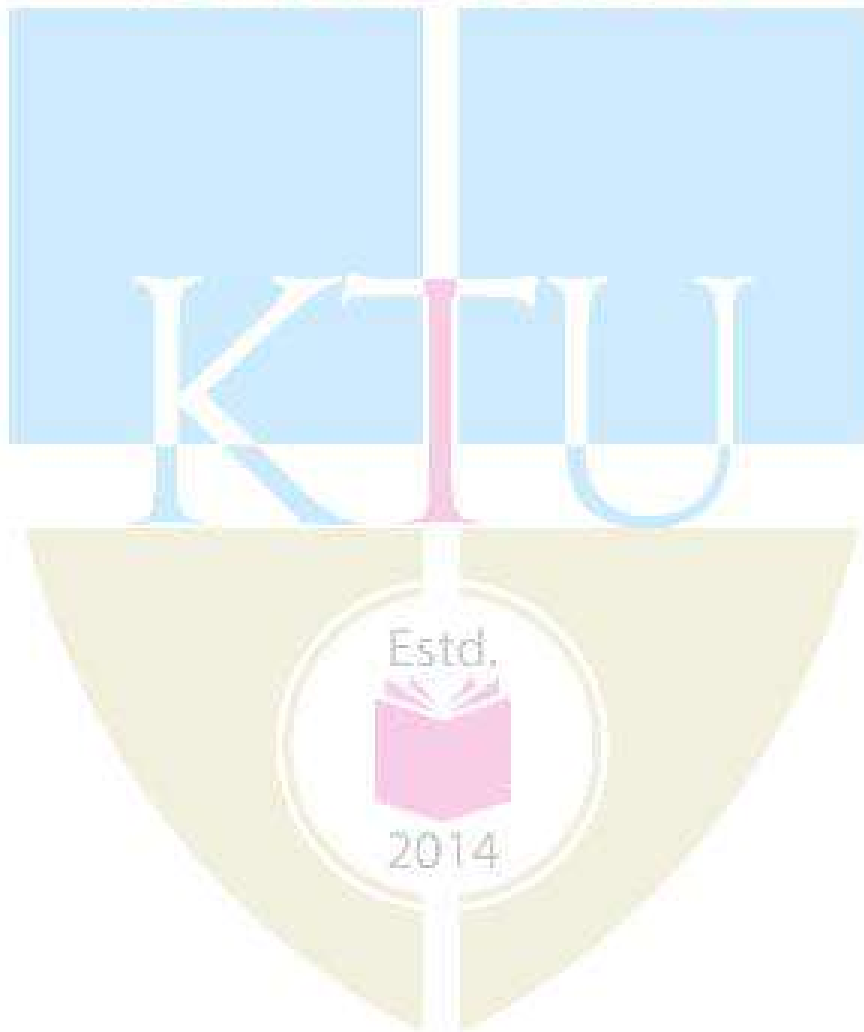
17. Performance characteristics of centrifugal pump.
18. Performance characteristics of Pelton wheel.
19. Performance characteristics of Francis turbine.
20. Performance characteristics of Kaplan turbine.

Internal Continuous Evaluation - 100 marks

Record/output (Average) - 60 marks

Viva-voce (Average) - 10 marks

Final practical exam -30 marks



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE301	DESIGN OF CONCRETE STRUCTURES I	3-1-0-4	2016

Pre-requisites: CE202 Structural Analysis I

Course objectives:

- To provide the students with the knowledge of the behavior of reinforced concrete structural elements in flexure, shear, compression and torsion
- To enable them to design essential elements such as beams, columns, slabs staircases and footings under various loads.

Syllabus:

Introduction- Limit State method of design- Analysis of singly reinforced rectangular beams- shear strength of RC beam-design of shear reinforcement-bond and development length- curtailment of reinforcement-design of singly reinforced beams-analysis and design of doubly reinforced beams – simply supported , cantilever- analysis of singly reinforced T-beams -design for torsion-design of one-way slab- cantilever slab- continuous slab (detailing only)- two way slabs- design using code coefficients- Limit State of Serviceability-deflection-cracking -Stair cases- design & detailing- Columns-effective length-design of axially loaded short columns with rectangular ties and helical reinforcement.

Expected Outcomes:

The students will be able to

- Apply the fundamental concepts of limit state method
- Use IS code of practice for the design of concrete elements
- Understand the structural behavior of reinforced concrete elements in bending, shear, compression and torsion.
- Design beams, slab, stairs, columns and draw the reinforcement details.
- Analyze and design for deflection and crack control of reinforced concrete members.

Text Books / References:

- Pillai S.U & Menon D – Reinforced Concrete Design, Tata McGraw Hill Publishing Co ., 2005
- Punmia, B. C, Jain A.K and, Jain A.K ,RCC Designs, Laxmi Publications Ltd., 10e, 2015
- Varghese P.C, Limit State Design of Reinforced Concrete, Prentice Hall of India Pvt Ltd,, 2008
- Relevant IS codes (I.S 456, I.S 875, SP 34)

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction- Plain and Reinforced concrete- Properties of concrete and reinforcing steel-Objectives of design-Different design philosophies- Working Stress and Limit State methods-Limit State	9	15

	method of design-Introduction to BIS code- Types of limit states-characteristic and design values-partial safety factors-types of loads and their factors. Limit State of Collapse in Bending-assumptions-stress-strain relationship of steel and concrete- analysis of singly reinforced rectangular beams-balanced-under reinforced-over reinforced sections-moment of resistance codal provisions		
II	Limit state of collapse in shear and bond- shear stresses in beams-types of reinforcement-shear strength of RC beam-IS code recommendations for shear design-design of shear reinforcement-examples Bond and development length - anchorage for reinforcement bars - code recommendations regarding curtailment of reinforcement	9	15
FIRST INTERNAL EXAMINATION			
III	Design of Singly Reinforced Beams- basic rules for design- design example of simply supported beam- design of cantilever beam-detailing Analysis and design of doubly reinforced beams – detailing, T-beams- terminology- analysis of T beams- examples - Design for torsion-IS code approach- examples.	9	15
IV	Design of slabs- introduction- one-way and two-way action of slabs - load distribution in a slab- IS recommendations for design of slabs- design of one-way slab- cantilever slab- numerical problems – concepts of detailing of continuous slab –code coefficients.	9	15
SECOND INTERNAL EXAMINATION			
V	Two- way slabs- simply supported and restrained slabs – design using IS Code coefficients Reinforcement detailing Limit State of Serviceability- limit state of deflection- short term and long term deflection-IS code recommendations- limit state of cracking- estimation of crack width- simple numerical examples	10	20
VI	Stair cases- Types-proportioning-loads- distribution of loads – codal provisions - design and detailing of dog legged stair- Concepts of tread-riser type stairs (detailing only) Columns- introduction –classification- effective length- short column - long column - reinforcement-IS specifications regarding columns- limit state of collapse: compression -design of axially loaded short columns-design examples with rectangular ties and helical reinforcement	10	20
END SEMESTER EXAMINATION			

Note

1. All designs shall be done as per current IS specifications
2. Special importance shall be given to detailing in designs
3. During tutorial hours detailing practice shall be done.
4. SI units shall be followed.
5. IS 456-2000 shall be permitted for the End Semester Examination

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100

Exam Duration: 3 Hrs

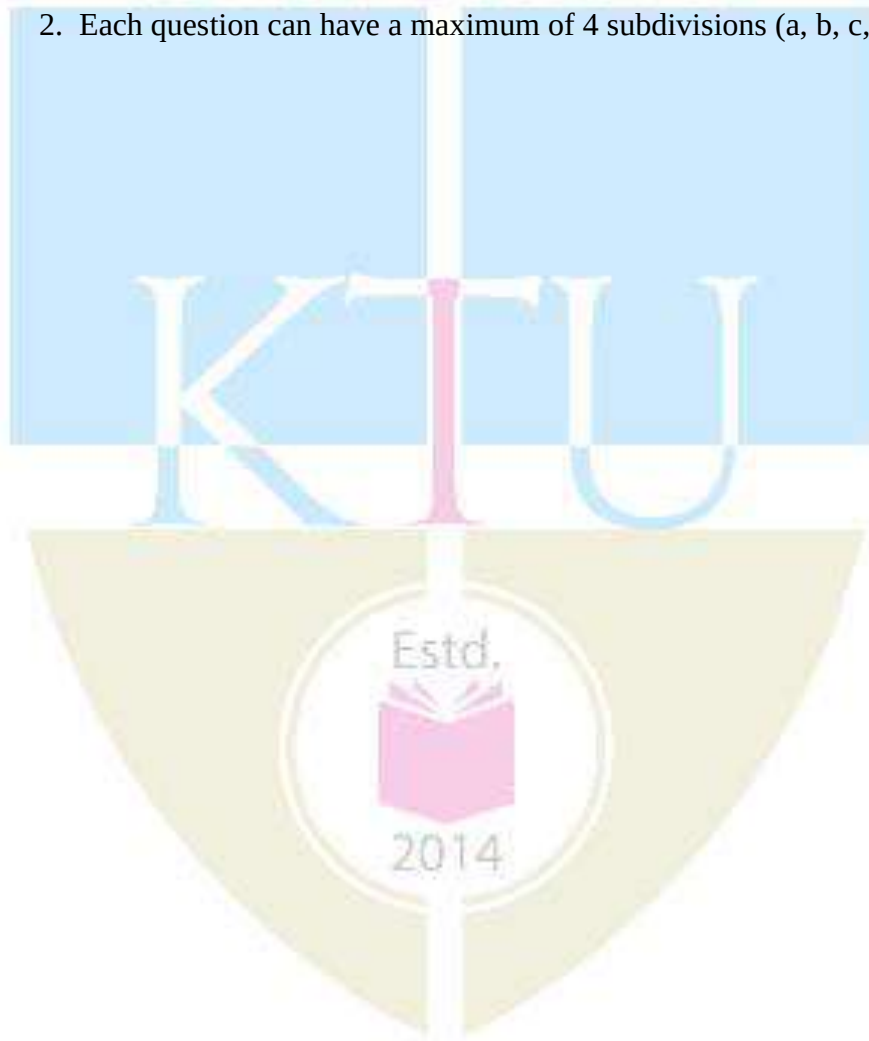
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a, b, c, d)



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE302	DESIGN OF HYDRAULIC STRUCTURES	4-0-0-4	2016

Prerequisite : CE309 Water Resources Engineering

Course objectives:

- To impart knowledge regarding the design of the various minor irrigation structures
- To convey the knowledge on the causes of failure, design criteria and stability analysis of different types of dams

Syllabus :

Diversion head works - layout and functions of components. Causes of failure of weirs on permeable soils, Bligh's theory and Khosla's theory. Irrigation canals- Design of unlined canals through alluvial soils-Kennedy's theory and Lacey's theory. Minor irrigation structures- Cross drainage works, Canal Regulation works : Falls and Regulators, Design of Hydraulic Structures: Aqueduct, siphon aqueduct, Canal falls-notch type, well type, Sarda type, and Cross regulator. Dams-Types, Gravity dam - forces acting - stability analysis and modes of failure - theoretical and practical profiles- Functions of shafts, galleries, keys and water stops. Arch dams-types, Thin cylinder theory. Earth dams-types, causes of failure and design criteria. Spillways-Types. Ogee type spillway-profile.

Course Outcomes:

The students will be able to

- Perform the stability analysis of gravity dams
- Explain the causes of failure of different types of dams and their design criteria
- Design minor irrigation structures such as regulators, cross drainage works and canal falls

Text Books :

- Garg S.K, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2006.
- Modi. P. N., Irrigation Water Resources and Water Power Engineering, Standard Book House, 2009.
- Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd. 2010.

References:

- Arora, K.R., "Irrigation, Water Power and Water Resources Engineering", Standard Publishers Distributors, 2010.
- Asawa. G.L. Irrigation and Water Resources Engineering, New Age International, 2000
- Sahasrabudhe S.R., Irrigation Engineering & Hydraulic Structures, S.K. Kataria & Sons, 2013
- Sathyanarayana M. C. Water Resources Engineering-Principles and Practice, New Age International Publishers. 2009
- Varshney, R.S. Theory & Design of Irrigation Structures - Vol III, Nem Chand & Bros., Roorkee.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Diversion head works- layout and functions of components, Weir and barrage- Causes of failure of weirs on permeable soils - Bligh's theory. Design of vertical drop weir. Khosla's theory of independent variables- Khosla's corrections-Use of Khosla's charts.	6	15

II	Irrigation canals, canal alignment- cross section of unlined canals- Design of canals through alluvial soils-Kennedy's theory and Lacey's theory. Cross drainage works-Types, selection of suitable type, Type of aqueducts. Regulation Works - Canal falls-necessity, classification. Canal regulators- Regulator cum road bridge- Head regulators and cross regulators.	8	15
FIRST INTERNAL EXAMINATION			
III	Design and Drawing of the following hydraulic structures: 1. Aqueduct (Type III) 2. Syphon Aqueduct (Type III) 3. Canal Fall (Trapezoidal Notch type) 4. Siphon Well Drop 5. Sarda Type Fall (High Discharge only) 6. Cross Regulator (Using Khoslas Theory)	30	50
SECOND INTERNAL EXAMINATION			
IV	Dams-Types, Gravity dam – selection of site- forces acting - stability analysis and modes of failure – Principal and shear stresses-Problems - Elementary profile –limiting height of gravity dams-high and low dams- Practical profiles, Functions of various components shafts, keys, water stops, and different types of gallery, Grouting. Instrumentation in dams (Concept only).	6	10
V	Arch dams-types, methods for design (list only)-Thin cylinder theory. Earth dams-types, causes for failure and design criteria. Spillways-Types. Effective length of spillway- Ogee type spillway-profile. Energy dissipation below spillways - Stilling basins- Indian standard Type I and Type II (design not necessary).	6	10
END SEMESTER EXAMINATION			

Note: In Internal Evaluation the marks for assignment shall be awarded based on the submission of drawings.

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks : 100

Exam Duration: 4 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III : One question out of 2 questions carrying 50 marks ; with weightage for design as 25 marks and sketching of two views of design specified in question : 25 marks

Part C - Module IV & V : 2 questions out of 3 questions carrying 10 marks each.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE303	STRUCTURAL ANALYSIS -11	3-0-0-3	2016

Pre-requisite: CE201 Mechanics of Solids

Course objectives:

- To equip the students with the force and displacement methods of structural analysis with emphasis on analysis of rigid frames and trusses

Syllabus :

Slope Deflection Method, Moment Distribution Method, Clapeyrons Theorem (Three Moment Equation) , Kani's method of analysis, Beams curved in Plan, Plastic Theory

Expected Outcomes:

The students will be able to

- analyse structures using force method
- analyse structures using displacement method
- analyse curved beams in plan
- analyse structures using plastic theory

Text Books :

- Kenneth Leet, Chia M Uang & Anne M Gilbert., Fundamentals of Structural Analysis, McGraw Hill, 4e, 2010
- R. Vaidyanathan and P. Perumal, Structural Analysis Volume I & II, Laxmi Publications (P) Ltd., 2017
- Reddy . C.S., Basic Structural Analysis, Tata McGraw Hill, 3e, 2011

References:

- Daniel L Schodak, Structures, Pearson Education, 7e, 2014
- Hibbeler, RC, Structural analysis, Pearson Education, 2012
- Kinney J. S., Indeterminate Structural Analysis, Oxford & IBH, 1966
- Negi L. S. and Jangid R. S, Structural Analysis, Tata McGraw Hill, 1997
- Rajasekaran S. and Sankarasubramanian G., Computational Structural Mechanics, PHI, 2008
- S.S. Bhavikatti, Structural Analysis II, Vikas Publication Houses (P) Ltd, 2016
- SP:6 (6): Application of Plastic Theory in Design of Steel Structures, Bureau of Indian Standards, 1972
- Timoshenko S. P. and Young D. H., Theory of Structures, McGraw Hill, 2e, 1965
- Utku S, Norris C. H & Wilbur J. B, Elementary Structural Analysis, McGraw Hill, 1990
- Wang C. K., Intermediate Structural Analysis, Tata McGraw Hill, 1989

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Clapeyrons Theorem (Three Moment Equation) : Derivation of three	7	15

	moment equation - application of three moment equation for analysis of continuous beams under the effect of applied loads and uneven support settlement.		
II	Slope Deflection Method : Analysis of continuous beams- beams with overhang- analysis of rigid frames - frames without sway and with sway - different types of loads -settlement effects	7	15
FIRST INTERNAL EXAMINATION			
III	Moment Distribution Method: Moment Distribution method – analysis of beams and frames – non sway and sway analysis .	7	15
IV	Kani's Method: Kani's Method of analysis applied to continuous beams and single bay single storey rigid frames rigid frames – frames without sway and with sway.	6	15
SECOND INTERNAL EXAMINATION			
V	Beams curved in plan: Analysis of cantilever beam curved in plan, analysis of circular beams over simple supports.	7	20
VI	Plastic Theory: Introduction – plastic hinge concepts – plastic modulus – shape factor – redistribution of moments – collapse mechanisms – Plastic analysis of beams and portal frames by equilibrium and mechanism methods.(Single Storey and Single bay Frames only)	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note :

1. Each part should have at least one question from each module.
2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE304	DESIGN OF CONCRETE STRUCTURES - II	3-0-0-3	2016

Pre-requisites : CE301 Design of Concrete Structures - I

Course objectives:

- To provide knowledge in the structural design of selected advanced structures of concrete and enable them to design reinforced concrete structures for real-world applications.

Syllabus :

Columns subjected to compression , uniaxial bending and biaxial bending- design using SP16 charts for limit state-design of slender columns- design of wall/strip footing- design of rectangular footings-eccentrically loaded rectangular footing- circular footings-detailing-combined footings-rectangular and trapezoidal (design principles only)- design of cantilever retaining wall without surcharge-detailing - design principles of counter fort retaining wall and detailing- Circular slabs- simply supported, fixed and partially fixed subjected to udl- design of water tanks-design philosophy and requirements-joints-IS code recommendations- design of rectangular and circular water tanks using IS code coefficients (IS 3370)- Pre-stressed concrete-concept of prestressing- materials-methods of prestressing – prestressing systems- losses of prestress. analysis of prestressed beams (rectangular and I-sections) at stages of transfer and service

Expected Outcomes:

The students will be able to

- Design eccentrically loaded and slender columns using SP 16 design charts and different
- types of foundations
- Design and detail cantilever retaining wall and understand the design principles of Counter fort retaining wall
- Design and detail circular slabs and domes
- Design rectangular and circular water tanks using IS code coefficients (IS 3370).
- Gain knowledge of prestressed concrete fundamentals and analyse pre and post tensioned beams.

Text Books / References:

- N. Krishnaraju, Prestressed Concrete , Tata McGraw- Hill, 5e, 2012
- Pillai S.U & Menon D – Reinforced Concrete Design, Tata McGraw Hill Book Co., 2009
- Punmia, B. C, Jain A.K and, Jain A.K , R C C Designs, Laxmi Publications Ltd., 10e, 2015
- Relevant IS codes (IS 456, IS 875IS 1343, IS 3370, SP 16, SP 34)

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Analysis and design of short columns under eccentric loading- Columns subjected to compression and uniaxial bending- design using SP16 charts for limit state Columns subjected to combined axial load and biaxial bending moments-code procedure for design- design using SP16 charts for	8	15

	limit state Slender columns- behavior of slender columns-braced and unbraced columns-design procedure- design using SP16 charts for limit state		
II	Foundations- classification-IS code provisions for design of isolated footings- design principles of rectangular footings- Design of rectangular footings-uniform thickness and sloped- eccentrically loaded rectangular footing of uniform thickness-detailing. Combined footings (design principles only)- analysis of combined footings-rectangular and trapezoidal.	8	15
FIRST INTERNAL EXAMINATION			
III	Retaining walls-Types- Cantilever retaining wall- earth pressure and forces acting-stability-proportioning-structural behavior of components -design example of cantilever retaining wall without surcharge-detailing Counterfort retaining wall- design principles of components and detailing (design not required)	6	15
IV	Circular slabs- stresses- reinforcements- simply supported, fixed and partially fixed subjected to uniformly distributed loads Design and detailing of spherical and conical domes	6	15
SECOND INTERNAL EXAMINATION			
V	Introduction to design of water tanks-design philosophy and requirements-joints- IS code recommendations Design of rectangular water tanks using IS code coefficients (IS 3370). Design of circular water tanks using- IS code coefficients (IS 3370)	7	20
VI	Introduction to Pre-stressed concrete: Concept of pre-stressing- Materials-High strength concrete and high tensile steel. Analysis of pre-stressed beams (Rectangular and I-sections) at stages of transfer and service. Losses in Prestress	7	20
END SEMESTER EXAMINATION			

- Note:**
1. All designs shall be done as per current IS specifications
 2. Special importance shall be given to detailing in designs
 3. SI units shall be followed.
 4. Students shall submit a term project on design and detailing of any structure of real- world application at the end of the semester.

QUESTION PAPER PATTERN (End semester examination) :

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each
Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each
Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

- Note :**
1. Each part should have at least one question from each module
 2. Each question can have a maximum of 4 subdivisions (a,

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE305	GEOTECHNICAL ENGINEERING - II	3-0-0-3	2016
Pre-requisite CE208 Geotechnical Engineering - I			
Course objectives: - To impart to the students, in-depth knowledge about the basic concepts and theories of foundation engineering; - To enable the students to acquire proper knowledge about various methods of foundation analysis for different practical situations.			
Syllabus: Stresses in subsoil due to loaded areas of various shapes, Boussinesq's formula, Newmark's chart, Lateral earth pressure, Rankine's and Coulomb's theories, Influence of surcharge, inclined backfill, water table and layering, Terzaghi's bearing capacity theory for isolated footings, Local and general shear failure, Total and differential settlements, soil improvement techniques, combined footings, raft foundations, well foundation, Problems encountered in well sinking, Pile foundations, Bearing capacity of single pile static and dynamic formulae, Capacity of Pile groups, Machine foundation, Methods of vibration isolation, site investigation, Guidelines for choosing spacing and depth of borings, boring methods, Standard Penetration Test.			
Expected Outcomes: The students will be able to understand - the basic concepts, theories and methods of analysis in foundation engineering; - the field problems related to geotechnical engineering and to take appropriate engineering decisions.			
Text Books : - Braja M. Das, "Principles of Foundation Engineering", Cengage Learning India Pvt. Ltd., Delhi, 2011. K. R. Arora, Soil Mechanics and Foundation Engineering, Standard Publishers, 2011 - Murthy V N S., "Advanced Foundation Engineering", CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2007			
References: - Alam Singh., "Soil Engineering in Theory and Practice", Vol.1, CBS Publishers & Distributors Pvt. Ltd., New Delhi. 2002 - Gopal Ranjan and Rao A.S.R., "Basic and Applied Soil Mechanics", New Age International (P) Limited, New Delhi, 2002. - Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Kindersley(India) Pvt. Ltd., 2013 - Teng W.E., "Foundation Design", Prentice Hall, New Jersey, 1962. - Venkataramiah, "Geotechnical Engineering", Universities Press (India) Limited, Hyderabad, 2000.			

COURSE PLAN			
Module	Contents	Hours	Sem. Exam Marks %
I	Stresses in soil due to loaded areas - Boussinesq's formula for point loads – assumptions [no derivation required] – Comments - numerical problems Vertical stress beneath loaded areas of strip, rectangular and circular shapes(no derivation required)- Newmark's chart[construction procedure not required] - Isobars- Pressure bulbs-numerical problems	6	15
II	Lateral earth pressure – At-rest, active and passive earth pressures – Practical examples Rankine's and Coulomb' theories[no derivation required]-Influence of surcharge, inclined backfill and water table on earth pressure-numerical problems Earth pressure on retaining walls with layered backfill- numerical problems	6	15
FIRST INTERNAL EXAMINATION			
III	Bearing capacity of shallow foundations – Ultimate, safe and allowable bearing capacity. - Failure mechanism, assumptions and equation of Terzaghi's bearing capacity theory for strip footing[no derivation required] – Terzaghi's formulae for circular and square footings numerical problems Local and general shear failure - Factors affecting bearing capacity – Influence of water table - numerical problems Total and differential settlement- Causes - Methods of reducing differential settlement–Brief discussion on soil improvement through installation of drains and preloading.	7	15
IV	Combined footings- Rectangular and Trapezoidal combined footings - numerical problems Raft foundations (Design Concepts only) - Allowable Bearing capacity of Rafts on sands and clays - Floating foundation. Deep foundations - Elements of a well foundation – Problems encountered in well sinking – Methods to rectify tilts and shifts	6	15
SECOND INTERNAL EXAMINATION			
V	Pile foundations - Point bearing and friction piles - Bearing capacity of single pile in clay and sand[I.S. Static formulae] - numerical problems Dynamic formulae(Modified Hiley formulae only) - I.S. Pile load test [conventional]- Negative skin friction - numerical problems Group action - Group efficiency - Capacity of Pile groups- numerical problems	8	20

VI	Brief introduction to Machine foundation –Mass spring model for undamped free vibrations - Natural frequency – Coefficient of uniform elastic compression – Methods of vibration isolation Brief introduction to site investigation –Objectives - Guidelines for choosing spacing and depth of borings [I.S. guidelines only] - Auger boring and wash boring methods - Standard Penetration Test – procedure, corrections and correlations.	9	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE306	COMPUTER PROGRAMMING AND COMPUTATIONAL TECHNIQUES	3-0-0-3	2016

Pre-requisites : Nil

Course Objectives:

- To provide adequate knowledge for coding in C++ language
- To give awareness about the different computational methods and their implementation to analyze basic Engineering problems

Syllabus

Computer programming - Elements of C++ programming language - control statements - Basic concepts of object oriented programming
Computational Techniques – Roots of transcendental equation- Interpolation -Functional approximation- Numerical Integration, Solution of simultaneous linear equations.

Expected Outcome:

- The students will be able to develop computer programs and implement numerical techniques for solving basic engineering problems using C++ language.

Text Books:

1. Balaguruswamy, Object Oriented programming with C++. Tata Mcgraw Hill., 2008
2. Gerald C. F. and P. O. Wheatley, Applied Numerical Analysis, Pearson Edu., 2004
3. Robert Lafore ., C++ Programming., Sams publishers.,4th Edition, 2001

Reference Books:

1. Barkakati N., Object Oriented Programming in C++, SAMS, 1991.
2. Kamthane A. M., Object Oriented Programming with ANSI & Turbo C++, Pearson Education, 2009.
3. Lippman S. B. and J. Lajoie, C++ Primer, Pearson Education, 2005.
4. Maria Litvin.and Gary Litvin, C++ for You++, Skylight Publishing, 1998.
5. Ravichandran D., Programming with C++, Tata McGraw Hill, 2007.

COURSE PLAN

Modules	Contents	Hours	Sem. Exam Marks %
I	Introduction to C++: Structure of C++ program; Character set; Keywords; Identifiers; Data types – integer, real, character, string, Boolean, Enumerated data types, Constants and Variables; Operators – assignment, arithmetic, relational, logical, increment, decrement and conditional operators; Statements – simple & compound, declaration statements. Input and output streams. Selection statements: if, if-else, switch statements	7	15
II	Looping statements - for, while, do-while statements, Jump statements – break, continue, goto, exit (). Arrays - single and multi-dimensional arrays, initializing array elements, pointers & arrays, Character arrays, string functions, Unformatted console I/O functions, Unformatted Stream I/O	6	15

	functions. Preparation of programs for evaluation of factorial of a number, Infinite series, Sorting, Searching and Matrix manipulations.		
FIRST INTERNAL TEST			
III	User defined functions – Arguments, return values, call by value, call by reference, functions calling functions, functions and arrays - Global variables, automatic, static and register variables, recursive functions.	6	15
IV	Structures - functions and structures - Arrays of structures - structures within structures, Structures containing arrays. Files - Input & Output, sequential & random access. Basic concepts of object oriented programming - class, objects, constructors and destructors, inheritance (Programs not required)	7	15
SECOND INTERNAL TEST			
V	Roots of Transcendental equations - Successive approximations, Regula - Falsi, Newton Raphson Methods, Interpolation-Lagrange interpolation method.	8	20
VI	Functional approximation - Fitting straight line & parabola, Numerical Integration - Trapezoidal, Simpson's rule & Gauss quadrature Method. Solution of simultaneous linear algebraic equations – Gauss elimination method. Solution of Partial differential Equation - Finite Difference Method	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE307	GEOMATICS	3-0-0-3	2016

Prerequisite : CE207 Surveying

Course objectives:

- To impart awareness on the advanced surveying techniques
- To understand the errors associated with survey measurements
- To provide a basic understanding on geospatial data acquisition and its process

Syllabus:

Traverse Survey, Curve Surveying, Global Navigation Satellite System, Global Positioning Systems, Remote Sensing, Geographical Information System

Course Outcomes:

- The students will possess knowledge on the advanced methods of surveying, the instruments and the spatial representation of data.

Text Books / References:

1. Dr. B.C. Punmia , Ashok Kumar Jain & Arun Kumar Jain - Surveying , Laxmi publications (P) Ltd , 2005
2. Prof. T.P. Kenetkar and Prof. S.V. Kulkarni - Surveying and Levelling, Pune Vidyarthi Griha Prakashan, 2004
3. R.Agor - A Text book of Surveying and Levelling, Khanna Publishers, 2005
4. S.K. Duggal - Surveying Vol. II, Tata McGraw Hill Ltd ,Reprint 2015

References :

1. Burrough P , Principles of Geographical Information systems, Oxford University Press, 1998
2. Chang,K , “Introduction to Geographic Information Systems”, Tata McGraw-Hill Publishing Co. Ltd, 2008
3. George Joseph, “Fundamentals of Remote Sensing”, University Press, 2003
4. Iliffe, C.J., Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, 2006
5. James M Andersen, Edward M Mikhail, Surveying Theory and Practice, McGraw Hill education, 7e, 1998
6. Kang-tsung Chang, ‘Introduction to GIS’ , Tata McGraw-Hill Publishing Co. Ltd, 8e, 2016
7. Lillesand M and Kiefer W, “Remote Sensing and Image Interpretation”. John Wiley and Sons, Inc., 2000

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Traverse Surveying - Methods of traversing, Checks in closed traverse, Traverse computations, Balancing the traverse- methods	6	15

II	Curve Surveying – Elements of simple and compound curves – Method of setting out– Elements of Reverse curve (Introduction only)– Transition curve – length of curve – Elements of transition curve - Vertical curve (introduction only)	8	15
FIRST INTERNAL EXAMINATION			
III	Global Navigation Satellite System- Types, Global Positioning Systems -Components and Principles, Satellite ranging-calculating position, Satellite signal structure, code phase and carrier phase measurements, GPS errors and biases, Application of GPS	6	15
IV	GPS Surveying methods -Static, Rapid static , Kinematic methods – DGPS, Phases of GPS Survey -Planning and preparation, Field operation-horizontal and vertical control, data sheet, visibility diagram, Processing and report preparation,	6	15
SECOND INTERNAL EXAMINATION			
V	Remote Sensing : Definition- Electromagnetic spectrum-Energy interactions with atmosphere and earth surface features-spectral reflectance of vegetation, soil and water- Classification of sensors-Active and Passive, Resolution-spatial, spectral radiometric and Temporal resolution, Multi spectral scanning-Along track and across track scanning	8	20
VI	Geographical Information System -components of GIS, GIS operations, Map projections- methods, Coordinate systems-Geographic and Projected coordinate systems, Data Types- Spatial and attribute data, Raster and vector data representation-Data Input methods-Geometric Transformation-RMS error, Vector data Analysis-buffering, overlay.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE308	TRANSPORTATION ENGINEERING - I	3-0-0-3	2016

Pre-requisite : NIL

Course objectives:

- To introduce the principles and practice of Highway Engineering and Airport Engineering.
- To enable students to have a strong analytical and practical knowledge of geometric design of highways.
- To introduce pavement design concepts, material properties, construction methods and to design highway pavements.
- To understand the principles of traffic engineering and apply this for efficient management of transportation facilities.

Syllabus:

Classification and alignment of highways- Geometric design of highways- Properties and testing of pavement materials- CBR method of flexible pavement design- Construction and maintenance of pavements- Design of runways, taxiways and aprons.

Traffic characteristics- Traffic studies and analysis- Traffic control devices

Airport characteristics- Aircraft component parts- Site selection-Design of runways, taxiways and aprons- Terminal area planning- Airport marking and lighting

Expected Outcomes:

The students will be able to

- Design various geometric elements of a highway
- Determine the characteristics of pavement materials and design flexible pavements
- Conduct traffic engineering studies and analyze data for efficient management of roadway facilities, Plan and design basic airport facilities

Text Books :

1. Khanna, S.K. & Justo E.G., Highway Engineering, Nem Chand & Bros., 2000
2. Kadiyali, L. R., Principles of Highway Engineering, Khanna Publishers, 2001
3. Khanna, S. K. & Arora. M. G., Airport Planning and Design, Nemchand & Bros.

References:

1. Horonjeff R. & McKelvy, F., Planning and Design of Airports, McGraw Hill, 5e, 2010
2. IRC: 37-2001, Guidelines for the Design of Flexible Pavements, IRC 2001, New Delhi
3. IRC:37-2012, Tentative Guidelines for the Design of Flexible Pavements
4. O' Flaherty, C.A (Ed.), Transport Planning and Traffic Engineering, Elsevier, 1997
5. Rangwala, S. C. , Airport Engg. Charotar Publishing Co., 16e, 2016
6. Yoder, E. J & Witezak, M. W, Principles of Pavement Design, John Wiley & Sons, 1991

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %

I	Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural area, Requirements and factors controlling alignment of roads, Engineering surveys for highway location- Introduction to geometric design of highways, Design controls and criteria, Design of highway cross section elements.	6	15
II	Sight distance, Stopping sight distance, Overtaking sight distance, Design of horizontal alignment and Vertical alignment	7	15
FIRST INTERNAL EXAMINATION			
III	Introduction to highway materials, design and construction, Desirable properties and testing of road aggregates, bituminous materials and sub grade soil. Flexible and rigid pavements, Factors influencing the design of pavements, CBR method and IRC guidelines for flexible pavements	7	15
IV	Introduction to performance grading and superpave, Construction of bituminous pavements, Types and causes of failures in flexible and rigid pavements, Highway drainage. Introduction to Traffic Engineering, Traffic characteristics, Traffic studies and their applications.	6	15
SECOND INTERNAL EXAMINATION			
V	Types of road intersections, Traffic control devices, Traffic signs, Road markings and Traffic signals, Design of isolated signals by Webster's method. Introduction to Airport Engineering, Aircraft characteristics and their influence on planning of airports, Components of airport, Selection of site for airport	8	20
VI	Runway orientation, basic runway length and corrections required, Geometric design of runways, Design of taxiways and aprons, Terminal area planning, Airport markings, Lighting of runway approaches, taxiways and aprons, Air traffic control	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE309	WATER RESOURCES ENGINEERING	3-0-0-3	2016

Pre-requisite : NIL

Course objectives

- To impart knowledge regarding the availability of water on hydrosphere, its distribution and quantification
- To convey the knowledge on the scientific methods for computing irrigation water requirements
- To communicate fundamental knowledge on reservoir engineering and river engineering

Syllabus

Hydrologic cycle, Precipitation, Infiltration and Evaporation-measurement and data analysis. Runoff-components and computation, Hydrograph, Unit Hydrograph and S-Hydrograph. Irrigation types and methods-Soil water plant relationships, Frequency of irrigation, Computation of crop water requirement. Stream flow measurement -Stage-discharge curve. Meandering of rivers, river training works. Surface water systems: diversion and storage systems, reservoir - estimation of storage capacity and yield of reservoirs - reservoir sedimentation -useful life of reservoir. Groundwater - Aquifer types and properties - Steady radial flow into a well. Estimation of yield of an open well.

Expected Outcome

After successful completion of this course, the students will be able to :

- Describe the hydrologic cycle and estimate the different components
- Determine crop water requirements for design of irrigation systems
- Compute the yield of aquifers and wells.
- Know the features of various river training works
- Estimate the storage capacity of reservoirs and their useful life.

Text Books:

1. Arora, K.R., "Irrigation, Water Power and Water Resources Engineering", Standard Publishers Distributors, New Delhi, 2009.
2. Garg S.K, Irrigation Engineering and Hydraulic Structures Khanna Publishers New Delhi 2006.
3. Modi. P. N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors New Delhi 2009.
4. Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd. 2010.

References:

1. Asawa. G.L. Irrigation and Water Resources Engineering, New Age International, 2000
2. Ojha.C.S.P., R.Berndtsson, P. Bhunya, Engineering Hydrology, Oxford university Press, 2015.
3. Patra. K.C., Hydrology and Water Resources Engineering, CRC Press, 2010.
4. Sahasrabudhe S.R., Irrigation Engineering & Hydraulic Structures, S.K. Kataria & Sons, 2013.
5. Subramanya. K., Engineering Hydrology, Tata Mc Graw Hill, 2011
6. Todd D. K., Ground Water Hydrology, Wiley, 2005.
7. Ven Te Chow, David R Maidment, L.W Mays., Applied Hydrology, McGraw Hill, 1988
8. Warren Viessman, G.L. Lewis, Introduction to Hydrology, Pearson Education, 2003.

COURSE PLAN			
Module	Contents	Hours	Sem. Exam Marks %
I	Hydrologic cycle-precipitation-mechanism, types and forms. Measurement of rainfall using rain gauges-optimum number of rain gauges. Estimation of missing precipitation. Representation of rainfall data-mass curve and hyetograph. Computation of mean precipitation over a catchment. Design rainfall - probable maximum rainfall. Infiltration-measurement by double ring infiltrometer. Horton's model. Evaporation-measurement by IMD land pan, control of evaporation.	8	15
II	Runoff-components of runoff-methods of estimation of runoff-infiltration indices, Hydrograph analysis-Hydrograph from isolated storm-Base flow separation. Unit hydrograph –uses. Assumptions and limitations of unit hydrograph theory. Computation of storm/flood hydrograph of different duration by method of superposition and by development of S– Hydrograph.	8	15
FIRST INTERNAL EXAMINATION			
III	Irrigation– Necessity, Benefits and ill effects. Types: flow and lift irrigation - perennial and inundation irrigation. Methods: flooding, furrow, sprinkler and drip irrigation (concepts only, no design aspects/problems), Soil water plant relationships, soil moisture constants, Computation of crop water requirement: depth and frequency of Irrigation, Duty and delta, relationship, variation of duty, factors. Computation of design discharge of conveyance channels, Irrigation efficiencies. Consumptive use of water: concept of Evapotranspiration. (No detailed discussion on estimation procedures)	6	15
IV	Stream flow measurement: methods, Estimation of stream flow by area velocity method only, Stage discharge curve. Meandering of rivers, River training – objectives and classification, description of river training works.	6	15
SECOND INTERNAL EXAMINATION			
V	Surface Water system: diversion and storage systems, necessity. River flow: Flow duration Curve, Firm yield. Reservoirs-types of reservoirs, zones of storage reservoir, reservoir planning-storage capacity and yield of reservoirs-analytical method and mass curve method. Reservoir sedimentation: trap efficiency, methods for control. Computation of useful life of reservoir.	7	20
VI	Ground water : vertical distribution of groundwater, classification of saturated formation, water table, Aquifer properties : Porosity, Specific yield, specific retention, Types of aquifers. Darcy's law, co-efficient of permeability, Transmissibility. Wells- Steady radial flow into a fully penetrating well in Confined and Unconfined aquifers. Estimation of yield of an open well, pumping and recuperation tests. Tube wells – types.	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100

Exam Duration: 3 Hrs

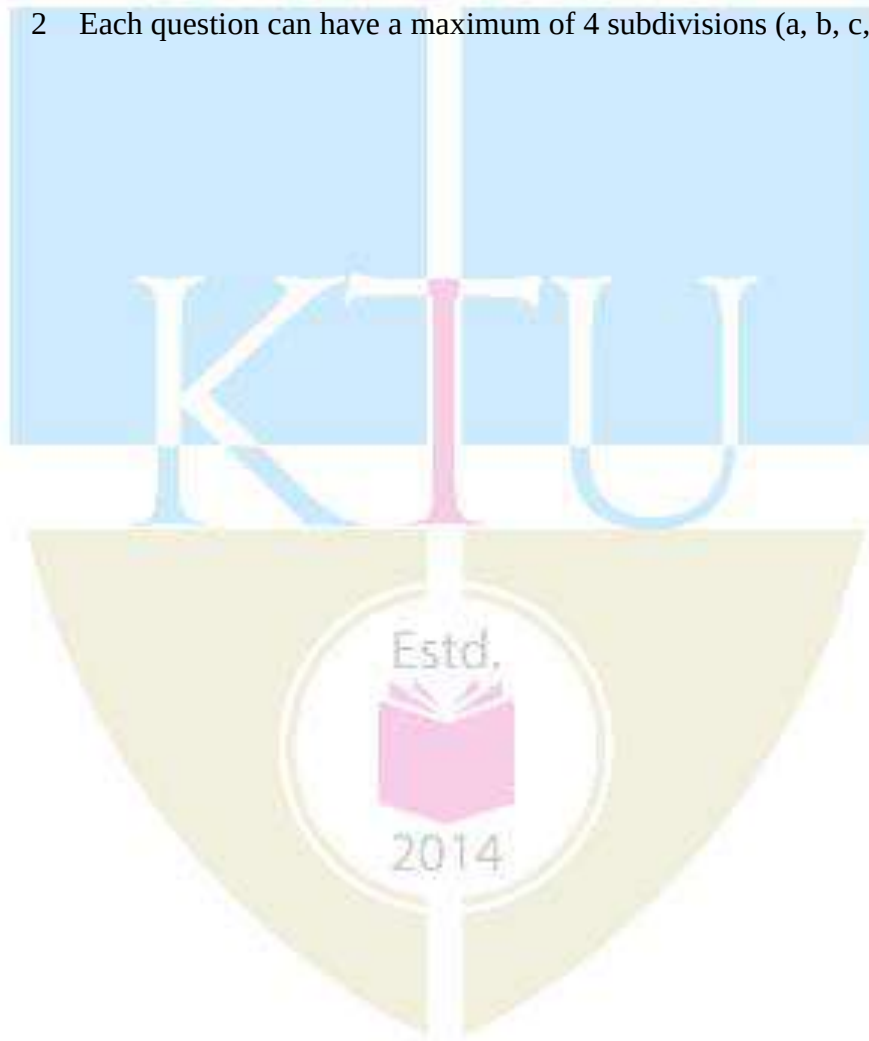
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2 Each question can have a maximum of 4 subdivisions (a, b, c, d)



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE332	TRANSPORTATION ENGINEERING LAB	0-0-3-1	2016

Pre-requisite : CE308 Transportation Engineering - I

Course objectives:

- To enable the students to conduct different tests to find various properties of aggregates, bitumen and soil subgrade and hence to assess their suitability in pavement construction.

List of Experiments (All experiments shall be conducted as per BIS/ASTM/AASHTO procedures)

I. Tests on aggregates

- Aggregate crushing value
- Aggregate impact value
- Los Angeles abrasion value
- Shape tests-Flakiness index and Elongation index
- Angularity of coarse aggregates and fine aggregates
- Specific gravity and water absorption of coarse aggregate
- Stripping value of road aggregates
- Dry Packing characteristics of aggregates (ASTM C29/ C29 M – 97)

II. Test on soil

- California Bearing Ratio test (*Soaked and Un-soaked CBR*)
- Dynamic cone penetration test (ASTM D6951 (2015) procedure)

III. Tests on bitumen

- Penetration value of bitumen
- Softening point of bitumen
- Ductility of bitumen
- Flash and Fire point of bitumen
- Measurement of mixing and compaction temperature of bitumen (Brookfield viscometer)
(The test was previously written in the draft syllabus as Viscosity test on bitumen, but we have specified it)

IV. Test on bituminous mixes

- Determination of theoretical specific gravity of loose mix and bulk specific gravity of

compacted mix (ASTM D2041, ASTM D1188)

2. *Moisture sensitivity test of bituminous mixes (AASHTO T283 procedure)*

V. Functional evaluation of pavements

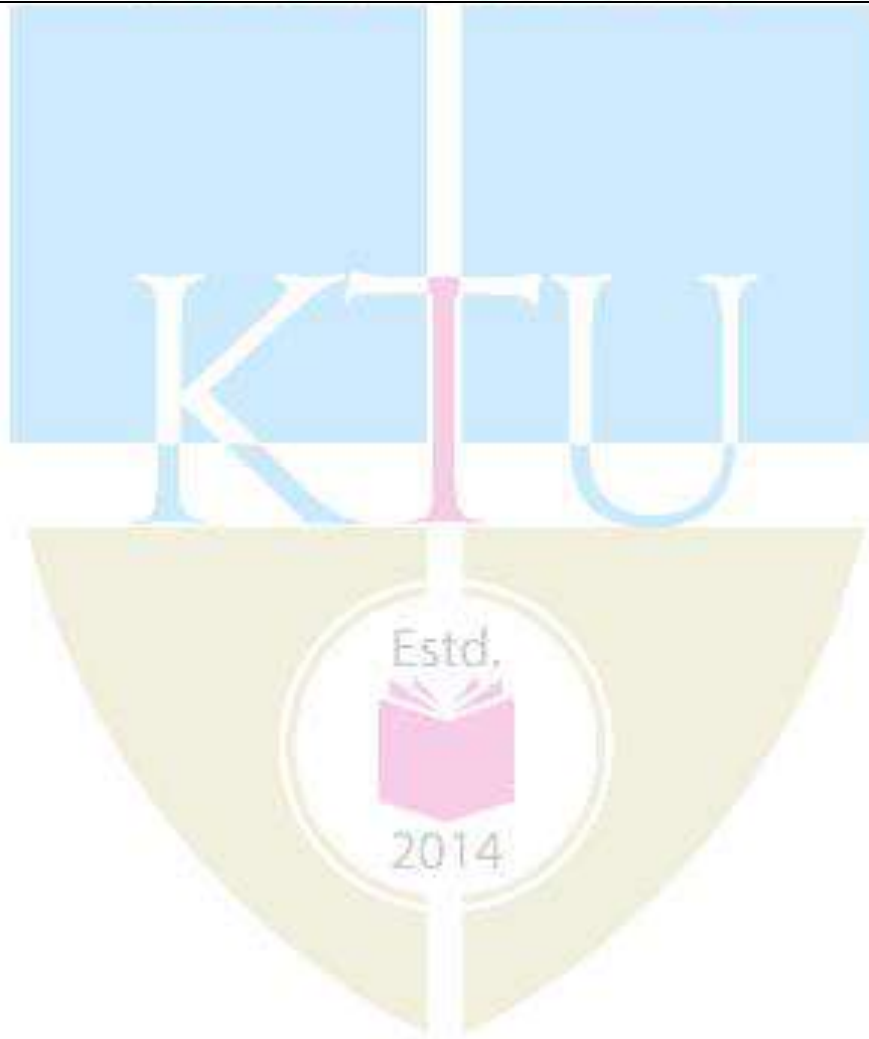
1. *Use of MERLIN apparatus to determine road roughness*

Expected outcome:

- The students will be able to assess the quality of various pavement materials and their suitability in highway construction.

Reference books :

1. L .R. Kadiyali, Principles and Practices of Highway Engineering, Khanna Publishers, 2009
2. MoRTH (2013) Specification for Road and bridge works (5th revision)
3. MS-2 manual (2015) Seventh edition, Asphalt Institute.
4. S. K. Khanna, C. E. G. Justo, A Veeraragavan, Highway Engineering, Khanna Publishers, 10e.



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE333	GEOTECHNICAL ENGINEERING LAB	0-0-3-1	2016

Pre-requisite : CE208 Geotechnical Engineering - I

Course objectives:

- To understand the laboratory tests used for determination of physical, index and Engineering properties of soil.

List of Experiments:

1. Determination of Water Content, Specific Gravity and Shrinkage Limit
2. Field Density determination and Sieve Analysis
3. Atterberg Limits (Liquid Limit and Plastic Limit)
4. Hydrometer Analysis
5. Direct Shear test
6. Standard Proctor Compaction Test
7. Permeability Test and Unconfined Compression Test
8. Consolidation Test
9. Swelling Test
10. Heavy compaction
11. California Bearing Ratio Test.

Expected Outcomes:

The students will

- i. have thorough knowledge about the procedures of laboratory tests used for determination of physical, index and engineering properties of soils
- ii. have the capability to classify soils based on test results and interpret engineering behavior based on test results
- iii. be able to evaluate the permeability and shear strength of soils
- iv. be able to evaluate settlement characteristics of soils
- v. be able to evaluate compaction characteristics required for field application

Text Books / References:

1. IS codes relevant to each test
2. C. Venkatramaiah, Geotechnical Engineering, New Age International publishers, 2012
3. Gopal Ranjan and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2012
4. K. R. Arora, Soil Mechanics and Foundation Engineering, Standard Publishers, 2011

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE334	COMPUTER AIDED CIVIL ENGINEERING LAB	0-0-3-1	2016
Prerequisite : CE231 Civil Engineering Drafting Lab			
Course objectives: 1. To introduce the fundamentals of Civil Engineering drafting and drawing. 2. To familiarize with the FEA software packages for analysis and Design of structures 3. To understand the Total Station data transfer and interpretation. 4. To enable the usage of Project Management Software			
List of Experiments : 1. Structural Drawings for a) Slabs and Beams i. One Way / Two way Slab/Continuous Slabs ii. Singly reinforced /Double reinforced Beams iii. Continuous / Flanged Beams b) Stair Case (Doglegged and Tread and Riser Type) c) Foundations (Isolated and Combined Rectangular) - II Analysis and design of steel and RCC elements using STAAD/SAP 2000/ ETABS/any FEM software package. a) Continuous and Cantilever beams b) Plane truss and Frames - III Use of Project Management Software (MS Project/Primavera) a) Preparation of Bar Chart/Gantt Charts/CPM/PERT Charts and finding Critical Path b) Practice on Resource allocation (and Project Monitoring(Cost and Time) IV. Conduct of Survey camp using Total Station (minimum 3 days duration) and its plotting.			
Expected Outcomes: • The students are expected to accomplish the abilities/skills for the use of Civil Engineering Drafting/Analysis, Design and Project Management Software.			
Text Books / References: 1. N Krishna Raju, Structural Design and Drawing, Second Edition, Universities Press (India), Private Limited, Hyderabad, 2009 2. Reference Manual of the Relevant Software 3. Satheesh Gopi, Dr. R Sathikumar, N Madhu, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education India, 2006 4. AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, US, 2015			

Note:

- (1) Evaluation of drawing, along with a viva, to be done at the end of every class.
- (2) A survey camp of minimum 3 days duration using total station is to be conducted in the semester, and is compulsory
- (3) Evaluation Criteria :

Best 8 plate/Exercises	- 40 marks
Survey Camp	- 30 marks
.End semester examination	- 30 marks
TOTAL	- 100 marks

Course code	Course Name	L-T-P-Credits	Year of Introduction
CE336	STRENGTH OF MATERIALS LAB	0-0-3-1	2016
Prerequisite : SB201 Mechanics of solids			
Course Objectives: - To study various types of failures occurring in service life of ductile metals. - Provide an environment to enable students to correlate theoretical knowledge gained in the class room with the physical world. - To study the properties of various materials under various working conditions.			
List of Exercises/ Experiments (Minimum 12 Mandatory) - Tests on Open Coiled Spring <i>Equipment: Spring Testing Machine, Vernier Calliper.</i> - Tests on Closed Coiled Spring <i>Equipment: Spring Testing Machine, Vernier Calliper.</i> - Bending Test on Wooden Beams Using U. T. M. <i>Equipment: Universal Testing Machine, Deflection Gauges, Measuring Tape.</i> - Verification of Clerk Maxwell's Law of Reciprocal Deflection and Determination of Young's Modulus 'E' for Steel. <i>Equipment: Apparatus for verification of Clerk Maxwell's Law of Reciprocal Theorem, Deflection gauges, Weights, Scale, Vernier Calliper.</i> - Torsion Pendulum Test for M.S. wires. <i>Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.</i> - Torsion Pendulum Test for Aluminium Wires. <i>Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.</i> - Torsion Pendulum Test for Brass Wires. <i>Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.</i> - Tension Test Using U. T. M. on M. S. Rod. <i>Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.</i> - Tension Test Using U. T. M. on Torsteel rod <i>Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.</i> - Tension Test Using U. T. M. on High Tensile Steel rod. <i>Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.</i> - Compression test on concrete specimen. <i>Equipment: Compression Testing Machine.</i> - Compression test on brick. <i>Equipment: Compression Testing Machine.</i> - Torsion Test on M. S. Rod. <i>Equipment: Torsion Testing Machine, Vernier Caliper.</i> - Shear Test on M.S. Rod. <i>Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.</i> - Impact Test Using Izod Apparatus and Charpy. <i>Equipment: Charpy/ Izod Impact Testing Machine.</i> - Impact Test Using Charpy Apparatus <i>Equipment: Charpy/ Izod Impact Testing Machine.</i>			

17. Hardness Test using Brinell Hardness Apparatus

Equipment: *Brinell Hardness Testing Machine.*

18. Strut Test.

Equipment: *Strut Testing Machine, Vernier Calliper.*

Course Outcome:

Upon successful completion of the course, the student will be:

- i. Familiar with the arrangement and conduct of experiments in the Material Testing laboratory environment.
- ii. Able to note down relevant readings and perform calculations while an experiment is in progress thereby correlating theoretical concepts of materials and their practical implications..
- iii. Able to comprehend the factors responsible for variation between theoretical and experimental results pertaining to the domain of Material Science.

Text books:

1. R.K. Bansal; Strength of Materials; Laxmi Publications.
2. Wonsiri Punurai; Mechanics of Materials-Laboratory and Experiments; LAP LAMBERT Academic Publishing.



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE361	ADVANCED CONCRETE TECHNOLOGY	3-0-0-3	2016

Prerequisite: CE204 Construction Technology,

Course objectives:

- To understand the behaviour of fresh and hardened concrete.
- To make aware the recent developments in concrete technology
- To understand factors affecting the strength, workability and durability of concrete
- To impart the methods of proportioning of concrete mixtures

Syllabus:

Review of Materials for concrete making. chemical and physical processes of hydration , Properties of fresh concrete - Mineral admixtures - Chemical Admixtures - Proportioning of concrete mixtures. Properties of hardened concrete- Durability of concrete, Non-destructive testing of concrete – special concretes

Expected Outcomes:

The students will be able to:

- Understand the testing of concrete materials as per IS code
- Know the procedure to determine the properties of fresh and hardened of concrete
- Design the concrete mix using ACI and IS code methods
- Select and Design special concretes depending on their specific applications
- Gain ideas on non-destructive testing of concrete

Text books:

1. Neville A.M., "Properties of Concrete", Trans-Atlantic Publications, Inc.; 5e, 2012
2. Job Thomas., "Concrete Technology", Cenage learning,
3. R. Santhakumar ,, Concrete Technology", Oxford Universities Press, 2006
4. Shetty M. S., Concrete Technology", S. Chand & Co., 2006

References:

1. Mehta and Monteiro, ,,Concrete-Micro structure, Properties and Materials", McGraw Hill Professional
2. Neville A. M. and Brooks J. J., Concrete Technology, Pearson Education, 2010
3. Lea, Chemistry of Cement and Concrete", Butterworth-Heinemann Ltd, 5e, 2017
4. Bungey, Millard, Grantham – Testing of Concrete in Structures- Taylor and Francis, 2006

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Aggregates: Review of types; sampling and testing; effects on properties of concrete, production of artificial aggregates. Cements: Review of types of cements, chemical composition; properties and tests, chemical and physical process of hydration,	6	15

	.Blended cements.		
II	Properties of fresh concrete - basics regarding fresh concrete – mixing, workability, placement, consolidation, and curing, segregation and bleeding Chemical Admixtures: types and classification; actions and interactions; usage; effects on properties of concrete.	7	15
FIRST INTERNAL EXAMINATION			
III	Mineral Admixtures: Flyash, ground granulated blast furnace slag, metakaolin, rice-husk ash and silica fume; chemical composition; physical characteristics; effects on properties of concrete; advantages and disadvantages. Proportioning of concrete mixtures: Factors considered in the design of mix . BIS Method, ACI method.	6	15
IV	Properties of hardened concrete: Strength- compressive tensile and flexure - Elastic properties - Modulus of elasticity - Creep- factors affecting creep, effect of creep - shrinkage- factors affecting shrinkage, plastic shrinkage, drying shrinkage, autogeneous shrinkage, carbonation shrinkage	6	15
SECOND INTERNAL EXAMINATION			
V	Durability of concrete: Durability concept; factors affecting, reinforcement corrosion; fire resistance; frost damage; sulfate attack; alkali silica reaction; concrete in sea water, statistical quality control, acceptance criteria as per BIS code. Non-destructive testing of concrete: Surface Hardness, Ultrasonic, Penetration resistance, Pull-out test, chemical testing for chloride and carbonation- core cutting - measuring reinforcement cover.	9	20
VI	Special concretes - Lightweight concrete- description of various types -High strength concrete - Self compacting concrete -Roller compacted concrete – Ready mixed concrete – Fibre reinforced concrete - polymer concrete Special processes and technology for particular types of structure - Sprayed concrete; underwater concrete, mass concrete; slip form construction, Prefabrication technology	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE363	GEOTECHNICAL INVESTIGATION	3-0-0-3	2016

Pre-requisite : CE208 Geotechnical Engineering - I

Course objectives:

- To impart to the students, a clear idea about how a geotechnical investigation programme is to be planned and executed;
- To impart in-depth knowledge about the various methods of geotechnical investigation and the field tests to be conducted in different situations.

Syllabus:

Objectives of soil exploration – Planning of a sub-surface exploration programme –Methods of exploration - Sounding methods – Standard Penetration Test - Cone Penetration Tests - Plate load test – Pressure meter test - Geophysical methods –pile load tests -Factors affecting sample disturbance and methods to minimise them –Types of samplers and Core retainers –Rock Quality Designation– Sub-soil investigation report

Expected Outcomes:

- The students will be able to understand the procedure, applicability and limitations of various methods of geotechnical investigation;
- Ability of the students in making proper engineering judgments and in taking appropriate decisions related to geotechnical investigations will be significantly improved.

Text Books:

1. Gopal Ranjan and Rao A.S.R., “ Basic and Applied Soil Mechanics”, New Age International (P) Limited, New Delhi, 2002.
2. Venkataramaiah, “Geotechnical Engineering”, Universities Press (India) Limited, Hyderabad, 2000.

References:

1. Arora K.R., “ Geotechnical Engineering”, Standard Publishers Distributors, New Delhi, 2006.
2. Joseph E. Bowles, ‘Foundation Analysis and Design’, Mc. Graw Hill Inc., New York, 1988.
3. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Kindersley(India) Pvt. Ltd., 2013
4. Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction and practical importance - Objectives of soil exploration – Planning of a sub-surface exploration programme –Collection of existing information, reconnaissance, preliminary and detailed investigation - I.S. and other guidelines for deciding the number, size, spacing and depth of boreholes	7	15

II	Methods of exploration - Open pits – Auger boring- -Wash boring, percussion drilling, rotary drilling – Comparison of the methods of exploration- Stabilization of bore holes Plate load test – Procedure, uses and limitations – modulus of subgrade reaction- Solution of numerical problems using plate load test data	6	15
FIRST INTERNAL EXAMINATION			
III	Sounding methods Standard Penetration Test – Procedure – corrections to be applied to observed N values – Procedure for estimation of representative average N value – Numerical examples - Factors influencing the SPT results and precautions to obtain reliable results – Merits/drawbacks of the test – Correlations of N value with various engineering and index properties of soils Static Cone Penetration Test – Procedure – Merits/drawbacks – Correlation of static CPT results with soil properties -Dynamic Cone Penetration Test – Procedure – Merits/drawbacks – Critical comparison of SPT, static CPT and dynamic CPT	8	15
IV	Geophysical methods – Seismic refraction method – Procedure, uses, limitations – Solution of numerical problems to estimate the velocity of seismic waves and the thickness of upper layer of a two-layered soil system - Electrical resistivity method – Electrical profiling and electrical sounding – Procedure, uses, limitations Pressure meter test - Procedure –Uses - limitations	6	15
SECOND INTERNAL EXAMINATION			
V	Soil sampling – Undisturbed, disturbed, and representative samples – Chunk and tube samples – Factors affecting sample disturbance and methods to minimise them –Area ratio - Inside clearance - Outside clearance - Recovery ratio –Ball check valve – Handling and transportation of samples – Extrusion of samples Types of samplers – Thin walled sampler – Piston sampler – Split spoon sampler – Methods for collection of sand samples from beneath the water table - Core retainers	8	20
VI	Rock Quality Designation –Bore log – Soil profile – Sub-soil investigation report Static pile load test – procedure for estimation of safe load - Cyclic pile load test –Procedure for separation of end bearing and skin friction resistance- solution of numerical problems using static and cyclic pile load test data	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

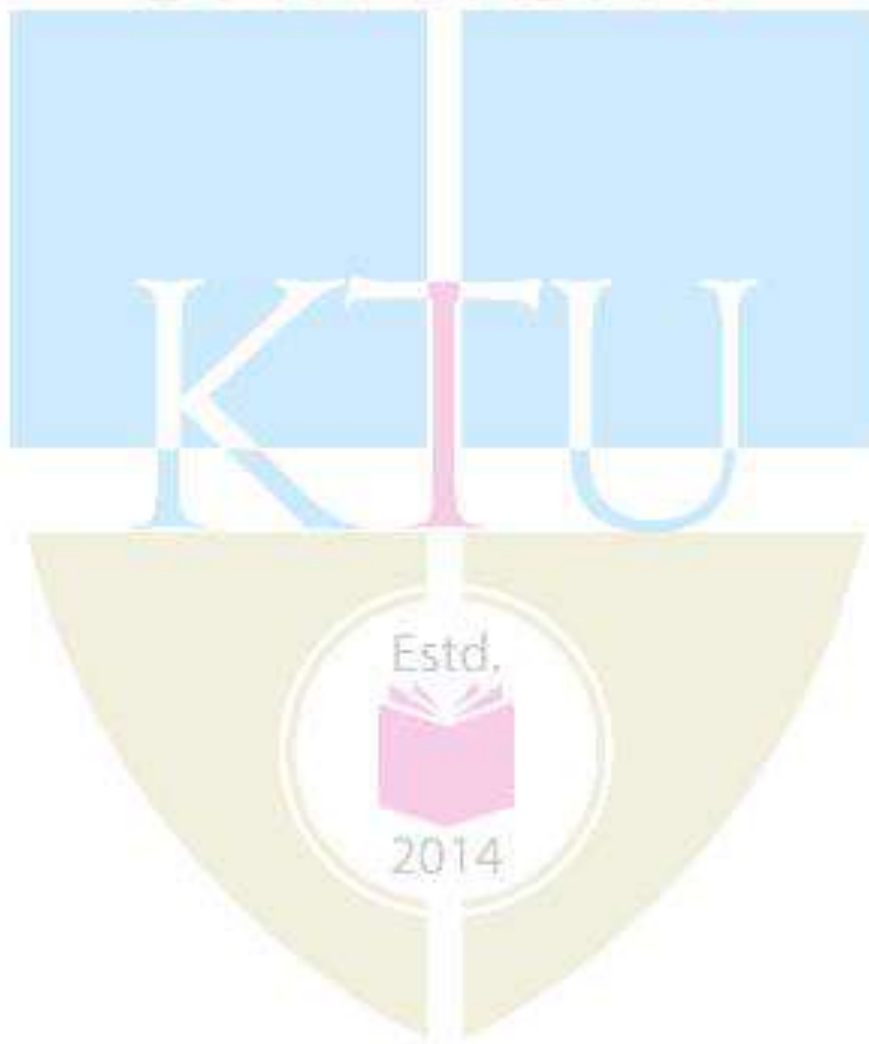
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE364	ADVANCED FOUNDATION ENGINEERING	3-0-0-3	2016

Prerequisite: CE305 Geotechnical Engineering - II

Course objectives:

- To impart to the students, the advanced topics in foundation engineering
- To enable the students to acquire proper knowledge about the design and analysis in real life situations.

Syllabus :

Advanced topics in shallow foundations- bearing capacity, settlement and allowable bearing pressure. Allowable bearing pressure from penetration test data. Consolidation settlement of footings. Raft foundations and combined footings. Problems of excavations. Deep foundations – need. Types. Classification of piles. static equation – Single piles – Critical depth concept. Pile capacity in clay and sand by the I.S. code method . Piles in layered soils. Piles with enlarged base in clays (under reamed piles). Pile capacity from SPT and CPT values. Piles for resisting uplift – straight shaft and under reamed piles in clays and sands – Dynamic formulae . Different types of pile load tests. ultimate load from pile load tests. Pile groups –Negative skin friction of single piles and pile groups – Settlement of pile groups in clays and sands –Equivalent raft approach – Skempton’s and Meyerhof’s methods- Drilled piers with enlarged base. Well foundations

Expected Outcomes:

- The students will be equipped to design foundations for field situations.
- The students will gain detailed knowledge of shallow foundations and deep foundations.

Text Books:

1. Murthy, V.N. S. Advanced Foundation Engineering, CBS Publishers, New Delhi, 2007
2. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.

References:

1. Gulhati, S. K. and Datta, M. Geotechnical Engineering, Tata McGraw Hill Education, 2005
2. Tomlinson, M. J. and Booman, R. Foundation Design and Construction, Prentice Hall Publishing, 2001.
3. Tomlinson, M. J. and Woodward, J. Pile Design and Construction Practice. CRS Press, 2015.
4. Kurien, N. P. Design of foundation systems: principles and practices. Alpha Science International, 2005

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Shallow foundations- estimating bearing capacity- Meyerhof’s, Hansen’s and I.S code methods- Effect of water table, eccentricity, and inclination of load on Bearing Capacity – Numerical problems using IS method Elastic settlement –Effect of size of footing on settlement. Steinbrenner’s method of calculating settlement– Numerical problems.	7	15

II	Allowable bearing pressure from penetration test data – Meyerhoff's and Teng's expressions. Consolidation settlement of footings - Combined footings and raft foundations (only concepts)– brief discussions on methods of analysis of raft, concept of floating raft, excavations.	6	15
FIRST INTERNAL EXAMINATION			
III	Deep foundations –need. Types. Classification of piles. static equation – Single piles – Critical depth concept. Pile capacity in clay and sand by the I.S. code method . Piles in layered soils. Piles with enlarged base in clays (under reamed piles). Problems. Pile capacity from SPT and CPT values. problems	6	15
IV	Piles for resisting uplift – straight shaft and under reamed piles in clays and sands – Dynamic formulae – Engineering News formula – Modified Hiley formula – Different types of pile load tests –initial and routine tests maintained load test, CRP test, pullout test, lateral load test and cyclic pile load test. Separation of skin friction and end bearing. – ultimate load from pile load tests.	7	15
SECOND INTERNAL EXAMINATION			
V	Pile groups – Efficiency of pile groups- Group capacity in clays– Minimum spacing of piles in a group – Negative skin friction of single piles and pile groups –Settlement of pile groups in clays – Equivalent raft approach – Settlement of pile groups in sands - Skempton's and Meyerhof's methods- Drilled piers with enlarged base.	8	20
VI	Well foundations– Components of a well foundation–Procedure for construction and sinking of wells–Thickness of well steining for sinking under self weight - Grip length- Problems encountered in well sinking–Tilts and Shifts– Causes – Permissible tilts and shifts - Methods to rectify tilts and shifts – Forces acting on a well foundation –Allowable bearing pressure – Lateral stability of well foundations - Terzaghi's analysis	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE365	FUNCTIONAL DESIGN OF BUILDINGS	3-0-0-3	2016

Prerequisite : CE204 Construction Technology

Course objectives:

- To understand the acoustical design concepts and noise control techniques
- To impart the fundamental concepts of natural and artificial lighting designs
- To provide principles of climatic conscious design of buildings with special emphasis on tropical climates.
- To understand the apparent position of sun with respect to earth during different periods of the year and apply it in computation of solar radiation and design of shading devices.

Syllabus:

Acoustics : Physics of sound- Behavior of sound- Sound insulation and reverberation control

Lighting: Principles- Day lighting and artificial lighting – design methods

Thermal design of buildings: Climatic elements – classification- thermal comfort and indices-solar radiation calculations and design of shading devices.

Thermo physical properties of building materials and thermal control- passive and active building design- Steady and periodic heat flow through building envelope. Concept of green building.

Expected Outcomes:

On completion of the course, the students will be able to:

- Analyze and make effective decisions in use of principles of functional planning of the buildings with respect to Acoustics and Lighting and Thermal design of buildings in various climatic zones that the student may encounter in his/her professional career.
- Select different building materials and explain the manner in which they can be used in different types of buildings with respect to various functional requirements like acoustics, lighting and thermal comfort.
- Apply the techniques learned to the estimate solar radiation falling on different surfaces of the buildings, design shading devices to protect from direct sunlight, design of energy efficient, functionally comfortable buildings, low energy buildings and green buildings.

References :

1. Ajitha Simha.D, Building Environment, Tata McGraw Hill Publishing Co., New Delhi, 1985
2. Bureau of Indian standards, Handbook on Functional Requirement of Buildings – SP:41(S and T) – 1987
3. Givoni. B Man,. Climate and Architecture, Applied Science Publication, 1976
4. Knudsen V.O. and Harris C.M., Acoustical Design in Architecture, John Wiley, 1980
5. Koenigseberger, Manual of tropical Housing and Building Part I – Climatic design, Orient Longman, 2011
6. Krishnan, Climate responsive architecture, Tata McGraw Hill, 1999
7. M David Egan , Architectural Acoustics, J.Ross Publishing, 2007
8. Olgy Victor, Design with climate-A bioclimatic approach to architectural regionalism- Princeton University press-1963

COURSE PLAN			
Module	Contents	Hours	Sem. Exam Marks %
I	Acoustics, fundamentals: Physics of sound-Frequency, period amplitude. Intensity of sound- Watts/m ² - Bel- Decibel scales- dBA- Phon. Addition of sound levels. Human Audibility range. Behavior of sound in free and reverberant fields. Noise- allowable limits-effect of noise on human-Air and structure born noises-equivalent noise levels-day and night equivalent.	7	15
II	Acoustics, applications: Measures of noise control- Source-path and receiving end. TL value and computation of TL value, Flanking paths. Sound absorption-materials and fixings. Reverberation-Sabines formula-Eyrings modification. Acoustical defects- acoustical design of auditoriums and small lecture halls. Acoustical considerations of offices, hospitals and Industrial buildings.	7	15
FIRST INTERNAL EXAMINATION			
III	Lighting, Natural: Visual tasks – Natural lighting- illumination requirements for various buildings –principles of day lighting – day light factor and its components- Design of side-lit windows-BIS and CBRI methods-skylights	6	15
IV	Lighting, Artificial: Artificial lighting- illumination requirements- lux meter – lamps and luminaries – polar distribution curves– Colour temperature and colour rendering index- glare -Design of artificial lighting – lumen method – point by point method. Basic idea of street lighting and outside lighting	6	15
SECOND INTERNAL EXAMINATION			
V	Thermal comfort: Factors affecting thermal comfort Effective temperature –Thermal comfort indices-ET-CET Charts-Bioclimate chart- Psychrometry and Psychrometric chart. Earth-Sun relationship: Sun's apparent movement with respect to the earth. Solar angles-Computation of solar radiation on different surfaces-solar path diagram-shadow-throw concept and design of shading devices	8	20
VI	Heat flow through building envelope: Thermo physical properties of building materials: Thermal quantities – heat flow – thermal conductivity – resistance and transmittance and surface coefficient - Sol- air temperature concept- solar gain factor. Thermal transmittance of structural elements – thermal gradients – heat gain/loss calculation. Periodic heat flow – time lag and decrement factor. Design approaches: Climate conscious designs- Climatic zones in India- orientation and shape of buildings in different climatic zones-Passive solar-Active solar and Active approaches. Requirements of buildings in tropical areas-Thermal insulation-Introduction to the concept of green-building	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

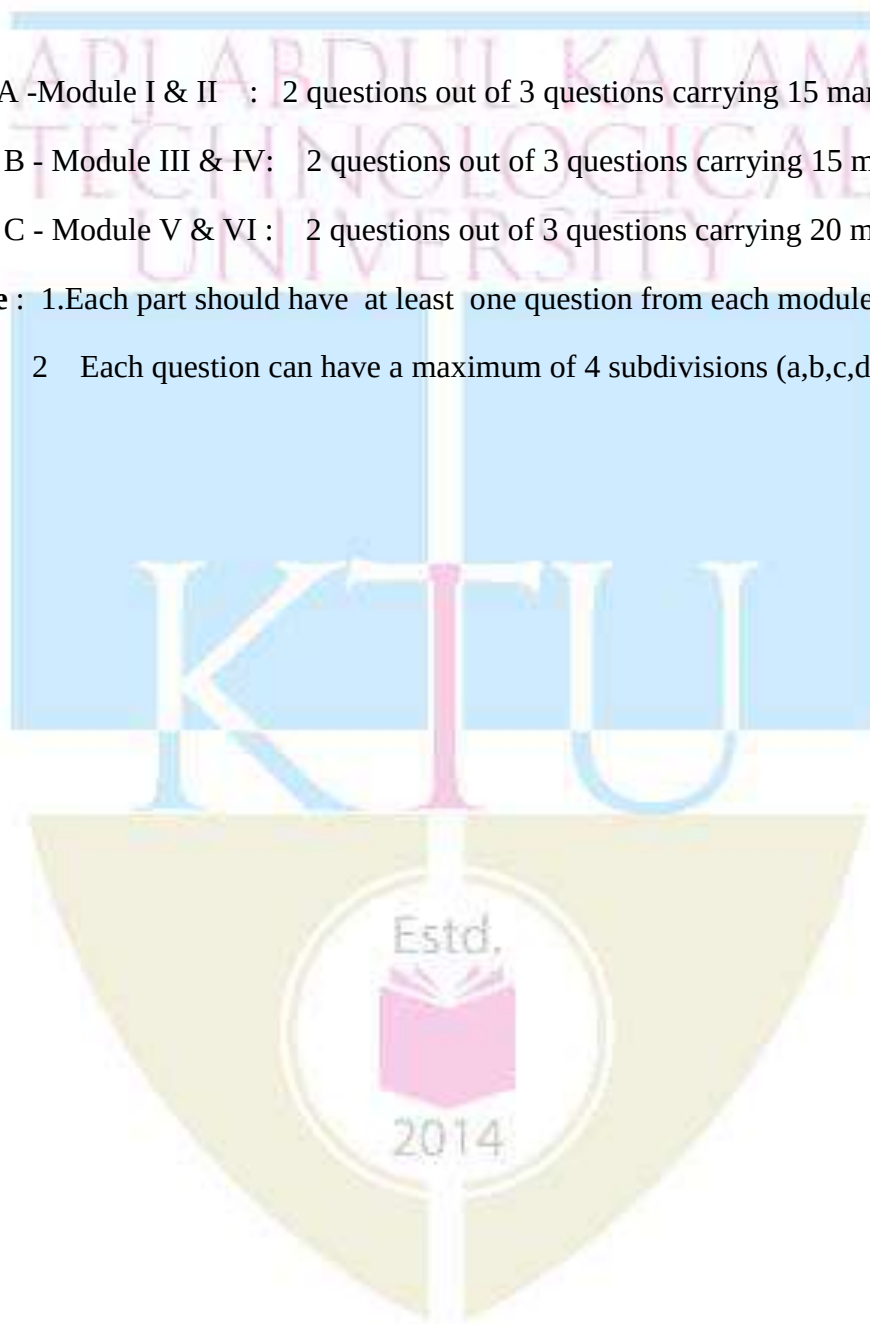
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2 Each question can have a maximum of 4 subdivisions (a,b,c,d)



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE366	TRAFFIC ENGINEERING AND MANAGEMENT	3-0-0-3	2016

Pre-requisite: NIL

Course objectives:

- To set a solid and firm foundation in traffic engineering management, traffic regulation, highway capacity, design of introduction and traffic flow theory concepts.

Syllabus:

Scope and objective of traffic engineering and management, Traffic regulation rules, Highway capacity and introduction to 2010 manual, Design of at grade, grade separated, rotary and signals, traffic safety, influencing factors and preventive measures for traffic accidents, basic diagrams of traffic flow theory, introduction to car following and queuing.

Expected Outcomes:

- This course will enable students to learn advanced topics in traffic engineering and management

Text Books:

- Kadiyali L.R. Traffic Engineering and Transport planning, Khanna Tech Publishers, 2011
- Khanna O.P and Justo C.G; Highway Engineering, Nem Chand Publishers, 9e.
- Donald Drew, Traffic Flow Theory Chapter 14 in Differential Equation Models, Springer, 1983

References:

- Martin Whol, Brian V Martin, Traffic system Analysis for Engineers and Planners, McGraw Hill, NY, 1967
- HCM 2010 (3 volume set), TRB Publications, 2010

Module	Contents	Hours	Sem. Exam Marks %
I	Traffic management – scope of traffic management measures – restrictions to turning movements – one way streets – tidal flow operations-Traffic segregation –Traffic calming- Exclusive bus lanes, Introduction to ITS	7	15
II	Regulation of traffic – Need and scope of traffic regulations- Motor Vehicle Act – Speed limit at different locations- regulation of the vehicle – regulations concerning the driver rules of the road enforcement	7	15

FIRST INTERNAL EXAMINATION

III	Highway capacity: Its importance in transportation studies – basic, possible and practical capacity – determination of theoretical maximum capacity -passenger car units – level of service – concept in HC manual – factors affecting level of service.	7	15
IV	Design of Intersection: Design of at grade & grade separated intersection – rotary intersection – capacity of rotary intersection – traffic signals – warrants of traffic signals,-types of signals, signal coordination, design of fixed time signal –Websters approach	7	15
SECOND INTERNAL EXAMINATION			
V	Traffic Safety: causes of road accidents – collection of accident data – influence of road, the vehicle .the driver, the weather and other factors on road accident – preventive measures	7	20
VI	Traffic Flow: theory of traffic flow – scope – definition and basic diagrams of traffic flow- basic concepts of light hill – Whitham's theory – Introduction to Car 'following theory and queuing'	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE367	WATER CONVEYANCE SYSTEMS	3-0-0-3	2016

Pre requisite : CE206 : Fluid Mechanics - II

Course objectives:

- To understand the mechanics of flow through open channel.
- To develop the ability to analyse the flow in a channel in order to design canals and canal structures.
- To enable identification of the components of pipe network system.
- To familiarize with analysis of water distribution systems.

Syllabus :

Open channel flow- Pressure distribution in curvilinear flows. Channel transitions with hump or change in width. Uniform flow-composite sections, Hydraulic exponents N and M Design of channels for uniform flow-Non erodible channel-Minimum permissible velocity-channel slopes-best hydraulic section. Erodible channels which scour but do not silt-. Gradually varied flow computations. Unsteady flow-Gradually and Rapidly varied unsteady flow. Head loss due to friction in pipes , Friction factor for smooth and rough pipes, Reservoirs, pumps and special valves, pipe network types and parameter interrelationships Analysis of water distribution network using Hardy cross method

Expected Outcomes:

- The students will be able to predict the behaviour of flow in a channel under different conditions.
- The students will understand the underlying principles and the design parameters involved in analysis of water distribution system and become capable of analysing a typical pipe network.

Text Books :

1. Bhawe P. R. and R. Gupta, Analysis of Flow in Water Distribution Networks, Narosa Publishing House, 2013
2. Rajesh Srivastava, Flow through Open Channels, Oxford University Press, 2007.
3. Subramanya.K. Flow in Open Channels, Tata McGraw Hill Publishing Co. 2009

References :

1. Chow V. T., Open Channel Hydraulics, McGraw Hill Book Co. New York, 1990.
2. Hanif Chaudhry.M., Open Channel Flow, Springer, 2008.
3. Hubert Chanson, Hydraulics of Open channel flow, Elsevier Butterworth-Heinemann, 2004.
4. Larry W Mays, Water distribution system Hand book, Mc Graw Hill, 2000.
5. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002
6. Richard H French, Open Chanel Hydraulics, Mc Graw Hill, 2000
7. Walksi T M, Analysis of water distribution System, Van Nostrand Reinheld G, New York, 1984

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %

I	Open channel flow- Pressure distribution in curvilinear flows. Application of specific energy principle to channel transitions with hump or change in width. Uniform flow-composite sections, Equivalent roughness, Hydraulic exponents N and M	6	15
II	Design of channels for uniform flow-Non erodible channel-Minimum permissible velocity-channel slopes-best hydraulic section. Erodible channels which scour but do not silt-Methods of approach-Method of permissible velocity-Tractive force – Method of tractive force-stable hydraulic section.	6	15
FIRST INTERNAL EXAMINATION			
III	Gradually Varied flow computations- Direct integration method, standard step method, Unsteady flow-Gradually varied unsteady flow, Rapidly varied unsteady flow channels- Positive surges, Negative surges.(No numerical problem from negative surges)	7	15
IV	Head loss due to friction in pipes-Nikuradse experiment with artificially roughened pipe, Moody diagram, Friction coefficient for laminar and turbulent flows, reduction of carrying capacity with age. Hazen William's formula. Reservoirs-Impounding reservoir, Service and Balancing reservoir. Two reservoir system, Three Reservoir system. Pumps- system head discharge curve and pump head discharge curve. Special valves-Check valve, Pressure reducing valve-modes of operation(No numerical problem with pressure reducing valve)	6	15
SECOND INTERNAL EXAMINATION			
V	Pipe Network types and parameter interrelationships. Rules for solvability of pipe networks.Formulation of equations-Basic unknown parameter, Pipe discharge equations, Nodal Head equations, Pipe discharge correction equations, Nodal Head correction equations	8	20
VI	Analysis of water distribution network- Single and multisource networks with known pipe resistances- Hardy cross method- Method of balancing head, Method of balancing flow.	9	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE368	PRESTRESSED CONCRETE	3-0-0-3	2016

Pre-requisite: CE201Mechanics of Solids

Course objectives:

- To make students familiar with the concepts and design of typical pre-stressed concrete structural elements and to have a knowledge of the codal provisions

Syllabus :

Basic concept and principles of pre-stressed concrete systems- analysis for flexure- loss of pre-stress, Design philosophy and design for flexure, codal provisions , Shear and torsional behavior – analysis and design - calculation of deflection (short & long term), Anchorage Zone stresses in post tensioned members, Prestressed concrete poles and sleepers, Partial pre-stressing, composite beams – analysis and design, Statically indeterminate structures

Expected Outcomes:

The students will be able to

- analyse prestressed concrete members
- design prestressed concrete members using codal provisions
- design for shear and torsion of prestressed concrete members
- design end blocks and provide detailing of reinforcements
- design composite members and other applications
- design continuous members

Text Books :

- G S Pandit & S P Gupta, " Prestressed Concrete", CBS Publishers,2014
- Krishna Raju N., Prestressed concrete, Tata McGraw Hill Company, New Delhi 1998
- Rajagopalan, N, "Prestressed Concrete", Alpha Science, 2002

References:

- Lin T.Y. Design of prestressed concrete structures, Asia Publishing House, Bombay 1995
- Mallik S.K. and Gupta A.P., Prestressed concrete, Oxford and IBH publishing Co. Pvt. Ltd., 1997
- Ramaswamy G.S., Modern prestressed concrete design, Arnold Heinimen, New Delhi, 1990
- IS 1343 – 1998 ISCode Bureau of Indian Standards

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Review- Basic concept and principles of pre-stressed concrete, materials, prestressing systems – Analysis of prestress and bending stresses loss of pre-stress Stresses at transfer and service loads.	6	15

II	Limit state design criteria: Inadequacy of elastic and ultimate load method, criteria for limit states, strength and serviceability. Design of sections for flexure codal provisions- ultimate strength in flexure	6	15
FIRST INTERNAL EXAMINATION			
III	Shear and torsional resistance: design of shear reinforcement, design of reinforcement for torsion, shear and bending.	7	15
IV	Deflections of prestressed concrete members: Importance, factors, short term and long term deflection. Codal provisions	7	15
SECOND INTERNAL EXAMINATION			
V	Anchorage Zone stresses in post tensioned members: Stress distribution in end block, anchorage zone reinforcement. Prestressed concrete poles and sleepers: Design of sections for compression and bending Partial pre-stressing- Definitions, principles and design approaches and applications	8	20
VI	Composite beams –Analysis and design – Ultimate strength – applications, Elementary idea of composite construction for tee beams in bridges. Statically Indeterminate structures: advantages of continuous member(Concepts and steps for analysis)-	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE369	DISASTER MANAGEMENT	3-0-0-3	2016

Prerequisite: NIL

Course objectives:

- To provide an overview of the common hazards and their dynamics
- To inculcate the basic concepts of disaster management

Syllabus :

Fundamental concepts of hazards and disasters: Relationship between disasters and development, implications. Introduction to key concepts and terminology of hazard, vulnerability, exposure, risk, crisis, emergencies, Disasters, Resilience.

Types of Natural Disasters I- Earth quakes, Landslides. Classification of Disasters and nature of Impacts.

Types of Natural Disasters II- Floods, Coastal disasters-Tidal waves, Cyclones, Tsunamis. Classification of Disasters and nature of Impacts.

Types of Anthropogenic Disasters I – Soil degradation and desertification.

Types of Anthropogenic Disasters II- Fundamental concepts of water and atmospheric pollution.

Hazard and disaster management plans for floods, cyclones, tidal waves.

Expected Outcomes:

The students will

- gain the general ideas about the processes involved in natural and anthropogenic disasters
- understand the concepts of disaster management and measures taken to mitigate and contain common episodes of disasters

References :

1. Andrew, S., "Environmental Modeling with GIS and Remote Sensing", John Willey, 2002
2. Ariyabandu, M. and Sahni P. "Disaster Risk Reduction in South Asia", Prentice-Hall (India), 2003.
3. Bell, F.G., "Geological Hazards: Their assessment, avoidance and mitigation", E & FN SPON Routledge, London. 1999
4. Bossler, J.D., "Manual of Geospatial Science and Technology", Taylor and Francis, 2001
5. David Alexander, "Natural Disasters", Research Press, New Delhi, 1993
6. Matthews, J.A., "Natural hazards and Environmental Change", Bill McGuire, Ian Mason, 2002
7. Mitigating Natural Disasters, Phenomena, Effects and options, A Manual for policy makers and planners, United Nations. New York, 1991
8. Nick Carter. W., "Disaster Management - A Disaster Manager's Handbook". Asian Development Bank, Philippines. 1991

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %

I	Fundamental concepts of hazards and disasters: Relationship between disasters and development, implications. Introduction to key concepts and terminology of hazard, vulnerability, exposure, risk, crisis, emergencies, Disasters, Resilience.	7	15
II	Types of Natural Disasters I- Earth quakes, Landslides. Classification and nature of impacts.	7	15
FIRST INTERNAL EXAMINATION			
III	Types of Natural Disasters II- Floods, Coastal disasters- Cyclones, Tsunamis. Classification and nature of impacts.	7	15
IV	Types of Anthropogenic Disasters I- soil and soil degradation, desertification.	7	15
SECOND INTERNAL EXAMINATION			
V	Types of Anthropogenic Disasters II-Fundamental concepts of water and atmospheric pollution.	7	20
VI	Hazard and disaster management plans for floods, cyclones, tidal waves.	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE362	GROUND IMPROVEMENT TECHNIQUES	3-0-0-3	2016

Pre-requisite :CE305 Geotechnical Engineering - II

Course objectives:

- To impart fundamental knowledge of Ground Improvement Techniques
- To make capable of choosing and designing the appropriate method of Ground Improvement according to site conditions and requirement

Syllabus :

Classification of Ground Modification Techniques- Soil distribution in India- Reclaimed soils- Ground Improvement Potential- Grouting – Aspects – Groutability, Grouting materials, Suspension grouts and solution grouts, Compaction grouting. Procedure and applications of grouting- Chemical stabilization – Granular admixtures, Cement, Lime, Calcium Chloride, Fly Ash, Bitumen, Chemical admixtures. Construction Methods-Ground Anchors – Applications, types and components, Anchor tests. Rock bolts – Applications and types- Rock bolt action around an excavation. Soil Nailing – construction sequence – analysis of nailed soil-Compaction- Moisture Density relationship. Shallow surface compaction-Rollers – operational aspects. Deep Compaction – Explosion- heavy tamping- vibro compaction and vibro replacement. Properties of compacted soil, Compaction control tests- Hydraulic modification- Methods of dewatering- open sumps and ditches, Well point systems, deep well drainage, Vacuum dewatering, Electro osmosis. Design of dewatering for excavations

Expected Outcomes:

- An understanding about types of ground improvement techniques and soil distribution in India
- Knowledge about various types of grouts and their applications
- Knowledge about types of chemical stabilization and their construction method
- Understanding about Ground Anchors, Rock Bolts and Soil Nailing
- Knowledge about Compaction of soil
- Understanding about various methods of dewatering of soil

Text Books / References:

1. Manfred. R. Hausmann, Engineering Principles of Ground Modification, McGraw Hill, 1989
2. P. Purushothamaraj, Ground Improvement Techniques ,University Science Press, 2005

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction to Engineering Ground Modification- Classification of Ground Modification Techniques- Soil distribution in India- Reclaimed soils- Ground Improvement Potential.	6	15

II	Grouting – Aspects – Groutability, Grouting materials, Suspension grouts and solution grouts, Compaction grouting. Procedure and applications of grouting.	6	15
FIRST INTERNAL EXAMINATION			
III	Chemical stabilization – Granular admixtures, Cement, Lime, Calcium Chloride, Fly Ash, Bitumen, Chemical admixtures. Construction Methods.	6	15
IV	Ground Anchors – Applications, types and components, Anchor tests. Rock bolts – Applications and types- Rock bolt action around an excavation. Soil Nailing – construction sequence – analysis of nailed soil	7	15
SECOND INTERNAL EXAMINATION			
V	Compaction- Moisture Density relationship. Shallow surface compaction-Rollers – operational aspects. Deep Compaction – Explosion- heavy tamping- vibro-compaction and vibro-replacement. Properties of compacted soil, Compaction control tests.	9	20
VI	Hydraulic modification- Methods of dewatering- open sumps and ditches, Well point systems, deep well drainage, Vacuum dewatering, Electro osmosis. Design of dewatering for excavations.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course code	Course Name	L-T-P Credits	Year of Introduction
CS201	DISCRETE COMPUTATIONAL STRUCTURES	3-1-0-4	2016
Pre-requisite: NIL			
Course Objectives 1. To introduce mathematical notations and concepts in discrete mathematics that is essential for computing. 2. To train on mathematical reasoning and proof strategies. 3. To cultivate analytical thinking and creative problem solving skills.			
Syllabus Review of Set theory, Countable and uncountable Sets, Review of Permutations and combinations, Pigeon Hole Principle, Recurrence Relations and Solutions, Algebraic systems (semigroups, monoids, groups, rings, fields), Posets and Lattices, Propositional and Predicate Calculus, Proof Techniques.			
Expected Outcome: Students will be able to 1. identify and apply operations on discrete structures such as sets, relations and functions in different areas of computing. 2. verify the validity of an argument using propositional and predicate logic. 3. construct proofs using direct proof, proof by contraposition, proof by contradiction and proof by cases, and by mathematical induction. 4. solve problems using algebraic structures. 5. solve problems using counting techniques and combinatorics. 6. apply recurrence relations to solve problems in different domains.			
Text Books 1. Trembly J.P and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw–Hill Pub.Co.Ltd, New Delhi, 2003. 2. Ralph. P. Grimaldi, “Discrete and Combinatorial Mathematics: An Applied Introduction”, 4/e, Pearson Education Asia, Delhi, 2002. References: 1. Liu C. L., “Elements of Discrete Mathematics”, 2/e, McGraw–Hill Int. editions, 1988. 2. Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, “Discrete Mathematical Structures”, Pearson Education Pvt Ltd., New Delhi, 2003 3. Kenneth H.Rosen, “Discrete Mathematics and its Applications”, 5/e, Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2003. 4. Richard Johnsonbaugh, “Discrete Mathematics”, 5/e, Pearson Education Asia, New Delhi, 2002. 5. Joe L Mott, Abraham Kandel, Theodore P Baker, “Discrete Mathematics for Computer Scientists and Mathematicians”, 2/e, Prentice-Hall India, 2009.			

Course Plan			
Module	Contents	Hou rs (54)	End Sem Exam Marks
I	Review of elementary set theory : Algebra of sets – Ordered pairs and Cartesian products – Countable and Uncountable sets	3	15 %
	Relations :- Relations on sets –Types of relations and their properties – Relational matrix and the graph of a relation – Partitions – Equivalence relations - Partial ordering- Posets – Hasse diagrams - Meet and Join – Infimum and Supremum	6	
	Functions :- <i>Injective, Surjective and Bijective functions - Inverse of a function- Composition</i>	1	
II	Review of Permutations and combinations, Principle of inclusion exclusion, Pigeon Hole Principle,	3	15 %
	Recurrence Relations: Introduction- Linear recurrence relations with constant coefficients– Homogeneous solutions – Particular solutions – Total solutions	4	
	Algebraic systems:- Semigroups and monoids - Homomorphism, Subsemigroups and submonoids	2	
FIRST INTERNAL EXAM			
III	Algebraic systems (contd...):- Groups, definition and elementary properties, subgroups, Homomorphism and Isomorphism, Generators - Cyclic Groups, Cosets and Lagrange’s Theorem	6	15 %
	Algebraic systems with two binary operations- rings, fields-sub rings, ring homomorphism	2	
IV	Lattices and Boolean algebra :- Lattices –Sublattices – Complete lattices – Bounded Lattices - Complemented Lattices – Distributive Lattices – Lattice Homomorphisms.	7	15 %
	Boolean algebra – sub algebra, direct product and homomorphisms	3	
SECOND INTERNAL EXAM			
V	Propositional Logic:- Propositions – Logical connectives – Truth tables	2	20 %
	Tautologies and contradictions – Contra positive – Logical	3	

	equivalences and implications		
	Rules of inference: Validity of arguments.	3	
VI	Predicate Logic:- Predicates – Variables – Free and bound variables – Universal and Existential Quantifiers – Universe of discourse. Logical equivalences and implications for quantified statements – Theory of inference : Validity of arguments.	3	20 %
		3	
	Proof techniques: Mathematical induction and its variants – Proof by Contradiction – Proof by Counter Example – Proof by Contra positive.	3	
		3	
END SEMESTER EXAM			

Question Paper Pattern:

- There will be *five* parts in the question paper – A, B, C, D, E
- Part A
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering module I and II; All four questions have to be answered.
- Part B
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering module I and II; Two questions have to be answered. Each question can have a maximum of three subparts
- Part C
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering module III and IV; All four questions have to be answered.
- Part D
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering module III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
- Part E
 - Total Marks: 40
 - Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - A question can have a maximum of three sub-parts.
- There should be at least 60% analytical/numerical questions.

Course code	Course Name	L-T-P -Credits	Year of Introduction
CS202	Computer Organization and Architecture	3-1-0-4	2016
Pre-requisite: CS203 Switching theory and logic design			
Course Objectives 1. To impart an understanding of the internal organization and operations of a computer. 2. To introduce the concepts of processor logic design and control logic design.			
Syllabus Fundamental building blocks and functional units of a computer. Execution phases of an instruction. Arithmetic Algorithms. Design of the processing unit – how arithmetic and logic operations are performed. Design of the control unit – hardwired and microprogrammed control. I/O organisation – interrupts, DMA, different interface standards. Memory Subsystem – different types.			
Expected outcome Students will be able to: 1. identify the basic structure and functional units of a digital computer. 2. analyze the effect of addressing modes on the execution time of a program. 3. design processing unit using the concepts of ALU and control logic design. 4. identify the pros and cons of different types of control logic design in processors. 5. select appropriate interfacing standards for I/O devices. 6. identify the roles of various functional units of a computer in instruction execution.			
Text Books: 1. Hamacher C., Z. Vranesic and S. Zaky, <i>Computer Organization</i> ,5/e, McGraw Hill, 2011. 2. Mano M. M., <i>Digital Logic & Computer Design</i>, 4/e, Pearson Education, 2013.			
References: 1. Mano M. M., <i>Digital Logic & Computer Design</i>, 4/e, Pearson Education, 2013. 2. Patterson D.A. and J. L. Hennessey, <i>Computer Organization and Design</i>, 5/e, Morgan Kauffmann Publishers, 2013. 3. William Stallings, <i>Computer Organization and Architecture: Designing for Performance</i>, Pearson, 9/e, 2013. 4. Chaudhuri P., <i>Computer Organization and Design</i>, 2/e, Prentice Hall, 2008. 5. Rajaraman V. and T. Radhakrishnan, <i>Computer Organization and Architecture</i>, Prentice Hall, 2011. 6. Messmer H. P., <i>The Indispensable PC Hardware Book</i>, 4/e, Addison-Wesley, 2001			
Course Plan			
Module	Contents	Hours (51)	Sem.ExamMarks
I	Basic Structure of computers –functional units – basic operational concepts –bus structures – software. Memory locations and addresses – memory operations – instructions and instruction sequencing – addressing modes – ARM Example (programs not required). Basic I/O operations – stacks subroutine calls.	6	15%

II	Basic processing unit – fundamental concepts – instruction cycle - execution of a complete instruction –multiple- bus organization – sequencing of control signals. Arithmetic algorithms: Algorithms for multiplication and division of binary and BCD numbers — array multiplier —Booth’s multiplication algorithm — restoring and non-restoring division — algorithms for floating point, multiplication and division.	10	15%
FIRST INTERNAL EXAMINATION			
III	I/O organization: accessing of I/O devices – interrupts –direct memory access –buses –interface circuits –standard I/O interfaces (PCI, SCSI, USB)	8	15%
IV	Memory system : basic concepts –semiconductor RAMs –memory system considerations – semiconductor ROMs –flash memory –cache memory and mapping functions.	9	15%
SECOND INTERNAL EXAMINATION			
V	Processor Logic Design: Register transfer logic – inter register transfer – arithmetic, logic and shift micro operations –conditional control statements. Processor organization: –design of arithmetic unit, logic unit, arithmetic logic unit and shifter –status register –processor unit –design of accumulator.	9	20%
VI	Control Logic Design: Control organization – design of hardwired control –control of processor unit –PLA control. Micro-programmed control: Microinstructions –horizontal and vertical micro instructions – micro-program sequencer –micro programmed CPU organization.	9	20%
END SEMESTER EXAM			

Question Paper Pattern:

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module I and II; All four questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module I and II; Two questions have to be answered. Each question can have a maximum of three subparts
4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module III and IV; All four questions have to be answered.
5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/numerical/design questions..

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CS203	Switching Theory and Logic Design	3-1-0-4	2016

Pre-requisite: Nil

Course Objectives

1. To impart an understanding of the basic concepts of Boolean algebra and digital systems.
2. To impart familiarity with the design and implementation of different types of practically used sequential circuits.
3. To provide an introduction to use Hardware Description Language

Syllabus

Introduction to Number Systems, Boolean Algebra, Canonical Forms, Logic Gates, Digital Circuit Design, Combination Logic Circuit Design, Sequential Circuit Design, Registers, Counter, Memory modules, Programmable Logical Arrays, Hardware Description Language for Circuit Design, Arithmetic algorithms

Expected Outcome:

Students will be able to:-

1. apply the basic concepts of Boolean algebra for the simplification and implementation of logic functions using suitable gates namely NAND, NOR etc.
2. design simple Combinational Circuits such as Adders, Subtractors, Code Convertors, Decoders, Multiplexers, Magnitude Comparators etc.
3. design Sequential Circuits such as different types of Counters, Shift Registers, Serial Adders, Sequence Generators.
4. use Hardware Description Language for describing simple logic circuits.
5. apply algorithms for addition/subtraction operations on Binary, BCD and Floating Point Numbers.

Text Books:

1. Mano M. M., *Digital Logic & Computer Design*, 4/e, Pearson Education, 2013. [Chapters: 1, 2, 3, 4, 5, 6, 7].
2. Floyd T. L., *Digital Fundamentals*, 10/e, Pearson Education, 2009. [Chapters: 5, 6].
3. M. Morris Mano, *Computer System Architecture*, 3/e, Pearson Education, 2007. [Chapter 10.1, 10.2, 10.5, 10.6, 10.7].
4. Harris D. M. and, S. L. Harris, *Digital Design and Computer Architecture*, 2/e, Morgan Kaufmann Publishers, 2013 [Chapter 4.1, 4.2]

References:

1. Tokheim R. L., *Digital Electronics Principles and Applications*, 7/e, Tata McGraw Hill, 2007.
2. Mano M. M. and M. D Ciletti, *Digital Design*, 4/e, Pearson Education, 2008.
3. Rajaraman V. and T. Radhakrishnan, *An Introduction to Digital Computer Design*, 5/e, Prentice Hall India Private Limited, 2012.
4. Leach D, Malvino A P, Saha G, *Digital Principles and Applications*, 8/e, McGraw Hill Education, 2015.

COURSE PLAN

Module	Contents	Contact Hours (52)	Sem. Exam Marks;%

I	Number systems – Decimal, Binary, Octal and Hexadecimal – conversion from one system to another – representation of negative numbers – representation of BCD numbers – character representation – character coding schemes – ASCII – EBCDIC etc. Addition, subtraction, multiplication and division of binary numbers (no algorithms). Addition and subtraction of BCD, Octal and Hexadecimal numbers. Representation of floating point numbers – precision – addition, subtraction, multiplication and division of floating point numbers	10	15%
II	Introduction — Postulates of Boolean algebra – Canonical and Standard Forms — logic functions and gates methods of minimization of logic functions — Karnaugh map method and QuinMcClusky method Product-of-Sums Simplification — Don't-Care Conditions.	09	15%
III	Combinational Logic: combinational Circuits and design Procedure — binary adder and subtractor — multi—level NAND and NOR circuits — Exclusive-OR and Equivalence Functions. Implementation of combination logic: parallel adder, carry look ahead adder, BCD adder, code converter, magnitude comparator, decoder, multiplexer, demultiplexer, parity generator.	10	15%
IV	Sequential logic circuits: latches and flip-flops – edge-triggering and level-triggering — RS, JK, D and T flip-flops — race condition — master-slave flip-flop. Clocked sequential circuits: state diagram — state reduction and assignment — design with state equations	08	15%
V	Registers: registers with parallel load - shift registers universal shift registers – application: serial adder. Counters: asynchronous counters — binary and BCD ripple counters — timing sequences — synchronous counters — up-down counter, BCD counter, Johnson counter — timing sequences and state diagrams.	08	20%

VI	Memory and Programmable Logic: Random-Access Memory (RAM)—Memory Decoding—Error Detection and Correction — Read only Memory (ROM), Programmable Logic Array (PLA). <i>HDL: fundamentals, combinational logic, adder, multiplexer.</i> Arithmetic algorithms: Algorithms for addition and subtraction of binary and BCD numbers, algorithms for floating point addition and subtraction.	08	20%

Question Paper Pattern:

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module I and II; All four questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module I and II; Two questions have to be answered. Each question can have a maximum of three subparts
4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module III and IV; All four questions have to be answered.
5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/design/numerical questions.

Course code	Course Name	L-T-P -Credits	Year of Introduction
CS204	Operating Systems	3-1-0-4	2016
Pre-requisite: CS205 Data structures			
Course Objectives 1. To impart fundamental understanding of the purpose, structure, functions of operating system. 2. To impart the key design issues of an operating system			
Syllabus Basic concepts of Operating System, its structure, Process management, inter-process communication, process synchronization, CPU Scheduling, deadlocks, Memory Management, swapping, segmentation, paging, Storage Management - disk scheduling, RAID, File System Interface-implementation. Protection.			
Expected outcome Students will be able to: 1. identify the significance of operating system in computing devices. 2. exemplify the communication between application programs and hardware devices through system calls. 3. compare and illustrate various process scheduling algorithms. 4. apply appropriate memory and file management schemes. 5. illustrate various disk scheduling algorithms. 6. appreciate the need of access control and protection in an operating system.			
Text Book: 1. Abraham Silberschatz, Peter B Galvin, Greg Gagne, Operating System Concepts, 9/e, Wiley India, 2015.			
References: 1. Garry Nutt, Operating Systems: 3/e, Pearson Education, 2004 2. Bhatt P. C. P., An Introduction to Operating Systems: Concepts and Practice, 3/e, Prentice Hall of India, 2010. 3. William Stallings, Operating Systems: Internals and Design Principles, Pearson, Global Edition, 2015. 4. Andrew S Tanenbaum, Herbert Bos, Modern Operating Systems, Pearson, 4/e, 2015. 5. Madnick S. and J. Donovan, Operating Systems, McGraw Hill, 2001. 6. Hanson P. B., Operating System Principle, Prentice Hall of India, 2001. 7. Deitel H. M., An Introduction to Operating System Principles, Addison-Wesley, 1990.			
Course Plan			
Module	Contents	Hours (52)	Sem. Exam marks

I	Introduction: Functions of an operating system. Single processor, multiprocessor and clustered systems – overview. Kernel Data Structures – Operating Systems used in different computing environments. Operating System Interfaces and implementation - User Interfaces, System Calls – examples. Operating System implementation – approaches. Operating System Structure – Monolithic, Layered, Micro-kernel, Modular. System Boot process.	7	15%
II	Process Management: Process Concept – Processes-States – Process Control Block – Threads. Scheduling – Queues – Schedulers – Context Switching. Process Creation and Termination. Inter Process Communication: Shared Memory, Message Passing, Pipes.	9	15%
FIRST INTERNAL EXAMINATION			
III	Process Synchronization: Critical Section- Peterson's solution. Synchronization – Locks, Semaphores, Monitors, Classical Problems – Producer Consumer, Dining Philosophers and Readers-Writers Problems	9	15%
IV	CPU Scheduling – Scheduling Criteria – Scheduling Algorithms. Deadlocks – Conditions, Modeling using graphs. Handling – Prevention – Avoidance – Detection-Recovery.	8	15%
SECOND INTERNAL EXAMINATION			
V	Memory Management: Main Memory – Swapping – Contiguous Memory allocation – Segmentation – Paging – Demand paging	9	20%
VI	Storage Management: Overview of mass storage structure- disks and tapes. Disk structure – accessing disks. Disk scheduling and management. Swap Space. File System Interface: File Concepts – Attributes – operations – types – structure – access methods. File system mounting. Protection. File system implementation. Directory implementation – allocation methods. Free space Management. Protection– Goals, Principles, Domain. Access Matrix.	10	20%
END SEMESTER EXAM			

Question Paper Pattern:

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module I and II; All four questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module I and II; Two questions have to be answered. Each question can have a maximum of three subparts
4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module III and IV; All four questions have to be answered.
5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/numerical/design questions.

Course code	Course Name	L-T-P-Credits	Year of Introduction
CS205	Data Structures	3-1-0-4	2016
Pre-requisite: B101-05 Introduction to Computing and Problem Solving			
Course Objectives 1. To impart a thorough understanding of linear data structures such as stacks, queues and their applications. 2. To impart a thorough understanding of non-linear data structures such as trees, graphs and their applications. 3. To impart familiarity with various sorting, searching and hashing techniques and their performance comparison. 4. To impart a basic understanding of memory management.			
Syllabus Introduction to various programming methodologies, terminologies and basics of algorithms analysis, Basic Abstract and Concrete Linear Data Structures, Non-linear Data Structures, Memory Management, Sorting Algorithms, Searching Algorithms, Hashing.			
Expected Outcome: Students will be able to 1. compare different programming methodologies and define asymptotic notations to analyze performance of algorithms. 2. use appropriate data structures like arrays, linked list, stacks and queues to solve real world problems efficiently. 3. represent and manipulate data using nonlinear data structures like trees and graphs to design algorithms for various applications. 4. illustrate and compare various techniques for searching and sorting. 5. appreciate different memory management techniques and their significance. 6. illustrate various hashing techniques.			
Text Books: 1. Samanta D., Classic Data Structures, Prentice Hall India, 2/e, 2009. 2. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning, 2005. References 1. Horwitz E., S. Sahni and S. Anderson, Fundamentals of Data Structures in C, University Press (India), 2008. 2. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication, 1983. 3. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill, 1995. 4. Peter Brass, Advanced Data Structures, Cambridge University Press, 2008 5. Lipschuts S., Theory and Problems of Data Structures, Schaum's Series, 1986. 6. Wirth N., Algorithms + Data Structures = Programs, Prentice Hall, 2004. 7. Hugges J. K. and J. I. Michtm, A Structured Approach to Programming, PHI, 1987. 8. Martin Barrett, Clifford Wagner, And Unix: Tools For Software Design, John Wiley, 2008 reprint.			

COURSE PLAN			
Module	Contents	Hours (56)	Sem. Exam Marks
I	Introduction to programming methodologies – structured approach, stepwise refinement techniques, programming style, documentation – analysis of algorithms: frequency count, definition of Big O notation, asymptotic analysis of simple algorithms. Recursive and iterative algorithms.	9	15%
II	Abstract and Concrete Data Structures- Basic data structures – vectors and arrays. Applications, Linked lists:- singly linked list, doubly linked list, Circular linked list, operations on linked list, linked list with header nodes, applications of linked list: polynomials,.	9	15%
III	Applications of linked list (continued): Memory management, memory allocation and de-allocation. First-fit, best-fit and worst-fit allocation schemes Implementation of Stacks and Queues using arrays and linked list, DEQUEUE (double ended queue). Multiple Stacks and Queues, Applications.	9	15%
IV	String: - representation of strings, concatenation, substring searching and deletion. Trees: - m-ary Tree, Binary Trees – level and height of the tree, complete-binary tree representation using array, tree traversals (Recursive and non-recursive), applications. Binary search tree – creation, insertion and deletion and search operations, applications.	10	15%
V	Graphs – representation of graphs, BFS and DFS (analysis not required) applications. Sorting techniques – <i>Bubble sort</i> , <i>Selection Sort</i> , Insertion sort, Merge sort, Quick sort, Heaps and Heap sort. Searching algorithms (Performance comparison expected. Detailed analysis not required)	09	20%
VI	Linear and Binary search. (Performance comparison expected. Detailed analysis not required) Hash Tables – Hashing functions – Mid square, division, folding, digit analysis, collusion resolution and Overflow handling techniques.	10	20%

Question Paper Pattern:

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module I and II; All four questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module I and II; Two questions have to be answered. Each question can have a maximum of three subparts
4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module III and IV; All four questions have to be answered.
5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/numerical/design questions.

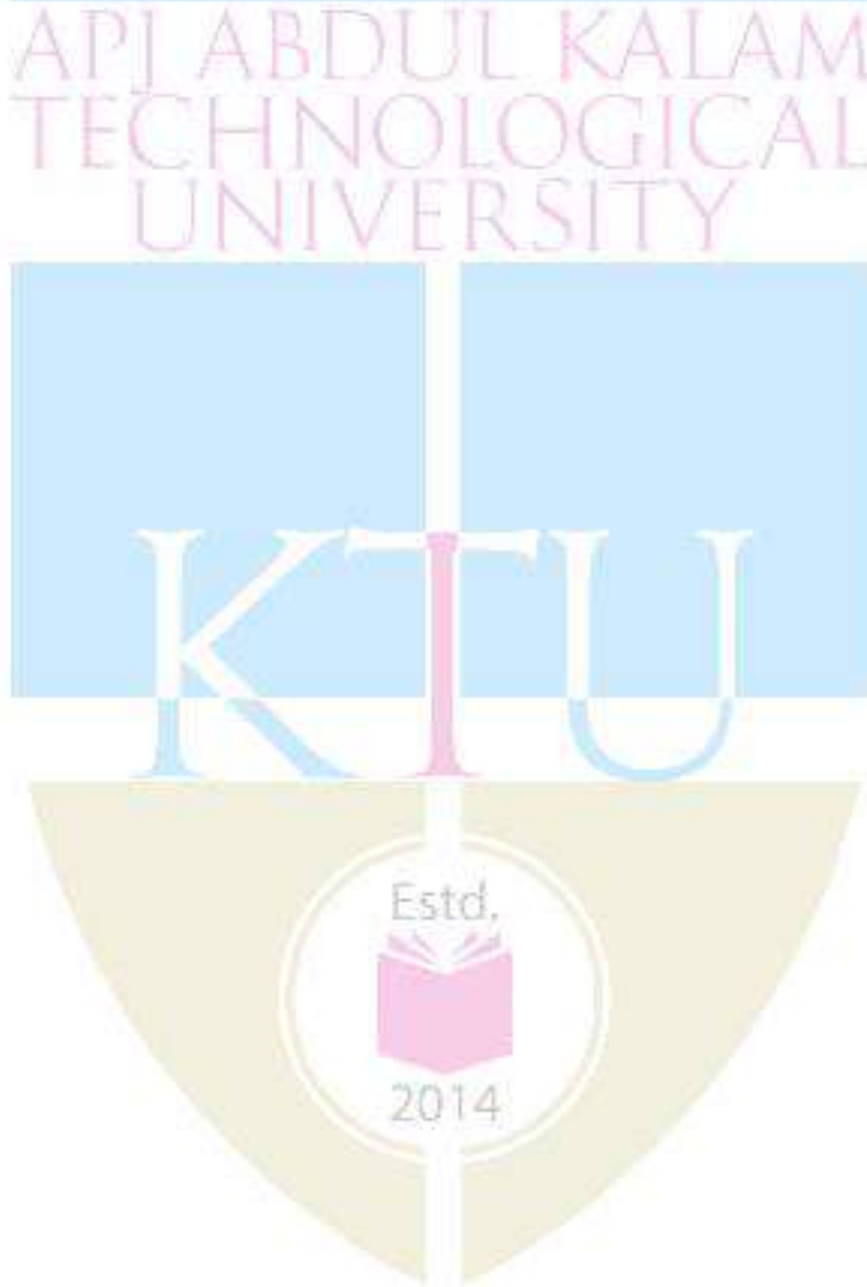
Course code	Course Name	L-T-P - Credits	Year of Introduction
CS206	Object Oriented Design and Programming	2-1-0-3	2016
Pre-requisite: CS205 Data structures			
Course Objectives 1. To introduce basic concepts of object oriented design techniques. 2. To give a thorough understanding of Java language. 3. To provide basic exposure to the basics of multithreading, database connectivity etc. 4. To impart the techniques of creating GUI based applications.			
Syllabus Object oriented concepts, Object oriented systems development life cycle, Unified Modeling Language, Java Overview, Classes and objects, Parameter passing, Overloading, Inheritance, Overriding, Packages, Exception Handling, Input/Output, Threads and multithreading, Applets, Event Handling mechanism, Working with frames and graphics, AWT Controls, Swings, Java database connectivity.			
Expected outcome. Students will be able to: 1. apply object oriented principles in software design process. 2. develop Java programs for real applications using java constructs and libraries. 3. understand and apply various object oriented features like inheritance, data abstraction, encapsulation and polymorphism to solve various computing problems using Java language. 4. implement Exception Handling in java. 5. use graphical user interface and Event Handling in java. 6. develop and deploy Applet in java.			
Text Books: 1. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011. 2. Bahrami A., Object Oriented Systems Development using the Unified Modeling Language, McGraw Hill, 1999.			
References: 1. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013. 2. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008. 3. Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005. 4. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004. 5. Sierra K., Head First Java, 2/e, O'Reilly, 2005. 6. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014. 7.			
Course Plan			
Module	Contents	Hours (42)	Sem. ExamMarks
I	Object oriented concepts, Object oriented systems development life cycle. Unified Modeling Language, UML class diagram, Use-case diagram. Java Overview: Java virtual machine, <i>data types</i> , <i>operators</i> , <i>control statements</i> , Introduction to Java programming.	08	15%

II	Classes fundamentals, objects, methods, constructors, parameter passing, overloading, access control keywords.	07	15%
FIRST INTERNAL EXAMINATION			
III	Inheritance basics, method overriding, abstract classes, interface. Defining and importing packages. Exception handling fundamentals, multiple catch and nested try statements.	06	15%
IV	Input/Output: files, stream classes, reading console input. Threads: thread model, use of Thread class and Runnable interface, thread synchronization, multithreading.	06	15%
SECOND INTERNAL EXAMINATION			
V	String class - basics. Applet basics and methods. Event Handling: delegation event model, event classes, sources, listeners.	07	20%
VI	Introduction to AWT: working with frames, graphics, color, font. AWT Control fundamentals. Swing overview. Java database connectivity: JDBC overview, creating and executing queries, dynamic queries.	08	20%
END SEMESTER EXAM			

Question Paper Pattern:

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module I and II; All four questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module I and II; Two questions have to be answered. Each question can have a maximum of three subparts
4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering module III and IV; All four questions have to be answered.
5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module III and IV; Two questions have to be answered. Each question can have a maximum of three subparts

6. Part E
- a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/design questions.



Course code	Course Name	L-T-P -Credits	Year of Introduction
CS207	ELECTRONIC DEVICES & CIRCUITS	3-0-0-3	2016
Pre-requisite: BE101-04 Introduction to Electronics Engg.			
Course Objectives: 1. To introduce to the students the fundamental concepts of electronic devices and circuits for engineering applications 2. To develop the skill of analysis and design of various analog circuits using electronic devices 3. To provide comprehensive idea about working principle, operation and applications of electronic circuits 4. To equip the students with a sound understanding of fundamental concepts of operational amplifiers 5. To expose to the diversity of operations that operational amplifiers can perform in a wide range of applications 6. To expose to a variety of electronic circuits/systems using various analog ICs			
Syllabus RC Circuits, Diode Circuits, Regulated power supplies, Field effect transistor , DC analysis of BJT, RC Coupled amplifier, MOSFET amplifiers, Feedback amplifiers, Power amplifiers, Oscillators, Multivibrators, Operational Amplifier and its applications, Timer IC.			
Expected Outcome: Students will be able to 1. explain, illustrate, and design the different electronic circuits using electronic components 2. design circuits using operational amplifiers for various applications			
Text Books: 1. David A Bell, Electronic Devices and Circuits, Oxford University Press, 2008 2. Salivahanan S. and V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008 References : 1. Neamen D., Electronic Circuits, Analysis and Design, 3/e, TMH, 2007 2. Robert Boylestad and L Nashelsky, Electronic Devices and Circuit Theory, Pearson. 3. Bogart T. F., Electronic Devices Circuits, 6/e, Pearson, 2012. 4. Maini A. K. and V. Agrawal, Electronic Devices and Circuits, Wiley India, 2011. 5. K.Gopakumar, Design and Analysis of Electronic Circuits, Phasor Books, Kollam, 2013 6. Millman J. and C. Halkias, Integrated Electronics, 2/e, McGraw-Hill, 2010.			
Course Plan			
Module	Contents	Hou rs (40)	Sem Exam Marks
1	Wave shaping circuits: Sinusoidal and non-sinusoidal wave shapes, Principle and working of RC differentiating and integrating circuits, Conversion of one non-sinusoidal wave shape into another. Clipping circuits - Positive, negative and biased clipper.	5	15%

	Clamping circuits - Positive, negative and biased clamper. Voltage multipliers- Voltage doubler and tripler. Simple sweep circuit using transistor as a switch.		
2	Regulated power supplies: Review of simple zener voltage regulator, Shunt and series voltage regulator using transistors, Current limiting and fold back protection, 3 pin regulators-78XX and 79XX, IC 723 and its use as low and high voltage regulators, DC to DC conversion, Circuit/block diagram and working of SMPS.	4	15 %
	Field effect transistors: JFET – Structure, principle of operation and characteristics, Comparison with BJT. MOSFET- Structure, Enhancement and Depletion types, principle of operation and characteristics.	3	
FIRST INTERNAL EXAM			
3	Amplifiers: Introduction to transistor biasing, operating point, concept of load line, thermal stability, fixed bias, self bias, voltage divider bias. Classification of amplifiers, RC coupled amplifier - voltage gain and frequency response. Multistage amplifiers - effect of cascading on gain and bandwidth. Feedback in amplifiers - Effect of negative feedback on amplifiers. MOSFET Amplifier- Circuit diagram and working of common source MOSFET amplifier.	7	15 %
4	Oscillators: Classification, criterion for oscillation, analysis of Wien bridge oscillator, Hartley and Crystal oscillator. Non-sinusoidal oscillators: Astable, monostable and bi-stable multivibrators using transistors (Only design equations and working of circuit are required, Analysis not required).	5	15 %
SECOND INTERNAL EXAM			
5	Operational amplifiers: Differential amplifier, characteristics of op-amps(gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp(IC741), applications of op-amps- scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator, Schmitt trigger, Wien bridge oscillator.	8	20 %

6	Integrated circuits: Active filters – Low pass and high pass (first and second order) active filters using op-amp with gain (No analysis required). D/A and A/D convertors – important specifications, Sample and hold circuit. Binary weighted resistor and R-2R ladder type D/A convertors. (concepts only). Flash, dual slope and successive approximation type A/D convertors. Circuit diagram and working of Timer IC555, astable and monostablemultivibrators using 555.	8	20 %
END SEMESTER EXAM			

Question Paper Pattern:

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 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering module I and II; All four questions have to be answered.
- Part B
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering module I and II; Two questions have to be answered. Each question can have a maximum of three subparts
- Part C
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering module III and IV; All four questions have to be answered.
- Part D
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering module III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
- Part E
 - Total Marks: 40
 - Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - A question can have a maximum of three sub-parts.
- There should be at least 60% analytical/numerical/design questions.

Course code	Course Name	L-T-P - Credits	Year of Introduction
CS208	Principles of Database Design	2-1-0-3	2016
Pre-requisite: CS205 Data structures			
Course Objectives - To impart the basic understanding of the theory and applications of database management systems. - To give basic level understanding of internals of database systems. - To expose to some of the recent trends in databases.			
Syllabus: Types of data, database and DBMS, Languages and users. Software Architecture, E-R and Extended E-R Modelling, Relational Model – concepts and languages, relational algebra and tuple relational calculus, SQL, views, assertions and triggers, relational db design, FDs and normal forms, Secondary storage organization, indexing and hashing, query optimization, concurrent transaction processing and recovery principles, recent topics.			
Expected outcome. Students will be able to: - define, explain and illustrate the fundamental concepts of databases. - construct an Entity-Relationship (E-R) model from specifications and to perform the transformation of the conceptual model into corresponding logical data structures. - model and design a relational database following the design principles. - develop queries for relational database in the context of practical applications - define, explain and illustrate fundamental principles of data organization, query optimization and concurrent transaction processing. - appreciate the latest trends in databases.			
Text Books: - Elmasri R. and S. Navathe, <i>Database Systems: Models, Languages, Design and Application Programming</i>, Pearson Education, 2013. - Sliberschatz A., H. F. Korth and S. Sudarshan, <i>Database System Concepts</i>, 6/e, McGraw Hill, 2011.			
References: - Powers S., <i>Practical RDF</i>, O'Reilly Media, 2003. - Plunkett T., B. Macdonald, <i>et al.</i>, <i>Oracle Big Data Hand Book</i>, Oracle Press, 2013.			
Course Plan			
Module	Contents	Hours (42)	Sem. Exam Marks
I	Introduction: Data: structured, semi-structured and unstructured data, Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS. Database architectures and classification. (Reading: Elmasri Navathe, Ch. 1 and 2. Additional Reading: Silberschatz, Korth, Ch. 1) Entity-Relationship Model: Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-	06	15%

	Relationship Diagram, Weak Entity Sets, Relationships of degree greater than 2 (Reading: Elmasri Navathe, Ch. 7.1-7.8)		
II	Relational Model: Structure of relational Databases, Integrity Constraints, synthesizing ER diagram to relational schema (Reading: Elmasri Navathe, Ch. 3 and 8.1, Additional Reading: Silbershatz, Korth, Ch. 2.1-2.4) Database Languages: Concept of DDL and DML relational algebra (Reading: Silbershatz, Korth, Ch 2.5-2.6 and 6.1-6.2, Elmasri Navathe, Ch. 6.1-6.5)	06	15%
FIRST INTERNAL EXAM			
III	Structured Query Language (SQL): Basic SQL Structure, examples, Set operations, Aggregate Functions, nested sub-queries (Reading: Elmasri Navathe, Ch. 4 and 5.1) Views, assertions and triggers (Reading: Elmasri Navathe, Ch. 5.2-5.3, Optional reading: Silbershatz, Korth Ch. 5.3).	07	15%
IV	Relational Database Design: Different anomalies in designing a database, normalization, functional dependency (FD), Armstrong's Axioms, closures, Equivalence of FDs, minimal Cover (proofs not required). Normalization using functional dependencies, 1NF, 2NF, 3NF and BCNF, lossless and dependency preserving decompositions (Reading: Elmasri and Navathe, Ch. 14.1-14.5, 15.1-15.2. Additional Reading: Silbershatz, Korth Ch. 8.1-8.5)	07	15%
SECOND INTERNAL EXAM			
V	Physical Data Organization: index structures, primary, secondary and clustering indices, Single level and Multi-level indexing, B+-Trees (basic structure only, algorithms not needed), (Reading Elmasri and Navathe, Ch. 17.1-17.4) Query Optimization: heuristics-based query optimization, (Reading Elmasri and Navathe, Ch. 18.1, 18.7)	07	20%
VI	Transaction Processing Concepts: overview of concurrency control and recovery acid properties, serial and concurrent schedules, conflict serializability. Two-phase locking, failure classification, storage structure, stable storage, log based recovery, deferred database modification, check-pointing, (Reading Elmasri and Navathe, Ch. 20.1-20.5 (except 20.5.4-20.5.5) , Silbershatz, Korth Ch. 15.1 (except 15.1.4-15.1.5), Ch. 16.1 – 16.5) Recent topics (preliminary ideas only): Semantic Web and RDF(Reading: Powers Ch.1, 2), GIS, biological databases (Reading: Elmasri and Navathe Ch. 23.3-23.4) Big Data (Reading: Plunkett and Macdonald, Ch. 1, 2)	09	20%
END SEMESTER EXAM			

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 - b. Four questions each having 3 marks, uniformly covering module III and IV; All four questions have to be answered.
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 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering module III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/numerical/design questions.

Course No.	Course Name	L-T-P - Credits	Year of Introduction
CS231	DATA STRUCTURES LAB	0-0-3-1	2016
Pre-requisite: CS205 Data structures			
Course Objectives 1. To implement basic linear and non-linear data structures and their major operations. 2. To implement applications using these data structures. 3. To implement algorithms for various sorting techniques.			
List of Exercises/Experiments : (Minimum 12 are to be done) 1. Implementation of Stack and Multiple stacks using one dimensional array. ** 2. Application problems using stacks: Infix to post fix conversion, postfix and pre-fix evaluation, MAZE problem etc. ** 3. Implementation of Queue, DEQUEUE and Circular queue using arrays. 4. Implementation of various linked list operations. ** 5. Implementation of stack, queue and their applications using linked list. 6. Implementation of trees using linked list 7. Representation of polynomials using linked list, addition and multiplication of polynomials. ** 8. Implementation of binary trees using linked lists and arrays- creations, insertion, deletion and traversal. ** 9. Implementation of binary search trees – creation, insertion, deletion, search 10. Application using trees 11. Implementation of sorting algorithms – bubble, insertion, selection, quick (recursive and non-recursive), merge sort (recursive and non-recursive), and heap sort. ** 12. Implementation of searching algorithms – linear search, binary search. ** 13. Representation of graphs and computing various parameters (in degree, out degree etc.) - adjacency list, adjacency matrix. 14. Implementation of BFS, DFS for each representation. 15. Implementation of hash table using various mapping functions, various collision and overflow resolving schemes. ** 16. Implementation of various string operations.			

17. Simulation of first-fit, best-fit and worst-fit allocations.

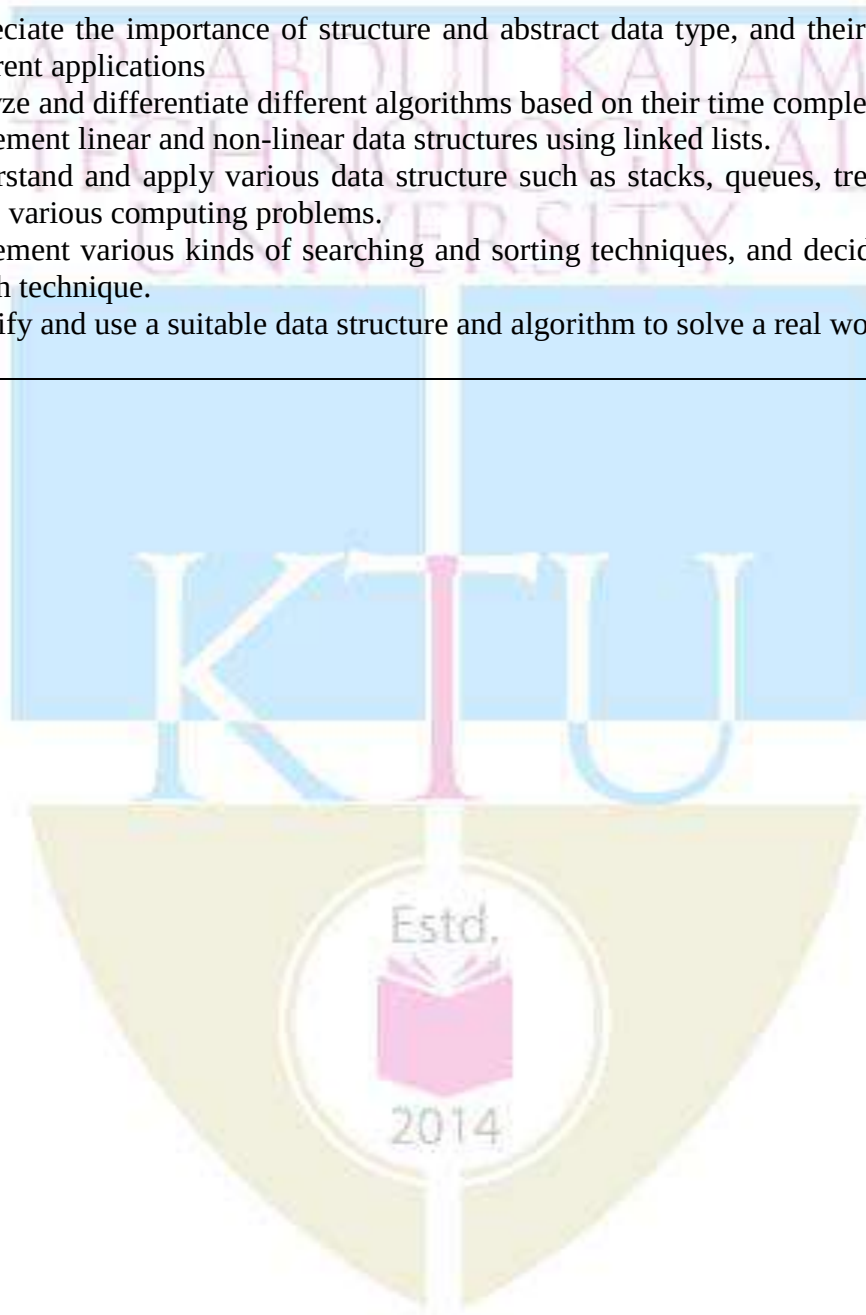
18. Simulation of a basic memory allocator and garbage collector using doubly linked list.

**** mandatory.**

Expected Outcome:

Students will be able to:

1. appreciate the importance of structure and abstract data type, and their basic usability in different applications
2. analyze and differentiate different algorithms based on their time complexity.
3. implement linear and non-linear data structures using linked lists.
4. understand and apply various data structure such as stacks, queues, trees, graphs, etc. to solve various computing problems.
5. implement various kinds of searching and sorting techniques, and decide when to choose which technique.
6. identify and use a suitable data structure and algorithm to solve a real world problem.



Course code	Course Name	L-T-P-Credits	Year of Introduction
CS232	Free and Open Source Software Lab	0-0-3-1	2016

Pre-requisite: CS204 Operating systems

Course Objectives: To expose students to FOSS environment and introduce them to use open source packages in open source platform.

List of Exercises/Experiments:

- Getting started with Linux basic commands for directory operations, displaying directory structure in tree format etc.
- Linux commands for operations such as redirection, pipes, filters, job control, changing ownership/permissions of files/links/directory.
- Advanced linux commands curl, wget, ftp, ssh and grep
- Shell Programming : Write shell script to show various system configuration like
 - Currently logged user and his login name
 - Your current shell
 - Your home directory
 - Your operating system type
 - Your current path setting
 - Your current working directory
 - Number of users currently logged in
- Write shell script to show various system configurations like
 - your OS and version, release number, kernel version
 - all available shells
 - computer CPU information like processor type, speed etc
 - memory information
 - hard disk information like size of hard-disk, cache memory, model etc
 - File system (Mounted)
- Write a shell script to implement a menu driven calculator with following functions
 - Addition
 - Subtraction
 - Multiplication
 - Division
 - Modulus
- Write a script called addnames that is to be called as follows
./addnames ulist username
 Here *ulist* is the name of the file that contains list of user names and *username* is a particular student's username. The script should
 - check that the correct number of arguments was received and print a message, in case the number of arguments is incorrect
 - check whether the ulist file exists and print an error message if it does not
 - check whether the username already exists in the file. If the username exists, print a message stating that the name already exists. Otherwise, add the username to the end of the list.

8. Version Control System setup and usage using GIT. Try the following features.
- Creating a repository
 - Checking out a repository
 - Adding content to the repository
 - Committing the data to a repository
 - Updating the local copy
 - Comparing different revisions
 - Revert
 - Conflicts and a conflict Resolution
9. Shell script which starts on system boot up and kills every process which uses more than a specified amount of memory or CPU.
10. Introduction to packet management system : Given a set of RPM or DEB, build and maintain, and serve packages over http or ftp. Configure client systems to access the package repository.
11. Perform simple text processing using Perl, Awk.
12. Running PHP : simple applications like login forms after setting up a LAMP stack
13. Virtualisation environment (e.g., xen, kqemu, virtualbox or lguest) to test applications, new kernels and isolate applications. It could also be used to expose students to other alternate OS such as freeBSD
14. Compiling from source : learn about the various build systems used like the auto* family, cmake, ant etc. instead of just running the commands. This could involve the full process like fetching from a cvs and also include autoconf, automake etc.,
15. Kernel configuration, compilation and installation : Download / access the latest kernel source code from *kernel.org*, compile the kernel and install it in the local system. Try to view the source code of the kernel
16. GUI Programming: Create scientific calculator – using any one of Gambas, GTK, QT
17. Installing various software packages. Either the package is yet to be installed or an older version is present. The student can practice installing the latest version. (Internet access is needed).
- Install samba and share files to windows
 - Install Common Unix Printing System(CUPS)
18. Set up the complete network interface by configuring services such as gateway, DNS, IP tables etc. using *ifconfig*

Expected outcome:

The students will be able to:

1. Identify and apply various Linux commands
2. Develop shell scripts and GUI for specific needs
3. Use tools like GIT
4. Perform basic level application deployment, kernel configuration and installation, packet management and installation etc.

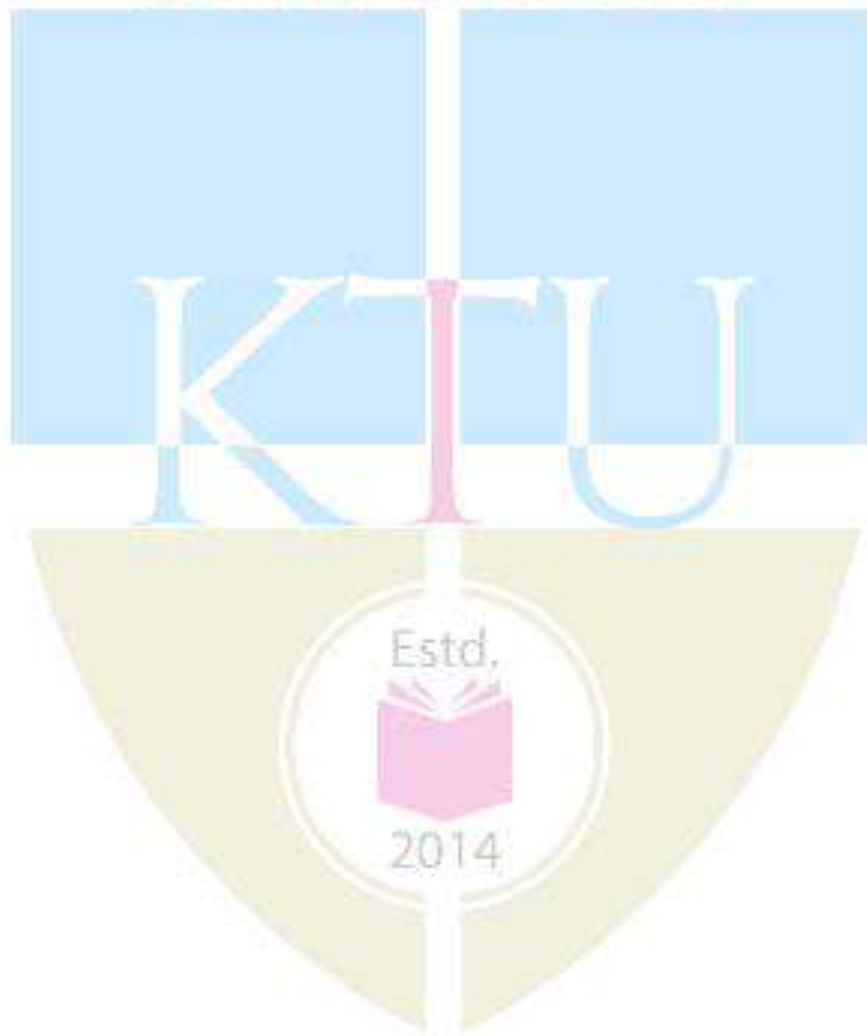
Course No.	Course Name	L-T-P - Credits	Year of Introduction
CS233	ELECTRONICS CIRCUITS LAB	0-0-3-1	2016
Pre-requisite: CS207 Electronic devices & circuits			
Course Objectives: 1. To introduce the working of analog electronic circuits. 2. To design, implement and demonstrate analog circuits using electronic components. 3. To provide hands-on experience to the students so that they are able to put theoretical concepts to practice. 4. To use computer simulation tools such as PSPICE, or Multisim to the simulation of electronic circuits. 5. To create an ability to develop descriptions, explanations, predictions and models using evidence. 6. To create an ability to communicate effectively the scientific procedures and explanations about the experiments in oral/report forms.			
List of Exercises/Experiments : (Minimum 13 experiments are to be done in the semester, at least 6 each should be selected from the first(Exp. 1-10) and second(Exp. 11-20) half. Experiment no. 18 is compulsory). 1. Forward and reverse characteristics of PN diode and Zener diode 2. Input and output characteristics of BJT in CE configuration and evaluation of parameters 3. RC integrating and differentiating circuits-Transient response with different time constant 4. RC low pass and high pass circuits- Frequency response with sinusoidal input 5. Clipping circuits (Positive, negative and biased) - Transient and transfer characteristics 6. Clamping circuits (Positive, negative and biased)- Transient characteristics 7. Bridge Rectifier - with and without filter- ripple factor and regulation 8. Simple Zener regulator- Line and load characteristics 9. RC coupled CE amplifier – Mid band gain and frequency response 10. RC phase shift or Wien bridge oscillator using transistor 11. Astable and Monostable multivibrators using transistors 12. Series voltage regulator (Two transistors)- Line and load characteristics 13. Voltage regulator using LM 723)- Line and load characteristics 14. Astable and mono stable multivibrators using 555 Timer 15. Inverting and non-inverting amplifier using op-amp IC741 16. Instrumentation amplifier using op-amp IC741 17. RC phase shift or Wien bridge oscillator using op-amp IC741 18. Simulation of simple circuits (at least 6 from above) using any SPICE software(Transient, AC and DC analysis)			

Expected Outcome:

Students will be able to:

1. identify basic electronic components, design and develop electronic circuits.
2. Design and demonstrate functioning of various discrete analog circuits
3. Be familiar with computer simulation of electronic circuits and how to use it proficiently for design and development of electronic circuits.
4. Understand the concepts and their applications in engineering.
5. Communicate effectively the scientific procedures and explanations in formal technical presentations/reports.

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Course code	Course Name	L-T-P - Credits	Year of Introduction
CS234	DIGITAL SYSTEMS LAB	0-0-3-1	2016
Pre-requisite: CS203 Switching theory and logic design			
Course Objectives: 1. To familiarize students with digital ICs, the building blocks of digital circuits 2. To provide students the opportunity to set up different types of digital circuits and study their behaviour			
List of Exercises/Experiments : (minimum 12 exercises/experiments are mandatory) 1. Familiarizations and verification of the truth tables of basic gates and universal gates. 2. Verification of Demorgan's laws for two variables. 3. Implementation of half adder and full adder circuits using logic gates. 4. Implementation of half subtractor and full subtractor circuits using logic gates. 5. Implementation of parallel adder circuit. 6. Realization of 4 bit adder/subtractor and BCD adder circuits using IC 7483. 7. Implementation of a 2 bit magnitude comparator circuit using logic gates. 8. Design and implementation of code convertor circuits 9. a) BCD to excess 3 code b) binary to gray code 10. Implementation of multiplexer and demultiplexer circuits using logic gates. Familiarization with various multiplexer and demultiplexer ICs. 11. Realization of combinational circuits using multiplexer/demultiplexer ICs. 12. Implementation of SR, D, JK, JK master slave and T flip flops using logic gates. Familiarization with IC 7474 and IC 7476. 13. Implementation of shift registers using flip flop Integrated Circuits. 14. Implementation of ring counter and Johnson counter using flip flop Integrated Circuits. 15. Realization of asynchronous counters using flip flop ICs. 16. Realization of synchronous counters using flip flop ICs. Familiarization with various counter Integrated Circuits. 17. Implementation of a BCD to 7 segment decoder and display. 18. Simulation of Half adder, Full adder using VHDL. <i>(Note: The experiments may be done using hardware components and/or VHDL)</i>			
Course outcome: Students will be able to: 1. identify and explain the digital ICs and their use in implementing digital circuits. 2. design and implement different kinds of digital circuits.			

Course code	Course Name	L-T-P Credits	Year of Introduction
CS301	THEORY OF COMPUTATION	3-1-0-4	2016
Prerequisite: Nil			
Course Objectives - To introduce the concept of formal languages. - To discuss the Chomsky classification of formal languages with discussion on grammar and automata for regular, context-free, context sensitive and unrestricted languages. - To discuss the notions of decidability and halting problem.			
Syllabus Introduction to Automata Theory, Structure of an automaton, classification of automata, grammar and automata for generating each class of formal languages in the Chomsky Hierarchy, decidability and Halting problem.			
Expected Outcome The Students will be able to - Classify formal languages into regular, context-free, context sensitive and unrestricted languages. - Design finite state automata, regular grammar, regular expression and Myhill- Nerode relation representations for regular languages. - Design push-down automata and context-free grammar representations for context-free languages. - Design Turing Machines for accepting recursively enumerable languages. - Understand the notions of decidability and undecidability of problems, Halting problem.			
Text Books - John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, Introduction to Automata Theory, Languages, and Computation, 3/e, Pearson Education, 2007 - John C Martin, Introduction to Languages and the Theory of Computation, TMH, 2007 - Michael Sipser, Introduction To Theory of Computation, Cengage Publishers, 2013			
References Dexter C. Kozen, Automata and Computability, Springer 1999.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Automata Theory and its significance. Type 3 Formalism: Finite state automata – Properties of transition functions, Designing finite automata, NFA, Finite Automata with Epsilon Transitions, Equivalence of NFA and DFA, Conversion of NFA to DFA, Equivalence and Conversion of NFA with and without Epsilon Transitions.	10	15 %
II	Myhill-Nerode Theorem, Minimal State FA Computation. Finite State Machines with Output- Mealy and Moore machine (Design Only), Two- Way Finite Automata. Regular Grammar, Regular Expressions, Equivalence of regular expressions and NFA with epsilon transitions. Converting Regular Expressions to NFA with epsilon transitions Equivalence of DFA and regular expressions, converting DFA to Regular Expressions.	10	15 %

FIRST INTERNAL EXAM			
III	Pumping Lemma for Regular Languages, Applications of Pumping Lemma. Closure Properties of Regular sets (Proofs not required), Decision Problems related with Type 3 Formalism Type 2 Formalism:- Context-Free Languages (CFL), Context-Free Grammar (CFG), Derivation trees, Ambiguity, Simplification of CFG, Chomsky Normal Form, Greibach normal forms	09	15 %
IV	Non-Deterministic Pushdown Automata (NPDA), design. Equivalence of acceptance by final state and empty stack in PDA. Equivalence between NPDA and CFG, Deterministic Push Down Automata, Closure properties of CFLs (Proof not required), Decision Problems related with Type 3 Formalism.	08	15 %
SECOND INTERNAL EXAM			
V	Pumping Lemma for CFLs, Applications of Pumping Lemma. Type 1 Formalism: Context-sensitive Grammar. Linear Bounded Automata (Design not required) Type 0 Formalism: Turing Machine (TM) – Basics and formal definition, TMs as language acceptors, TMs as Transducers, Designing Turing Machines.	09	20 %
VI	Variants of TMs -Universal Turing Machine, Multi- tape TMs, Non Deterministic TMs, Enumeration Machine (Equivalence not required), Recursively Enumerable Languages, Recursive languages, Properties of Recursively Enumerable Languages and Recursive Languages, Decidability and Halting Problem. Chomsky Hierarchy	08	20 %
END SEMESTER EXAM			

Question Paper Pattern

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- Part B
 - Total marks : 18
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- Part C
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
- Part D
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
- Part E
 - Total Marks: 40
 - Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered. A question can have a maximum of three sub-parts.

There should be at least 60% analytical/numerical questions.

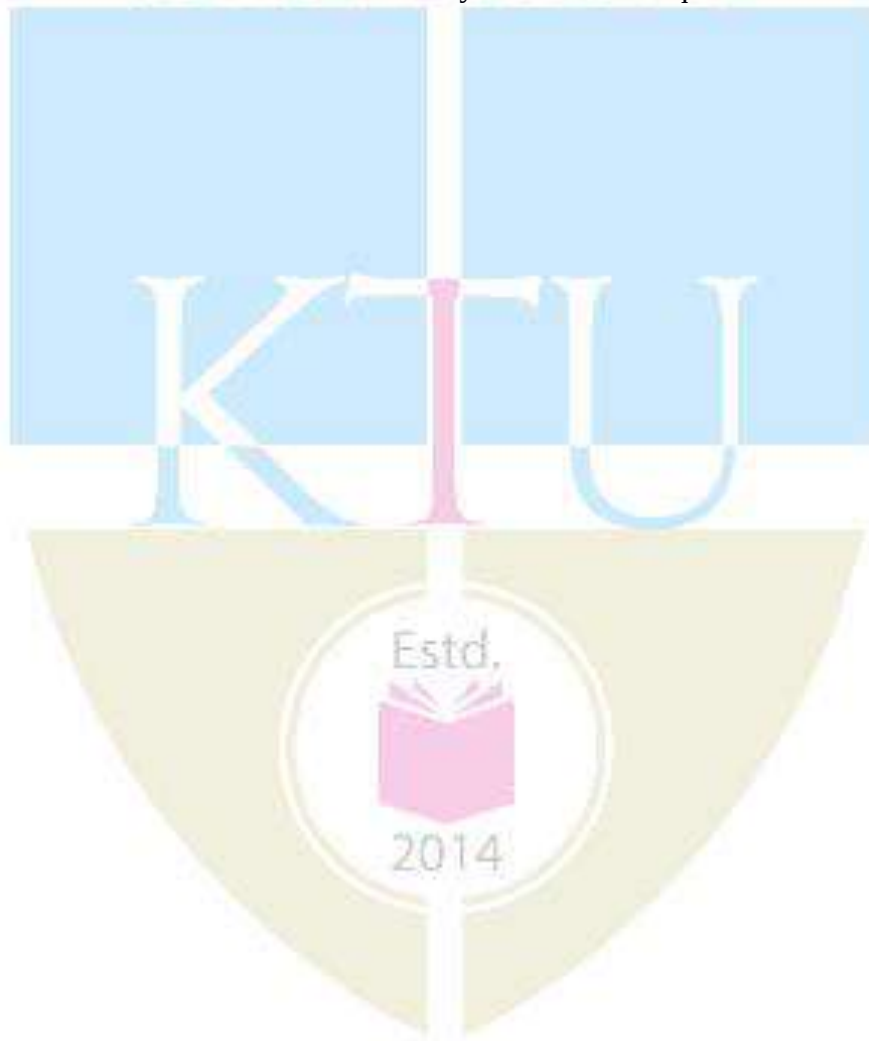
Course code	Course Name	L-T-P - Credits	Year of Introduction
CS302	Design and Analysis of Algorithms	3-1-0-4	2016
Prerequisite: Nil			
Course Objectives - To introduce the concepts of Algorithm Analysis, Time Complexity, Space Complexity. - To discuss various Algorithm Design Strategies with proper illustrative examples. - To introduce Complexity Theory.			
Syllabus Introduction to Algorithm Analysis, Notions of Time and Space Complexity, Asymptotic Notations, Recurrence Equations and their solutions, Master's Theorem, Divide and Conquer and illustrative examples, AVL trees, Red-Black Trees, Union-find algorithms, Graph algorithms, Divide and Conquer, Dynamic Programming, Greedy Strategy, Back Tracking and Branch and Bound, Complexity classes			
Expected outcome The students will be able to - Analyze a given algorithm and express its time and space complexities in asymptotic notations. - Solve recurrence equations using Iteration Method, Recurrence Tree Method and Master's Theorem. - Design algorithms using Divide and Conquer Strategy. - Compare Dynamic Programming and Divide and Conquer Strategies. - Solve Optimization problems using Greedy strategy. - Design efficient algorithms using Back Tracking and Branch Bound Techniques for solving problems. - Classify computational problems into P, NP, NP-Hard and NP-Complete.			
Text Books - Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Computer Algorithms, Universities Press, 2007 [Modules 3,4,5] - Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, MIT Press, 2009 [Modules 1,2,6]			
References - Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, The Design and Analysis of Computer Algorithms, Pearson Education, 1999. - Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson, 3rd Edition, 2011. - Gilles Brassard, Paul Bratley, Fundamentals of Algorithmics, Pearson Education, 1995. - Richard E. Neapolitan, Kumarss Naimipour, Foundations of Algorithms using C++ Psuedocode, Second Edition, 1997.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks

I	Introduction to Algorithm Analysis Time and Space Complexity- Elementary operations and Computation of Time Complexity- Best, worst and Average Case Complexities- Complexity Calculation of simple algorithms Recurrence Equations: Solution of Recurrence Equations – Iteration Method and Recursion Tree Methods	04 04	15 %
II	Master's Theorem (Proof not required) – examples, Asymptotic Notations and their properties- Application of Asymptotic Notations in Algorithm Analysis- Common Complexity Functions AVL Trees – rotations, Red-Black Trees insertion and deletion (Techniques only; algorithms not expected). B-Trees – insertion and deletion operations. Sets- Union and find operations on disjoint sets.	05 05	15%
FIRST INTERNAL EXAM			
III	Graphs – DFS and BFS traversals, complexity, Spanning trees – Minimum Cost Spanning Trees, single source shortest path algorithms, Topological sorting, strongly connected components.	07	15%
IV	Divide and Conquer: The Control Abstraction, 2 way Merge sort, Strassen's Matrix Multiplication, Analysis Dynamic Programming : The control Abstraction- The Optimality Principle- Optimal matrix multiplication, Bellman-Ford Algorithm	04 05	15%
SECOND INTERNAL EXAM			
V	Analysis, Comparison of Divide and Conquer and Dynamic Programming strategies Greedy Strategy: - The Control Abstraction- the Fractional Knapsack Problem, Minimal Cost Spanning Tree Computation- Prim's Algorithm – Kruskal's Algorithm.	02 04 03	20%
VI	Back Tracking: -The Control Abstraction – The N Queen's Problem, 0/1 Knapsack Problem Branch and Bound: Travelling Salesman Problem. Introduction to Complexity Theory :- Tractable and Intractable Problems- The P and NP Classes- Polynomial Time Reductions - The NP- Hard and NP-Complete Classes	03 03 03	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be *five* parts in the question paper – A, B, C, D, E
- Part A
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules I and II; All four questions have to be answered.
- Part B
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
- Part C

- a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
5. Part D
- a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
- a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/numerical questions.



Course code	Course Name	L-T-P Credits	Year of Introduction
CS303	SYSTEM SOFTWARE	2-1-0-3	2016
Prerequisite: Nil			
Course Objectives To make students understand the design concepts of various system software like Assembler, Linker, Loader and Macro pre-processor, Utility Programs such as Text Editor and Debugger.			
Syllabus Different types of System Software, SIC & SIC/XE Architecture and Programming, Basic Functions of Assembler, Assembler Design, Single pass and 2 Pass Assemblers and their Design, Linkers and Loaders, Absolute Loader and Relocating loader, Design of Linking Loader, Macro Processor and its design, Fundamentals of Text Editor Design, Operational Features of Debuggers			
Expected Outcome The Students will be able to - distinguish different software into different categories.. - design, analyze and implement one pass, two pass or multi pass assembler. - design, analyze and implement loader and linker. - design, analyze and implement macro processors. - critique the features of modern editing /debugging tools.			
Text book Leland L. Beck, System Software: An Introduction to Systems Programming, 3/E, Pearson Education Asia, 1997.			
References - D.M. Dhamdhare, Systems Programming and Operating Systems, Second Revised Edition, Tata McGraw Hill. http://gcc.gnu.org/onlinedocs/gcc-2.95.3/cpp_1.html - The C Preprocessor - J Nithyashri, System Software, Second Edition, Tata McGraw Hill. - John J. Donovan, Systems Programming, Tata McGraw Hill Edition 1991. - Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, Linux Device Drivers, Third Edition, O.Reilly Books M. Beck, H. Bohme, M. Dziadzka, et al., Linux Kernel Internals, Second Edition, Addison Wesley Publications, - Peter Abel, IBM PC Assembly Language and Programming, Third Edition, Prentice Hall of India. - Writing UNIX device drivers - George Pajari – Addison Wesley Publications (Ebook : http://tocs.ulb.tu-darmstadt.de/197262074.pdf).			
Course Plan			
Module	Contents	Hours	End Sem Exam. Marks

I	Introduction : System Software Vs. Application Software, Different System Software– Assembler, Linker, Loader, Macro Processor, Text Editor, Debugger, Device Driver, Compiler, Interpreter, Operating System(Basic Concepts only) SIC & SIC/XE Architecture, Addressing modes, SIC & SIC/XE Instruction set, Assembler Directives and Programming.	2	15%
		6	
II	Assemblers Basic Functions of Assembler. Assembler output format – Header, Text and End Records- Assembler data structures, Two pass assembler algorithm, Hand assembly of SIC/XE program, Machine dependent assembler features.	6	15 %
FIRST INTERNAL EXAM			
III	Assembler design options: Machine Independent assembler features – program blocks, Control sections, Assembler design options- Algorithm for Single Pass assembler, Multi pass assembler, Implementation example of MASM Assembler	7	15 %
IV	Linker and Loader Basic Loader functions - Design of absolute loader, Simple bootstrap Loader, Machine dependent loader features- Relocation, Program Linking, Algorithm and data structures of two pass Linking Loader, Machine dependent loader features, Loader Design Options.	7	15 %
SECOND INTERNAL EXAM			
V	Macro Preprocessor:- Macro Instruction Definition and Expansion. One pass Macro processor Algorithm and data structures, Machine Independent Macro Processor Features, Macro processor design options	7	20 %
VI	Device drivers: Anatomy of a device driver, Character and block device drivers, General design of device drivers	2	20 %
	Text Editors: Overview of Editing, User Interface, Editor Structure.	2	
	Debuggers :- Debugging Functions and Capabilities, Relationship with other parts of the system, Debugging Methods- By Induction, Deduction and Backtracking.	4	
END SEMESTER EXAM			

Question Paper Pattern

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules I and II; Allfour questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules III and IV; Allfour questions have to be answered.
5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/numerical questions.



Course code	Course Name	L-T-P Credits	Year of Introduction
CS304	COMPILER DESIGN	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives To provide a thorough understanding of the internals of Compiler Design.			
Syllabus Phases of compilation, Lexical analysis, Token Recognition, Syntax analysis, Bottom Up and Top Down Parsers, Syntax directed translation schemes, Intermediate Code Generation, Triples and Quadruples, Code Optimization, Code Generation.			
Expected Outcome The students will be able to - Explain the concepts and different phases of compilation with compile time error handling. - Represent language tokens using regular expressions, context free grammar and finite automata and design lexical analyzer for a language. - Compare top down with bottom up parsers, and develop appropriate parser to produce parse tree representation of the input. - Generate intermediate code for statements in high level language. - Design syntax directed translation schemes for a given context free grammar. - Apply optimization techniques to intermediate code and generate machine code for high level language program.			
Text Books - Aho A. Ravi Sethi and D Ullman. Compilers – Principles Techniques and Tools, Addison Wesley, 2006. D. M.Dhamdhare, System Programming and Operating Systems, Tata McGraw Hill & Company, 1996.			
References - Kenneth C. Loudon, Compiler Construction – Principles and Practice, Cengage Learning Indian Edition, 2006. - Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company, 1984.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to compilers – Analysis of the source program, Phases of a compiler, Grouping of phases, compiler writing tools – bootstrapping Lexical Analysis: The role of Lexical Analyzer, Input Buffering, Specification of Tokens using Regular Expressions, Review of Finite Automata, Recognition of Tokens.	07	15%
II	Syntax Analysis: Review of Context-Free Grammars – Derivation trees and Parse Trees, Ambiguity. Top-Down Parsing: Recursive Descent parsing, Predictive parsing, LL(1) Grammars.	06	15%

FIRST INTERNAL EXAM			
III	Bottom-Up Parsing: Shift Reduce parsing – Operator precedence parsing (Concepts only) LR parsing – Constructing SLR parsing tables, Constructing, Canonical LR parsing tables and Constructing LALR parsing tables.	07	15%
IV	Syntax directed translation: Syntax directed definitions, Bottom- up evaluation of S-attributed definitions, L- attributed definitions, Top-down translation, Bottom-up evaluation of inherited attributes. Type Checking : Type systems, Specification of a simple type checker.	08	15%
SECOND INTERNAL EXAM			
V	Run-Time Environments: Source Language issues, Storage organization, Storage-allocation strategies. Intermediate Code Generation (ICG): Intermediate languages – Graphical representations, Three-Address code, Quadruples, Triples. Assignment statements, Boolean expressions.	07	20%
VI	Code Optimization: Principal sources of optimization, Optimization of Basic blocks Code generation: Issues in the design of a code generator. The target machine, A simple code generator.	07	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be *five* parts in the question paper – A, B, C, D, E
- Part A
 - Total marks : 12 b.. Four questions each having 3 marks, uniformly covering modules I and II; All four questions have to be answered.
- Part B
 - Total marks : 18 b. Three questionseach having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
- Part C
 - Total marks : 12 b. Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
- Part D
 - Total marks : 18 b. Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
- Part E
 - Total Marks: 40 b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - A question can have a maximum of three sub-parts.
- There should be at least 60% analytical/numerical questions.

Course code	Course Name	L-T-P - Credits	Year of Introduction
CS305	Microprocessors and Microcontrollers	2-1-0-3	2016
Prerequisite: CS202 Computer Organisation and Architecture			
Course Objectives - To impart basic understanding of the internal organisation of 8086 Microprocessor and 8051 microcontroller. - To introduce the concepts of interfacing microprocessors with external devices. - To develop Assembly language programming skills.			
Syllabus Introduction to 8086 Microprocessor; Architecture and signals, Instruction set of 8086, Timing Diagram, Assembly Language Programming, Memory and I/O interfacing, Interfacing with 8255, 8279, 8257, Interrupts and Interrupt handling, Microcontrollers - 8051 Architecture and its salient features, Instruction Set and Simple Programming Concepts.			
Expected Outcome The Students will be able to - Describe different modes of operations of a typical microprocessor and microcontroller. - Design and develop 8086 assembly language programs using software interrupts and various assembler directives. - Interface microprocessors with various external devices. - Analyze and compare the features of microprocessors and microcontrollers. - Design and develop assembly language programs using 8051 microcontroller.			
Text Books - Bhurchandi and Ray, <i>Advanced Microprocessors and Peripherals</i>, Third Edition McGraw Hill, 2012 - Raj Kamal, <i>Microcontrollers: Architecture, Programming, Interfacing and System Design</i>, Pearson Education, 2011. - Douglas V. Hall, SSSP Rao, <i>Microprocessors and Interfacing</i>, Third Edition, McGrawHill Education, 2012.			
References - Barry B. Brey, <i>The Intel Microprocessors – Architecture, Programming and Interfacing</i>, Eighth Edition, Pearson Education, 2015 A. NagoorKani, <i>Microprocessors and Microcontrollers</i>, Second Edition, Tata McGraw Hill, 2012.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Evolution of microprocessors, 8086 Microprocessor - Architecture and signals, Memory organisation, Minimum and maximum mode of operation, Minimum mode Timing Diagram. Comparison of 8086 and 8088.	07	15%
II	8086 Addressing Modes, 8086 Instruction set and Assembler Directives - Assembly Language Programming with Subroutines, Macros, Passing Parameters, Use of stack.	08	15%

FIRST INTERNAL EXAM			
III	Interrupts - Types of Interrupts and Interrupt Service Routine. Handling Interrupts in 8086, Interrupt programming. Basic Peripherals and their Interfacing with 8086 - Programmable Interrupt Controller - 8259 - Architecture.	07	15%
IV	Interfacing Memory, I/O, 8255 - Detailed study - Architecture, Control word format and modes of operation, Architecture and modes of operation of 8279 and 8257 (Just mention the control word, no need to memorize the control word format)	07	15%
SECOND INTERNAL EXAM			
V	Microcontrollers - Types of Microcontrollers - Criteria for selecting a microcontroller - Example Applications. Characteristics and Resources of a microcontroller. Organization and design of these resources in a typical microcontroller - 8051. 8051 Architecture, Register Organization, Memory and I/O addressing, Interrupts and Stack.	08	20%
VI	8051 Addressing Modes, Different types of instructions and Instruction Set, Simple programs. Peripheral Chips for timing control - 8254/8253.	08	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be *five* parts in the question paper – A, B, C, D, E
- Part A
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules I and II; All four questions have to be answered.
- Part B
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
- Part C
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
- Part D
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
- Part E
 - Total Marks: 40
 - Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - A question can have a maximum of three sub-parts.
- There should be at least 60% analytical/numerical questions.

Course code	Course Name	L-T-P - Credits	Year of Introduction
CS306	Computer Networks	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives - To build an understanding of the fundamental concepts of computer networking. - To introduce the basic taxonomy and terminology of computer networking. - To introduce advanced networking concepts.			
Syllabus Concept of layering, LAN technologies (Ethernet), Flow and error control techniques, switching, IPv4/IPv6, routers and routing algorithms (distance vector, link state), TCP/UDP and sockets, congestion control, Application layer protocols.			
Expected Outcome The students will be able to - Visualise the different aspects of networks, protocols and network design models. - Examine various Data Link layer design issues and Data Link protocols. - Analyse and compare different LAN protocols. - Compare and select appropriate routing algorithms for a network. - Examine the important aspects and functions of network layer, transport layer and application layer in internetworking.			
Text Books - Andrew S. Tanenbaum, Computer Networks, 4/e, PHI. - Behrouz A. Forouzan, Data Communications and Networking, 4/e, Tata McGraw Hill. - Larry L. Peterson & Bruce S. Dave, Computer Networks-A Systems Approach, 5/e, Morgan Kaufmann, 2011.			
References - Fred Halsall, Computer Networking and the Internet, 5/e. - James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e. - Keshav, An Engineering Approach to Computer Networks, Addison Wesley, 1998. - Request for Comments (RFC) Pages - IETF -https://www.ietf.org/rfc.html W. Richard Stevens. TCP/IP Illustrated volume 1, Addison-Wesley, 2005. - William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction – Uses – Network Hardware – LAN –MAN – WAN, Internetworks – Network Software – Protocol hierarchies – Design issues for the layers – Interface & Service – Service Primitives. Reference models – OSI – TCP/IP.	07	15%
II	Data Link layer Design Issues – Flow Control and ARQ techniques. Data link Protocols – HDLC. DLL in Internet. MAC Sub layer – IEEE 802 FOR LANs & MANs, IEEE 802.3, 802.4, 802.5. Bridges - Switches – High Speed LANs - Gigabit Ethernet. Wireless LANs - 802.11 a/b/g/n, 802.15.PPP	08	15%
FIRST INTERNAL EXAMINATION			

III	Network layer – Routing – Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, RIP, OSPF, Routing for mobile hosts.	07	15%
IV	Congestion control algorithms – QoS. Internetworking – Network layer in internet. IPv4 - IP Addressing – Classless and Classfull Addressing. Sub-netting.	07	15%
SECOND INTERNAL EXAMINATION			
V	Internet Control Protocols – ICMP, ARP, RARP, BOOTP. Internet Multicasting – IGMP, Exterior Routing Protocols – BGP. IPv6 – Addressing – Issues, ICMPv6.	07	20%
VI	Transport Layer – TCP & UDP. Application layer –FTP, DNS, Electronic mail, MIME, SNMP. Introduction to World Wide Web.	07	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be *five* parts in the question paper – A, B, C, D, E
- Part A
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules I and II; All four questions have to be answered.
- Part B
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
- Part C
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
- Part D
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
- Part E
 - Total Marks: 40
 - Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - A question can have a maximum of three sub-parts.
- There should be at least 60% analytical/numerical questions.

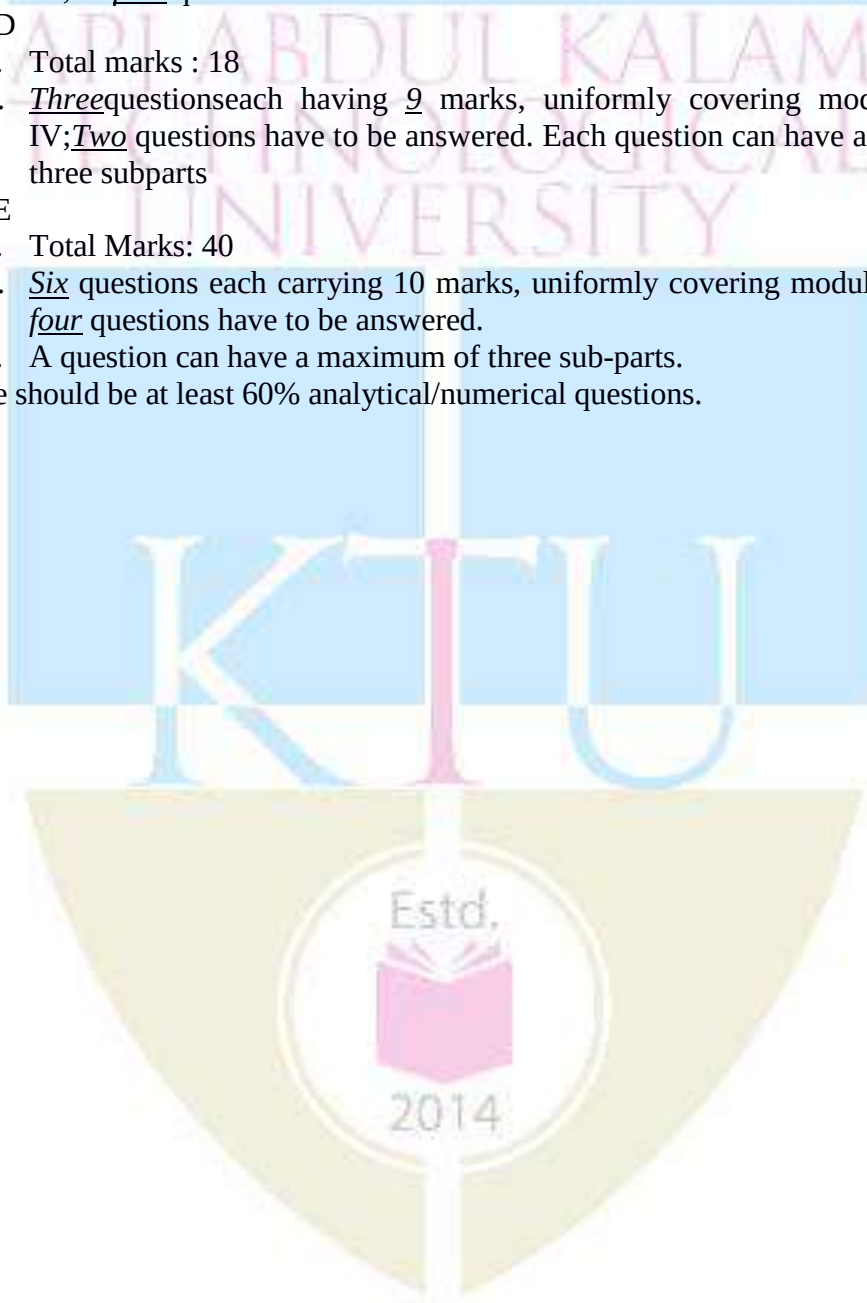
Course code.	Course Name	L-T-P-Credits	Year of Introduction
CS307	DATA COMMUNICATION	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives - To introduce fundamental communication models. - To discuss various time domain and frequency domain concepts of data communication. - To introduce the concepts of encoding, multiplexing and spread spectrum.			
Syllabus Data Transmission, Transmission Impairments, Channel Capacity, Transmission media, Wireless propagation, Signal encoding Techniques, Multiplexing, Digital data transmission techniques, Sampling theorem, Error detection and correction, Spread spectrum, Basic principles of switching.			
Expected Outcome The Students will be able to - Identify and list the various issues present in the design of a data communication system. - Apply the time domain and frequency domain concepts of signals in data communication. - Compare and select transmission media based on transmission impairments and channel capacity. - Select and use appropriate signal encoding techniques and multiplexing techniques for a given scenario. - Design suitable error detection and error correction algorithms to achieve error free data communication and explain different switching techniques.			
Text Books - Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning. [Chapter 3,4,9,10] - Forouzan B. A., Data Communications and Networking, 5/e, Tata McGraw Hill, 2013. [Chapters:3,4, 5, 6,7,8] - Schiller J., Mobile Communications, 2/e, Pearson Education, 2009. [Chapters:2,3] - William Stallings, Data and Computer Communication 9/e, Pearson Education, Inc. [Chapters: 4, 5, 6, 7, 8, 9].			
References - Forouzan B. A., Data Communications and Networking, 4/e, Tata McGraw Hill, 2007. - Tanenbaum A. S. and D. Wetherall, Computer Networks, Pearson Education, 2013.			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam Marks

I	Data Transmission: Communication model Simplex, half duplex and full duplex transmission - Periodic Analog signals: Sine wave, phase, wavelength, time and frequency domain, bandwidth - Digital Signals; Digital data Transmission:- Analog & Digital data, Analog & Digital signals, Analog & Digital transmission – Transmission Impairments: Attenuation, Delay distortion, Noise - Channel capacity: Nyquist Bandwidth, Shannon's Capacity formula.	08	15%
II	Transmission media - Guided Transmission Media: Twisted pair, Coaxial cable, optical fiber, Wireless Transmission, Terrestrial microwave, Satellite microwave. Wireless Propagation: Ground wave propagation, Sky Wave propagation, LoS Propagation.	07	15%
FIRST INTERNAL EXAM			
III	Signal Encoding techniques - Digital Data Digital Signals: NRZ, Multilevel binary, Biphase - Digital Data Analog Signals : ASK, FSK, PSK - Analog Data Digital Signals: Sampling theorem, PCM, Delta Modulation - Analog Data Analog Signals: AM, FM, PM.	07	15%
IV	Multiplexing- Space Division Multiplexing-Frequency Division Multiplexing: Wave length Division Multiplexing - Time Division multiplexing: Characteristics, Digital Carrier system, SONET/SDH-Statistical time division multiplexing: Cable Modem - Code Division Multiplexing. Multiple Access– CDMA.	07	15%
SECOND INTERNAL EXAM			
V	Digital Data Communication Techniques - Asynchronous transmission, Synchronous transmission-Detecting and Correcting Errors-Types of Errors-Error Detection: Parity check, Cyclic Redundancy Check (CRC) - Error Control Error Correction: Forward Error Correction and Hamming Distance.	06	20%
VI	Spread Spectrum Techniques-Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS). Basic principles of switching - Circuit Switched Networks, Structure of Circuit Switch - Packet Switching: Datagram Networks, Virtual Circuit Networks, Structure of packet switches.	07	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be *five* parts in the question paper – A, B, C, D, E
- Part A
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules I and II; All four questions have to be answered.
- Part B

- a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
4. Part C
- a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
5. Part D
- a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
- a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
7. There should be at least 60% analytical/numerical questions.



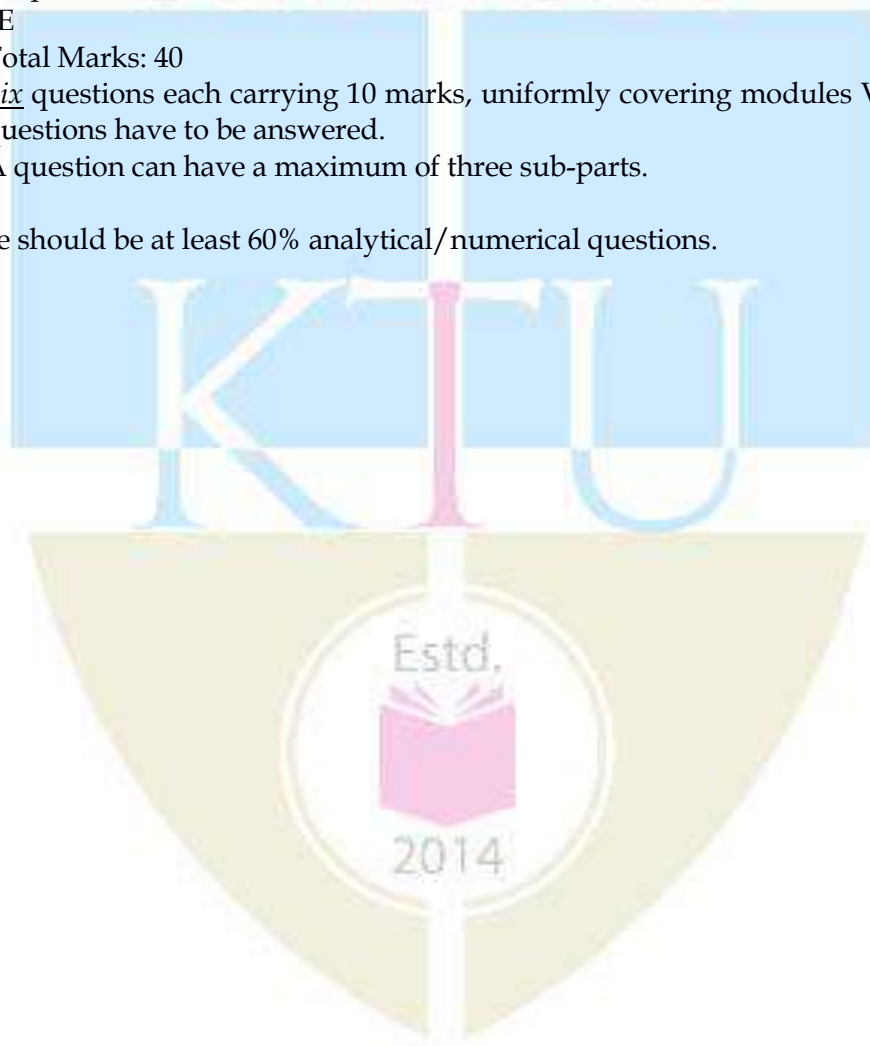
Course code	Course Name	L-T-P-Credits	Year of Introduction
CS308	Software Engineering and Project Management	3-0-0-3	2016
Pre-requisite: Nil			
Course Objectives - To introduce the fundamental concepts of software engineering. - To build an understanding on various phases of software development. - To introduce various software process models.			
Syllabus Introduction to software engineering, Software process models, Software development phases, Requirement analysis, Planning, Design, Coding, Testing, Maintenance.			
Expected Outcome The students will be able to - Identify suitable life cycle models to be used. - Analyze a problem and identify and define the computing requirements to the problem. - Translate a requirement specification to a design using an appropriate software engineering methodology. - Formulate appropriate testing strategy for the given software system. - Develop software projects based on current technology, by managing resources economically and keeping ethical values.			
References - Ian Sommerville, Software Engineering, University of Lancaster, Pearson Education, Seventh edition, 2004. K. K. Aggarwal and Yogesh Singh, Software Engineering, New age International Publishers, Second edition, 2005. - Roger S. Pressman, Software Engineering : A practitioner's approach, McGraw Hill publication, Eighth edition, 2014 - S.A. Kelkar, Software Project Management: A concise study, PHI, Third edition, 2012. - Walker Royce, Software Project Management : A unified frame work, Pearson Education, 1998			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to software engineering- scope of software	07	15%

	engineering - historical aspects, economic aspects, maintenance aspects, specification and design aspects, team programming aspects. Software engineering a layered technology - processes, methods and tools. Software process models - prototyping models, incremental models, spiral model, waterfall model.		
II	Process Framework Models: Capability maturity model (CMM), ISO 9000. Phases in Software development - requirement analysis- requirements elicitation for software, analysis principles, software prototyping, specification.	06	15%
FIRST INTERNAL EXAM			
III	Planning phase - project planning objective, software scope, empirical estimation models- COCOMO, single variable model, staffing and personal planning. Design phase - design process, principles, concepts, effective modular design, top down, bottom up strategies, stepwise refinement.	07	15%
IV	Coding - programming practice, verification, size measures, complexity analysis, coding standards. Testing - fundamentals, white box testing, control structure testing, black box testing, basis path testing, code walk-throughs and inspection, testing strategies-Issues, Unit testing, integration testing, Validation testing, System testing.	07	15%
SECOND INTERNAL EXAM			
V	Maintenance-Overview of maintenance process, types of maintenance. Risk management: software risks - risk identification-risk monitoring and management. Project Management concept: People - Product-Process-Project.	07	20%
VI	Project scheduling and tracking: Basic concepts-relation between people and effort-defining task set for the software project-selecting software engineering task Software configuration management: Basics and standards User interface design - rules. Computer aided software engineering tools - CASE building blocks, taxonomy of CASE tools, integrated CASE environment.	08	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be *five* parts in the question paper - A, B, C, D, E
- Part A
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules I and II;

- Allfour questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
 4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules III and IV; Allfour questions have to be answered.
 5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
 6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.
 7. There should be at least 60% analytical/numerical questions.

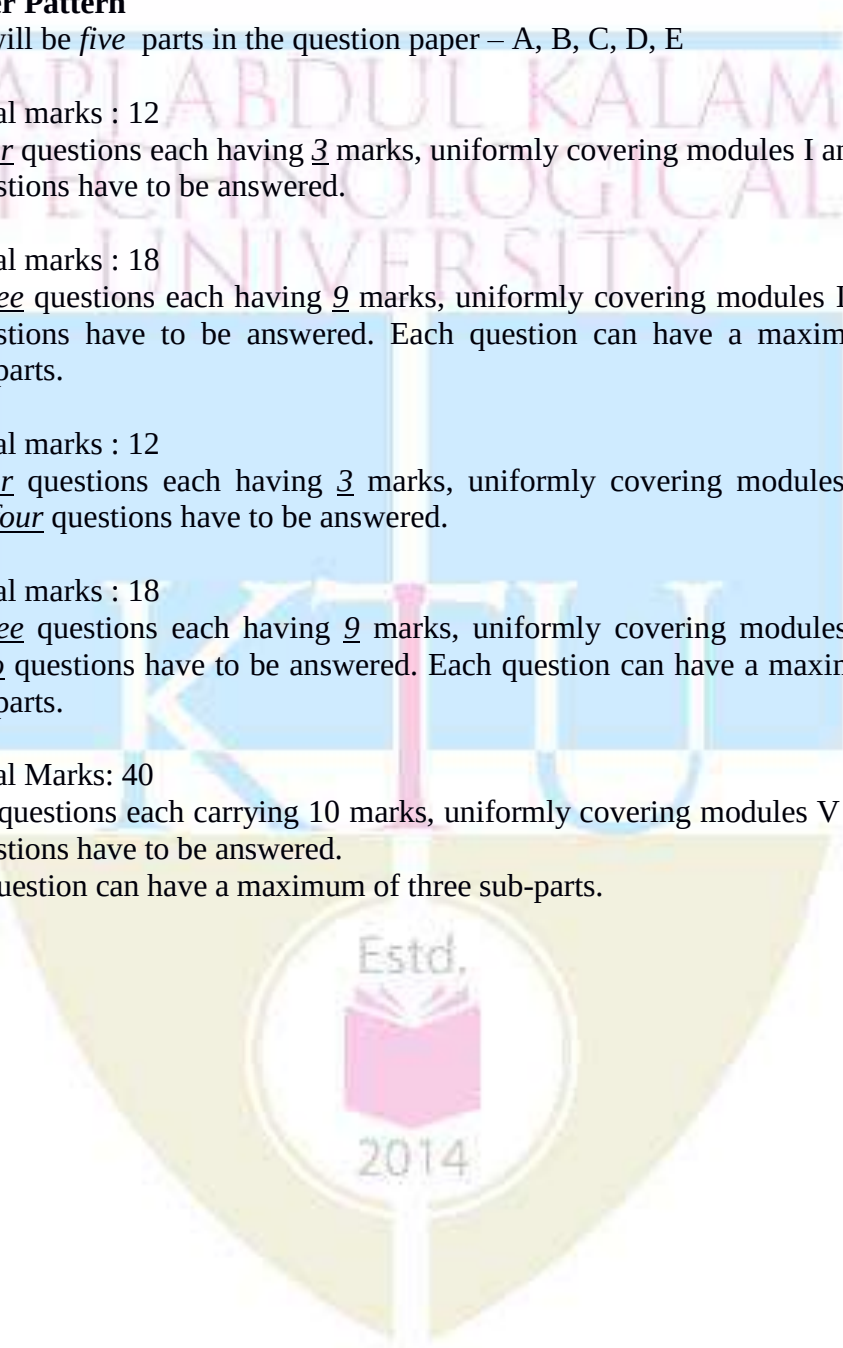


Course code	Course Name	L-T-P Credits	Year of Introduction
CS366	Natural language processing	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives - To introduce the fundamentals of Language processing from the algorithmic viewpoint. - To discuss various issues those make natural language processing a hard task. - To discuss some applications of Natural Language Processing (NLP).			
Syllabus Levels of Language Analysis, Syntax, Semantics and Pragmatics of Natural Language, Language Processing, Issues and approaches to solutions, Applications of Natural Language Processing (NLP).			
Expected Outcome The student able to 1. appreciate the fundamental concepts of Natural Language Processing. 2. design algorithms for NLP tasks. 3. develop useful systems for language processing and related tasks involving text processing.			
Text Books 1. D. Jurafsky and J. H. Martin, Speech and Language Processing, Prentice Hall India, 2000 2. James Allen, Natural Language Understanding, 2e, The Benjamin/Cummings Publishing Company Inc., Redwood City, CA.			
References 1. Charniak, Eugene, Introduction to Artificial intelligence, Addison-Wesley, 1985.. 2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 1999. 3. U. S. Tiwary and Tanveer Siddiqui, Natural Language Processing and Information Retrieval, Oxford University Press, 2008.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Natural Language Understanding- Levels of language analysis- Syntax, Semantics, Pragmatics. Linguistic Background- An Outline of English Syntax.	8	15%
II	Lexicons, POS Tagging, Word Senses. Grammars and Parsing- Features, Agreement and Augmented Grammars.	7	15%
FIRST INTERNAL EXAM			
III	Grammars for Natural Language, Parsing methods and Efficient Parsing. Ambiguity Resolution- Statistical Methods. Probabilistic Context Free Grammar.	9	15%
IV	Semantics and Logical Form: Linking Syntax and Semantics- Ambiguity Resolution- other Strategies for Semantic Interpretation- Scoping and the Interpretation of Noun Phrases.	6	15%
SECOND INTERNAL EXAM			
V	Knowledge Representation and Reasoning- Local Discourse	8	20%

	Context and Reference- Using World Knowledge- Discourse Structure- Defining a Conversational Agent.		
VI	Applications- Machine Translation, Information Retrieval and Extraction, Text Categorization and Summarization.	4	20%
END SEMESTER EXAM			

Question Paper Pattern

1. There will be five parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules I and II; Allfour questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules III and IV; Allfour questions have to be answered.
5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts.
6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.



Course code	Course Name	L-T-P - Credits	Year of Introduction
CS367	Logic for Computer Science	3-0-0-3	2016
Pre-requisites : CS205 Data Structures			
Course Objectives - To introduce the concepts of mathematical logic and its importance. - To discuss propositional, predicate, temporal and modal logic and their applications.			
Syllabus Propositional Logic, Resolution, binary decision diagrams, Predicate logic, resolution, temporal logic, deduction, program verification, modal logic.			
Expected Outcome The students will be able to - Gain the concept of logic and its importance. - Understand fundamental concepts in propositional, predicate and temporal logic and apply resolution techniques. - Apply the concept of program verification in real-world scenarios. - Know the fundamental concepts in modal logic.			
Text Books - Arindhama Singh, Logics for Computer Science, Prentice Hall India, 2004. - Modechai Ben-Ari, Mathematical Logic for Computer Science, Springer, 3/e, 2012.			
Reference Michael Huth, Mark Ryan, Logic in Computer Science: Modeling and Reasoning about Systems, Cambridge University Press, 2005.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introductory Concepts: Mathematical Logic, Propositional Logic, First Order Logic, Modal and Temporal logic, Program Verification. (Reading: Ben-Ari, Chapter 1) Propositional Logic: Formulae and interpretations, Equivalence, Satisfiability & Validity, Semantic Tableaux, Soundness and Completeness. (Reading: Ben-Ari, Chapter 2 except 2.4, Additional Reading : Singh, Chapter 1)	06	15%
II	The Hilbert Deductive System, Derived Rules, Theorems and operators, Soundness and Completeness, Consistency. (Reading: Ben-Ari, Chapter 3 except 3.7 and 3.8, Additional Reading : Singh, Chapter 1) Resolution in Propositional Logic: Conjunctive Normal form, Clausal form, resolution rule. (Reading: Ben-Ari, Chapter 4.1, 4.2, 4.3, Additional Reading : Singh, Chapter 1)	06	15%
FIRST INTERNAL EXAM			
III	Binary Decision Diagrams: Definition, Reduced and ordered BDD, Operators. (Reading: Ben-Ari, Chapter 5.1 – 5.5) Predicate Logic: Relations, predicates, formulae and interpretation, logical equivalence, semantic tableaux, soundness. Reading: Ben-Ari, Chapter 7.1-7.6, Additional Reading : Singh, Chapter 2)	07	15%

IV	The Hilbert deduction system for predicate logic. Functions, PCNF and clausal form, Herbrand model. Resolution in predicate logic: ground resolution, substitution, unification, general resolution. Reading: Ben-Ari, Chapter 8.1-8.4, 9.1, 9.3, 10.1-10.4, Additional Reading : Singh, Chapter 2, Chapter 3)	08	15%
SECOND INTERNAL EXAM			
V	Temporal logic: Syntax and semantics, models of time, linear time temporal logic, semantic tableaux. Deduction system of temporal logic. (Reading: Ben-Ari, Chapter 13.1-13.5, 14.1-14.2)	07	20%
VI	Program Verification: Need for verification, Framework for verification, Verification of sequential programs, deductive system, verification, synthesis. (Reading: Ben-Ari, Chapter 15.1-15.4, Additional Reading : Singh, Chapter 5) Modal Logic: Need for modal logic, Case Study: Syntax and Semantics of K, Axiomatic System KC, (Reading: Singh, Chapter 6.1-6.3)	08	20%
END SEMESTER EXAM			

Assignments: Some of the assignments can be given on an interactive theorem prover like Isabelle or Coq.

Question Paper Pattern

- There will be *five* parts in the question paper – A, B, C, D, E
- Part A
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules I and II; All four questions have to be answered.
- Part B
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
- Part C
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
- Part D
 - Total marks : 18
 - Three questionseach having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
- Part E
 - Total Marks: 40
 - Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - A question can have a maximum of three sub-parts.

There should be at least 60% analytical/numerical questions.

Course code	Course Name	L-T-P - Credits	Year of Introduction
CS368	Web Technologies	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives - To impart the design, development and implementation of Dynamic Web Pages. - To develop programs for Web using Scripting Languages. - To give an introduction to Data Interchange formats in Web.			
Syllabus Basics of Internet and World Wide Web, HTML and XHTML, Cascading Style Sheets, Frameworks, Basics of JavaScript, JQuery, Introduction to XML and JSON, Overview of PHP			
Expected Outcome The student will be able to - Understand different components in web technology and to know about CGI and CMS. - Develop interactive Web pages using HTML/XHTML. - Present a professional document using Cascaded Style Sheets. - Construct websites for user interactions using JavaScript and JQuery. - Know the different information interchange formats like XML and JSON. - Develop Web applications using PHP.			
Text Books P. J. Deitel, H.M. Deitel, Internet & World Wide Web How To Program, 4/e, Pearson International Edition 2010. - Robert W Sebesta, Programming the World Wide Web, 7/e, Pearson Education Inc., 2014.			
References - Bear Bibeault and Yehuda Katz, jQuery in Action, Second Edition, Manning Publications.[Chapter 1] Black Book, Kogent Learning Solutions Inc. 2009. - Bob Boiko, Content Management Bible, 2nd Edition, Wiley Publishers. [Chapter 1, 2] - Chris Bates, Web Programming Building Internet Applications, 3/e, Wiley India Edition 2009. - Dream Tech, Web Technologies: HTML, JS, PHP, Java, JSP, ASP.NET, XML, AJAX, - Jeffrey C Jackson, Web Technologies A Computer Science Perspective, Pearson Education Inc. 2009. - Lindsay Bassett, Introduction to JavaScript Object Notation: A To-the-Point Guide to JSON 1st Edition, O'Reilly.[Chapter 1,2,3,4] - Matthew MacDonald, WordPress: The Missing Manual, 2nd Edition, O'Reilly Media. [Chapter 1]			
Web Resources www.w3.org/CGI/ old.tree.ro/en/strategy-white-papers/content-management-systems.pdf httpd.apache.org/download.cgi https://alistapart.com/article/frameworks http://getbootstrap.com/css/ https://www.w3.org/TR/WD-DOM/introduction.html			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks

I	Introduction to the Internet: The World Wide Web, Web Browsers, Web Servers, Uniform Resource Locators, Multipurpose Internet Mail Extensions, The Hypertext Transfer Protocol. Common Gateway Interface(CGI), Content Management System – Basics <i>Case Study:</i> Apache Server, WordPress.	06	15%
II	Introduction to HTML/XHTML : Origins and Evolution of HTML and XHTML, Basic Syntax of HTML, Standard HTML Document Structure, Basic Text Markup, Images, Hypertext Links, Lists, Tables, Forms, HTML5, Syntactic Differences between HTML and XHTML.	07	15%
FIRST INTERNAL EXAM			
III	Introduction to Styles sheets and Frameworks Cascading Style Sheets: Levels of Style Sheets - Style Specification Formats, Selector Forms, Property-Value Forms, Font Properties, List Properties, Alignment of Text, Color, The Box Model, Background Images, The span and div Tags. Frameworks: Overview and Basics of Responsive CSS Frameworks - Bootstrap.	06	15%
IV	Introduction to JavaScript and jQuery The Basics of JavaScript: Overview of JavaScript, Object Orientation and JavaScript, General Syntactic Characteristics-Primitives, Operations, and Expressions, Screen Output and Keyboard Input, Control Statements, Object Creation and Modification, Arrays, Functions. Callback Functions, JavaScript HTML DOM. Introduction to jQuery: Overview and Basics.	07	15%
SECOND INTERNAL EXAMINATION			
V	Introduction to Data Interchange Formats XML: The Syntax of XML, XML Document Structure, Namespaces, XML Schemas, Displaying Raw XML Documents, Displaying XML Documents with CSS, XSLT Style Sheets, XML Applications. JSON(Basics Only): Overview, Syntax, Datatypes, Objects, Schema, Comparison with XML.	08	20%
VI	Introduction to PHP: Origins and Uses of PHP, Overview of PHP - General Syntactic Characteristics - Primitives, Operations, and Expressions - Control Statements, Arrays, Functions, Pattern Matching, Form Handling, Cookies, Session Tracking.	08	20%
END SEMESTER EXAM			

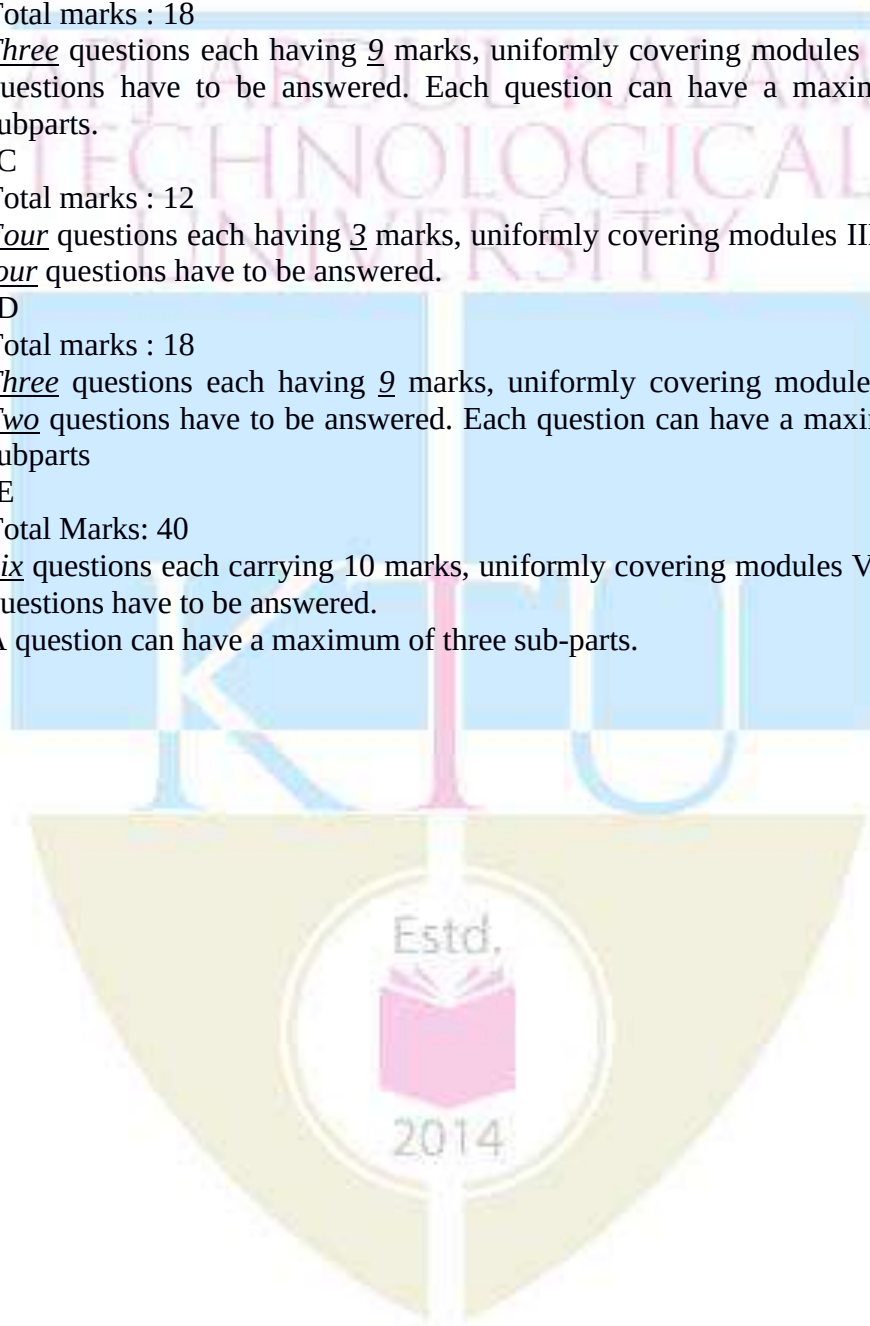
Assignment:

It is highly recommended to give assignment based on:

1. JavaScript Frameworks (like AngularJS or/and NodeJS)
2. Any PHP web app based on frameworks (like Laravel, CodeIgniter, CakePHP, Zend etc.)

Question Paper Pattern

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules I and II; All four questions have to be answered.
3. Part B
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three subparts.
4. Part C
 - a. Total marks : 12
 - b. Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
5. Part D
 - a. Total marks : 18
 - b. Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
6. Part E
 - a. Total Marks: 40
 - b. Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - c. A question can have a maximum of three sub-parts.



Course code	Course Name	L-T-P - Credits	Year of Introduction
CS369	Digital System Testing & Testable Design	3-0-0-3	2016
Pre-requisites : CS234 Digital Systems Lab			
Course Objectives - To expose the students to the basics of digital testing techniques applied to VLSI circuits. - To introduce the concepts of algorithm development for automatic test pattern generation for digital circuits. - To discuss fundamentals of design for testability.			
Syllabus Basic terminology used in testing - functional and structural models of digital systems -logic simulation for design verification and testing-fault modeling - fault simulation - testing for faults - design for testability.			
Expected Outcome The students will be able to - Appreciate the basics of VLSI testing and functions modeling of circuits. - Apply fault modeling using single stuck & multiple stuck modeling for combinational circuits. - Evaluate different methods for logic and fault simulations. - Generate test patterns using automatic test pattern generation methods like D, PODEM & FAN algorithms for combinational circuits. - Explain automatic test pattern generation using time frame expansion and simulation based method for sequential circuits. - Design digital circuits using scan path and self tests.			
Text Books - Alexander Miczo, Digital Logic Testing and Simulation, Wiley, 2e, 2003. - Michael L. Bushnell and Vishwani D. Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Springer, 2002. - Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, Digital Systems Testing and Testable Design, Jaico Publishers, 2006.			
Reference Zainalabedin Navabi, Digital System test and testable design, Springer, 2011.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Fundamentals of Testing: Testing & Diagnosis, testing at different levels of abstraction, errors & faults, modeling & evaluation, types of testing, test generation Modeling: Functional modeling at logic level, functional modeling at register level & structural models.	06	15%
II	Fault Modeling : Logic fault models, Fault detection and redundancy, Fault equivalence & fault location, fault dominance, single stuck faults, multiple stuck fault models .	06	15%
FIRST INTERNAL EXAM			

III	Logic & fault Simulation: Simulation for verification & test evaluation, types of simulation – compiled code & Event driven, serial fault simulation, statistical method for fault simulation.	07	15%
IV	Combinational circuit test generation: ATG for SSFs in combinational circuits – fault oriented ATG- fault independent ATG- random test generation, Sensitized path, D-algorithm, PODEM and FAN.	07	15%
SECOND INTERNAL EXAM			
V	Sequential circuit test generation: ATPG for single clock synchronous circuits, time frame expansion method, simulation based sequential circuit ATPG – genetic algorithm.	07	20%
VI	Design for Testability: introduction to testability, design for testability techniques, controllability and observability by means of scan registers, generic scan based designs – scan path, boundary scan, Introduction to BIST.	09	20%
END SEMESTER EXAM			

Question Paper Pattern:

- There will be *five* parts in the question paper – A, B, C, D, E
- Part A
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules I and II; All four questions have to be answered.
- Part B
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules I and II; Two questions have to be answered. Each question can have a maximum of three sub-parts
- Part C
 - Total marks : 12
 - Four questions each having 3 marks, uniformly covering modules III and IV; All four questions have to be answered.
- Part D
 - Total marks : 18
 - Three questions each having 9 marks, uniformly covering modules III and IV; Two questions have to be answered. Each question can have a maximum of three subparts
- Part E
 - Total Marks: 40
 - Six questions each carrying 10 marks, uniformly covering modules V and VI; four questions have to be answered.
 - A question can have a maximum of three sub-parts.
- There should be at least 60% analytical/numerical/design questions.

Course code.	Course Name	L-T-P - Credits	Year of Introduction
CS372	HIGH PERFORMANCE COMPUTING	3-0-0-3	2016
Pre-requisites : CS202 Computer Organization and Architecture			
Course Objectives - To introduce the concepts of Modern Processors. - To introduce Optimization techniques for serial code. - To introduce Parallel Computing Paradigms. - To introduce Parallel Programming using OpenMP and MPI.			
Syllabus Modern processors - pipelining-superscalarity-multicore processors- Mutithreaded processors- vector processors- basic optimization techniques for serial code - taxonomy of parallel computing paradigms- shared memory computers- distributed-memory computers- Hierarchical Systems- networks- basics of parallelization - data parallelism - function parallelism- Parallel scalability- shared memory parallel programming with OpenMp - Distributed-memory parallel programming with MPI.			
Expected Outcome The students will be able to - appreciate the concepts used in Modern Processors for increasing the performance. - appreciate Optimization techniques for serial code. - appreciate Parallel Computing Paradigms. - identify the performance issues in Parallel Programming using OpenMP and MPI.			
Text Book Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, Chapman & Hall / CRC Computational Science series, 2011.			
References - Charles Severance, Kevin Dowd, High Performance Computing, O'Reilly Media, 2nd Edition, 1998. - Kai Hwang, Faye Alaye Briggs, Computer Architecture and Parallel Processing, McGraw Hill, 1984.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Modern Processors : Stored Program Computer Architecture- General purpose cache- based microprocessor-Performance based metrics and benchmarks- Moore's Law- Pipelining- Superscalarity- SIMD- Memory Hierarchies Cache- mapping- prefetch- Multicore processors- Mutithreaded processors- Vector Processors- Design Principles- Maximum performance estimates- Programming for vector architecture.	07	15%

II	Basic optimization techniques for serial code : scalar profiling- function and line based runtime profiling- hardware performance counters- common sense optimizations- simple measures, large impact- elimination of common subexpressions- avoiding branches- using simd instruction sets- the role of compilers - general optimization options- inlining - aliasing- computational accuracy- register optimizations- using compiler logs- c++ optimizations - temporaries- dynamic memory management- loop kernels and iterators data access optimization: balance analysis and light speed estimates- storage order- case study: jacobi algorithm and dense matrix transpose.	07	15%
FIRST INTERNAL EXAM			
III	Parallel Computers : Taxonomy of parallel computing paradigms- Shared memory computers- Cache coherence- UMA - ccNUMA- Distributed-memory computers- Hierarchical systems- Networks- Basic performance characteristics- Buses- Switched and fat- tree networks- Mesh networks- Hybrids - Basics of parallelization - Why parallelize - Data Parallelism - Function Parallelism- Parallel Scalability- Factors that limit parallel execution- Scalability metrics- Simple scalability laws- parallel efficiency - serial performance Vs Strong scalability- Refined performance models- Choosing the right scaling baseline- Case Study: Can slow processors compute faster- Load balance.	07	15%
IV	Distributed memory parallel programming with MPI : message passing - introduction to MPI – example - messages and point-to-point communication - collective communication – nonblocking point-to-point communication- virtual topologies - MPI parallelization of Jacobi solver- MPI implementation - performance properties	08	15%
SECOND INTERNAL EXAM			
V	Shared memory parallel programming with OpenMp : introduction to OpenMp - parallel execution - data scoping- OpenMp work sharing for loops- synchronization - reductions - loop scheduling - tasking - case study: OpenMp- parallel jacobi algorithm- advanced OpenMpwavefront parallelization- Efficient OpenMP programming: Profiling OpenMP programs - Performance pitfalls- Case study: Parallel Sparse matrix-vector multiply.	08	20%
VI	Efficient MPI programming : MPI performance tools- communication parameters- Synchronization, serialization, contention- Reducing communication overhead- optimal domain decomposition- Aggregating messages – Nonblocking Vs Asynchronous communication- Collective communication- Understanding intra-node point-to-point communication.	08	20%
END SEMESTER EXAM			

Question Paper Pattern

1. There will be *five* parts in the question paper – A, B, C, D, E
2. Part A
 - a. Total marks : 12

Course code	Course Name	L-T-P Credits	Year of Introduction
CS401	COMPUTER GRAPHICS	4-0-0-4	2016
Course Objectives : - To introduce concepts of graphics input and display devices. - To discuss line and circle drawing algorithms. - To introduce 2D and 3D transformations and projections. - To introduce fundamentals of image processing.			
Syllabus: Basic Concepts in Computer Graphics. Input devices. Display devices. Line and circle drawing Algorithms. Solid area scan-conversion. Polygon filling. Two dimensional transformations. Windowing, clipping. 3D Graphics, 3D transformations. Projections – Parallel, Perspective. Hidden Line Elimination Algorithms. Image processing – digital image representation – edge detection – Robert, Sobel, Canny edge detectors. Scene segmentation and labeling – region-labeling algorithm – perimeter measurement.			
Expected Outcome: The Students will be able to : - compare various graphics devices - analyze and implement algorithms for line drawing, circle drawing and polygon filling - apply geometrical transformation on 2D and 3D objects - analyze and implement algorithms for clipping - apply various projection techniques on 3D objects - summarize visible surface detection methods - interpret various concepts and basic operations of image processing			
Text Books: - Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996 E. Gose, R. Johnsonbaugh and S. Jost., Pattern Recognition and Image Analysis, PHI PTR, 1996 (Module VI – Image Processing part) - William M. Newman and Robert F. Sproull , Principles of Interactive Computer Graphics. McGraw Hill, 2e, 1979 - Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 1986.			
References: - David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill, 2001. M. Sonka, V. Hlavac, and R. Boyle, Image Processing, Analysis, and Machine Vision, Thomson India Edition, 2007. - Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing. Pearson, 2017			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Basic concepts in Computer Graphics – Types of Graphic Devices – Interactive Graphic inputs – Raster Scan and Random Scan Displays.	7	15%
II	Line Drawing Algorithm- DDA, Bresenham's algorithm – Circle Generation Algorithms –Mid point circle algorithm, Bresenham's algorithm- Scan Conversion-frame buffers – solid area scan conversion – polygon filling algorithms	8	15%
FIRST INTERNAL EXAM			
III	Two dimensional transformations. Homogeneous coordinate systems – matrix formulation and concatenation of transformations. Windowing concepts –Window to Viewport Transformation- Two dimensional clipping-Line clipping – Cohen Sutherland, Midpoint Subdivision algorithm	8	15%
IV	Polygon clipping-Sutherland Hodgeman algorithm, Weiler-Atherton algorithm, Three dimensional object representation- Polygon surfaces, Quadric surfaces – Basic 3D transformations	8	15%
SECOND INTERNAL EXAM			
V	Projections – Parallel and perspective projections – vanishing points. Visible surface detection methods– Back face removal- Z-Buffer algorithm, A-buffer algorithm, Depth-sorting method, Scan line algorithm.	9	20%
VI	Image processing – Introduction - Fundamental steps in image processing – digital image representations – relationship between pixels – gray level histogram –spatial convolution and correlation – edge detection – Robert, Prewitt, Sobel.	8	20%
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

1. There will be **FOUR** parts in the question paper – A, B, C, D
2. **Part A**
 - a. **Total marks : 40**
 - b. **TEN** questions, each have **4 marks**, covering **all the SIX modules** (**THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**).
All the TEN questions have to be answered.
3. **Part B**
 - a. **Total marks : 18**
 - b. **THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question *uniformly* covers **modules I & II**.
 - c. *Any TWO* questions have to be answered.
 - d. Each question can have *maximum THREE* subparts.
4. **Part C**
 - a. **Total marks : 18**
 - b. **THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question *uniformly* covers **modules III & IV**.
 - c. *Any TWO* questions have to be answered.
 - d. Each question can have *maximum THREE* subparts.
5. **Part D**
 - a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question *uniformly* covers **modules V & VI**.
 - c. *Any TWO* questions have to be answered.
 - d. Each question can have *maximum THREE* subparts.
6. There will be **AT LEAST 50%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P Credits	Year of Introduction
CS402	DATA MINING AND WAREHOUSING	3-0-0-3	2016
Course Objectives: - To introduce the concepts of data Mining and its applications - To understand investigation of data using practical data mining tools. - To introduce Association Rules Mining - To introduce advanced Data Mining techniques			
Syllabus: Data Mining, Applications, Data Mining Models, Data Warehousing and OLAP, Challenges, Tools, Data Mining Principles, Data Preprocessing: Data Preprocessing Concepts, Data Visualization, Data Sets and Their Significance, Classification Models, Multi Resolution Spatial Data Mining, Classifiers, Association Rules Mining, Cluster Analysis, Practical Data Mining Tools, Advanced Data Mining Techniques, Web Mining, Text Mining, CRM Applications and Data Mining, Data warehousing.			
Expected Outcome: The Student will be able to : - identify the key process of Data mining and Warehousing - apply appropriate techniques to convert raw data into suitable format for practical data mining tasks - analyze and compare various classification algorithms and apply in appropriate domain - evaluate the performance of various classification methods using performance metrics - make use of the concept of association rule mining in real world scenario - select appropriate clustering and algorithms for various applications - extend data mining methods to the new domains of data			
Text Books: - Dunham M H, "Data Mining: Introductory and Advanced Topics", Pearson Education, New Delhi, 2003. - Jaiwei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Elsevier, 2006.			
References: - M Sudeep Elayidom, "Data Mining and Warehousing", 1st Edition, 2015, Cengage Learning India Pvt. Ltd. - Mehmed Kantardzic, "Data Mining Concepts, Methods and Algorithms", John Wiley and Sons, USA, 2003. - Pang-Ning Tan and Michael Steinbach, "Introduction to Data Mining", Addison Wesley, 2006.			

Course Plan			
Module	Contents	Hours	End Sem Exam . Marks
I	Data Mining:- Concepts and Applications, Data Mining Stages, Data Mining Models, Data Warehousing (DWH) and On-Line Analytical Processing (OLAP), Need for Data Warehousing, Challenges, Application of Data Mining Principles, OLTP Vs DWH, Applications of DWH	6	15%
II	Data Preprocessing: Data Preprocessing Concepts, Data Cleaning, Data integration and transformation, Data Reduction, Discretization and concept hierarchy.	6	15%
FIRST INTERNAL EXAM			
III	Classification Models: Introduction to Classification and Prediction, Issues regarding classification and prediction, Decision Tree- ID3, C4.5, Naive Bayes Classifier.	6	15%
IV	Rule based classification- 1R. Neural Networks-Back propagation. Support Vector Machines, Lazy Learners-K Nearest Neighbor Classifier. Accuracy and error Measures-evaluation. Prediction:-Linear Regression and Non-Linear Regression.	6	15%
SECOND INTERNAL EXAM			
V	Association Rules Mining: Concepts, Apriori and FP-Growth Algorithm. Cluster Analysis: Introduction, Concepts, Types of data in cluster analysis, Categorization of clustering methods. Partitioning method: K-Means and K-Medoid Clustering.	8	20
VI	Hierarchical Clustering method: BIRCH. Density-Based Clustering –DBSCAN and OPTICS. Advanced Data Mining Techniques: Introduction, Web Mining- Web Content Mining, Web Structure Mining, Web Usage Mining. Text Mining. Graph mining:- Apriori based approach for mining frequent subgraphs. Social Network Analysis:- characteristics of social networks. Link mining:- Tasks and challenges.	8	20
END SEMESTER EXAMINATION			

Question Paper Pattern

1. There will be **FOUR** parts in the question paper – **A, B, C, D**
2. **Part A**
 - a. **Total marks : 40**
 - b. **TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**).
All the TEN questions have to be answered.
3. **Part B**
 - a. **Total marks : 18**
 - b. **THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question **uniformly** covers **modules I & II**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
4. **Part C**
 - a. **Total marks : 18**
 - b. **THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question **uniformly** covers **modules III & IV**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
5. **Part D**
 - a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question **uniformly** covers **modules V & VI**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
6. There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P Credits	Year of Introduction
CS403	PROGRAMMING PARADIGMS	3-0-0-3	2016
Course Objectives: - To introduce the basic constructs that underlie all programming languages - To introduce the basics of programming language design and implementation - To introduce the organizational framework for learning new programming languages.			
Syllabus: Names, Scopes, and Bindings - Binding Time, Scope Rules, Storage Management, Overloading, Polymorphism; Control Flow - Expression Evaluation, Structured and Unstructured Flow, Non-determinacy; Data Types - Type Systems, Type Checking, Equality Testing and Assignment; Subroutines and Control Abstraction - Static and Dynamic Links, Calling Sequences, Parameter Passing, Exception Handling, Co-routines; Functional and Logic Languages; Data Abstraction and Object Orientation -Encapsulation, Inheritance, Dynamic Method Binding; Innovative features of Scripting Languages; Concurrency - Threads, Synchronization, Language-Level Mechanisms; Run-time program Management.			
Expected Outcome: The Students will be able to : - compare scope and binding of names in different programming languages - analyze control flow structures in different programming languages - appraise data types in different programming languages - analyze different control abstraction mechanisms - appraise constructs in functional, logic and scripting languages - analyze object oriented constructs in different programming languages - compare different concurrency constructs - interpret the concepts of run- time program management			
Text book: Scott M L, Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers, 2009.			
References: - David A Watt, Programming Language Design Concepts, Wiley Dreamtech, 2004 - Ghezzi C and M. Jazayeri, Programming Language Concepts, 3rd Edn, Wiley.1997 - Kenneth C Loudon, Programming Languages: Principles and Practice, 3rd Edn., Cengage Learning, 2011. - Pratt T W, M V Zelkowitz, and T. V. Gopal, Programming Languages: Design and Implementation, 4th Edn., Pearson Education, 2001 - R W Sebesta, Concepts of Programming Languages, 11th Edn., Pearson Education, 2015 - Ravi Sethi, Programming Languages: Concepts & Constructs, 2nd Edn., Pearson Education, 2006 - Tucker A B and R E Noonan, Programming Languages: Principles and Paradigms, 2nd Edn, McGraw Hill, 2006.			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Names, Scopes and Bindings:- Names and Scopes, Binding Time, Scope Rules, Storage Management, Binding of Referencing Environments. Control Flow: - Expression Evaluation, Structured and Unstructured Flow, Sequencing, Selection, Iteration, Recursion, Non-determinacy.	7	15 %
II	Data Types:-Type Systems, Type Checking, Records and Variants, Arrays, Strings, Sets, Pointers and Recursive Types, Lists, Files and Input/Output, Equality Testing and Assignment.	7	15 %
FIRST INTERNAL EXAM			
III	Subroutines and Control Abstraction: - Static and Dynamic Links, Calling Sequences, Parameter Passing, Generic Subroutines and Modules, Exception Handling, Co-routines.	7	15 %
IV	Functional and Logic Languages:- Lambda Calculus, Overview of Scheme, Strictness and Lazy Evaluation, Streams and Monads, Higher-Order Functions, Logic Programming in Prolog, Limitations of Logic Programming.	7	15 %
SECOND INTERNAL EXAM			
V	Data Abstraction and Object Orientation:-Encapsulation, Inheritance, Constructors and Destructors, Aliasing, Overloading, Polymorphism, Dynamic Method Binding, Multiple Inheritance. Innovative features of Scripting Languages:-Scoping rules, String and Pattern Manipulation, Data Types, Object Orientation.	7	20 %
VI	Concurrency:- Threads, Synchronization. Run-time program Management:- Virtual Machines, Late Binding of Machine Code, Reflection, Symbolic Debugging, Performance Analysis.	7	20 %
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

1. There will be **FOUR** parts in the question paper – A, B, C, D
2. **Part A**
 - a. **Total marks : 40**
 - b. **TEN** questions, each have **4 marks**, covering **all the SIX modules** (**THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**).
All the TEN questions have to be answered.
3. **Part B**
 - a. **Total marks : 18**
 - b. **THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question **uniformly** covers **modules I & II**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
4. **Part C**
 - a. **Total marks : 18**
 - b. **THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question **uniformly** covers **modules III & IV**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
5. **Part D**
 - a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question **uniformly** covers **modules V & VI**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
6. There will be **AT LEAST 50%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P -Credits	Year of Introduction
CS404	Embedded Systems	3-0-0-3	2016
Course Objectives: - To introduce the technologies behind embedded computing systems. - To introduce and discuss various software components involved in embedded system design and development. - To expose students to the recent trends in embedded system design.			
Syllabus: Introduction to embedded systems, basic components, its characteristics. Modelling embedded systems, firmware development. Integration and testing of embedded systems, development environment. Characteristics of RTOS, interrupt handling, creating tasks in a typical RTOS. Embedded product development life cycle.			
Expected Outcome: The Student will be able to : - demonstrate the role of individual components involved in a typical embedded system - analyze the characteristics of different computing elements and select the most appropriate one for an embedded system - model the operation of a given embedded system - substantiate the role of different software modules in the development of an embedded system - develop simple tasks to run on an RTOS - examine the latest trends prevalent in embedded system design			
References: - J Staunstrup and Wayne Wolf, Hardware / Software Co-Design: Principles and Practice, Prentice Hall. - Jean J. Labrose, Micro C/OS II: The Real Time Kernel, 2e, CRC Press, 2002. - Raj Kamal, Embedded Systems: Architecture, Programming and Design, Third Edition, McGraw Hill Education (India), 2014. - Shibu K.V., Introduction to Embedded Systems, McGraw Hill Education (India), 2009. - Steve Heath, Embedded System Design, Second Edition, Elsevier. - Wayne Wolf , Computers as Components-Principles of Embedded Computer System Design, Morgan Kaufmann publishers, Third edition, 2012.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Fundamentals of Embedded Systems- complex systems and microprocessors- Embedded system design process .Specifications- architecture design of embedded system- design of hardware and software components- structural and behavioural description.	6	15%
II	Hardware Software Co-Design and Program Modelling – Fundamental Issues, Computational Models- Data Flow Graph, Control Data Flow Graph, State Machine,. Sequential Model, Concurrent Model, Object oriented model, UML	9	15%

FIRST INTERNAL EXAMINATION			
III	Design and Development of Embedded Product – Firmware Design and Development – Design Approaches, Firmware Development Languages.	6	15%
IV	Integration and Testing of Embedded Hardware and Firmware- Integration of Hardware and Firmware. Embedded System Development Environment – IDEs, Cross Compilers, Disassemblers, Decompilers, Simulators, Emulators and Debuggers.	6	15%
SECOND INTERNAL EXAMINATION			
V	RTOS based Design – Basic operating system services. Interrupt handling in RTOS environment. Design Principles. Task scheduling models. How to Choose an RTOS. Case Study – MicroC/OS-II.	9	20%
VI	Networks – Distributed Embedded Architectures, Networks for embedded systems, Network based design, Internet enabled systems. Embedded Product Development Life Cycle – Description – Objectives -Phases – Approaches1. Recent Trends in Embedded Computing.	6	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be **FOUR** parts in the question paper – A, B, C, D
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**). **All** questions have to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question **uniformly** covers **modules I & II**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part C**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question **uniformly** covers **modules III & IV**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part D**
 - Total marks : 24**
 - THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question **uniformly** covers **modules V & VI**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- There will be **AT LEAST 50%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P -Credits	Year of Introduction
CS405	COMPUTER SYSTEM ARCHITECTURE	3-0-0-3	2016
Course Objectives: - To impart a basic understanding of the parallel architecture and its operations - To introduce the key features of high performance computers			
Syllabus: Basic concepts of parallel computer models, SIMD computers, Multiprocessors and multi-computers, Cache Coherence Protocols, Multicomputers, Pipelining computers and Multithreading.			
Expected outcome : The Students will be able to : - summarize different parallel computer models - analyze the advanced processor technologies - interpret memory hierarchy - compare different multiprocessor system interconnecting mechanisms - interpret the mechanisms for enforcing cache coherence - analyze different message passing mechanisms - analyze different pipe lining techniques - appraise concepts of multithreaded and data flow architectures			
Text Book: K. Hwang and Naresh Jotwani, Advanced Computer Architecture, Parallelism, Scalability, Programmability, TMH, 2010.			
References: - H P Hayes, Computer Architecture and Organization, McGraw Hill, 1978. K. Hwang & Briggs , Computer Architecture and Parallel Processing, McGraw Hill International, 1986 - M J Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House, 2012. - M Sasikumar, D Shikkare and P Raviprakash, Introduction to Parallel Processing, PHI, 2014. - P M Kogge, The Architecture of Pipelined Computer, McGraw Hill, 1981. - P V S Rao , Computer System Architecture, PHI, 2009. - Patterson D. A. and Hennessy J. L., Morgan Kaufmann , Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann Pub, 4/e, 2010.			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Parallel computer models - Evolution of Computer Architecture, System Attributes to performance, Amdahl's law for a fixed workload. Multiprocessors and Multicomputers, Multivector and SIMD computers, Architectural development tracks, Conditions of parallelism.	6	15%
II	Processors and memory hierarchy - Advanced processor technology- Design Space of processors, Instruction Set Architectures, CISC Scalar Processors, RISC Scalar Processors, Superscalar and vector processors, Memory hierarchy technology.	8	15%
FIRST INTERNAL EXAM			
III	Multiprocessors system interconnects - Hierarchical bus systems, Cross bar switch and multiport memory, Multistage and combining networks. Cache Coherence and Synchronization Mechanisms, Cache Coherence Problem, Snoopy Bus Protocol, Directory Based Protocol, Hardware Synchronization Problem	7	15%
IV	Message Passing Mechanisms-Message Routing schemes, Flow control Strategies, Multicast Routing Algorithms. Pipelining and Superscalar techniques - Linear Pipeline processors and Nonlinear pipeline processors	8	15%
SECOND INTERNAL EXAM			
V	Instruction pipeline design, Arithmetic pipeline design - Super Scalar Pipeline Design	8	20%
VI	Multithreaded and data flow architectures - Latency hiding techniques, Principles of multithreading - Multithreading Issues and Solutions, Multiple context Processors, Fine-grain Multicomputer- Fine-grain Parallelism. Dataflow and hybrid architecture	8	20%
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

1. There will be **FOUR** parts in the question paper – A, B, C, D
2. **Part A**
 - a. **Total marks : 40**
 - b. **TEN** questions, each have **4 marks**, covering **all the SIX modules** (**THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**).
All the TEN questions have to be answered.
3. **Part B**
 - a. **Total marks : 18**
 - b. **THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question *uniformly* covers **modules I & II**.
 - c. *Any TWO* questions have to be answered.
 - d. Each question can have *maximum THREE* subparts.
4. **Part C**
 - a. **Total marks : 18**
 - b. **THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question *uniformly* covers **modules III & IV**.
 - c. *Any TWO* questions have to be answered.
 - d. Each question can have *maximum THREE* subparts.
5. **Part D**
 - a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question *uniformly* covers **modules V & VI**.
 - c. *Any TWO* questions have to be answered.
 - d. Each question can have *maximum THREE* subparts.
6. There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P - Credits	Year of Introduction
CS407	DISTRIBUTED COMPUTING	3-0-0-3	2016
Course Objectives: - To introduce fundamental principles of distributed systems, technical challenges and key design issues. - To impart knowledge of the distributed computing models, algorithms and the design of distributed system.			
Syllabus: Introduction to distributed computing, Design issues, Distributed Computing Models, System models, Inter-process communication, Distributed file system, Name Service , Distributed mutual exclusion , Distributed system design.			
Expected Outcome The Students will be able to : - distinguish distributed computing paradigm from other computing paradigms - identify the core concepts of distributed systems - illustrate the mechanisms of inter process communication in distributed system - apply appropriate distributed system principles in ensuring transparency, consistency and fault-tolerance in distributed file system - compare the concurrency control mechanisms in distributed transactional environment - outline the need for mutual exclusion and election algorithms in distributed systems			
Text Books: - George Coulouris, Jean Dollimore and Tim Kindberg , Distributed Systems: Concepts and Design, Fifth Edition , Pearson Education, 2011 - Pradeep K Sinha, Distributed Operating Systems : Concepts and Design, Prentice Hall of India			
References: - A S Tanenbaum and M V Steen , Distributed Systems: Principles and paradigms, Pearson Education, 2007 - M Solomon and J Krammer, Distributed Systems and Computer Networks, PHI			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Evolution of Distributed Computing -Issues in designing a distributed system- Challenges- Minicomputer model - Workstation model - Workstation-Server model- Processor - pool model - Trends in distributed systems	7	15%
II	System models: Physical models - Architectural models - Fundamental models	6	15%

FIRST INTERNAL EXAM			
III	Interprocess communication: characteristics - group communication - Multicast Communication -Remote Procedure call - Network virtualization. Case study : Skype	7	15%
IV	Distributed file system: File service architecture - Network file system- Andrew file system- Name Service	7	15%
SECOND INTERNAL EXAM			
V	Transactional concurrency control:- Transactions, Nested transactions-Locks-Optimistic concurrency control	7	20%
VI	Distributed mutual exclusion - central server algorithm - ring based algorithm- Maekawa's voting algorithm - Election: Ring -based election algorithm - Bully algorithm	7	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be **FOUR** parts in the question paper - A, B, C, D
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules** (**THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**).
All the TEN questions have to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question *uniformly* covers **modules I & II**.
 - Any TWO** questions have to be answered.
 - Each question can have *maximum THREE* subparts.
- Part C**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question *uniformly* covers **modules III & IV**.
 - Any TWO** questions have to be answered.
 - Each question can have *maximum THREE* subparts.
- Part D**
 - Total marks : 24**
 - THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question *uniformly* covers **modules V & VI**.
 - Any TWO** questions have to be answered.
 - Each question can have *maximum THREE* subparts.
- There will be **AT LEAST 50%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P Credits	Year of Introduction
CS409	CRYPTOGRAPHY AND NETWORK SECURITY	3-0-0-3	2016
Course Objectives: - To introduce fundamental concepts of symmetric and asymmetric cipher models. - To introduce fundamental concepts of authentication. - To introduce network security and web security protocols.			
Syllabus: Symmetric Cipher Models - Differential and linear Cryptanalysis- Block Cipher Design principles- Primitive operations- Key expansions- Inverse Cipher- Principles of Public key Cryptography Systems - Authentication functions- Message authentication codes- Hash functions- Digital signatures- Authentication protocols- Network security - Web Security - secure Socket Layer and Transport layer Security- Secure electronic transaction –Firewalls.			
Expected Outcome: The Students will be able to : - summarize different classical encryption techniques - identify mathematical concepts for different cryptographic algorithms - demonstrate cryptographic algorithms for encryption/key exchange - summarize different authentication and digital signature schemes - identify security issues in network, transport and application layers and outline appropriate security protocols			
Text Books: - Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw-Hill. 2010 - William Stallings, Cryptography and Network Security, Pearson Education, 2014			
References: B. Schneier , Applied Cryptography, Protocols, Algorithms, and Source Code in C, 2 nd Edn, Wiley, 1995. - Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security, PHI, 2002			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Symmetric Cipher Models- Substitution techniques- Transposition techniques- Rotor machines-Steganography. Simplified DES- Block Cipher principles- The Data Encryption Standard, Strength of DES- Differential and linear Cryptanalysis. Block Cipher Design principles- Block Cipher modes of operations.	7	15 %
II	IDEA: Primitive operations- Key expansions- One round, Odd round, Even Round- Inverse keys for decryption. AES: Basic Structure- Primitive operation- Inverse Cipher- Key Expansion, Rounds, Inverse Rounds. Stream Cipher –RC4.	7	15 %
FIRST INTERNAL EXAM			

III	Public key Cryptography: - Principles of Public key Cryptography Systems, Number theory- Fundamental Theorem of arithmetic, Fermat's Theorem, Euler's Theorem, Euler's Totient Function, Extended Euclid's Algorithm, Modular arithmetic. RSA algorithm- Key Management - Diffie-Hellman Key Exchange, Elliptic curve cryptography	7	15 %
IV	Authentication requirements- Authentication functions- Message authentication codes- Hash functions- SHA -1, MD5, Security of Hash functions and MACs- Authentication protocols-Digital signatures-Digital signature standards.	7	15 %
SECOND INTERNAL EXAM			
V	Network security: Electronic Mail Security: Pretty good privacy- S/MIME. IP Security: Architecture- authentication Header- Encapsulating Security payload- Combining Security associations- Key management.	7	20 %
VI	Web Security: Web Security considerations- secure Socket Layer and Transport layer Security- Secure electronic transaction. Firewalls-Packet filters- Application Level Gateway- Encrypted tunnels.	7	20 %
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

- There will be **FOUR** parts in the question paper – A, B, C, D
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**). **All** questions have to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question **uniformly** covers **modules I & II**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part C**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question **uniformly** covers **modules III & IV**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part D**
 - Total marks : 24**
 - THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question **uniformly** covers **modules V & VI**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P - Credits	Year of Introduction
CS431	COMPILER DESIGN LAB	0-0-3-1	2016
Pre-requisite : CS331 System Software Lab			
Course Objectives: - To implement the different Phases of compiler. - To implement and test simple optimization techniques. - To give exposure to compiler writing tools.			
List of Exercises/Experiments : - Design and implement a lexical analyzer for given language using C and the lexical analyzer should ignore redundant spaces, tabs and new lines. - Implementation of Lexical Analyzer using Lex Tool - Generate YACC specification for a few syntactic categories. - Program to recognize a valid arithmetic expression that uses operator +, -, *, and /. - Program to recognize a valid variable which starts with a letter followed by any number of letters or digits. - Implementation of Calculator using LEX and YACC - Convert the BNF rules into YACC form and write code to generate abstract syntax tree - Write program to find ϵ - closure of all states of any given NFA with ϵ transition. - Write program to convert NFA with ϵ transition to NFA without ϵ transition. - Write program to convert NFA to DFA - Write program to minimize any given DFA. - Develop an operator precedence parser for a given language. - Write program to find Simulate First and Follow of any given grammar. - Construct a recursive descent parser for an expression. - Construct a Shift Reduce Parser for a given language. - Write a program to perform loop unrolling. - Write a program to perform constant propagation. - Implement Intermediate code generation for simple expressions. - Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, jump etc.			
Expected Outcome: The Student will be able to : - Implement the techniques of Lexical Analysis and Syntax Analysis. - Apply the knowledge of Lex & Yacc tools to develop programs. - Generate intermediate code. - Implement Optimization techniques and generate machine level code.			

Course code	Course Name	L-T-P Credits	Year of Introduction
CS461	COMPUTATIONAL GEOMETRY	3-0-0-3	2016
Course Objectives: - To introduce techniques for designing efficient algorithms for geometric problems. - To discuss data structures used for geometric problems - To introduce combinatorial complexity of geometric problems. - To study rigorous algorithmic analysis of geometric problems.			
Syllabus: Geometric preliminaries, Plane sweep technique, Line segment intersection, Point location, Searching, Triangulation, Art Gallery theorem, Linear programming, Arrangements of lines, Convex Hulls and Verona Diagrams.			
Expected Outcome: The Students will be able to : - Develop efficient algorithms by exploiting geometric properties, and using appropriate data structures and geometric techniques. - Apply techniques and algorithms for solving problems in diversified fields like database searching, data mining, graphics and image processing, pattern recognition, computer vision, motion planning and robotics. - Perform complexity analysis of algorithms - Identify properties of geometric objects, express them as lemmas or theorems, and prove their correctness - Implement geometric algorithms.			
Text Books: - Franco P. Preparata and Michael Ian Shamos, <i>Computational Geometry an Introduction</i>. Texts and Monographs in Computer Science, Springer Verlag. - Joseph O'Rourke, <i>Computational Geometry in C</i>. Cambridge University Press 2nd Edn. - Mark. de Berg, Marc. van Kreveld, Mark. Overmars and Otfried Cheong, <i>Computational Geometry- Algorithms and Applications</i>. Springer- Verlag 3rd Edn.			
References: - Herbert Edelsbrunner, <i>Algorithms in Combinatorial Geometry</i>, EATCS Monographs on Theoretical Computer Science, Springer Verlag. - Joseph O' Rourke, <i>Art Gallery Theorems</i>. Oxford Press publications.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Geometric Preliminaries, DCEL (Doubly Connected Edge List) data structure, Polygon, Planar Straight Line Graph (PSLG) Area of a triangle, area of a polygon, Determinant used to test position of a point with respect to a directed line. Convex polygons, properties and point location in convex polygon (inside-outside test) Plane sweep algorithm, Algorithm for Line segment intersection problem using plane sweep technique.	6	15%

II	Point location in PSLG – Slab method, Chain method and complexity analysis. Range Searching – 1D Range search, Kd Trees.	6	15%
FIRST INTERNAL EXAM			
III	Polygon Triangulation: Regularization of polygons, properties of triangulations –Proofs, triangulation of monotone polygon – algorithm and complexity analysis. Linear Programming – Half plane intersection, Incremental algorithm and Randomized algorithm	8	15%
IV	Art Gallery Theorem, Guarding Art Gallery, Fisk's proof using three colouring. Arrangements of Lines – Duality, Combinatorics of arrangements, Zone Theorem, Algorithm for Constructing arrangements of lines.	6	15%
SECOND INTERNAL EXAM			
V	Convex Hulls- Convex Hull Algorithms in the Plane -Graham's Scan Algorithm, Jarvi's March, Divide and Conquer Algorithm.	6	20%
VI	Voronoi Diagrams- Properties and applications in the plane. Proofs of properties related to vertices and edges of voronoi diagrams Algorithm for constructing voronoi diagram. Delaunay Triangulation.	8	20%
END SEMESTER EXAM			

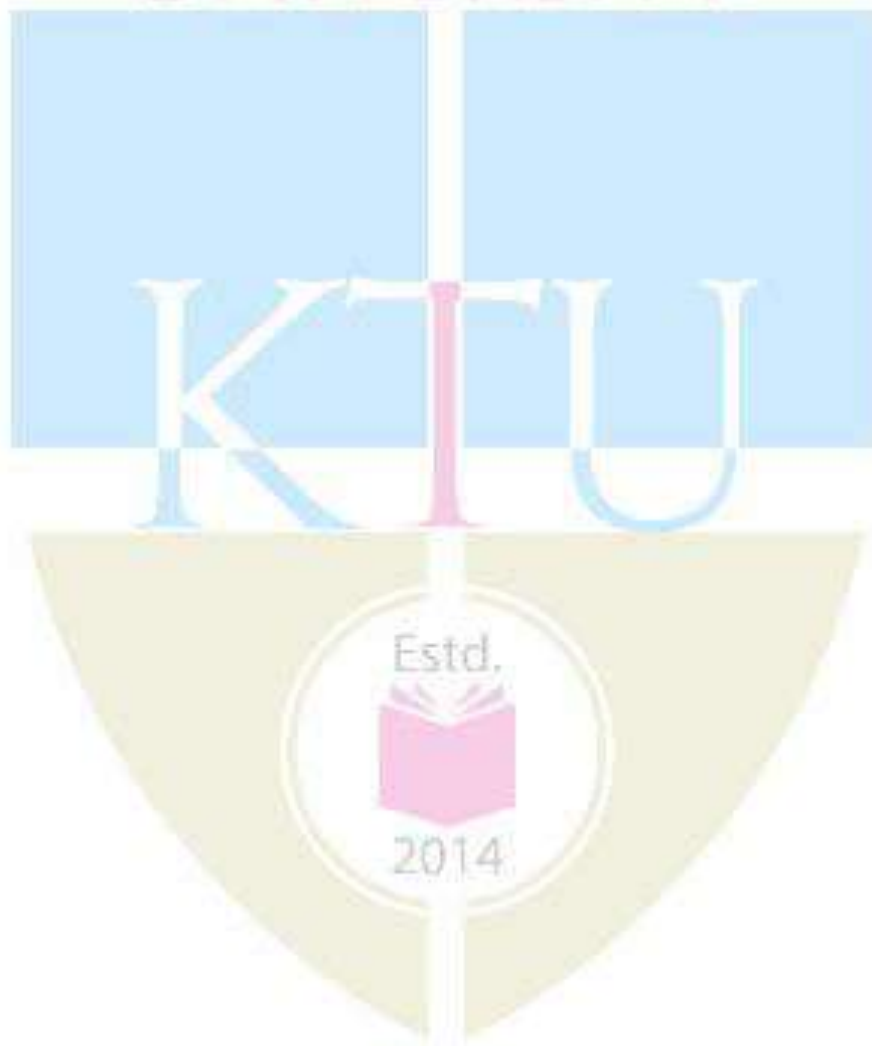
Question Paper Pattern End semester exam)

- There will be **FOUR** parts in the question paper – **A, B, C, D**
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II; THREE** questions from **modules III & IV; FOUR** questions from **modules V & VI)**.
All the TEN questions have to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question **uniformly** covers **modules I & II**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part C**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question **uniformly** covers **modules III & IV**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.

5. Part D

- a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question *uniformly* covers **modules V & VI**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
6. There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.

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Course code	Course Name	L-T-P - Credits	Year of Introduction
CS462	FUZZY SET THEORY AND APPLICATIONS	3-0-0-3	2016
Course Objectives: - To introduce the theory of fuzzy sets. - To discuss theoretical differences between fuzzy sets and classical sets. - To discuss fuzzy logic inference - To introduce fuzzy arithmetic concepts. - To discuss fuzzy inference applications in the area of control.			
Syllabus: Theory of Fuzzy Sets: Classical Sets vs Fuzzy Sets, Types of Fuzzy Sets, Operations on Fuzzy Sets, Zadeh's Extension Principle, Fuzzy Relations, Fuzzy Relational Equations, Possibility Theory and Fuzzy Measures. Applications of Fuzzy Sets: Approximate Reasoning, Fuzzy Relational Inference, Fuzzy Controllers, Efficiency and Effectiveness of inference schemes, Functional Approximation capabilities.			
Expected Outcome: The Student will be able to : - interpret fuzzy set theory and uncertainty concepts - identify the similarities and differences between probability theory and fuzzy set theory and their application conditions - apply fuzzy set theory in modeling and analyzing uncertainty in a decision problem - apply fuzzy control by examining simple control problem examples			
Text Books: - George J Klir and Bo Yuan, "<i>Fuzzy Sets and Fuzzy Logic : Theory and Applications</i>", Prentice Hall NJ,1995. - Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, Willey, 2010.			
References: - E P Klement, R Mesiar and E. Pap, Triangular norms, Kluwer Academic Press, Dordrecht, 2000. - H.J. Zimmermann, <i>Fuzzy Set Theory and its Applications</i>, Allied Publishers, New Delhi, 1991. - Kevin M Passino and Stephen Yurkovich, <i>Fuzzy Control</i>, Addison Wesley Longman, 1998. - M Grabisch et al., <i>Aggregation Functions</i>, Series - Encyclopedia Of Mathematics And Its Applications, Cambridge University Press, 2009 - Michal Baczynski and Balasubramaniam Jayaram, <i>Fuzzy Implications</i>, Springer Verlag, Heidelberg, 2008.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Classical sets vs Fuzzy Sets - Need for fuzzy sets - Definition and Mathematical representations - Level Sets - Fuzzy functions - Zadeh's Extension Principle.	06	15%
II	Operations on [0,1] - Fuzzy negation, triangular norms, t-	06	15%

	conorms, fuzzy implications, Aggregation Operations, Fuzzy Functional Equations		
FIRST INTERNAL EXAMINATION			
III	Fuzzy Binary and n-ary relations - composition of fuzzy relations - Fuzzy Equivalence Relations - Fuzzy Compatibility Relations - Fuzzy Relational Equations	07	15%
IV	Fuzzy Measures - Evidence Theory - Necessity and Belief Measures - Probability Measures vs Possibility Measures	07	15%
SECOND INTERNAL EXAMINATION			
V	Fuzzy Decision Making - Fuzzy Relational Inference - Compositional Rule of Inference - Efficiency of Inference - Hierarchical	08	20%
VI	Fuzzy If-Then Rule Base - Inference Engine - Takagi-Sugeno Fuzzy Systems - Function Approximation Applications <i>Advanced topics: Adaptive fuzzy inference systems: Adaptive networks - Architectures - Learning rules.</i> <i>Adaptive neuro-fuzzy inference systems (ANFIS) - Architectures - Hybrid learning rules.</i>	08	20%
END SEMESTER EXAM			

Question Paper Pattern

- There will be **FOUR** parts in the question paper – A, B, C, D
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**). **All** questions have to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question **uniformly** covers **modules I & II**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part C**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question **uniformly** covers **modules III & IV**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part D**
 - Total marks : 24**
 - THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question **uniformly** covers **modules V & VI**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P-Credits	Year of Introduction
CS463	DIGITAL IMAGE PROCESSING	3-0-0-3	2016

Course Objectives:

- To introduce and discuss the fundamental concepts and applications of Digital Image Processing.
- To discuss various basic operations in Digital Image Processing.
- To know various transform domains

Syllabus:

Introduction on digital image processing fundamentals; Image Transforms; Spatial and frequency domain filtering; Image segmentation; Morphological Image processing; Representation and Description.

Expected Outcome

The Students will be able to :

- compare different methods for image acquisition, storage and representation in digital devices and computers
- appreciate role of image transforms in representing, highlighting, and modifying image features
- interpret the mathematical principles in digital image enhancement and apply them in spatial domain and frequency domain
- apply various methods for segmenting image and identifying image components
- summarise different reshaping operations on the image and their practical applications
- identify image representation techniques that enable encoding and decoding images

Text Books:

1. A K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing (English) 3rd Edition, Pearson India, 2013.

References:

1. Al Bovik, The Essential Guide to Image Processing, Academic Press, 2009.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis, and Machine Vision, Thomson Learning, 2008.
3. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing, McGraw Hill Education , 2009.

COURSE PLAN

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Image processing: Fundamental steps in image processing; Components of image processing system; Pixels; coordinate conventions; Imaging Geometry; Spatial Domain; Frequency Domain; sampling and quantization; Basic relationship between pixels; Applications of Image Processing.	6	15%

II	Image transforms and its properties – Unitary transform; Discrete Fourier Transform; Discrete Cosine Transform; Walsh Transform; Hadamard Transform;	7	15%
FIRST INTERNAL EXAM			
III	Image Enhancement in spatial domain Basic Gray Level Transformation functions – Image Negatives; Log Transformations; Power-Law Transformations. Piecewise-Linear Transformation Functions: Contrast Stretching; Gray Level Slicing; Bit Plane Slicing; Histogram Processing–Equalization; Specification. Basics of Spatial Filtering – Smoothing: Smoothing	8	15%
IV	Image Enhancement in Frequency Domain Basics of Filtering in Frequency Domain, Filters - Smoothing Frequency Domain Filters : Ideal Low Pass Filter; Gaussian Low Pass Filter; Butterworth Low Pass Filter; Sharpening Frequency Domain Filters: Ideal High Pass Filter; Gaussian High Pass Filter; Butterworth High Pass Filter; Homomorphic Filtering	6	15%
SECOND INTERNAL EXAM			
V	Image Segmentation: Pixel-Based Approach- Multi-Level Thresholding, Local Thresholding, Threshold Detection Method; Region-Based Approach- Region Growing Based Segmentation, Region Splitting, Region Merging, Split and Merge, Edge Detection -	8	20%
VI	Morphological Operations Basics of Set Theory; Dilation and Erosion - Dilation, Erosion; Structuring Element; Opening and Closing; Hit or Miss Transformation. Representation and Description Representation - Boundary, Chain codes, Polygonal approximation approaches, Boundary segments.	7	20%
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

- There will be **FOUR** parts in the question paper – **A, B, C, D**
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II; THREE** questions from **modules III & IV; FOUR** questions from **modules V & VI**).
All the TEN questions have to be answered.

3. Part B

- a. **Total marks : 18**
- b. **THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question *uniformly* covers **modules I & II**.
- c. **Any TWO** questions have to be answered.
- d. Each question can have **maximum THREE** subparts.

4. Part C

- a. **Total marks : 18**
- b. **THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question *uniformly* covers **modules III & IV**.
- c. **Any TWO** questions have to be answered.
- d. Each question can have **maximum THREE** subparts.

5. Part D

- a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question *uniformly* covers **modules V & VI**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
6. There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.



Course code	Course Name	L-T-P - Credits	Year of Introduction
CS464	ARTIFICIAL INTELLIGENCE	3-0-0-3	2016
Course Objectives: - To introduce basic principles that drive complex real world intelligence applications. - To introduce and discuss the basic concepts of AI Techniques and Learning			
Syllabus: Introduction to AI, Solving Problems by Searching-uninformed, informed, heuristic, constraint Satisfaction problems -AI Representational Schemes-Learning-Advanced searches-Alpha beta pruning, Expert Systems-Natural Language Processing Concepts.			
Expected Outcome: The Student will be able to : - appreciate the scope and limits of the artificial intelligence (AI) field - assess the applicability, strengths, and weaknesses of the basic knowledge representation - interpret the role of knowledge representation, problem solving, and learning - explain various search algorithms (uninformed, informed, and heuristic) for problem solving - comprehend the fundamentals of Natural Language Processing			
Text Books: - E Rich, K Knight, Artificial Intelligence, 3/e, Tata McGraw Hil, 2009. - George.F.Luger, Artificial Intelligence- Structures and Strategies for Complex Problem Solving, 4/e, Pearson Education. 2002.			
References: D. Poole and A. Mackworth. Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010 Available online: http://artint.info/ - Dan W Patterson, Introduction to Artificial Intelligence,Pearson,2009 - Deepak Khemeni,A First course in Artificial Intelligence,Tata McGraw Hill,2013 - Maja J. Mataric ,Robotics Primer,MIT press,2007 - Patrick Henry Winston,Artificial intelligence,Addisson wessley,1992 - Stefan Edelkamp, Stefan Schroedl, Heuristic Search: Theory and Applications, Morgan Kaufman, 2011. - Stuart Jonathan Russell, Peter Norvig, Artificial intelligence, A modern approach,3rd edition, pearson,2010			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction: What is AI, The foundations of AI, History and applications, Production systems. Structures and strategies for state space search. Informed and Uninformed searches.	5	15%
II	Search Methods: data driven and goal driven search. Depth first and breadth first search, DFS with iterative deepening. Heuristic search-best first search, A * algorithm.AO* algorithm, Constraint Satisfaction. Crypt Arithmetic Problems	8	15%
FIRST INTERNAL EXAMINATION			
III	AI representational schemes- Semantic nets, conceptual dependency, scripts, frames, introduction to agent based problem solving, Machine learning-symbol based-a frame work for symbol based learning.	6	15%
IV	Advanced Search: Heuristics in Games, Design of good heuristic-an example. Min-Max Search Procedure, Alpha Beta pruning,	6	15%
SECOND INTERNAL EXAMINATION			
V	Learning Concepts: Version space search. Back propagation learning. Social and emergent models of learning-genetic algorithm, classifier systems and genetic programming.	9	20%
VI	Expert Systems: rule based expert systems. Natural language processing-natural language understanding problem, deconstructing language. Syntax stochastic tools for language analysis, natural language applications	9	20%
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

- There will be **FOUR** parts in the question paper – A, B, C, D
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II; THREE** questions from **modules III & IV; FOUR** questions from **modules V & VI).**
All the TEN questions have to be answered.

3. Part B

- a. **Total marks : 18**
- b. **THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question *uniformly* covers **modules I & II**.
- c. **Any TWO** questions have to be answered.
- d. Each question can have **maximum THREE** subparts.

4. Part C

- a. **Total marks : 18**
- b. **THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question *uniformly* covers **modules III & IV**.
- c. **Any TWO** questions have to be answered.
- d. Each question can have **maximum THREE** subparts.

5. Part D

- a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question *uniformly* covers **modules V & VI**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
6. There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.



Course code	Course Name	L-T-P Credits	Year of Introduction
CS465	BIOINFORMATICS	3-0-0-3	2016

Course Objectives:

- To introduce concepts and data representations in bioinformatics
- To introduce fundamentals of Sequence alignment and Gene Recognition
- To discuss predictive methods using DNA and Protein Sequences

Syllabus:

Introduction to bioinformatics and molecular biology: Databases tools and their uses, Data searches and Pairwise Alignments, Multiple Sequence Alignments, Molecular Phylogenetic, Genomics and Gene Recognition, Protein and RNA structure Prediction

Expected Outcome:

The Students will be able to :

- interpret the concepts of bioinformatics
- identify different types of biological sequence
- analyse multiple sequences and find conserved regions
- predict RNA and Protein secondary structures
- analyse genomic sequences and identify encoded gene regions

References:

1. S C Rastogi, N Mendiratta and P Rastogi, " Bioinformatics: Methods and Applications" , ISBN : 978-81-203-4785-4, published by PHI Learning Private Limited, New Delhi, 2015.
2. D E Krane and M L Raymer, Fundamental Concepts of Bioinformatics, ISBN 978-81-7758-757-9, Pearson Education, 2006.
3. Andreas D.Baxeavanis, B F Francis Ouellette, "Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins", Third Edition, 2005-2006, ISBN: 978-81-265-2192-0, published by John Wiley & Sons INC. , U.K.
4. Neil C Jones and Pavel A Pevzner, An Introduction to Bioinformatics Algorithms, MIT press, 2004.

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Bioinformatics and Computational Biology, Nature & Scope of Bioinformatics. The central dogma of molecular biology and bio-sequences associated with it, RNA classification –coding and non coding RNA- mRNA, tRNA, miRNA and sRNA, RNAi. DNA and RNA structure – Nucleic Acid structure and function, Genetic Code, Genes and Evolution	6	15%
II	Importance of databases - Biological databases-primary sequence databases, Composite sequence databases- Secondary databases- nucleic acid sequence databases - Protein sequence data bases - structure databases, Types of databases, Data retrieval tools - Entrez	8	15%

FIRST INTERNAL EXAM			
III	Sequence alignment – local/global, pairwise sequence alignment, scoring methods. Needleman and Wunsch algorithm, global and local alignments. Multiple sequence alignment. Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, principles based on which these matrices are derived. Differences between distance & similarity matrix.	8	20%
IV	Introduction, Advantages, Phylogenetic Trees, Tree topologies, Methods for phylogenetic analysis- Distance Matrix methods, Character based methods. HMM (Hidden Markov Model): Introduction to HMM, Forward algorithm, Viterbi algorithm, applications in Bioinformatics	6	15%
SECOND INTERNAL EXAM			
V	General introduction to Gene expression in prokaryotes and eukaryotes- Prokaryotic Genomes – Gene structure, GC content, Gene Density, Eukaryotic Genomes- Gene structure, GC content, Gene Density, Gene Expression, Transposition, Gene prediction approaches.	8	20%
VI	Protein and RNA structure Prediction: Predicting RNA secondary structure - Nussinov Algorithm, Energy minimisation methods - Zuker Algorithm. Amino Acids, Polypeptide Composition, Protein Structures, Algorithm for protein folding, Structure prediction	6	15%
END SEMESTER EXAM			

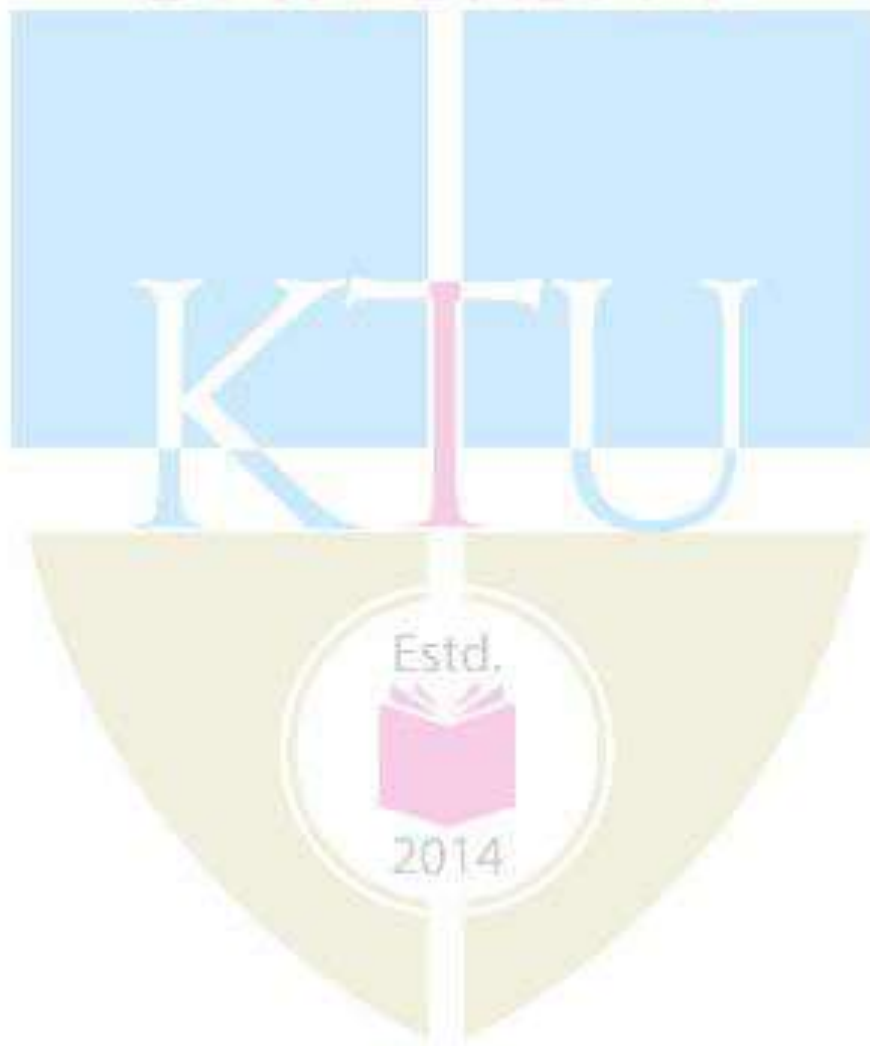
Question Paper Pattern (End semester exam)

- There will be **FOUR** parts in the question paper – A, B, C, D
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules** (**THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**). **All the TEN** questions have to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question **uniformly** covers **modules I & II**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part C**
 - Total marks : 18**

- b. **THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question **uniformly** covers **modules III & IV**.
- c. **Any TWO** questions have to be answered.
- d. Each question can have **maximum THREE** subparts.

5. Part D

- a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question **uniformly** covers **modules V & VI**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have **maximum THREE** subparts.
6. There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.



Course code	Course Name	L-T-P Credits	Year of Introduction
CS466	DATA SCIENCE	3-0-0-3	2016
Course Objectives: - To introduce fundamental algorithmic ideas to process data. - To introduce and discuss techniques for applying hypotheses and data into actionable predictions. - To introduce documentation and visualization techniques.			
Syllabus: Modern scientific, engineering, and business applications are increasingly dependent on data, existing traditional data analysis technologies were not designed for the complexity of the modern world. Data Science has emerged as a new, exciting and fast-paced discipline that explores novel statistical, algorithmic, and implementation challenges that emerge in processing, storing, and extracting knowledge from Big Data.			
Expected Outcome: The Student will be able to : - explain and discuss the significance of data science and its key functionalities - discuss and demonstrate various models suitable for data science - perform preliminary statistical analysis using R language on simple data sets - perform python-based predication and filtering on simple data sets - perform Hadoop and Map-Reduce for data analysis - perform data visualization techniques at a basic level			
References: - Boris Lublinsky, Kevin T. Smith. Alexcy Yakubovich, "Professional Hadoop Solutions", Wiley, 2015. - Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, "Mining of Massive Datasets". Cambridge University Press, 2014. - Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization and Statistics", Wiley, 2011. - Nina Zumel, John Mount "Practical Data Science with R". Manning Publications. 2014. - Sameer Madhavan , "Mastering Python for Data Science", Packt Publishing Limited, 2015. - Tony Ojeda, Sean Patrick Murphy, Benjarnin Bengfort. Abhijit Dasgupta. "Practical Data Science Cookbook", Packt Publishing Limited, 2014. W. N. Venables. D. M. Smith and the R Core Team, "An Introduction to R", 2013.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks %
I	Data science process-roles, stages in data science project-working with data from files-working with relational databases-exploring data –managing data-cleaning and sampling for modeling and validation-introduction to NoSQL	6	15

II	Choosing and evaluating models-mapping problems to machine learning, evaluating clustering models, validating models-cluster analysis-k-means algorithm, Naive Bayes-Memorization Methods - Linear and logistic regression-unsupervised methods.	8	20
FIRST INTERNAL EXAM			
III	Reading and getting data into R- ordered and unordered factors - arrays and matrices lists and data frames - reading data from files - probability distributions - statistical models In R manipulating objects - data distribution.	8	15
IV	Python-based data visualization, predication through linear regression, collaborative filtering.	6	15
SECOND INTERNAL EXAM			
V	Introduction distributed file system mar reduce. Algorithm using Map Reduce –Matrix –Vector Multiplication by map reduce – Hadoop – Understanding Map Reduce architecture – writing Hadoop Map-Reduce programs-Loading data into HDFS Map-Reduce Programs - Loading data into HDFS - Executing the Map phase - Shuffling and sorting - Reducing phase execution.	6	20
VI	Documentation and deployment - producing effective presentations - introduction to graphical analysis – plot() function - display ing multivariate data - matrix plots multiple plots in one window - exporting graph - using graphics parameters. Case studies.	6	15
END SEMESTER EXAM			

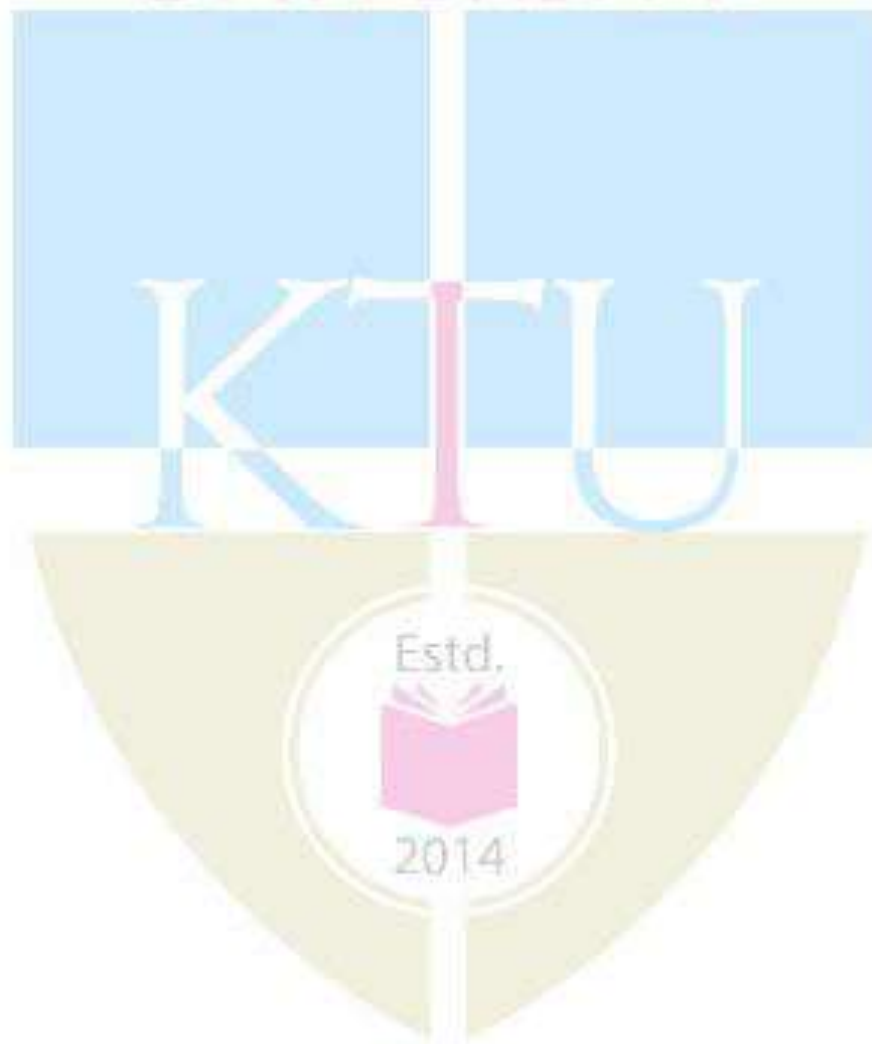
Question Paper Pattern (End semester exam)

- There will be **FOUR** parts in the question paper – **A, B, C, D**
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**).
All the TEN questions have to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question *uniformly* covers **modules I & II**.
 - Any TWO* questions have to be answered.
 - Each question can have *maximum THREE* subparts.
- Part C**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question *uniformly* covers **modules III & IV**.
 - Any TWO* questions have to be answered.
 - Each question can have *maximum THREE* subparts.

5. Part D

- a. Total marks : 24
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question *uniformly* covers **modules V & VI**.
 - c. *Any TWO* questions have to be answered.
 - d. Each question can have *maximum THREE* subparts.
6. There will be **AT LEAST 40%** analytical/numerical questions in all possible combinations of question choices.

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Course code	Course Name	L-T-P Credits	Year of Introduction
CS469	COMPUTATIONAL COMPLEXITY	3-0-0-3	2016
Course Objectives: - To introduce the fundamentals of computational complexity theory. - To discuss basic concepts such as computational models, computational complexity measures (e.g., time and space complexity measures), complexity classes, reducibility and completeness notions. - To familiarize the concepts of randomized and approximation algorithms and discuss the related complexity classes.			
Syllabus: Turing machines, decision problems, time and space complexity, polynomial time algorithms, NP and NP-completeness, standard time and space complexity classes, optimization problems and approximation algorithms, randomized algorithms and complexity classes based on randomized machine models, interactive proofs and their relation to approximation.			
Expected Outcome The Students will be able to : - determine whether a problem is computable, and prove that some problems are not computable - categorize problems into appropriate complexity classes - classify problems based on their computational complexity using reductions - analyse optimization problems using the concept of interactive proofs - classify optimization problems into appropriate approximation complexity classes			
Text Books: - Michael Sipser, Introduction to the Theory of Computation, (First edition - PWS Publishing Company, January 1997, or second edition - Thomson Course Technology, 2005). - Sanjeev Arora and Boaz Barak, Computational Complexity: A Modern Approach, Cambridge University Press, 2009			
References: - Christos H Papadimitriou, Computational Complexity, Addison-Wesley, 1994. - M R Garey and D S Johnson, Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, 1979. - Oded Goldreich, Computational Complexity, Cambridge University press, 2008. - Vijay Vazirani, Approximation Algorithms, Springer--Verlag, 2001			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks %
I	Introduction: Easy and hard problems. Algorithms and complexity. Turing machines: Models of computation. Multi-tape deterministic and non-deterministic Turing machines. Decision problems	5	15%

II	The Halting Problem and Undecidable Languages: Counting and diagonalization. Tape reduction. Universal Turing machine. Undecidability of halting. Reductions. Rice's theorem. Deterministic Complexity Classes: DTIME[t]. Linear Speed-up Theorem. P Time. Polynomial reducibility. Polytime algorithms: 2-satisfiability, 2-colourability.	8	15%
FIRST INTERNAL EXAM			
III	NP and NP-completeness: Non-deterministic Turing machines. NTIME[t]. NP. Polynomial time verification. NP-completeness. Cook-Levin Theorem. Polynomial transformations: 3-satisfiability, clique, colourability, Hamilton cycle, partition problems. Pseudo-polynomial time. Strong NP-completeness. Knapsack. NP-hardness.	8	15%
IV	Space complexity and hierarchy theorems: DSPACE[s]. Linear Space Compression Theorem. PSPACE, NPSPACE. PSPACE = NPSPACE. PSPACE-completeness. Quantified Boolean Formula problem is PSPACE-complete. L, NL and NL-completeness. NL=coNL. Hierarchy theorems.	8	15%
SECOND INTERNAL EXAM			
V	Randomized Complexity: The classes BPP, RP, ZPP. Interactive proof systems: IP = PSPACE.	6	20%
VI	Optimization and approximation: Combinatorial optimization problems. Relative error. Bin-packing problem. Polynomial and fully polynomial approximation schemes. Vertex cover, traveling salesman problem, minimum partition.	7	20%
END SEMESTER EXAM			

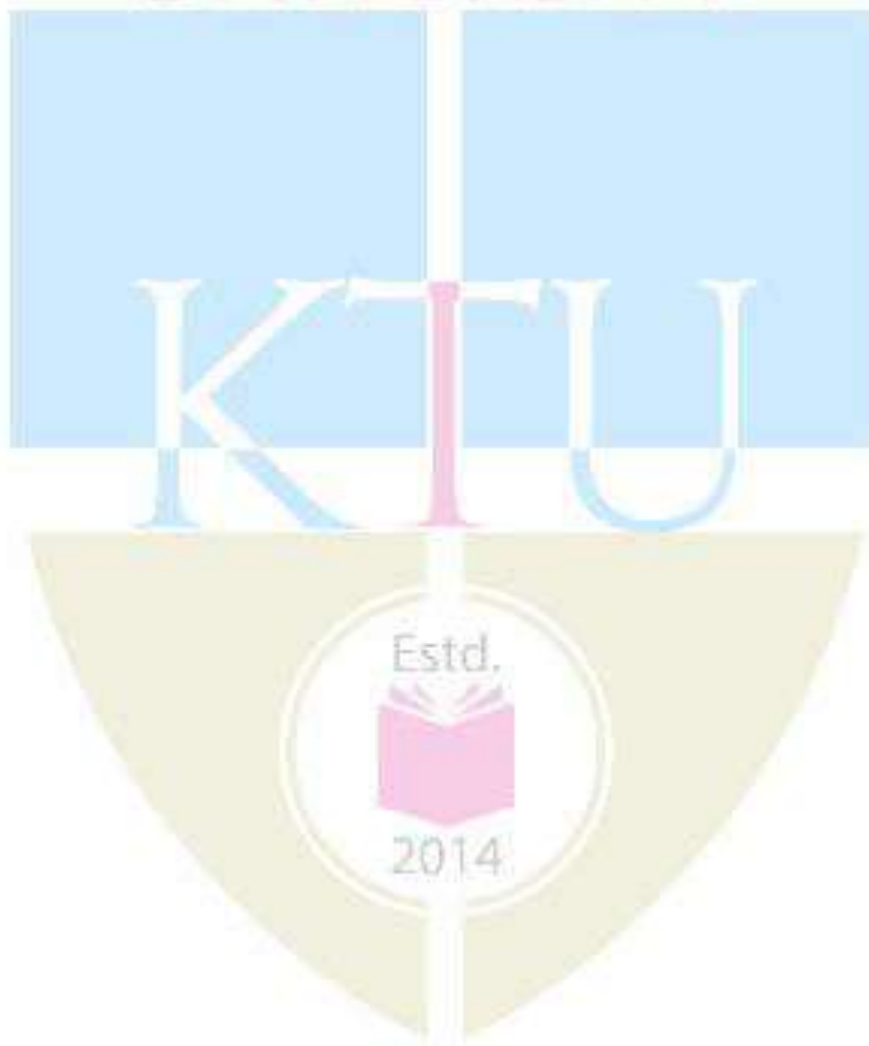
Question Paper Pattern (End semester exam)

- There will be **FOUR** parts in the question paper – A, B, C, D
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules** (**THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**).
All the TEN questions have to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question *uniformly* covers **modules I & II**.
 - Any TWO* questions have to be answered.
 - Each question can have *maximum THREE* subparts.
- Part C**
 - Total marks : 18**

- b. **THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question *uniformly* covers **modules III & IV**.
- c. **Any TWO** questions have to be answered.
- d. Each question can have *maximum THREE* subparts.

5. Part D

- a. **Total marks : 24**
 - b. **THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question *uniformly* covers **modules V & VI**.
 - c. **Any TWO** questions have to be answered.
 - d. Each question can have *maximum THREE* subparts.
6. There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.



Course code	Course Name	L-T-P - Credits	Year of Introduction
CS472	PRINCIPLES OF INFORMATION SECURITY	3-0-0-3	2016

Course Objectives

- To introduce fundamental concepts of security.
- To introduce and discuss the relevance of security in operating system, web services etc.
- To introduce fundamental concepts of secure electronic transactions.

Syllabus

Overview of computer security, Security concepts, Need of Security, Access Control, Access control matrix, Security policies, Software vulnerabilities, Security in current domains - Wireless LAN security, Cell phone security, Secure Electronic transactions, Web Services security

Expected Outcome:

The Student will be able to :

- appreciate the common threats faced today
- interpret the foundational theory behind information security
- design a secure system
- identify the potential vulnerabilities in software
- appreciate the relevance of security in various domains
- develop secure web services and perform secure e-transactions

Text Books:

1. Bernard Menezes, Network security and Cryptography, Cengage Learning India, 2010.
2. M Bishop, Computer Security: Art and Science, Pearson Education, 2003.

References:

1. E Whiteman and J Mattord, Principles of information security 4th edn, Cengage Learning
2. V K Pachghare, Cryptography and information security, PHI
3. Behrousz A Forouzan, D Mukhopadhyay, Cryptography and network Security, McGraw Hill
4. W Mao, Modern Cryptography: Theory & Practice, Pearson Education, 2004.
5. C P. Fleeger and S L Fleeger, Security in Computing, 3/e, Pearson Education, 2003.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction: Overview of computer security, Security concepts, Need of Security- Threats- Deliberate software attacks, Deviation in quality of service, Attacks- malicious code, brute force, Timing attack, sniffers Access Control Mechanisms - Access Control, Access control matrix, Access control in OS-Discretionary and Mandatory access control, Role-based access control, case study SELinux	7	15%

II	Security policies and models: confidentiality policies, Bell-LaPadula model, Integrity policies, Biba model, Clark-Wilson models, Chinese wall model, waterfall model	7	15%
FIRST INTERNAL EXAMINATION			
III	Software vulnerabilities: Buffer and stack overflow, Cross-site scripting(XSS) , and vulnerabilities, SQL injection and vulnerabilities , Phishing.	6	15%
IV	Malware: Viruses, Worms and Trojans. Topological worms. Internet propagation models for worms.	6	15%
SECOND INTERNAL EXAMINATION			
V	Security in current domains: Wireless LAN security - WEP details. wireless LAN vulnerabilities – frame spoofing. Cellphone security - GSM and UMTS security. Mobile malware - bluetooth security issues.	8	20%
VI	Secure Electronics transactions: Framework, strength and weakness, Security in current applications : Online banking , Credit Card Payment Systems. Web Services security: XML, SOAP, SAML, RFID	8	20%
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

- There will be **FOUR** parts in the question paper – **A, B, C, D**
- Part A**
 - Total marks : 40**
 - TEN** questions, each have **4 marks**, covering **all the SIX modules (THREE** questions from **modules I & II**; **THREE** questions from **modules III & IV**; **FOUR** questions from **modules V & VI**). **All** questions are to be answered.
- Part B**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question **uniformly** covers **modules I & II**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part C**
 - Total marks : 18**
 - THREE** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question **uniformly** covers **modules III & IV**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- Part D**
 - Total marks : 24**
 - THREE** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question **uniformly** covers **modules V & VI**.
 - Any TWO** questions have to be answered.
 - Each question can have **maximum THREE** subparts.
- There will be **AT LEAST 60%** analytical/numerical questions in all possible combinations of question choices.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC201	NETWORK THEORY	3-1-0-4	2016
Prerequisite: Nil			
Course objectives:			
- To make the students capable of analyzing any linear time invariant electrical network. - To study time domain, phasor and Laplace transform methods of linear circuit analysis. - To study the transient response of networks subject to test signals. - To develop understanding of the concept of resonance, coupled circuits and two port networks.			
Syllabus:			
Circuit variables and Circuit elements, Kirchhoff's laws, Network topology, Mesh and node analysis of network, Laplace transform, Inverse Laplace transform, Solution of differential equations by using Laplace transforms, Transient analysis of RL, RC, and RLC networks, Network functions for the single port and two ports, Parameters of two-port network, Resonance, Coupled circuits			
Expected outcome:			
At the end of the course students will be able to analyze the linear time invariant electrical circuits.			
Text Books			
1. Ravish R., Network Analysis and Synthesis, 2/e, McGraw-Hill, 2015. 2. Valkenburg V., Network Analysis, 3/e, PHI, 2011.			
References:			
1. Sudhakar A, S. P. Shyammohan, Circuits and Networks- Analysis and Synthesis, 5/e, McGraw-Hill, 2015. 2. Choudhary R., Networks and Systems, 2/e, New Age International, 2013. 3. Franklin F. Kuo, Network Analysis and Synthesis, 2/e, Wiley India, 2012. 4. Pandey S. K., Fundamentals of Network Analysis and Synthesis, 1/e, S. Chand, 2012. 5. Edminister, Electric Circuits – Schaum's Outline Series, McGraw-Hill, 2009.			
Course Plan			
Module	Course content (48 hrs)	Hours	Sem. Exam Marks
I	Introduction to circuit variables and circuit elements, Review of Kirchhoff's Laws, Independent and dependent Sources, Source transformations	3	15
	Network topology, Network graphs, Trees, Incidence matrix, Tie-set matrix and Cut-set matrix	2	
	Solution methods applied to dc and phasor circuits: Mesh and node analysis of network containing independent and dependent sources	3	
II	Network theorems applied to dc and phasor circuits: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Millman's theorem, Maximum power transfer theorem	6	15

	Laplace transform, properties Laplace Transforms and inverse Laplace transform of common functions, Important theorems: Time shifting theorem, Frequency shifting theorem, Time differentiation theorem, Time integration theorem, s domain differentiation theorem, s domain integration theorem, Initial value theorem, Final value theorem	4	
FIRST INTERNAL EXAM			
III	Partial Fraction expansions for inverse Laplace transforms, Solution of differential equations using Laplace transforms	3	15
	Transformation of basic signals and circuits into s-domain	2	
	Transient analysis of RL, RC, and RLC networks with impulse, step, pulse, exponential and sinusoidal inputs	3	
	Analysis of networks with transformed impedance and dependent sources.	3	
IV	Network functions for the single port and two ports, properties of driving point and transfer functions, Poles and Zeros of network functions, Significance of Poles and Zeros	3	15
	Time domain response from pole zero plot, Impulse Response	1	
	Network functions in the sinusoidal steady state, Magnitude and Phase response	3	
SECOND INTERNAL EXAM			
V	Parameters of two port network: impedance, admittance, transmission and hybrid parameters, Interrelationship among parameter sets	5	20
	Series and parallel connections of two port networks	2	
	Reciprocal and Symmetrical two port network	2	
	Characteristic impedance, Image impedance and propagation constant (derivation not required)	2	
VI	Resonance: Series resonance, bandwidth, Q factor and Selectivity, Parallel resonance	3	20
	Coupled circuits: single tuned and double tuned circuits, dot convention, coefficient of coupling, Analysis of coupled circuits	4	
END SEMESTER EXAM			

Question Paper Pattern

The question paper consists of three parts. Part A covers modules I and II, Part B covers modules III and IV and Part C covers modules V and VI. Each part has three questions. Each question can have a maximum of four subparts. Among the three questions one will be a compulsory question covering both the modules and the remaining two questions will be as one question from each module, of which one is to be answered. Mark pattern is according to the syllabus with maximum 30% for theory and 70% for logical/numerical problems, derivation and proof.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC202	SIGNALS & SYSTEMS	3-1-0 -4	2016
Prerequisite: Nil			
Course Objectives 1. To train students for an intermediate level of fluency with signals and systems in both continuous time and discrete time, in preparation for more advanced subjects in digital signal processing, image processing, communication theory and control systems. 2. To study continuous and discrete-time signals and systems, their properties and representations and methods those are necessary for the analysis of continuous and discrete-time signals and systems. 3. To familiarize with techniques suitable for analyzing and synthesizing both continuous-time and discrete time systems. 4. To gain knowledge of time-domain representation and analysis concepts as they relate to differential equations, difference equations, impulse response and convolution, etc. 5. To study frequency-domain representation and analysis concepts using Fourier analysis tools, Laplace Transform and Z-transform. To study concepts of the sampling process, reconstruction of signals and interpolation.			
Syllabus Elementary signals, Continuous time and Discrete time signals and systems, Signal operations, Differential equation representation, Difference equation representation, Continuous time LTI Systems, Discrete time LTI Systems, Correlation between signals, Orthogonality of signals, Frequency domain representation, Continuous time Fourier series, Continuous time Fourier transform, Laplace transform, Inverse Laplace transform, Unilateral Laplace transform, Transfer function, Frequency response, Sampling, Aliasing, Z transform, Inverse Z transform, Unilateral Z transform, Frequency domain representation of discrete time signals, Discrete time Fourier series and discrete time Fourier transform (DTFT), Analysis of discrete time LTI systems using the above transforms			
Expected outcome . The student will be able to: i. Define, represent, classify and characterize basic properties of continuous and discrete time signals and systems. ii. Represent the CT signals in Fourier series and interpret the properties of Fourier transform and Laplace transform iii. Outline the relation between convolutions, correlation and to describe the orthogonality of signals. iv. Illustrate the concept of transfer function and determine the magnitude and phase response of LTI systems. v. Explain sampling theorem and techniques for sampling and reconstruction. vi. Determine z transforms, inverse z transforms and analyze LTI systems using z transform.			
Text Book: 1. Alan V. Oppenheim and Alan Willsky, Signals and Systems, PHI, 2/e, 2009 2. Simon Haykin, Signals & Systems, John Wiley, 2/e, 2003			
References: 1. Anand Kumar, Signals and Systems, PHI, 3/e, 2013. 2. B P. Lathi, Principles of Signal Processing & Linear systems, Oxford University Press. 3. Gurung, Signals and System, PHI. 4. Mahmood Nahvi, Signals and System, Mc Graw Hill (India), 2015. 5. P Ramakrishna Rao, Shankar Prakriya, Signals and System, MC Graw Hill Edn 2013.			

6. Rodger E. Ziemer, Signals & Systems - Continuous and Discrete, Pearson, 4/e, 2013			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Elementary Signals, Classification and representation of continuous time and discrete time signals, Signal operations	4	15%
	Continuous time and discrete time systems - Classification, Properties.	3	
	Representation of systems: Differential equation representation of continuous time systems. Difference equation representation of discrete systems.	2	
II	Continuous time LTI systems and convolution integral.	3	15%
	Discrete time LTI systems and linear convolution.	2	
	Stability and causality of LTI systems.	2	
	Correlation between signals, Orthogonality of signals.	2	
FIRST INTERNAL EXAMINATION			
III	Frequency domain representation of continuous time signals-continuous time Fourier series and its properties.	4	15%
	Convergence, Continuous time fourier transform and its properties.	3	
	Laplace Transform, ROC, Inverse transform, properties, unilateral Laplace transform.	3	
	Relation between Fourier and Laplace transforms.	1	
IV	Analysis of LTI systems using Laplace and Fourier transforms. Concept of transfer function, Frequency response, Magnitude and phase response.	4	15%
	Sampling of continuous time signals, Sampling theorem for lowpass signals, aliasing.	3	
SECOND INTERNAL EXAMINATION			
V	Z transform, ROC , Inverse transform, properties, Unilateral Z transform.	4	20%
	Frequency domain representation of discrete time signals, Discrete time fourier series and its properties.	4	
	Discrete time fourier transform (DTFT) and its properties	4	
VI	Relation between DTFT and Z-Transform, Analysis of discrete time LTI systems using Z transforms and DTFT, Transfer function, Magnitude and phase response.	6	20%
END SEMESTER EXAM			

Assignment: Convolution by graphical methods, Solution of differential equations.

Project: Use of Matlab in finding various transforms: magnitude and phase responses.

Question Paper Pattern

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part shall have three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Part A & Part B questions shall carry 15 marks each and Part C questions shall carry 20 marks each with maximum 30% for theory and 70% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC203	SOLID STATE DEVICES	3-1-0-4	2016
Prerequisite: Nil			
Course objectives: - To provide an insight into the basic semiconductor concepts - To provide a sound understanding of current semiconductor devices and technology to appreciate its applications to electronics circuits and systems			
Syllabus: Elemental and compound semiconductors, Fermi-Dirac distribution, Equilibrium and steady state conditions: Equilibrium concentration of electrons and holes, Temperature dependence of carrier concentration, Carrier transport in semiconductors, High field effects, Hall effect, Excess carriers in semiconductors, PN junctions, contact potential, electrical field, potential and charge density at the junction, energy band diagram, minority carrier distribution, ideal diode equation, electron and hole component of current in forward biased pn junction, piecewise linear model of a diode, effect of temperature on VI characteristics, Diode capacitances, electrical breakdown in pn junctions, Tunnel Diode, Metal semiconductor contacts, bipolar junction transistor, metal insulator semiconductor devices, MOSFET, FinFET			
Expected outcome: The students should have a good knowledge in semiconductor theory and electronic devices.			
Text Books: - Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson, 6/e, 2010 - Achuthan, K N Bhat, Fundamentals of Semiconductor Devices, 1e, McGraw Hill, 2015			
References: - Tyagi M.S., Introduction to Semiconductor Materials and Devices, Wiley India, 5/e, 2008 - Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005 - Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012 - Pierret, Semiconductor Devices Fundamentals, Pearson, 2006 - Rita John, Solid State Devices, McGraw-Hill, 2014 - Bhattacharya .Sharma, Solid State Electronic Devices, Oxford University Press, 2012 - Dasgupta and Dasgupta, Semiconductor Devices : Modelling and Technology (PHI)			
Course Plan			
Module	Course content (48hrs)	Hours	Sem. Exam Marks
I	Elemental and compound semiconductors, Fermi-Dirac distribution, Equilibrium and steady state conditions, Equilibrium concentration of electrons and holes, Temperature dependence of carrier concentration	4	15
	Carrier transport in semiconductors, drift, conductivity and mobility, variation of mobility with temperature and doping, High Field Effects, Hall effect	5	
II	Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi Fermi levels, diffusion, Einstein relations, Continuity equations, Diffusion length, Gradient of quasi Fermi level	9	15
FIRST INTERNAL EXAM			

III	PN junctions : Contact potential, Electrical Field, Potential and Charge density at the junction, Energy band diagram, Minority carrier distribution, Ideal diode equation, Electron and hole component of current in forward biased p-n junction, piecewise linear model of a diode effect of temperature on V-I characteristics	9	15
IV	Diode capacitances, switching transients, Electrical Breakdown in PN junctions, Zener and avalanche break down (abrupt PN junctions only), Tunnel Diode basics only, Metal Semiconductor contacts, Ohmic and Rectifying Contacts, current voltage characteristics	9	15
SECOND INTERNAL EXAM			
V	Bipolar junction transistor , current components, Minority carrier distributions, basic parameters, Evaluation of terminal currents (based on physical dimensions), Transistor action, Base width modulation	9	20
VI	Metal Insulator semiconductor devices: The ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, work function difference, interface charge, threshold voltage MOSFET: Output characteristics, transfer characteristics, sub threshold characteristics, MOSFET scaling (basic concepts)	9	20
	FinFET-structure and operation	1	
END SEMESTER EXAM			

Question Paper Pattern

The question paper consists of three parts. Part A covers modules I and II, Part B covers modules III and IV and Part C covers modules V and VI. Each part has three questions. Each question can have a maximum of four subparts. Among the three questions one will be a compulsory question covering both the modules and the remaining two questions will be as one question from each module, of which one is to be answered. Mark pattern is according to the syllabus with maximum 70 % for theory, derivation, proof and 30% for logical/numerical problems.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC204	ANALOG INTEGRATED CIRCUITS	4-0-0-4	2016
Prerequisite: Nil			
Course Objectives - To equip the students with a sound understanding of fundamental concepts of operational amplifiers - To understand the wide range of applications of operational amplifiers - To introduce special function integrated circuits - To introduce the basic concepts and types of data converters			
Syllabus Differential amplifier configurations, Operational amplifiers, Block diagram, Ideal op-amp parameters, Effect of finite open loop gain, bandwidth and slew rate on circuit performance, op-amp applications-linear and nonlinear, Active filters, Specialized ICs and their applications, Monolithic Voltage Regulators - types and its applications, Data converters - specifications and types.			
Expected outcome . The students will - have a thorough understanding of operational amplifiers - be able to design circuits using operational amplifiers for various applications			
Text Book: - Franco S., Design with Operational Amplifiers and Analog Integrated Circuits, 3/e, Tata McGraw Hill, 2008 - Salivahanan S. ,V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008			
References: - Botkar K. R., Integrated Circuits, 10/e, Khanna Publishers, 2010 - C.G. Clayton, Operational Amplifiers, Butterworth & Company Publ. Ltd. Elsevier, 1971 - David A. Bell, Operational Amplifiers & Linear ICs, Oxford University Press, 2nd edition, 2010 - Gayakwad R. A., Op-Amps and Linear Integrated Circuits, Prentice Hall, 4/e, 2010 - R.F. Coughlin & Fredrick Driscoll, Operational Amplifiers & Linear Integrated Circuits, 6th Edition, PHI,2001 - Roy D. C. and S. B. Jain, Linear Integrated Circuits, New Age International, 3/e, 2010 - Sedra A. S. and K. C. Smith, Microelectronic Circuits, 6/e, Oxford University Press, 2013			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Differential amplifiers: Differential amplifier configurations using BJT, Large and small signal operations, Input resistance, Voltage gain, CMRR, Non-ideal characteristics of differential amplifier. Frequency response of differential amplifiers, Current sources, Active load, Concept of current mirror circuits, Wilson current mirror circuits (Analysis using hybrid 'pi' model only).	6	15%
	Operational amplifiers: Introduction, Block diagram, Ideal op-amp parameters, Equivalent circuit, Voltage transfer curve, Open loop op-amp configurations, Effect of finite open loop gain, Bandwidth and slew rate on circuit performance	5	
II	Op-amp with negative feedback: Introduction, Feedback	3	15%

	configurations, Voltage series feedback, Voltage shunt feedback, Properties of practical op-amp.		
	Op-amp applications: Inverting and non inverting amplifier, DC and AC amplifiers, Summing, Scaling and averaging amplifiers, Instrumentation amplifier.	4	
FIRST INTERNAL EXAMINATION			
III	Op-amp applications: Voltage to current converter, Current to voltage converter, Integrator, Differentiator, Precision rectifiers, Log and antilog amplifier, Phase shift and Wien bridge oscillators	7	15%
IV	Astable and monostable multivibrators, Triangular and saw tooth wave generators, Comparators, Zero crossing detector, Schmitt trigger	5	15%
	Active filters: Advantages, First and second order low pass, High pass, Band pass and band reject filters, Design of filters using Butterworth approximations	5	
SECOND INTERNAL EXAMINATION			
V	Specialized ICs and its applications: Timer IC 555 : Astable and monostable operations, applications. Analog Multipliers: Introduction, Gilbert multiplier cell. Voltage Controlled Oscillator IC AD633 and their applications.	3	20%
	Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL for AM & FM detection and Frequency multiplication, Frequency division, Frequency synthesizing.	4	
	Monolithic Voltage Regulators - Fixed voltage regulators, 78XX and 79XX series, Adjustable voltage regulators, IC 723 – Low voltage and high voltage configurations, Current boosting, Current limiting, Short circuit and Fold-back protection.	4	
VI	Data Converters: D/A converter, Specifications, Weighted resistor type, R-2R Ladder type.	3	20%
	A/D Converters: Specifications, Classification, Flash type, Counter ramp type, Successive approximation type, Single slope type, Dual slope type, Sample-and-hold circuits.	5	
END SEMESTER EXAM			

Assignment

1. Explain the importance of frequency compensated networks in opamps and the commonly used compensation techniques.
2. Write short notes on commercially available integrated circuits (Opamp, ADC, DAC, VCO, Analog multiplier, PLL) with pin outs and their important features

Question Paper Pattern

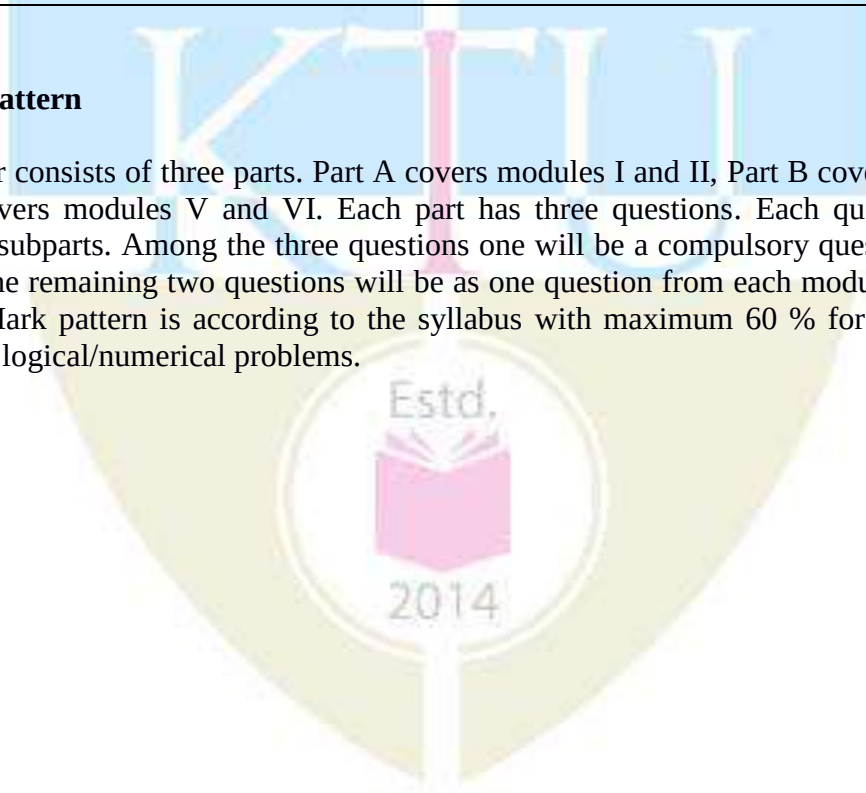
The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions, which may have maximum four subdivisions. Among the three questions, one will be a compulsory question covering both modules and the remaining from each module, of which, one to be answered. Part A & Part B questions shall carry 15 marks each and Part C questions shall carry 20 marks each with maximum 60% for theory and 40% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC205	ELECTRONIC CIRCUITS	3-1-0-4	2016
Prerequisite: Nil			
Course objectives: To develop the skill of analysis and design of various analog circuits using discrete electronic devices as per the specifications.			
Syllabus: High pass and low pass RC circuits, Differentiator, Integrator, Analysis of BJT biasing circuits, small signal analysis of transistor configurations using small signal hybrid π model, low frequency and high frequency analysis of BJT amplifiers, Cascade amplifiers, Wide band amplifiers, Feedback amplifiers, Oscillators, Tuned amplifiers, Power amplifiers, Sweep circuits and multivibrators, transistor voltage regulator, DC analysis of MOSFET circuits, small signal equivalent circuit, Small signal analysis of MOSFET amplifier circuits, Analysis of multistage MOSFET amplifiers			
Expected outcome: At the end of the course, students will be able to analyse and design the different electronic circuits using discrete electronic components.			
Text Books: - Sedra A. S. and K. C. Smith, Microelectronic Circuits, 6/e, Oxford University Press, 2013 - Millman J. and C. Halkias, Integrated Electronics, 2/e, McGraw-Hill, 2010			
References: - Neamen D., Electronic Circuits - Analysis and Design, 3/e, TMH, 2007 - Rashid M. H., Microelectronic Circuits - Analysis and Design, Cengage Learning, 2/e, 2011 - Spencer R. R. and M. S. Ghausi, Introduction to Electronic Circuit Design, Pearson, 2003 - Razavi B., Fundamentals of Microelectronics, Wiley, 2015			
Course Plan			
Module	Course content (48 hrs)	Hours	Sem. Exam Marks
I	RC Circuits: Response of high pass and low pass RC circuits to sine, step, pulse and square wave inputs, Differentiator, Integrator	5	15
	BJT biasing circuits: Types, Q point, Bias stability, Stability factors, RC coupled amplifier and effect of various components, Concept of DC and AC load lines, Fixing of operating point, Classification of amplifiers	5	
II	Small signal analysis of CE, CB and CC configurations using small signal hybrid π model (gain, input and output impedance). Small signal analysis of BJT amplifier circuits, Cascade amplifier	7	15
FIRST INTERNAL EXAM			
III	High frequency equivalent circuits of BJT, Short circuit current gain, cutoff frequency, Miller effect, Analysis of high frequency response of CE, CB and CC amplifiers	4	15
	Wide band amplifier: Broad banding techniques, low frequency and high frequency compensation, Cascode amplifier.	4	
IV	Feedback amplifiers: Effect of positive and negative feedback on gain, frequency response and distortion, Feedback topologies and	3	15

	its effect on input and output impedance, Feedback amplifier circuits in each feedback topologies (no analysis required)		
	Oscillators & Tuned Amplifiers: Classification of oscillators, Barkhausen criterion, Analysis of RC phase shift and Wien bridge oscillators, Working of Hartley, Colpitts and Crystal oscillators; Tuned amplifiers, synchronous and stagger tuning	6	
SECOND INTERNAL EXAM			
V	Power amplifiers: Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, efficiency and distortion, Transformer-less class B and Class AB power amplifiers, Class C power amplifier (no analysis required)	6	20
	Switching Circuits: Simple sweep circuit, Bootstrap sweep circuit, Astable, Bistable, and Monostable multivibrators, Schmitt Trigger	5	
VI	Transistor based voltage regulator: Design and analysis of shunt and series voltage regulator, load and line regulation, Short circuit protection	4	20
	MOSFET amplifiers: Biasing of MOSFET amplifier, DC analysis of single stage MOSFET amplifier, small signal equivalent circuit. Small signal voltage and current gain, input and output impedances of CS configuration, MOSFET Cascade amplifier	5	
END SEMESTER EXAM			

Question Paper Pattern

The question paper consists of three parts. Part A covers modules I and II, Part B covers modules III and IV and Part C covers modules V and VI. Each part has three questions. Each question can have a maximum of four subparts. Among the three questions one will be a compulsory question covering both the modules and the remaining two questions will be as one question from each module, of which one is to be answered. Mark pattern is according to the syllabus with maximum 60 % for theory, derivation, proof and 40% for logical/numerical problems.



Course code	Course Name	L-T-P - Credits	Year of Introduction
EC206	COMPUTER ORGANISATION	3-0-0-3	2016
Prerequisite: EC207 Logic Circuit Design			
Course Objectives - To impart knowledge in computer architecture. - To impart knowledge in machine language programming. - To develop understanding on I/O accessing techniques and memory structures.			
Syllabus Functional units of a computer, Arithmetic circuits, Processor architecture, Instructions and addressing modes, Execution of program, Micro architecture design process, Design of data path and control units, I/O accessing techniques, Memory concepts, Memory interface, Cache and Virtual memory concepts.			
Expected outcome . The students will be able to: i. Understand the functional units of a computer ii. Identify the different types of instructions iii. Understand the various addressing modes iv. Understand the I/O addressing system v. Categorize the different types of memories			
Text Book: 1. David A. Patterson and John L. Hennessey, Computer Organisation and Design, Fourth Edition, Morgan Kaufmann 2. David Money Harris, Sarah L Harris, Digital Design and Computer Architecture,Morgan Kaufmann – Elsevier, 2009			
References: 1. Carl Hamacher : “Computer Organization ”, Fifth Edition, Mc Graw Hill 2. John P Hayes: “Computer Architecture and Organisation”, Mc Graw Hill 3. William Stallings: “Computer Organisation and Architecture”, Pearson Education 4. Andrew S Tanenbaum: “Structured Computer Organisation”, Pearson Education 5. Craig Zacker: “PC Hardware : The Complete Reference”, TMH			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Functional units of a computer Arithmetic Circuits: Adder-carry propagate adder, Ripple carry adder, Basics of carry look ahead and prefix adder, Subtractor, Comparator, ALU	4	15%
	Shifters and rotators, Multiplication, Division	3	
	Number System: Review of Fixed point & Floating point number system	1	
II	Architecture : Assembly Language, Instructions, Operands, Registers, Register set, Memory, Constants	2	15%
	Machine Language: R-Type, I-Type, J-Type Instructions, Interpreting machine language code	3	
FIRST INTERNAL EXAMINATION			
III	MIPS Addressing modes – Register only, Immediate, Base, PC-relative, Pseudo - direct	3	15%

	MIPS memory map , Steps for executing a program - Compilation, Assembling, Linking, Loading	3	
	Pseudoinstructions, Exceptions, Signed and Unsigned instructions, Floating point instructions	3	
IV	MIPS Microarchitectures – State elements of MIPS processor	1	15%
	Design process and performance analysis of Single cycle processor, Single cycle data path, Single cycle control for R – type arithmetic/logical instructions.	3	
	Design process and performance analysis of multi cycle processor, Multi cycle data path, Multi cycle control for R – type arithmetic/logical instructions.	3	
SECOND INTERNAL EXAMINATION			
V	I/O system – Accessing I/O devices, Modes of data transfer, Programmed I/O, Interrupt driven I/O, Direct Memory Access, Standard I/O interfaces – Serial port, Parallel port, PCI, SCSI, and USB.	3	20%
	Memory system – Hierarchy, Characteristics and Performance analysis, Semiconductor memories (RAM, ROM, EPROM), Memory Cells – SRAM and DRAM, internal organization of a memory chip, Organization of a memory unit.	4	
VI	Cache Memory – Concept/principle of cache memory, Cache size, mapping methods – direct, associated, set associated, Replacement algorithms, Write policy- Write through, Write back.	3	20%
	Virtual Memory – Memory management, Segmentation, Paging, Address translation, Page table, Translation look aside buffer.	3	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions, which may have maximum four subdivisions. Among the three questions, one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Part A & Part B questions shall carry 15 marks each and Part C questions shall carry 20 marks each with maximum 80 % for theory and 20% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC207	LOGIC CIRCUIT DESIGN	3-0-0-3	2016
Prerequisite: Nil			
Course objectives:			
- To work with a positional number systems and numeric representations - To introduce basic postulates of Boolean algebra and show the correlation between Boolean expression - To outline the formal procedures for the analysis and design of combinational circuits and sequential circuits - To study the fundamentals of HDL - To design and implement combinational circuits using basic programmable blocks - To design and implement synchronous sequential circuits			
Syllabus:			
Positional Number Systems, Boolean algebra, Combinational Logic, HDL concepts ,Digital ICs, Programmable Logic Devices, Sequential Logic, Sequential Circuits			
Expected outcome:			
The student should able to:			
1. Compare various positional number systems and binary codes			
2. Apply Boolean algebra in logic circuit design			
3. Design combinational and sequential circuits			
4. Design and implement digital systems using basic programmable blocks			
5. Formulate various digital systems using HDL			
Text Books:			
1. Donald D Givone, Digital Principles and Design, Tata McGraw Hill, 2003 2. John F Wakerly, Digital Design Principles and Practices, Pearson Prentice Hall, 2007			
References:			
1. Ronald J Tocci, Digital Systems, Pearson Education, 11 th edition, 2010 2. Thomas L Floyd, Digital Fundamentals, Pearson Education, 8 th edition 2009 3. Moris Mano, Digital Design, Prentice Hall of India, 3 rd edition, 2002 4. John M Yarbrough, Digital Logic Applications and Design, Cenage learning, 2009 5. David Money Harris, Sarah L Harris, Digital Design and Computer Architecture, Morgan Kaufmann – Elsevier, 2009			
Course Plan			
Module	Course content (42 hrs)	Hours	Sem. Exam Marks
I	Number systems- decimal, binary, octal, hexa decimal, base conversion	2	15
	1's and 2's complement, signed number representation Binary arithmetic, binary subtraction using 2's complement	2	
	Binary codes (grey, BCD and Excess-3), Error detection and correcting codes : Parity(odd, even), Hamming code (7,4), Alphanumeric codes : ASCII	2	
II	Logic expressions, Boolean laws, Duality, De Morgan's law, Logic functions and gates	2	15
	Canonical forms: SOP, POS, Realisation of logic expressions using K-	2	

	map (2,3,4 variables)			
	Design of combinational circuits – adder, subtractor, 4 bit adder/subtractor, BCD adder, MUX, DEMUX, Decoder,BCD to 7 segment decoder, Encoder, Priority encoder, Comparator (2/3 bits)	4		
FIRST INTERNAL EXAM				
III	Introduction to HDL : Logic descriptions using HDL, basics of modeling (only for assignments)	2	0	
	Logic families and its characteristics: Logic levels, propagation delay, fan in, fan out, noise immunity , power dissipation, TTL subfamilies	1		15
	NAND in TTL (totem pole, open collector and tri-state), CMOS:NAND, NOR, and NOT in CMOS, Comparison of logic families (TTL,ECL,CMOS) in terms of fan-in, fan-out, supply voltage, propagation delay, logic voltage and current levels, power dissipation and noise margin	2		
	Programmable Logic devices - ROM, PLA, PAL, implementation of simple circuits using PLA	2		
IV	Sequential circuits - latch, flip flop (SR, JK, T, D), master slave JK FF, conversion of FFs, excitation table and characteristic equations	3	15	
	Asynchronous and synchronous counter design, mod N counters, random sequence generator	5		
SECOND INTERNAL EXAM				
V	Shift Registers - SIPO, SISO, PISO, PIPO, Shift registers with parallel LOAD/SHIFT Shift register counter - Ring Counter and Johnson Counter	3	20	
	Mealy and Moore models, state machine ,notations, state diagram, state table, transition table, excitation table, state equations	3		
VI	Construction of state diagram – up down counter, sequence detector	3	20	
	Synchronous sequential circuit design - State equivalence	2		
	State reduction – equivalence classes, implication chart	2		
END SEMESTER EXAM				

Assignments:

1. Simple combinational circuit design using MUX, DEMUX, PLA & PAL
2. HDL simulation of circuits like simple ALU, up-down counter, linear feedback shift register, sequence generator

Question Paper Pattern

The question paper consists of three parts. Part A covers modules I and II, Part B covers modules III and IV and Part C covers modules V and VI. Each part has three questions. Each question has a maximum of four subparts. Among the three questions one will be a compulsory question covering both the modules and the remaining two questions will be as one question from each module, of which one is to be answered. Mark pattern is according to the syllabus with maximum 50 % for theory, derivation, proof and 50% for logical/numerical problems.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC208	ANALOG COMMUNICATION ENGINEERING	3-0-0-3	2016
Prerequisite: EC205 Electronic Circuits			
Course Objectives - To study the concepts and types of modulation schemes. - To study different types of radio transmitters and receivers. - To study the effects of noise in analog communication systems. - To impart basic knowledge on public telephone systems.			
Syllabus Elements of communication system, Need for modulation, Noises, Amplitude Modulation, Amplitude modulator circuits, Demodulator circuits, AM transmitters, Types of AM, Angle modulation: principles of frequency modulation, phase modulation, AM and FM Receivers, Frequency modulator circuits, FM transmitters, FM receiver, Noise in AM and FM systems, Public telephone systems, standard telephone set, cordless telephones.			
Expected outcome . The students will be able to: i. understand the different analog modulation schemes. ii. understand the fundamental ideas of noises and its effect in communication systems. iii. explain the principle and working of analog transmitters and receivers. iv. know the basic idea of telephone systems.			
Text Book: 1. Dennis Roody and John Coolen, Electronic Communication, Pearson, 4/e, 2011. 2. George Kennedy, Electronic Communication Systems, McGrawHill, 4/e, 2008. 3. Tomasi, Electronic Communications System, Pearson, 5/e, 2011.			
References: 1. Blake, Electronic Communication system, Cengage, 2/e, 2012. 2. Simon Haykin, Communication Systems, Wiley 4/e, 2006. 3. Taub, Schilling, Saha, Principles of communication system, McGraw Hill, 2013. 4. Tomasi, Advanced Electronic Communications Systems, Pearson, 6/e, 2012.			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction, Elements of communication systems, Need for modulation	2	15%
	Noise in communication system, Thermal noise (white noise), Shot noise, Partition noise, Flicker noise, Burst noise, Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.	3	
II	Amplitude modulation: Sinusoidal AM, Modulation index, Average power, Effective voltage and current, Nonsinusoidal modulation.	4	15%
	Amplitude modulator circuits, Amplitude demodulator circuits, AM transmitters, Noise in AM Systems.	5	
FIRST INTERNAL EXAMINATION			
III	Single Sideband Modulation: Principles, Balanced modulators, Singly & doubly balanced modulators, SSB generation, Filter method, Phasing method & Third method, SSB reception, Modified SSB systems, Pilot carrier SSB & ISB, Companded SSB.	6	15%

IV	Angle modulation: Frequency modulation, Sinusoidal FM, Frequency spectrum, Modulation index, Average power, Non-sinusoidal modulation, Deviation ratio, Comparison of AM and FM.	4	15%
	AM & FM Receivers: Super heterodyne receiver, Tuning range, Tracking, Sensitivity and gain, Image rejection, Double conversion, Adjacent channel selectivity, Automatic Gain Control (AGC).	4	
SECOND INTERNAL EXAMINATION			
V	Phase modulation, Equivalence between PM and FM, Sinusoidal phase modulation, Digital phase modulation.	3	20%
	Angle modulator Circuits: Varactor diode modulators, Transistor modulators. FM Transmitters: Direct and Indirect Methods.	3	
VI	Angle modulation detectors, Slope detector, Balanced slope detector, Foster-Seeley discriminator, PLL demodulator, Automatic Frequency Control (AFC), Amplitude limiters, Noise in FM systems, Pre-emphasis and De-emphasis.	4	20%
	Telephone systems, standard telephone set, basic call procedures and tones, DTMF, cordless telephones.	4	
END SEMESTER EXAM			

Assignment

Study of

1. The telephone circuit - Local subscriber loop, Private-line circuits, Voice-frequency circuit arrangements.
2. The public telephone network - Instruments, Local loops, Trunk circuits and exchanges, Local central exchanges, Automated central office switches and exchanges.

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions, which may have maximum four subdivisions. Among the three questions, one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Part A & Part B questions shall carry 15 marks each and Part C questions shall carry 20 marks each with maximum 60 % for theory and 40% for logical/numerical problems, derivation and proof.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC209	Analog Electronics	3-1-0-4	2016
Prerequisites :Nil			
Course Objectives - To familiarize basic electronic elements and their characteristics - To develop understanding about BJT and FET circuits - To understand the concept of power amplifier and differential amplifiers			
Syllabus Diode: Diode as a circuit element-diode clipping circuits-clamping circuits-voltage regulators- BJT: Operating point of a BJT-thermal runaway-h parameter model of a BJT-frequency response of amplifiers-FET: Construction and characteristics of JFET and MOSFET-Feedback: - Concepts – negative and positive feedback-Power Amplifiers- Class A, B, AB, C, D & S power amplifier-Differential Amplifiers:- The BJT differential pair- Large and small signal operation-MOS differential amplifier- Large and small signal operation-UJT- 555 Timer IC, PLL.			
Expected outcome. Will get knowledge on electronic elements and their characteristics.			
Text Book: - Allen Mottershead, <i>Electronic Devices and Circuits: An Introduction</i>, Prentice Hall of India. V. Boylestad and Nashelsky, <i>Electronic Devices and Circuits</i>, Pearson Education - Ramakant A Gayakwad, <i>Op- Amps and Linear Integrated Circuits</i>, Prentice Hall of India			
References: - Schilling and Belove, <i>Electronic Circuits</i>, McGraw Hill - Theodore F. Bogart Jr., <i>Electronic Devices and Circuits</i>, - Coughlin and Driscoll, <i>Operational amplifiers and Linear Integrated Circuits</i>, K. R. Botkar, <i>Integrated Circuits</i>, Khanna Publishers - Somanathan Nair, <i>Linear Integrated Circuits – Analysis, Design & Application</i>, Wiley-India			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Diode: Diode as a circuit element - load line - piecewise linear model – single-phase half wave and full wave rectifier circuits – voltage regulation - ripple factor - rectifier efficiency - bridge rectifier - rectifier filters - diode clipping circuits - single level and two level clippers - clamping circuits –Zener diodes - Zener voltage regulators.	9	15%
II	BJT: Operating point of a BJT – DC biasing - bias stability - thermal runaway - AC Concepts –role of capacitors in amplifiers – common emitter AC equivalent circuit - amplifier gain and impedance calculations- h parameter model of a BJT –cascaded amplifiers, frequency response of amplifiers	9	15%

FIRST INTERNAL EXAMINATION			
III	FET Construction and characteristics of JFET and MOSFET, biasing a JFET and MOSFET, JFET and MOSFET small signal model - CS and CD amplifiers. feedback: - Concepts – negative and positive feedback feedback -feedback connection types - practical feedback circuits	9	15%
IV	Power Amplifiers Class A, B, AB, C, D & S power amplifiers - harmonic distortion efficiency -wide band amplifier - broad banding techniques - low frequency and high frequency compensation -cascode amplifier - broad banding using inductive loads - Darlington pairs.	10	15%
SECOND INTERNAL EXAMINATION			
V	OSCILLATORS & MULTI VIBRATORS Classification of oscillators – Barkhausen criteria- operation and analysis of RC phase shift – Hartely and Colpitts oscillators – Multi vibrators – astable, mono stable and bi stable multi vibrators	9	20%
VI	UJT-construction –working-UJT oscillator-UPS-brief overview of online UPS &off line UPS-SMPS-operation Timer IC 555: Functional diagram- astable and monostable modes Phase Locked Loops: Principles – building blocks of PLL-VCO-lock and capture ranges - capture process - frequency multiplication using PLL	10	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100

Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules
(8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions
(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions
(2 x15 = 30 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC212	Linear Integrated Circuits and Digital Electronics	4-0-0 -4	2016
Prerequisites :Nil			
Course Objectives - To introduce the concepts for realizing functional building blocks in ICs and applications of IC. - To know the fundamentals of combinational and sequential digital circuits.			
Syllabus Ideal OP-AMP characteristics, DC characteristics- AC characteristics- offset voltage and current: voltage series feedback - shunt feedback amplifiers, differential amplifier- frequency response of OP-AMP- Basic applications of OP-AMP – summer, differentiator ,integrator, V/I &I/V converter-Instrumentation amplifier-Basic Comparators- regenerative comparators-multivibrators- waveform Generators- clippers- clampers- peak detector- S/H circuit- First and Second order active filter-, D/A converter (R-2R ladder and weighted resistor types)- A/D converter - Dual slope- successive approximation and flash types- 555 Timer circuit – Functional block- characteristics & applications:- IC 566-voltage controlled oscillator circuit- OP-AMP- Voltage regulator-Series- Shunt and Switching regulator- Review of number system:- types and conversion- codes- Boolean algebra: De-Morgan's theorem- Minimization of Boolean function using K-maps & Quine McCluskey method- Combinational circuits: -Adder- subtractors- code converters- encoders- decoders- multiplexers and demultiplexers- Combinational Logic by using Multiplexers- ROM- PLA and PAL-Memories - ROM, Static and Dynamic RAM- Read/Write Memory- EPROM, EEPROM-Flip flops – SR- D- JK - T and Master Slave FF- Shift registers- Counters-Asynchronous and Synchronous Counters- Up-Down Counter- Modulo Counter- Ring Counter-Analysis of Asynchronous Counters			
Expected outcome: The students will learn to know about the IC'S and their application, digital circuits, combinational and sequential circuits.			
Text Book: - Ramakant A.Gayakward, Op-amps and Linear Integrated Circuits, IV edition, Pearson Education, 2003 / PHI. - D.Roy Choudhary, Sheil B.Jani, Linear Integrated Circuits, II edition, New Age, 2003. M. Morris Mano, Digital Logic and Computer Design, Prentice Hall of India, 2002			
References: - Robert F.Coughlin, Fredrick F.Driscoll, Op-amp and Linear ICs, Pearson Education, 4th edition, 2002 /PHI. - David A.Bell, Op-amp & Linear ICs, Prentice Hall of India, 2nd edition, 1997. - Charles H.Roth, Fundamentals Logic Design, Jaico Publishing, IV edition, 2002. - Floyd, Digital Fundamentals, 8th edition, Pearson Education, 2003.			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	OP-AMP-Ideal OP-AMP characteristic-offset voltage and current: voltage series feedback and shunt feedback amplifiers, differential amplifier- frequency response of OP-AMP- Basic applications of op-amp – differentiator and integrator, V/I & I/V converter.	9	15%
II	Instrumentation amplifier- Basic Comparators- regenerative comparators- multivibrators- waveform generators- clippers, clampers- peak detector- S/H circuit- isolation amplifier - log and antilog amplifiers analog multipliers	9	15%
FIRST INTERNAL EXAMINATION			
III	D/A converter (R-2R ladder and weighted resistor types)- A/D converter - Dual slope, successive approximation and flash types Active filters-filter transfer function-Butterworth and Chebyshev filters-First order and second order function for low-pass, high-pass, band –pass, band-stop and all –pass filters	9	15%
IV	Review of number system- types and conversion- codes- one's complement and two's complement-Arithmetic operations of Binary Boolean algebra: De-Morgan's theorem- Minimization of Boolean function using K-maps & QuineMcCluskey method.	9	15%
SECOND INTERNAL EXAMINATION			
V	Combinational circuits: Adder- subtractor- code converters, encoders, decoders, multiplexers and demultiplexers. Implementation of Combinational Logic by using Multiplexers, ROM, PLA and PAL. Memories – ROM- Static and Dynamic RAM- Read/Write Memory- EPROM- EEPROM	10	20%
VI	Flip flops - SR, D, JK , T and Master Slave Flip Flop -Shift registers -Counters-Asynchronous and Synchronous Counters-Up-Down Counter- Modulo Counter- Ring Counter-Analysis of Asynchronous Counters-sequence detector.	10	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100

Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC230	LOGIC CIRCUIT DESIGN LAB	0-0-3-1	2016
Prerequisite: EC207 Logic circuit design			
Course objectives: - To study the working of standard digital ICs and basic building blocks - To design and implement combinational circuits - To design and implement sequential circuits			
List of Experiments: -(Minimum 12 experiments are to be done) - Realization of functions using basic and universal gates (SOP and POS forms). - Design and Realization of half /full adder and subtractor using basic gates and universal gates. 4 bit adder/subtractor and BCD adder using 7483. 2/3 bit binary comparator. - Binary to Gray and Gray to Binary converters. - Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates - Asynchronous Counter: Realization of 4-bit counter - Asynchronous Counter: Realization of Mod-N counters. - Asynchronous Counter:3 bit up/down counter - Synchronous Counter: Realization of 4-bit up/down counter. - Synchronous Counter: Realization of Mod-N counters. - Synchronous Counter:3 bit up/down counter - Shift Register: Study of shift right, SIPO, SISO, PIPO, PISO (using FF & 7495) - Ring counter and Johnson Counter. (using FF & 7495) - Realization of counters using IC's (7490, 7492, 7493). - Multiplexers and De-multiplexers using gates and ICs. (74150, 74154), - Realization of combinational circuits using MUX & DEMUX. - Random sequence generator. - LED Display: Use of BCD to 7 Segment decoder / driver chip to drive LED display - Static and Dynamic Characteristic of NAND gate (MOS/TTL)			
Expected outcome:			
The student should able to:			
- Design and demonstrate functioning of various combination circuits - Design and demonstrate functioning of various sequential circuits - Function effectively as an individual and in a team to accomplish the given task			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC231	Electronic Devices & Circuits Lab	0-0-3-1	2016
Prerequisite: Should have registered for EC205 Electronic circuits			
Course objectives:			
- To study the working of analog electronic circuits. - To design and implement analog circuits as per the specifications using discrete electronic components.			
List of Experiments: (12 Mandatory Experiments) - VI Characteristics of rectifier and zener diodes - RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response) - Clipping and clamping circuits (Transients and transfer characteristics) - Fullwave Rectifier -with and without filter- ripple factor and regulation - Simple Zener voltage regulator (load and line regulation) - Characteristics of BJT in CE configuration and evaluation of parameters - Characteristics of MOSFET in CS configuration and evaluation of parameters - RC coupled CE amplifier - frequency response characteristics - MOSFET amplifier (CS) - frequency response characteristics - Cascade amplifier – gain and frequency response - Cascode amplifier -frequency response - Feedback amplifiers (current series, voltage series) - gain and frequency response - Low frequency oscillators –RC phaseshift, Wien bridge, - High frequency oscillators –Colpitt's and Hartley - Power amplifiers (transformer less) - Class B and Class AB - Transistor series voltage regulator (load and line regulation) - Tuned amplifier - frequency response - Bootstrap sweep circuit - Multivibrators -Astable, Monostable and Bistable - Schmitt trigger			
Expected outcome:			
The student should able to: - Design and demonstrate functioning of various discrete analog circuits. - Function effectively as an individual and in a team to accomplish the given task.			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC232	ANALOG INTEGRATED CIRCUITS LAB	0-0-3-1	2016
Prerequisite: ..Should have registered for EC204 Analog Integrated Circuits			
Course objectives: - To acquire skills in designing and testing analog integrated circuits - To expose the students to a variety of practical circuits using various analog ICs.			
List of Experiments: (Minimum 12 experiments are to be done) 1. Familiarization of Operational amplifiers - Inverting and Non inverting amplifiers, frequency response, Adder, Integrator, comparators. 2. Measurement of Op-Amp parameters. 3. Difference Amplifier and Instrumentation amplifier. 4. Schmitt trigger circuit using Op –Amps. 5. Astable and Monostable multivibrator using Op -Amps. 6. Timer IC NE555 7. Triangular and square wave generators using Op- Amps. 8. Wien bridge oscillator using Op-Amp - without & with amplitude stabilization. 9. RC Phase shift Oscillator. 10. Precision rectifiers using Op-Amp. 11. Active second order filters using Op-Amp (LPF, HPF, BPF and BSF). 12. Notch filters to eliminate the 50Hz power line frequency. 13. IC voltage regulators. 14. A/D converters- counter ramp and flash type. 15. D/A Converters- ladder circuit. 16. Study of PLL IC: free running frequency lock range capture range			
Expected outcome:			
The student should able to:			
1. Design and demonstrate functioning of various analog circuits 2. Students will be able to analyze and design various applications of analog circuits.			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC233	ELECTRONICS DESIGN AUTOMATION LAB	0-0-3-1	2016
Prerequisite: Nil			
Course Objectives : The primary objective of this course is to familiarize the students, how to simulate the electronics/digital circuits, signals and systems using the soft-wares which are available for the modern design methodologies for the rapid design and verification of complex electronic systems.			
List of Exercises / Experiments			
1	<u>Introduction to SPICE</u> [Institution can use any one circuit simulation package with schematic entry like EDWinXP, PSpice, Multisim, Proteus or CircuitLab.] Introduction to SPICE software. Recognize various schematic symbols /model parameters of resistor, capacitor, inductor, energy sources (VCVS, C CVS, Sinusoidal source, pulse, etc), transformer, DIODE, BJT, FET, MOSFET, etc., units & values. Use SPICE Schematic Editor to draw and analyse (DC, AC, Transient) simple analog and digital electronic circuits. List of Experiments using SPICE [Six experiments mandatory] Simulation of following circuits using SPICE [Schematic entry of circuits using standard package, Analysis –Transient, AC, DC] 1. Potential divider network 2. RC integrating and differentiating circuits 3. Diode, BJT and MOSFET characteristics 4. Diode Circuits (Clipping, Clamping, Rectifiers) 5. RC coupled amplifier (Single & two stages) 6. RC oscillator (RC phase shift / Wien Bridge) 7. Astable multivibrator 8. Truth table verification of basic and universal gates 9. Half adder /full adder circuits using gates 10. 4 bit adder/BCD adder 11. Encoder/Multiplexers 12. Flipflops/Counters		
2	<u>Introduction to MATLAB</u> [Institution can use any one numerical computational package like SciLab, Octave, Spyder, Python (scipy) or Freemat instead of MATLAB] Fundamentals, basic operations on array, matrix, complex numbers etc., Script and function files, plotting commands, control statements. Writing simple programs for handling arrays and plotting of mathematical functions, plotting of analog, discrete and noise signals, analysing the simple electronic circuits/network using node and mesh equations. List of Experiments [Four experiments mandatory] Write program and obtain the solutions 1. Solve /plot the mathematical equations containing complex numbers, array, matrix multiplication and quadratic equations etc		

	- Obtain different types of plots (2D/3D, surface plot, polar plot) - Generate and plot various signals like sine square, pulse in same window. - Plot the diode/transistor characteristics. - Solve node, mesh and loop equations of simple electrical/network circuits. - Find the poles and zeros hence plot the transfer functions/polynomials - Sort numbers in ascending order and save to another text file using text read and sort function after reading n floating point numbers from a formatted text file stored in the system. - Plot a full wave rectified waveform using Fourier series
3	<u>Introduction to HDL</u> [Institution can choose VHDL or Verilog as language to describe the problem and any one simulation/synthesis tool like Xilinx ISE, Modelsim, QSim, verilog, VHDL, EDwinXP or ORCAD etc. for the simulation.] List of Experiments using HDL Write the HDL code to realise and simulate the following circuits: (at least 4 of the following) - Basic gates/universal gates - Combinational Circuits (Half adder/Half subtractor) - Full adder in 3 modelling styles (Dataflow/structural/Behavioural) - Multiplexer/De-multiplexer - Decoder/Encoder 4 bit adder/BCD adder - Flipflops (SR,JK,T,D) - Binary Counters - Finite state machines <u>Expected outcomes:</u> - An ability to apply knowledge of computer, science, and engineering to the analysis of electrical and electronic engineering problems. - An ability to design systems which include hardware and software components. - An ability to identify, formulate and solve engineering problems. - An ability to use modern engineering techniques

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC234	Linear Integrated Circuits and Digital Electronics Laboratory	0-0-3--1	2016
Prerequisite: EC212 Linear integrated circuits and digital electronics			
Course Objectives To study various digital and linear integrated circuits used in simple system configuration			
List of Exercises/Experiments : (10 experiments are mandatory) - Operational Amplifiers (IC741)-Characteristics - Square , triangular and ramp generation using op-amps - Log and Antilog amplifiers. - Astable and monostable multivibrators using op-amps - Active notch filter realization using op-amps - Wein bridges oscillator using OpAmp - OpAmp Integrator and Differentiator. - Code converter - Binary to gray and Gray to binary. - Adder and Subtractor Circuits using logic IC - Implementation of combinational logic circuits using MUX IC - Design and implementation of multiplexer and demultiplexer. 3-bit synchronous counter design - Asynchronous counter design and Mod-n counter - Shift registers - SISO/SIPO & PISO/PIPO - Ring and Johnson Counters			
List of major equipment CRO, Function generator , Single power supply , Dual power supply, Digital multimeter, Ammeter , Voltmeter.			
Expected outcome . On completion ,the students will be able to - Design simple circuits like amplifiers using OP-AMPS. - Design waveform Generating circuits. - Understand Digital concepts - Logically explain the concepts of combinational and sequential circuits.			
Text Book: - Ramakant A. Gayakward, Op-amps and Linear Integrated Circuits, IV edition, Pearson Education, 2003 / PHI. D. Roy Choudhary, Sheil B. Jani, Linear Integrated Circuits, II edition, New Age, 2003. M. Morris Mano, Digital Logic and Computer Design, Prentice Hall of India, 2002			

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC235	ANALOG ELECTRONICS LABORATORY	0-0-3:1	2016
Prerequisite: EC209 Analog electronics			
Course Objectives To develop working knowledge on electronic devices and their performance characteristics			
List of Exercises/Experiments : (Ten experiments are mandatory) - Study & Use of CRO: Measurement of current voltage, frequency and phase shift. - Diode Clipping Circuits - Clamping Circuits - Rectifiers and filters with and without shunt capacitors- Characteristics full wave rectifier- Ripple factor, Rectification efficiency, and % regulation - RC coupled amplifier using BJT in CE configuration- Measurement of gain, input and output impedance and frequency response - FET amplifier- Measurement of voltage gain, current gain, input and output impedance - Darlington Emitter Follower - R.C. Phase Shift Oscillator using BJT or Op- Amp - Characteristics of voltage regulators- Design and testing of: a) simple zener voltage regulator b) zener regulator with emitter follower output - Series & Parallel Resonance Circuits - Voltage Series Feedback Amplifier - Class 'B' Push-Pull Amplifier - Astable and monostable multivibrators using IC 555 - Design of PLL for given lock and capture ranges& frequency multiplication - Applications using PLL			
List of major equipments CRO, Function generator, Regulated power supply , Dual power supply, Digital multimeter, Ammeter ,Voltmeter.			
Expected outcome. On completion of the course the student will be able to understand the working of electrical devices ,their performance characteristics and will be able to design circuits for various electronic devices			
Text Book: Allen Mottershead, <i>Electronic Devices and Circuits: An Introduction</i> , Prentice Hall of India			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC301	Digital Signal Processing	3-1-0-4	2016
Prerequisite: EC 202 Signals & Systems			
Course objectives: 1. To provide an understanding of the principles, algorithms and applications of DSP 2. To study the design techniques for digital filters 3. To give an understanding of Multi-rate Signal Processing and its applications 4. To introduce the architecture of DSP processors			
Syllabus Discrete Fourier Transform and its Properties, Linear Filtering methods based on the DFT, Frequency analysis of signals using the DFT, Computation of DFT, FFT Algorithms, IDFT computation using Radix-2 FFT Algorithms, Efficient computation of DFT of two real sequences and a 2N-Point real sequence, Design of FIR Filters, Design of linear phase FIR Filters using window methods and frequency sampling method, Design of IIR Digital Filters from Analog Filters, IIR Filter Design, Frequency Transformations, FIR Filter Structures, IIR Filter Structures, Introduction to TMS320C67xx digital signal processor, Multi-rate Digital Signal Processing, Finite word length effects in DSP systems, IIR digital filters, FFT algorithms.			
Expected outcome: The students will understand (i) the principle of digital signal processing and applications. (ii) the utilization of DSP to electronics engineering			
Text Books: 1. Oppenheim A. V., Schafer R. W. and Buck J. R., Discrete Time Signal Processing, 3/e, Prentice Hall, 2007. 2. Proakis J. G. and Manolakis D. G., Digital Signal Processing, 4/e, Pearson Education, 2007.			
References: 1. Chassaing, Rulph., DSP applications using C and the TMS320C6x DSK. Vol. 13. John Wiley & Sons, 2003. 2. Ifeachor E.C. and Jervis B. W., Digital Signal Processing: A Practical Approach, 2/e, Pearson Education, 2009. 3. Lyons, Richard G., Understanding Digital Signal Processing, 3/e. Pearson Education India, 2004. 4. Mitra S. K., Digital Signal Processing: A Computer Based Approach, 4/e McGraw Hill (India), 2014. 5. NagoorKani, Digital Signal Processing, 2e, Mc Graw –Hill Education New Delhi, 2013 6. Salivahanan, Digital Signal Processing, 3e, Mc Graw –Hill Education New Delhi, 2014 (Smart book) 7. Singh A., Srinivasan S., Digital Signal Processing: Implementation Using DSP Microprocessors, Cenage Learning, 2012.			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	The Discrete Fourier Transform: DFT as a linear transformation, Relationship of the DFT to other transforms, IDFT	2	15
	Properties of DFT and examples Circular convolution	4	
	Linear Filtering methods based on the DFT- linear convolution using circular convolution, overlap save and overlap add methods	3	
	Frequency Analysis of Signals using the DFT	2	
II	Computation of DFT: Radix-2 Decimation in Time and Decimation in Frequency FFT Algorithms	3	15
	IDFT computation using Radix-2 FFT Algorithms	2	
	Efficient computation of DFT of Two Real Sequences and a 2N-Point Real Sequence	2	
FIRST INTERNAL EXAM			
III	Design of FIR Filters- Symmetric and Anti-symmetric FIR Filters	2	15
	Design of linear phase FIR Filters using Window methods (rectangular, Hamming and Hanning) and frequency sampling Method	6	
	Comparison of Design Methods for Linear Phase FIR Filters	1	
IV	Design of IIR Digital Filters from Analog Filters (Butterworth)	4	15
	IIR Filter Design by Impulse Invariance, and Bilinear Transformation	3	
	Frequency Transformations in the Analog and Digital Domain	2	
SECOND INTERNAL EXAM			
V	Block diagram and signal flow graph representations of filters	1	20
	FIR Filter Structures: (Linear structures), Direct Form, Cascade Form and Lattice Structure	3	
	IIR Filter Structures: Direct Form, Transposed Form, Cascade Form and Parallel Form	2	
	Computational Complexity of Digital filter structures	1	
	Computer architecture for signal processing : Introduction to TMS320C67xx digital signal processor	2	
VI	Multi-rate Digital Signal Processing: Decimation and Interpolation (Time domain and Frequency Domain Interpretation without proof)	3	20
	Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating-point DSP arithmetic, ADC quantization noise	2	

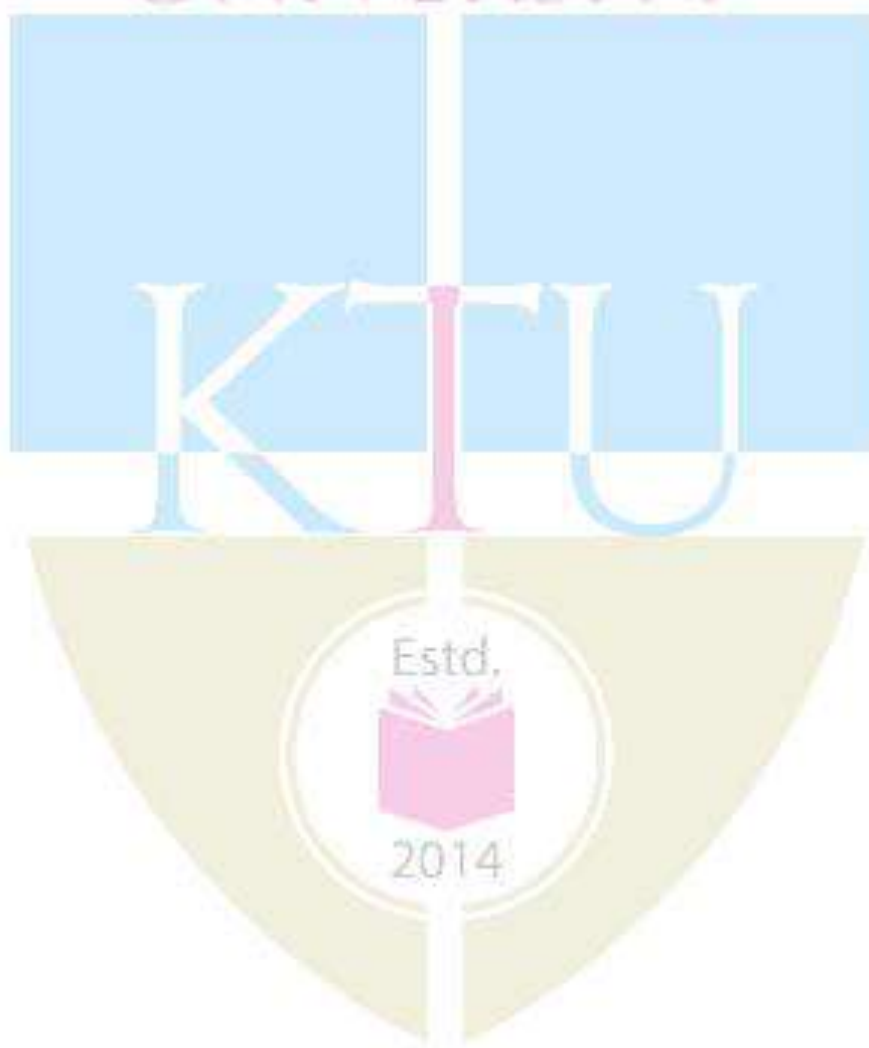
	Finite word length effects in IIR digital filters: coefficient quantization errors	2	
	Finite word length effects in FFT algorithms: Round off errors	2	
END SEMESTER EXAM			

Question Paper Pattern (End Sem Exam)

Maximum Marks: 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 40 % for theory and 60% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC302	Digital Communication	4-0-0-4	2016
Prerequisite: EC204 Signals and Systems, EC208 Analog Communication			
Course Objectives: - To understand the concept of Digital representation of analog source - To understand the Performance comparison various pulse modulation schemes - To discuss Inter Symbol Interference (ISI) problem in digital communication and to derive the Nyquist Criteria for zero ISI in data Transmission - To analyse the need for introducing ISI in controlled manner - To understand signal space representation of signal using Gram Schmidt orthonormalisation procedure - To analyse the error probability for different modulation schemes like BPSK, BFSK, QPSK etc. - To understand the principle of spread spectrum communication and to illustrate the concept of FHSS and DSSS - To understand various Multiple Access Techniques			
Syllabus: Overview of Random variables and Random process, Overall picture and relevance of digital communication, Digital Pulse modulation, Signal space concepts, Matched filter receiver, Review of Gaussian random process, Digital band pass modulation schemes, Detection of signals in Gaussian noise, Pseudo-noise sequences, Importance of synchronization, Spread spectrum communication, Diversity techniques, Multiple Access Techniques.			
Expected Outcome The students will be able to - Illustrate the Digital representation of analog source - Compare the performance of various Digital Pulse Modulation Schemes - Apply the knowledge of ISI problems in Digital communication to derive Nyquist criteria for zero ISI - Analyse the need for introducing ISI in Digital Communication in a controlled manner - Construct signal space representation of signal using Gram Schmidt orthonormalisation procedure - Compare the error probability for different digital modulation schemes like BPSK, BFSK, QPSK etc. - Describe the principle of spread spectrum communication and to illustrate the concept of FHSS and DSSS - Understand various Diversity Techniques			
Text Books: - John G. Proakis, Masoud Salehi, Digital Communication, McGraw Hill Education Edition, 2014 - Nishanth N, Digital Communication, Cengage Learning India , 2017 - Ramakrishna Rao, Digital communication, Tata McGraw Hill Education Pvt. Limited. - Simon Haykin, Communication Systems, 4/e Wiley India, 2012.			

References:

1. Couch: Analog and Digital Communication. 8e, Pearson Education India, 2013.
2. H.Taub and Schilling Principles of Communication Systems, , TMH, 2007
3. K.Sam Shanmugham, Digital and Analog Communication Systems, John Wiley & Sons
4. Pierre Lafrance ,Fundamental Concepts in Communication, Prentice Hall India.
5. Sheldon.M.Ross, “Introduction to Probability Models”, Academic Press, 7th edition.
6. Sklar: Digital Communication, 2E, Pearson Education.
7. T L Singal, Digital Communication, McGraw Hill Education (India) Pvt Ltd, 2015

Course Plan

Module	Course content	Hours	End Sem. Exam Marks
I	Overview of Random variables and Random process: Random variables–continuous and Discrete, random process-Stationarity, Autocorrelation and power spectral density, Transmission of Random Process through LTI systems, PSD, AWGN	3	15
	Pulse Code Modulation (PCM): Pulse Modulation, Sampling process, Performance comparison of various sampling techniques Aliasing, Reconstruction, PAM, Quantization, Noise in PCM system	3	
	Modifications of PCM: Delta modulation, DPCM, ADPCM, ADM, Performance comparison of various pulse modulation schemes, Line codes, PSD of various Line codes	4	
II	Transmission over baseband channel: Matched filter, Inter Symbol Interference (ISI), Nyquist Criteria for zero ISI, Ideal solution, Raised cosine spectrum, Eye Pattern	4	15
	Correlative Level Coding - Duobinary coding, precoding, Modified duobinary coding, Generalized Partial response signalling.	3	
FIRST INTERNAL EXAM			
III	Signal Space Analysis: Geometric representation of signals, Gram Schmidt orthogonization procedure.	3	15
	Transmission Over AWGN Channel: Conversion of the continuous AWGN channel into a vector channel, Likelihood function, Maximum Likelihood Decoding, Correlation Receiver	4	
IV	Digital Modulation Schemes: Pass band transmission model, Coherent Modulation Schemes- BPSK, QPSK, BFSK. Non-Coherent orthogonal modulation schemes, Differential Phase Shift Keying (DPSK)	4	15
	Detection of Binary modulation schemes in the presence of noise, BER for BPSK, QPSK, BFSK	5	
SECOND INTERNAL EXAM			
V	Pseudo–noise sequences: Properties of PN sequences. Generation of PN Sequences, generator polynomials, Maximal length codes and Gold Codes.	3	20

	Importance of synchronization: Carrier, frame and symbol/chip synchronization techniques.	2	
	Spread spectrum communication: Direct sequence spread spectrum with coherent binary phase shift keying, Processing gain, Probability of error, Anti-jam Characteristics, Frequency Hop spread spectrum with MFSK, Slow and Fast frequency hopping.	4	
VI	Multipath channels: classification, Coherence time, Coherence bandwidth, Statistical characterization of multi path channels, Binary signalling over a Rayleigh fading channel.	3	20
	Diversity techniques: Diversity in time, frequency and space.	2	
	Multiple Access Techniques: TDMA, FDMA, CDMA and SDMA – RAKE receiver, Introduction to Multicarrier communication- OFDM	5	
END SEMESTER EXAM			

Question Paper Pattern (End Semester Exam)

Maximum Marks : 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 30% for theory and 70% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC303	Applied Electromagnetic Theory	3-0-0-3	2016
Prerequisite: Nil			
Course objectives: 1. To introduce basic mathematical concepts related to electromagnetic vector fields. 2. To impart knowledge on the basic concepts of electric and magnetic fields 3. To develop a solid foundation in the analysis and application of electromagnetic fields, Maxwell's equations and Poynting theorem. 4. To become familiar with propagation of signal through transmission lines and waveguides.			
Syllabus: Co-ordinate transformation, vector algebra, vector calculus, electrostatics, magneto statics, Maxwell's equations, Boundary condition, Solution of wave equation, propagation of plane EM wave in different media, Poynting vector theorem, transmission lines, Smith chart, Waveguides.			
Expected outcome: At the end of the course, students will be able: 1. To develop a solid foundation and a fresh perspective in the analysis and application of electromagnetic fields. 2. To analyse the propagation of electromagnetic waves in different media. 3. To analyze the characteristics of transmission lines. 4. To solve the different transmission line problems using Smith chart 5. To understand the different modes of propagation in waveguides.			
Text Books: 1. John D. Kraus, Electromagnetics, 5/e, TMH, 2010. 2. Mathew N O Sadiku, Elements of Electromagnetics, Oxford University Press, 6/e, 2014. 3. William, H., Jf Hayt, and John A. Buck. Engineering Electromagnetics. McGraw-Hill, 8/e McGraw-Hill, 2014.			
References: 1. Jordan and Balmain , Electromagnetic waves and Radiating Systems, PHI, 2/e,2013 2. Joseph A Edminister , Electromagnetics, Schaum's Outline Series McGraw Hill, 4/e, 1995 3. Martin A Plonus , Applied Electromagnetics, McGraw Hill, 2/e,1978. 4. <u>Matthew N.O. Sadiku & S.V. Kulkarni</u> "'Principles of Electromagnetics', Oxford University Press Inc. Sixth Edition, Asian Edition,2015 5. Nannapaneni Narayana Rao, Elements of Engineering Electromagnetics, Pearson, 6/e, 2006. 6. Umran S. Inan and Aziz S. Inan, Engineering Electromagnetics, Pearson, 2010.			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Review of vector calculus, Spherical and Cylindrical coordinate system, Coordinate transformation	1	0
	Curl, Divergence, Gradient in spherical and cylindrical coordinate system.	1	
	Electric field – Application of Coulomb’s law, Gauss law and Amperes current law (proof not required, simple problems only)	1	15
	Poisson and Laplace equations (proof not required, simple problems only), Determination of E and V using Laplace equation.	1	
	Derivation of capacitance and inductance of two wire transmission line and coaxial cable. Energy stored in Electric and Magnetic field.	2	
	Displacement current density, continuity equation. Magnetic vector potential. Relation between scalar potential and vector potential.	2	
II	Maxwell’s equation from fundamental laws.	1	15
	Boundary condition of electric field and magnetic field from Maxwell's equations	1	
	Solution of wave equation	1	
	Propagation of plane EM wave in perfect dielectric, lossy medium, good conductor, media-attenuation, phase velocity, group velocity, skin depth.	3	
FIRST INTERNAL EXAM			
III	Reflection and refraction of plane electromagnetic waves at boundaries for normal & oblique incidence (parallel and perpendicular polarization), Snell’s law of refraction, Brewster angle.	4	15
	Power density of EM wave, Poynting vector theorem, Complex Poynting vector.	3	
	Polarization of electromagnetic wave-linear, circular and elliptical polarisation.	2	
IV	Uniform lossless transmission line - line parameters	1	15
	Transmission line equations, Voltage and Current distribution of a line terminated with load	2	
	Reflection coefficient and VSWR. Derivation of input impedance of transmission line.	2	
SECOND INTERNAL EXAM			
V	Transmission line as circuit elements (L and C).	2	20
	Half wave and quarter wave transmission lines.	1	
	Development of Smith chart - calculation of line impedance and VSWR using smith chart.	2	

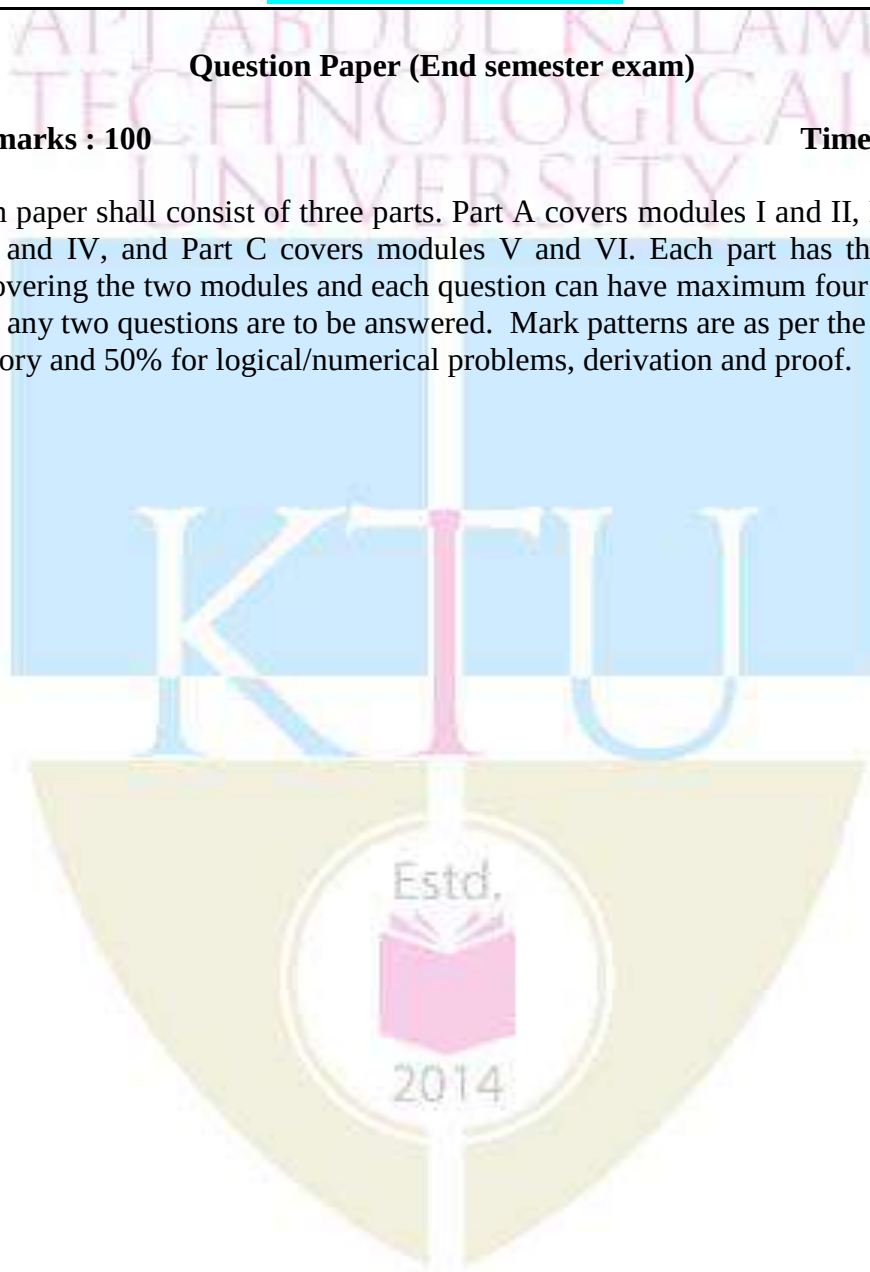
	Single stub matching (Smith chart and analytical method).	2	
VI	Parallel-Plate Waveguide - TE & TM waves.	1	20
	The hollow rectangular wave guide – modes of propagation of wave- dominant mode, group velocity and phase velocity - derivation and simple problems only.	3	
	Attenuation in wave guides, guide wavelength and impedance -derivation and simple problems only.	3	
END SEMESTER EXAM			

Question Paper (End semester exam)

Maximum marks : 100

Time: 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50 % for theory and 50% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC304	VLSI	3-0-0-3	2016
Prerequisite: EC203 Solid State Devices, EC204 Analog Integrated Circuit.			
Course objectives: - To give the knowledge about IC Fabrication Techniques - To impart the skill of analysis and design of MOSFET and CMOS logic circuits.			
Syllabus: IC Fabrication Technology, CMOS IC Fabrication Sequence, CMOS inverters, Design rules, Static CMOS Design, Dynamic CMOS circuits, Pass transistor, Read Only Memory, Random Access Memory, Sense amplifiers, Adders, multipliers, Testing of VLSI circuits.			
Expected outcome: The students will be able to design and analyse various MOSFET and CMOS logic circuits.			
Text Books: 1. John P Uyemura, Introduction to VLSI Circuits and Systems, Wiley India, 2006 2. S.M. SZE, VLSI Technology, 2/e, Indian Edition, McGraw-Hill,2003			
References: 1. Jan M.Rabaey, Digital Integrated Circuits- A Design Perspective, Prentice Hall, Second Edition, 2005. 2. Neil H.E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design- A Systems Perspective, Second Edition. Pearson Publication, 2005 3. Razavi - Design of Analog CMOS Integrated Circuits,1e, McGraw Hill Education India Education, New Delhi, 2003. 4. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Design, McGraw-Hill, Third Ed., 2003. 5. Yuan Taur & Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, 2008			
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Material Preparation- Purification, Crystal growth (CZ and FZ process), wafer preparation	4	15
	Thermal Oxidation- Growth mechanisms, Dry and Wet oxidation, Deal Grove model.		
	Diffusion- Fick’s Laws, Diffusion with constant surface concentration and from a constant source, diffusion techniques.	3	
II	Ion implantation-Technique, Range Theory, annealing.		15
	Epitaxy : Vapour phase epitaxy and molecular beam epitaxy	4	
	Lithography- Photo lithographic sequence, Electron Beam Lithography, Etching and metal deposition		
III	Methods of isolation	3	15
	Circuit component fabrication: transistor, diodes, resistors, capacitors, N-well CMOS IC		
	Fabrication Sequence		
FIRST INTERNAL EXAM			
III	CMOS inverters- DC characteristics, switching characteristics, power dissipation	4	15

	Layout Design rules , Stick Diagram and layout of CMOS Inverter, two input NAND and NOR gates	4	
IV	MOSFET Logic Design -Pass transistor logic, Complementary pass transistor logic and transmission gate logic , realization of functions	6	15
SECOND INTERNAL EXAM			
V	Read Only Memory -4x4 MOS ROM Cell Arrays(OR,NOR,NAND) Random Access Memory –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell	4	20
	Sense amplifiers –Differential Voltage Sensing Amplifiers Introduction to PLDs and FPGAs, Design of PLAs.	3	
VI	Adders - Static adder, Carry-By pass adder, Linear Carry-Select adder, Square- root carry- select adder Multipliers -Array multiplier	4	20
END SEMESTER EXAM			

Question Paper Pattern (End Semester Exam)

Maximum Marks : 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70% for theory and 30% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC305	Microprocessor & Microcontroller	3-0-0-3	2016
Prerequisite: EC207 Logic Circuit Design			
Course objectives: 1. To understand fundamental operating concepts of microprocessors and microcontrollers. 2. To communicate with various devices using controller. 3. To design a microcontroller based system with the help of the interfacing devices. 4. To program the controller to make various peripherals work for specified application.			
Syllabus: Microprocessors: 8085 architecture and its operation, microprocessor initiated operations and bus organization, pin configuration and functions, generation of control signals for external operations- fetch, IO/M, read/write, machine cycles and bus timings. Addressing modes, instruction set, instruction classification. Overview/concept of peripheral IC interfacing with 8085 microprocessor (8251, 8253, 8255, 8279). Simple examples in assembly language programming for 8085 (only for internal examination). Introduction to development tools: IDE, cross assembler, builder, linker and debugger.(not required for exam). Introduction to 8086 and comparison between 8086, 80286, 80386, 80486 and Pentium. Microcontrollers: 8051- features, architecture, memory organization, registers, I/O ports, pin configuration and functions. Addressing modes, instruction set, instruction classification. Assembly language programming. Interrupts in 8051. Timer/Counter programming: Operating modes, time delay generation, Waveform generation. Serial communication: RS 232 interface, registers in UART, modes of operation, programming examples for serial data transmission and reception. Interfacing of DIP switch, stepper motor, ADC, DAC, LEDs and seven segment displays, alphanumeric LCD module with 8051.			
Expected outcome: The students will be able to: 1. Distinguish various types of processor architectures. 2. Describe architectures, memory organization of 8085 microprocessor and 8051. 3. Develop programming skills in assembly for interfacing peripheral devices with 8051			
Text Books: 1. Kenneth J. Ayala, The 8051 Microcontroller, Cengage learning, 3/e. 2. Lyla B.Das : Microprocessors and Microcontrollers, Pearson Education, India, 2011 3. Ramesh S. Goankar. 8085 Microprocessors Architecture Application and Programming, Penram International, 5/e.			
References: 1. Aditya P Mathur, Introduction to Microprocessor. Tata Mc Graw – Hill 2. Han Way Hung, “PIC Microcontroller, An introduction to software and hardware interfacing “, Cenage learning. 3. I.Scott Mackenzie, Raphel C.-W Phan, The 8051 microcontroller, 4th edition. 4. Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2nd edition 5. Nagoorkani, Microprocessors and Microcontrollers 2e, McGraw Hill Education India, 2012. 6. Soumitra Kumar Mandal. Microprocessors and Microcontrollers Architecture, Programming & Interfacing Using 8085, 8086 and 8051, McGraw Hill Education (2011). 7.			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Microprocessors: Introduction, organization of a microprocessor based system, evolution of microprocessors, 8085 architecture and its operation, microprocessor initiated operations and bus organization, pin configuration and functions, generation of control signals for external operations-fetch, IO/M, read/write.	5	15
II	Machine cycles and bus timings, Addressing modes, instruction set instruction classification.	4	15
	Overview/concept of peripheral IC interfacing with 8085 microprocessor (8251, 8253, 8255, 8279).	3	
	Simple examples in assembly language programming for 8085 (only for internal examination)	2	0
	Introduction to development tools: IDE, cross assembler, builder, linker and debugger.(not required for exam)	3	
FIRST INTERNAL EXAM			
III	Introduction to 8086 and comparison between 8086,80286,80386,80486 and Pentium	2	15
	Microcontrollers: Introduction, comparison between microprocessors and microcontrollers, microcontroller families, 8051- features, architecture, memory organization, registers, I/O ports, pin configuration and functions.	6	
IV	Addressing modes, instruction set, instruction classification.	2	15
	Assembly language programming examples for 8051.	3	
SECOND INTERNAL EXAM			
V	Interrupts in 8051: Types, interrupt source, interrupt handling and programming	2	20
	Timer/Counter programming: Operating modes, time delay generation, Waveform generation.	2	
	Serial communication: RS 232 interface, registers in UART, modes of operation, programming examples for serial data transmission and reception	2	
VI	Interfacing: Interfacing (block schematic and assembly language programming) of DIP switch, stepper motor, ADC, DAC, LEDs and seven segment displays, alphanumeric LCD module with 8051.	6	20
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

Max. Marks: 100

Time: 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 80 % for theory and 20% for logical/numerical problems and programming.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC306	Antenna & Wave Propagation	3-0-0-3	2016
Prerequisite: EC303 Applied Electromagnetic Theory			
Course objectives: • To learn the basic working of antennas. • To study various antennas, arrays and radiation patterns of antennas. • To understand various techniques involved in various antenna parameter measurements. • To understand the propagation of radio waves in the atmosphere.			
Syllabus: Antenna and antenna parameters, Duality of antennas, Derivation of electromagnetic fields and directivity of short dipole and half wave dipole, Measurement of antenna parameters. Antenna arrays and design of Endfire, broadside, binomial and Dolphchebyshev arrays, Principles of practical antennas. Traveling wave antennas, principle and applications of V and rhombic antennas Principles of Horn, Parabolic dish antenna and Cassegrain antenna, Log periodic antenna array and Helical antenna. Design of rectangular Patch antennas. Principle of smart antenna, Radio wave propagation, Different modes, effect of earth's magnetic field. Fading and diversity techniques.			
Expected outcome: The student will be able to know: i. The basic working of antennas. ii. Various antennas, arrays and radiation patterns of antennas iii. Various techniques involved in various antenna parameter measurements. iv. The propagation of radio waves in the atmosphere.			
Text Books: 1. Balanis, Antenna Theory and Design, 3/e, Wiley Publications. 2. John D. Krauss, Antennas for all Applications, 3/e, TMH.			
References: 1. Collin R.E, Antennas & Radio Wave Propagation, McGraw Hill. 1985. 2. Jordan E.C. & K. G. Balmain, Electromagnetic Waves & Radiating Systems, 2/e, PHI. 3. Raju G.S.N., Antenna and Wave Propagation, Pearson, 2013. 4. Sisir K.Das & Annapurna Das, Antenna and Wave Propagation, McGraw Hill, 2012 5. Terman, Electronics & Radio Engineering, 4/e, McGraw Hill. 6. Thomas A. Milligan, Modern Antenna Design, IEEE PRESS, 2/e, Wiley Inter science.			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Basic antenna parameters - gain, directivity, beam solid angle, beam width and effective aperture calculations. Effective height - wave polarization - antenna temperature - radiation resistance - radiation efficiency - antenna field zones - principles of reciprocity. Duality of antennas.	7	15
II	Concept of retarded potential. Field, directivity and radiation resistance of a short dipole and half wave dipole. Measurement of radiation pattern, gain, directivity and impedance of antenna	7	15
FIRST INTERNAL EXAM			
III	Arrays of point sources - field of two isotropic point sources - principle of pattern multiplication - linear arrays of ‘n’ isotropic point sources. Grating lobes.	4	15
	Design of Broadside, Endfire & Binomial arrays. Design of DolphChebyshev arrays.	4	
IV	Basic principle of beam steering. Travelling wave antennas. Principle and applications of V and rhombic antennas. Principles of Horn, Parabolic dish antenna, Cassegrain antenna (expression for E, H and Gain without derivation).	6	15
SECOND INTERNAL EXAM			
V	Principle of Log periodic antenna array and Helical antenna. Antennas for mobile base station and handsets.	3	20
	Design of rectangular Patch antennas. Principle of smart antenna.	3	
VI	Radio wave propagation , Modes , structure of atmosphere, sky wave propagation , effect of earth’s magnetic field, Ionospheric abnormalities and absorption, space wave propagation, LOS distance	4	20
	Field strength of space wave, duct propagation, VHF and UHF Mobile radio propagation, tropospheric scatter propagation, fading and diversity techniques.	4	
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

Max. Marks : 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50% for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC307	Power Electronics & Instrumentation	3-0-0-3	2016
Prerequisite: EC205 Electronic Circuits			
Course objectives: 1. To provide an insight on the concepts of Power Electronics and Electronic instruments. 2. To study the applications of Power electronics such as Switched mode regulators and inverters. 3. To develop understanding of the concept of Transducers and Digital instruments.			
Syllabus: Power semiconductor switches and its static and dynamic characteristics. Switched mode regulators, SMPS, Switched mode inverters, UPS. Performance characteristics of instruments, Measurement of passive components, Different Transducers, Digital Instruments.			
Expected outcome: The students will be able: 1. To understand the concepts of Power Electronics and the various applications. 2. To get an insight on various electronic instruments, their configuration and measurements using them. 3. To understand the principle of operation of Transducers			
Text Books: 1. Bell D. A., Electronic Instrumentation and Measurements, Oxford University Press, 2003. 2. Rashid M. H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi. 3. Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015.			
References: 1. Daniel W. Hart, Power Electronics, McGraw Hill, 2011. 2. Doebelin E., Measurement Systems, 5/e, McGraw Hill, 2003. 3. Helfrick A. D. and W. D. Cooper: Modern Electronic Instrumentation and Measurement Techniques, 5/e, PHI, 2003. 4. Mandal, Power Electronics 1e, McGraw Hill Education India, 2014 5. Mohan N. and T. M. Undeland, Power Electronics: Converters, Applications and Design, John Wiley, 2007. 6. Nakra, Instrumentation, Measurement and Analysis, 4e, Mc Graw –Hill Education New Delhi, 2016 7. Patranabis D., Principles of Electronic Instrumentation, PHI, 2008.			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Linear Electronics versus Power Electronics - Power semiconductor switches.	1	15
	Power diodes-structure, static and dynamic characteristics	2	
	Power transistors - Power BJT, Power MOSFET, GTO and IGBT	3	
	Steady state and switching characteristics of Power BJT, Power MOSFET and IGBT.	2	
II	Introduction to Switched mode regulators	1	15
	Buck, Boost and Buck-Boost DC-DC converters	2	
	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (Derivation not required)	1	
	Isolated converters - Flyback, Forward, Push Pull, Half Bridge and Full Bridge Converters - waveforms and governing equations. (Derivation not required)	3	
FIRST INTERNAL EXAM			
III	Overview of SMPS, Switched mode inverters- Principles of PWM switching schemes.	2	15
	Single phase inverters - half bridge, full bridge and push pull.	2	
	UPS - on line and off line.	1	
	Three phase inverters - PWM and Space vector modulation in three phase inverters.	3	
IV	Generalized configurations of instruments - Functional elements. Classification of instruments	1	15
	Generalized performance characteristics of instruments - Static characteristics and Dynamic characteristics.	2	
	Measurement of: resistance using Wheastone's bridge, inductance using Maxwell-Wien bridge, and capacitance using Schering's bridge.	2	
SECOND INTERNAL EXAM			
V	Transducers - Classification, Selection of transducers.	1	20
	Resistance transducers - Principle of operation, strain gauge.	2	
	Inductive Transducers: LVDT.	2	
	Capacitive transducers - different types, capacitor microphone, Hall Effect transducer, proximity transducers.	2	
VI	Electronic Multimeter, Audio Power Meter, RF power meter	2	20
	Digital Instruments - Basics, digital measurement of time, phase, frequency and digital voltmeter.	2	
	Frequency synthesizer, Spectrum analyzers, Logic State analyzers (block diagram only).	1	

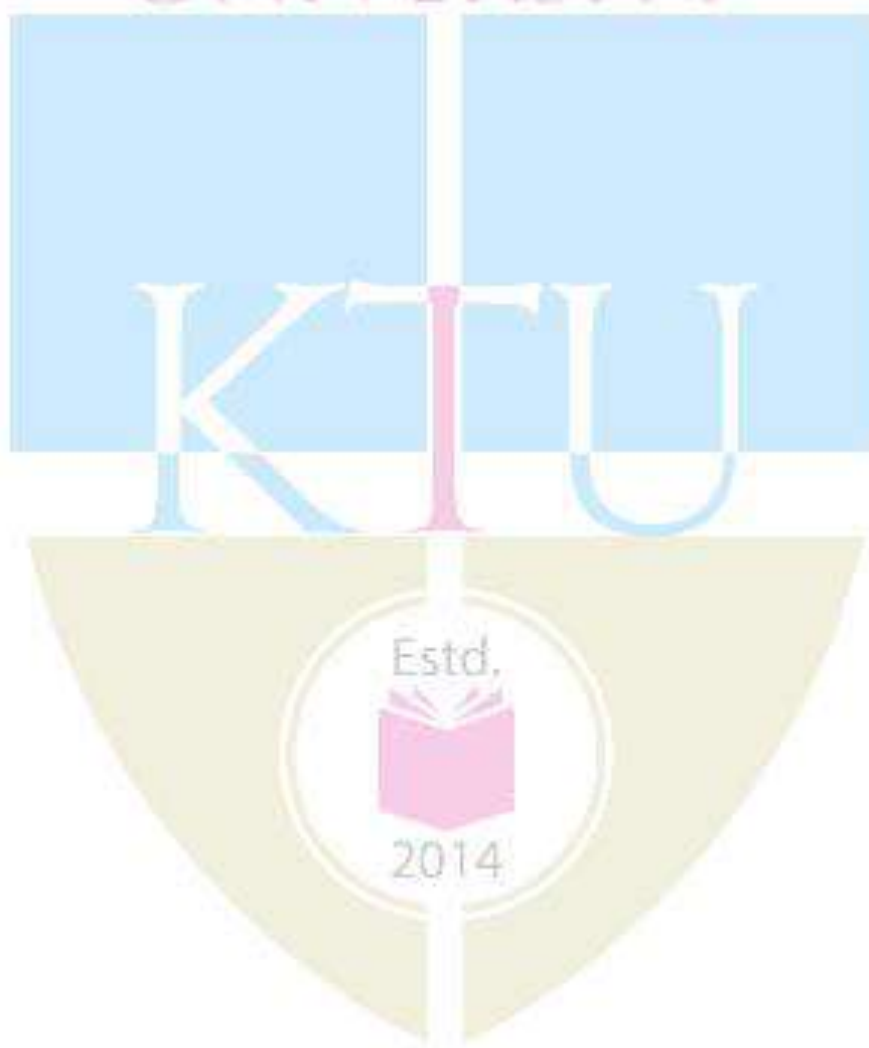
	Digital storage oscilloscope – Working Principle, controls and applications.	2	
END SEMESTER EXAM			

Question Paper Pattern (End Sem Exam)

Max. Marks: 100

Time: 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 100 % for theory.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC308	Embedded Systems	3-0-0 -3	2016
Prerequisite: EC206 Computer Organization, EC305 Microprocessors & Microcontrollers			
Course objectives: • To have a thorough understanding of the basic structure and design of an Embedded System • To study the different ways of communicating with I/O devices and standard I/O interfaces. • To study the basics of RTOS for Embedded systems. • To study the programming concepts of Embedded Systems • To study the architecture of System-on-Chip and some design examples.			
Syllabus: Introduction to Embedded Systems, Embedded system design process, Serial and parallel communication standards and devices, Memory devices and device drivers, Programming concepts of embedded programming - Embedded C++ and embedded java, Real Time Operating Systems Micro C/OS-II.			
Expected outcome: The students will be able to: - Understand the basics of an embedded system - Develop program for an embedded system. - Design, implement and test an embedded system.			
Text Books: - David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000. - Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers - Elsevier 3ed, 2008			
References: - Frank Vahid and Tony Givargis, Embedded Systems Design – A Unified Hardware / Software Introduction, John Wiley, 2002 - Iyer - Embedded Real time Systems, 1e, McGraw Hill Education New Delhi, 2003 - K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016. - Lyla B. Das, Embedded Systems: An Integrated Approach, 1/e , Lyla B. Das, Embedded Systems, 2012 - Rajkamal, Embedded Systems Architecture, Programming and Design, TMH, 2003 - Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002 - Tammy Noergaard, Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers, Newnes – Elsevier 2ed, 2012			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Introduction to Embedded Systems– Components of embedded system hardware–Software embedded into the system – Embedded Processors - CPU architecture of ARM processor (ARM9) – CPU Bus Organization and Protocol.	4	15
	Design and Development life cycle model - Embedded system design process – Challenges in Embedded system design	3	
II	Serial Communication Standards and Devices - UART, HDLC, SCI and SPI.	3	15
	Serial Bus Protocols - I2C Bus, CAN Bus and USB Bus. Parallel communication standards ISA, PCI and PCI-X Bus.	3	
FIRST INTERNAL EXAM			
III	Memory devices and systems - memory map – DMA - I/O Devices – Interrupts - ISR – Device drivers for handling ISR – Memory Device Drivers – Device Drivers for on-board bus.	6	15
IV	Programming concepts of Embedded programming – Features of Embedded C++ and Embedded Java (basics only). Software Implementation, Testing, Validation and debugging, system-on-chip.	6	15
	Design Examples: Mobile phones, ATM machine, Set top box	1	0
SECOND INTERNAL EXAM			
V	Inter Process Communication and Synchronization -Process, tasks and threads –Shared data– Inter process communication - Signals – Semaphore – Message Queues – Mailboxes – Pipes – Sockets – Remote Procedure Calls (RPCs).	8	20
VI	Real time operating systems - Services- Goals – Structures - Kernel - Process Management – Memory Management – Device Management – File System Organization. Micro C/OS-II RTOS - System Level Functions – Task Service Functions – Memory Allocation Related Functions – Semaphore Related Functions. Study of other popular Real Time Operating Systems.	8	20
END SEMESTER EXAM			

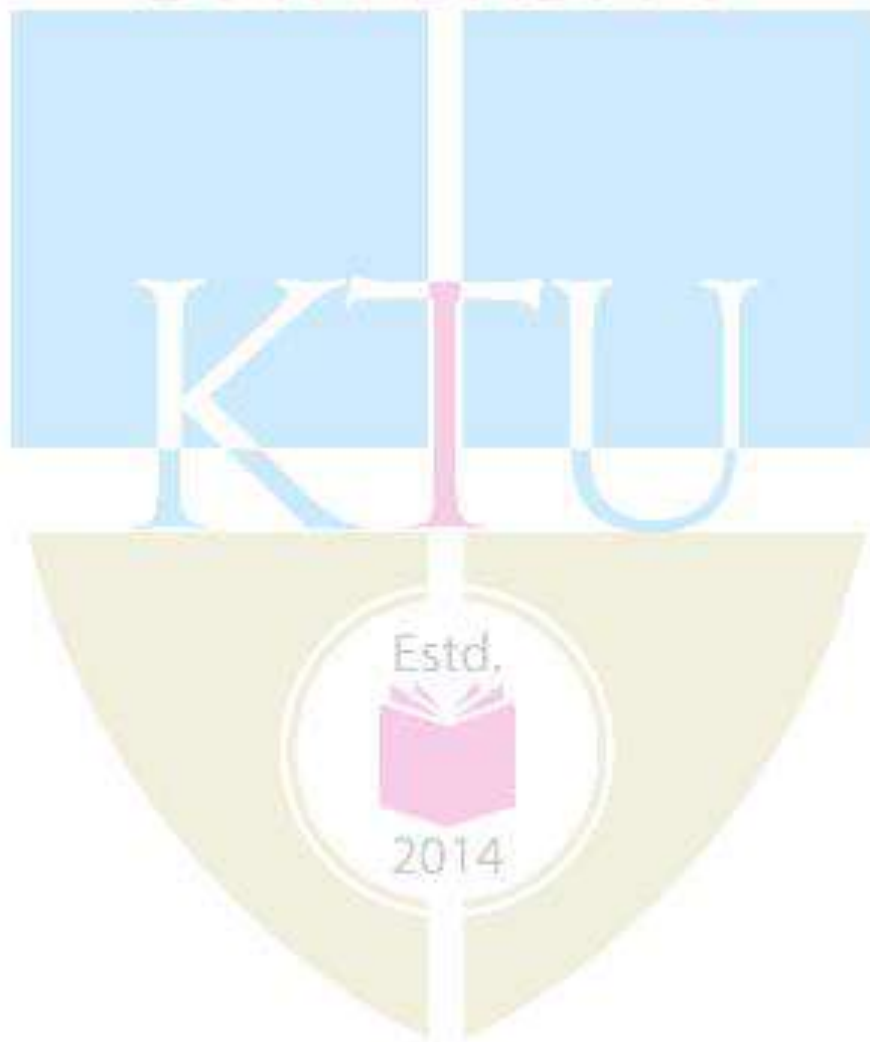
Question Paper Pattern (End semester exam)

Maximum Marks : 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 100 % for theory.

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC312	Object Oriented Programming	3-0-0-3	2016
Prerequisite: NIL			
Course objectives: - To introduce the Object Oriented Programming paradigm using C++ and Java as the languages. - To learn simple Android application development from the fundamentals.			
Syllabus: Object Oriented Programming and basics of C++, Advanced features of C++ programming such as exception handling and templates. Object oriented features of Java and their implementation. Advanced features of Java including packages, multithreading and error management. Introduction to Android application development with a case study.			
Expected outcome: The students will have: - A thorough understanding of the features of OOP like class construction, polymorphism and inheritance of C++ and Java. - An understanding of advanced features of C++ such as templates, abstract classes and virtual functions. - Knowledge of advanced features of Java such as multithreading, packages and error management. - Skills in designing android application development. - Skills in debugging, deploying and testing mobile applications.			
Text Books: E. Balagurusamy, Object Oriented Programming with C++ and JAVA, McGrawHill, 2015 - Hardy, Brian, and Bill Phillips, Android Programming: The Big Nerd Ranch Guide. Addison-Wesley Professional, 2013. - Yashwant P. Kanetkar, Let us C++, 2/e, BPB Publications, 2003			
References: - Deitel, Harvey M., and Paul J. Deitel., Java how to program.,7th International edition.” (2007): 390-420. G. Booch, R. A. Maksimchuk, M. W. Engel, and B J. Young, Object-oriented Analysis and Design with Applications, Addison-Wesley, 3rd Edition, 2007. - Horstmann, Cay S., and Gary Cornell., Core Java 2: Volume I, Fundamentals, Pearson Education, 2002. - Samanta, Debasis, Object-Oriented programming with C++ and Java, PHI Learning Pvt. Ltd., 2006. - Stroustrup, Bjarne. The C++ programming language, Pearson Education India, 1986. www.tutorialspoint.com/android/android_tutorial.pdf			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Concepts of OOP – Introduction to OOP, Procedural Vs. Object Oriented Programming, Principles of OOP, Benefits and applications of OOP.	2	15
	Beginning with C++: Overview and Structure of C++ Program, Classes and Objects, Constructors and Destructors.	4	
II	Operator Overloading and Inheritance – Overloading Unary Operators, Overloading Binary Operators, Overloading Binary Operators using Friends, Manipulation of Strings Using Operators.	4	15
	Inheritance – Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance. Virtual Base Classes, Abstract Classes, Constructors in Derived Classes, Member Classes: Nesting of Classes	5	
FIRST INTERNAL EXAM			
III	Virtual Functions and Polymorphism – Pointers to objects, this pointer, Pointers to derived classes, Virtual functions, Virtual Constructors and Destructors.	6	15
IV	Programming with JAVA – Overview of Java Language, Classes Objects and Methods, Method Overloading and Inheritance, Overriding Methods, Final Variables and Methods. Interfaces, Packages, Multithreaded programming, Managing Errors and Exceptions.	8	15
SECOND INTERNAL EXAM			
V	Introduction to Android : Setting up Development Environment, Basic Building blocks – Activities, Services, Broadcast Receivers & Content providers, UI Components – Views & notifications, Components for communication – Intents & Intent Filters,	6	20
VI	Application Structure-Android Manifest.xml, uses-permission & uses-sdk, Layouts & Drawable Resources, First sample Application, Emulator-Android Virtual Device, Basic UI design, Styles & Themes, Content Providers-SQLite Programming, Case study –Develop an App to demonstrate database usage.	7	20
END SEMESTER EXAM			

Assignment:

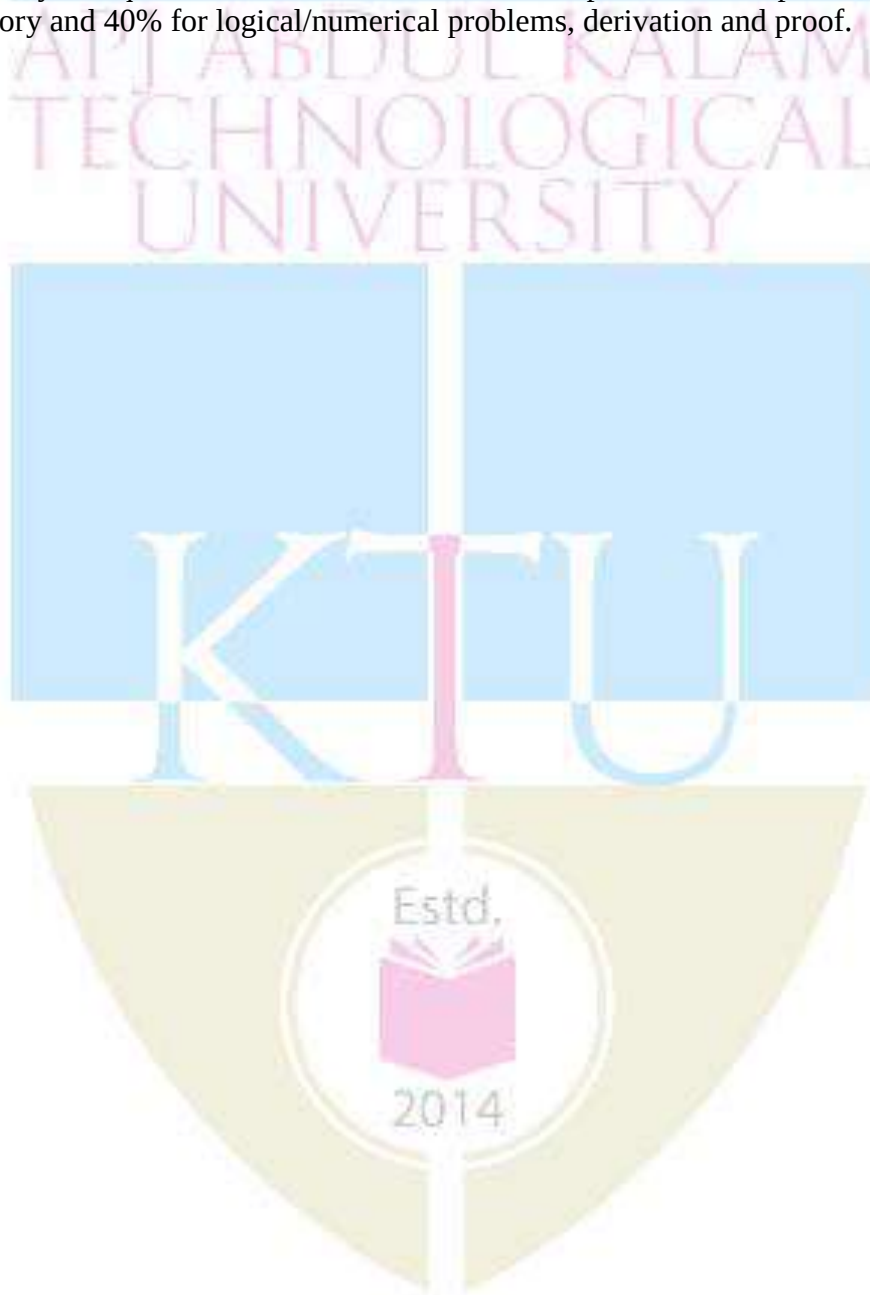
1. Assignment for implementing virtual base class in C++ related to some application.
2. Assignment for implementing a simple interactive applet in Java (eg: calculator)
3. A group assignment on simple android mobile app (eg: managing students' details and rank calculation of a class).

Question Paper Pattern (End semester exam)

Maximum marks : 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 60 % for theory and 40% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC332	Communication Engineering Lab (Analog & Digital)	0-0-3-1	2016
Prerequisite: EC204 Analog Integrated Circuit, EC208 Analog Communication Engineering.			
Course objectives: To provide experience on design, testing and analysis of few electronic circuits used in communication engineering.			
List of Experiments: Cycle I (Six experiments are mandatory) 1. AM generation using discrete components. 2. AM using multiplier IC AD534 or AD633. 3. AM detection using envelope detector. 4. IF tuned amplifier. 5. FM using 555 IC. 6. FM generation and demodulation using PLL. 7. Frequency multiplier using PLL 8. Pre-emphasis and de-emphasis circuits 9. Analog signal sampling & Reconstruction Cycle II (Six mandatory) 10. Generation of Pseudo Noise Binary sequence using Shift registers 11. Time Division Multiplexing and Demultiplexing 12. Generation & Detection of DM/SIGMA DELTA/ ADM 13. Generation & Detection of PAM/PWM/PPM 14. Generation & Detection of BPSK/DPSK/DEPSK 15. Generation & Detection of PCM 16. 16 QPSK Modulation and Demodulation			
Expected outcome: The students will be able to understand the basic concepts of circuits used in communication systems.			



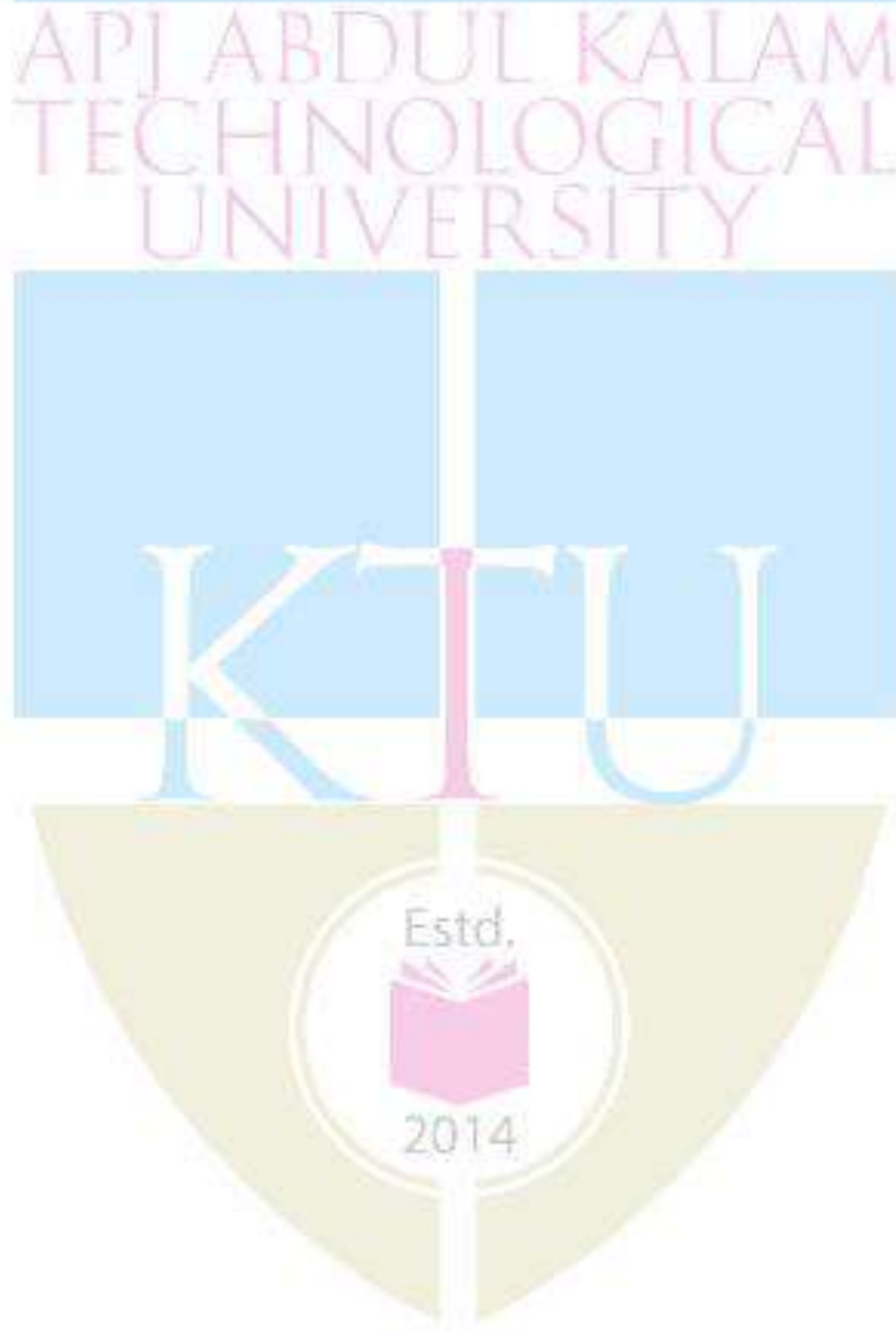
COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC333	Digital Signal Processing Lab	0-0-3-1	2016
Prerequisite: EC 213 Electronics Design Automation Lab, EC 202 Signals & Systems			
Course objectives: To enable the students to explore the concepts of design, simulation and implementation of various systems using MATLAB/SciLab/OCTAVE and DSP kit.			
List of Experiments: Part A: Experiments on Digital Signal Processor/ DSP kits: (All experiments are mandatory) 1. Generation of sine wave and standard test signals. 2. Convolution : Linear and Circular 3. Real Time FIR Filter implementation (Low-pass, High-pass and Band-pass) by inputting a signal from the signal generator 4. Real Time IIR Filter implementation (Low-pass, High-pass and Band-pass) by inputting a signal from the signal generator 5. Sampling of analog signal and study of aliasing. Part B: Experiments based on MATLAB/SciLab/OCTAVE (7 experiments are mandatory) 1. Generation of Waveforms (Continuous and Discrete) 2. Verification of Sampling Theorem. 3. Time and Frequency Response of LTI systems (First and second order). 4. Linear Convolution, Circular Convolution and Linear Convolution using Circular Convolution. 5. To find the DFT and IDFT for the given input sequence. 6. Linear convolution using DFT (Overlap-add and Overlap-Save methods). 7. To find the DCT and IDCT for the given input sequence. 8. To find FFT and IFFT for the given input sequence. 9. FIR and IIR filter design using Filter Design Toolbox. 10. FIR Filter (Low-pass, High-pass and Band-pass)design (Window method). 11. IIR Filter (Low-pass, High-pass and Band-pass)design (Butterworth and Chebychev). 12. Generation of AM, FM & PWM waveforms and their spectrum. 13. Generation of DTMF signal. 14. Study of sampling rate conversion (Decimation, Interpolation, Rational factor). 15. Filtering of noisy signals 16. Implementation of simple algorithms in audio processing (delay, reverb, flange etc.). 17. Implementation of simple algorithms in image processing (detection, de-noising, filtering etc.)			
Expected outcome: The students will be able to: Design, simulate and realize various systems related to DSP.			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC334	Microcontroller Lab	0-0-3-1	2016
Prerequisite: EC305 Microprocessors & Microcontrollers			
Course objectives: 1. To understand Assembly Language/embedded C programming of Microcontroller. 2. To interface simple peripheral devices to a Microcontroller. 3. To equip student groups to design and implement simple embedded systems.			
List of Experiments: PART –A (At least 6 experiments are mandatory) Assembly Language Programming experiments using 8051 Trainer kit. 1. Data transfer/exchange between specified memory locations. 2. Largest/smallest from a series. 3. Sorting (Ascending/Descending) of data. 4. Addition / subtraction / multiplication / division of 8/16 bit data. 5. Sum of a series of 8 bit data. 6. Multiplication by shift and add method. 7. Square / cube / square root of 8 bit data. 8. Matrix addition. 9. LCM and HCF of two 8 bit numbers. 10. Code conversion – Hex to Decimal/ASCII to Decimal and vice versa. PART –B (At least 4 experiments are mandatory) Interfacing experiments using 8051 Trainer kit and interfacing modules. 1. Time delay generation and relay interface. 2. Display (LED/Seven segments/LCD) and keyboard interface. 3. ADC interface. 4. DAC interface with wave form generation. 5. Stepper motor and DC motor interface. 6. Realization of Boolean expression through port. 7. Elevator interfacing. PART -C(At least 2 experiments are mandatory) Programming / interfacing experiments with IDE for 8051/PIC/MSP/Arduino/Raspberry Pi based interfacing boards/sensor modules (Direct downloading of the pre-written ALP/‘C’/Python programs can be used). 1. Relay control 2. Distance measurement. 3. Temperature measurement / Digital Thermometer 4. Txr-Rxr interface. 5. Alphanumeric LCD display interface. 6. Simple project work including multiple interfaces.			

Expected outcome:

The students will be able to:

1. Program Micro controllers.
2. Interface various peripheral devices to Micro controller.
3. Function effectively as an individual and in a team to accomplish the given task.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC335	Power Electronics & Instrumentation Lab	0-0-3-1	2016
Prerequisite: NIL			
Course objectives:			
- To design and implement basic power electronic circuits - To study the working of transducers - To train the usage of Digital Instruments			
List of Experiments (8 experiments mandatory):			
Cycle I (Four mandatory) - Design and Set up DC-DC converter - Design and Set up Push pull DC- DC Converter - Design and Set up Buck DC-DC Converters - Design and Set up Simple SMPS - Design and Set up Half bridge and full bridge converters - Design and Set up basic Inverter Circuits Cycle II (Four mandatory) - Transducer measurements using diode thermometer - Transducer measurements using LVDT - Transducer measurements using Strain gauge. - Transducer measurements using Pressure transducer. - Transducer measurements using Thermocouple & RTDS - Transducer measurements using Photocells Desired Experiment - Study of Digital LCR meter, Frequency synthesizer, Spectrum analyzer and Logic State analyzer application.			
Expected outcome:			
The students will be able to: - Design and demonstrate basic power electronic circuits. - Use transducers for application. - Function effectively as an individual and in a team to accomplish the given task.			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC360	Soft Computing	3-0-0 -3	2016
Prerequisite: NIL			
Course objectives: 1. To familiarize various components of soft computing like fuzzy logic, neural networks and genetic algorithm. 2. To give an overview of fuzzy Logic and to understand the concepts and terminologies of fuzzy systems 3. To give a description on artificial neural networks with its advantages and application. 4. To study the fundamentals of Genetic Algorithm (GA). 5. To understand the concepts of hybrid systems.			
Syllabus: Fuzzy sets and systems. Neural Networks - Applications - typical architecture, pattern Classification and pattern Association. Fundamentals of Genetic Algorithm, AI search algorithm and hybrid structure.			
Expected outcome: The students will be able to: 1. Identify and describe soft computing techniques and their roles in building intelligent Machines. 2. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems 3. Recognize the feasibility of applying a soft computing methodology for a particular Problem. 4. Apply neural networks to pattern classification and regression problems. 5. Apply genetic algorithms to combinatorial optimization problems			
Text Books: 1. D.E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley,N.Y, 1989. 2. Laurene V. Fausett, (1993) "Fundamentals of Neural Networks: Architecture, Algorithms and Applications", Prentice Hall. 3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.			
References: 1. Ibrahim A. M., Introduction to Applied Fuzzy Electronics, PHI, 2013. 2. J. Yen and R. Langari, Fuzzy Logic, Intelligence, Control and Information, Pearson Education. 3. K.H.Lee, First Course on Fuzzy Theory and Applications, Springer-Verlag. 4. Lin C. T. and C.S. G. Lee, Neural Fuzzy Systems, Prentice Hall, 1996. 5. S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications" Prentice Hall of India. 6. S.N. Sivanandan and S.N. Deepa, Principles of Soft Computing, Wiley India, 2007. ISBN: 10: 81-265-1075-7.			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Soft computing: Introduction, soft computing vs hard computing, Fuzzy Computing, Neural Computing, Genetic Algorithms. applications of soft computing	2	15
	Introduction to fuzzy sets and systems-crispness, vagueness, uncertainty and fuzziness. Basics of fuzzy sets, membership functions, support of a fuzzy set height, normalized fuzzy set, alpha cuts.	3	
II	Type- 2 fuzzy sets. Operation on fuzzy set-complement, intersection, union, Demorgan's Law Equality & subset hood.	4	15
	Extension Principle and its application, Fuzzy relation-operations, projection, max-min, min-max composition, cylindrical extension.	3	
FIRST INTERNAL EXAM			
III	Reflexivity, symmetry and transitivity of fuzzy relations. Fuzzy prepositions, fuzzy connectives, linguistic variables, hedges.	4	15
	Approximate reasoning or fuzzy inference, Fuzzy rule based system. Fuzzification and defuzzification using centroid, centre of sums.	4	
IV	Introduction to Neural Networks - Applications –Biological neuron- Typical architecture of Artificial Neural Networks - Common activation function.	4	15
	McCulloh Pitts Neuron – Architecture, logic implementatons. Supervised and Unsupervised learning	4	
SECOND INTERNAL EXAM			
V	Linear Separability, Pattern Classification: Perceptrons	2	20
	Back propagation network and its architecture, Back propagation learning, back propagation algorithm	4	
VI	Genetic Algorithm Basic concepts, Initialization and selection, Survival of the Fittest - Fitness Computations.	5	20
	Operators - Cross over, Mutation.	3	
END SEMESTER EXAM			

Question Paper (End semester exam)

Max. Marks: 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50 % for theory, derivation, proof and 50% for logical/numerical problems.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC361	Digital System Design	3-0-0-3	2016
Prerequisite: EC207 Logic Circuit Design			
Course objectives: - To study synthesis and design of CSSN - To study synthesis and design of ASC - To study hazards and design hazard free circuits - To study PLA folding - To study architecture of one CPLDs and FPGA family			
Syllabus: Clocked synchronous networks, asynchronous sequential circuits, Hazards, Faults, PLA, CPLDs and FPGA			
Expected outcome: The student will be able: - To analyze and design clocked synchronous sequential circuits - To analyze and design asynchronous sequential circuits - To apply their knowledge in diagnosing faults in digital circuits, PLA - To interpret architecture of CPLDs and FPGA			
Text Books: - Donald G Givone, Digital Principles & Design, Tata McGraw Hill, 2003 - John F Wakerly, Digital Design, Pearson Education, Delhi 2002 - John M Yarbrough, Digital Logic Applications and Design, Thomson Learning			
References: - Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, Digital Systems Testing and Testable Design, John Wiley & Sons Inc. - Morris Mano, M.D.Ciletti, Digital Design, 5th Edition, PHI. N. N. Biswas, Logic Design Theory, PHI - Richard E. Haskell, Darrin M. Hanna, Introduction to Digital Design Using Digilent FPGA Boards, LBE Books- LLC - Samuel C. Lee, Digital Circuits and Logic Design, PHI Z. Kohavi, Switching and Finite Automata Theory, 2nd ed., 2001, TMH			
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Analysis of clocked Synchronous Sequential Networks(CSSN)	2	15
	Modelling of CSSN – State assignment and reduction	1	
	Design of CSSN	2	
	Iterative circuits	1	
	ASM Chart and its realization	2	
II	Analysis of Asynchronous Sequential Circuits (ASC)	2	15
	Flow table reduction- Races in ASC	1	
	State assignment problem and the transition table- Design of AS	2	
	Design of Vending Machine controller.	2	

FIRST INTERNAL EXAM			
III	Hazards – static and dynamic hazards – essential	1	15
	Design of Hazard free circuits – Data synchronizers	1	
	Mixed operating mode asynchronous circuits	1	
	Practical issues- clock skew and jitter	1	
	Synchronous and asynchronous inputs – switch bouncing	2	
IV	Fault table method – path sensitization method – Boolean difference method	2	15
	Kohavi algorithm	2	
	Automatic test pattern generation – Built in Self Test(BIST)	3	
SECOND INTERNAL EXAM			
V	PLA Minimization - PLA folding	2	20
	Foldable compatibility Matrix- Practical PLA	2	
	Fault model in PLA	1	
	Test generation and Testable PLA Design.	3	
VI	CPLDs and FPGAs - Xilinx XC 9500 CPLD family, functional block diagram– input output block architecture - switch matrix	3	20
	FPGAs – Xilinx XC 4000 FPGA family – configurable logic block - input output block, Programmable interconnect	3	
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

Max. Marks: 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50 % for theory, derivation, proof and 50% for logical/numerical problems.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC362	Modelling & Simulation of Communication Systems	3-0-0-3	2016
Prerequisite: EC301 Digital Signal Processing			
Course objectives: - To impart the basic concepts of modeling and simulation of Communication Systems - To study and evaluate the behavior and performance of the systems.			
Syllabus: Simulation and Modelling Methodology, Review of Random Processes, Random Number generation, Modelling of Transmitter and Receiver subsystems, Communication channels and models, Estimation of parameters in simulation, Estimation of performance measures from simulation, Analysis of simulation results.			
Expected outcome: The students will be able to apply modeling and computational techniques to problems in the communication field			
Text Books: 1. M.C. Jeruchim, Philip Balaban , K.Sam Shanmugam, Simulation of communication systems, Kluwer Academic/Plenum Press, New York, 2000 2. Raj Jain. The Art of Computer Systems Performance Analysis, John Wiley and Sons, 1991 (Chapter 25)			
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Simulation and Modelling Methodology: Review of Random Processes, Univariate and multivariate models, Transformation of random variables	3	15
	Bounds and approximations, Random process models, Markov and ARMA Sequences, Poisson Process, Gaussian Process	3	
	Random Number Generation, Generation of Random sequences	1	
	Testing Random Number Generators	1	
II	Modelling of Transmitter and Receiver subsystems: Information sources	1	15
	Channel coding, Radio frequency and optical modulation	2	
	Demodulation and detection, Filtering	1	
	Multiple Access : Issues in the simulation of Multiple Access	1	
FIRST INTERNAL EXAM			
III	Communication channels and models: Fading and multipath channels, The Almost Free space channel	3	15
	Conducting and Guided wave media	1	
	Finite state channel models, Methodology for simulating Communication systems operating over Fading Channels.	4	
IV	Estimation of parameters in simulation: Quality of an estimator, Estimating the average level of a waveform,	3	15

	Estimating the average power of a waveform, Estimating the power spectral density of a process	2	
	Estimating Delay and Phase.	2	
SECOND INTERNAL EXAM			
V	Estimation of performance measures from simulation: Estimation of SNR	3	20
	Estimating Performance measures for digital systems-The Monte Carlo Method	2	
	Importance sampling method	2	
VI	Analysis of simulation results: Model Verification Techniques, Model Validation Techniques	3	20
	Transient Removal, Terminating Simulations	2	
	Stopping Criteria, Variance Reduction	2	
END SEMESTER EXAM			

Question Paper Pattern (end semester exam)

Maximum marks : 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 30% for theory and 70% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC363	Optimization Techniques	3-0-0-3	2016
Prerequisite: NIL			
Course objectives: 1. To understand the need and origin of the optimization methods. 2. To get a broad picture of the various applications of optimization methods used in engineering. 3. To define optimization problem and its various components			
Syllabus: Engineering applications of optimization, Formulation of design problems as mathematical programming problems, objective function, constraints, classification of optimization problems/techniques, necessary and sufficient conditions for optimality, unimodality, convexity, Mathematical formulation of LP Problems, Reduction of a LPP to the standard form. Feasible solutions, Graphical solution methods, optimality conditions, degeneracy, Simplex algorithm, Duality in linear programming, Transportation Problem, Game theory, Network path models, Nonlinear unconstrained optimization, Modern methods of optimization, Genetic algorithm. Introduction to optimization tools and software.			
Expected outcome: The students will (i) have a thorough understanding of optimization techniques (ii) be able to formulate and solving the engineering optimization problems			
Text Books: 1. H.A. Taha, “ Operations Research”, 5/e, Macmillan Publishing Company, 1992. 2. Kalynamoy Deb. “Optimization for Engineering Design- Algorithms and Examples”, Prentice-Hall of India Pvt. Ltd., New Delhi 3. Singiresu S Rao, “Engineering optimization Theory and Practice”, New Age International, 2009			
References: 1. A. Ravindran, D. T. Phillips, J. J. Solberg, Operations Research – Principles and Practice, John Wiley and Sons. 2. Ashok D Belegundu, Tirupathi R Chandrupatla, “Optimization concepts and Application in Engineering”, Pearson Education. 3. Hadley, G. “Linear programming”, Narosa Publishing House, New Delhi 4. J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company. 5. Kanti Swarup, P.K.Gupta and Man Mohan, Operations Research, Sultan Chand and Sons 6. Papalambros & Wilde, Principles of Optimal Design, Cambridge University Press, 2008			

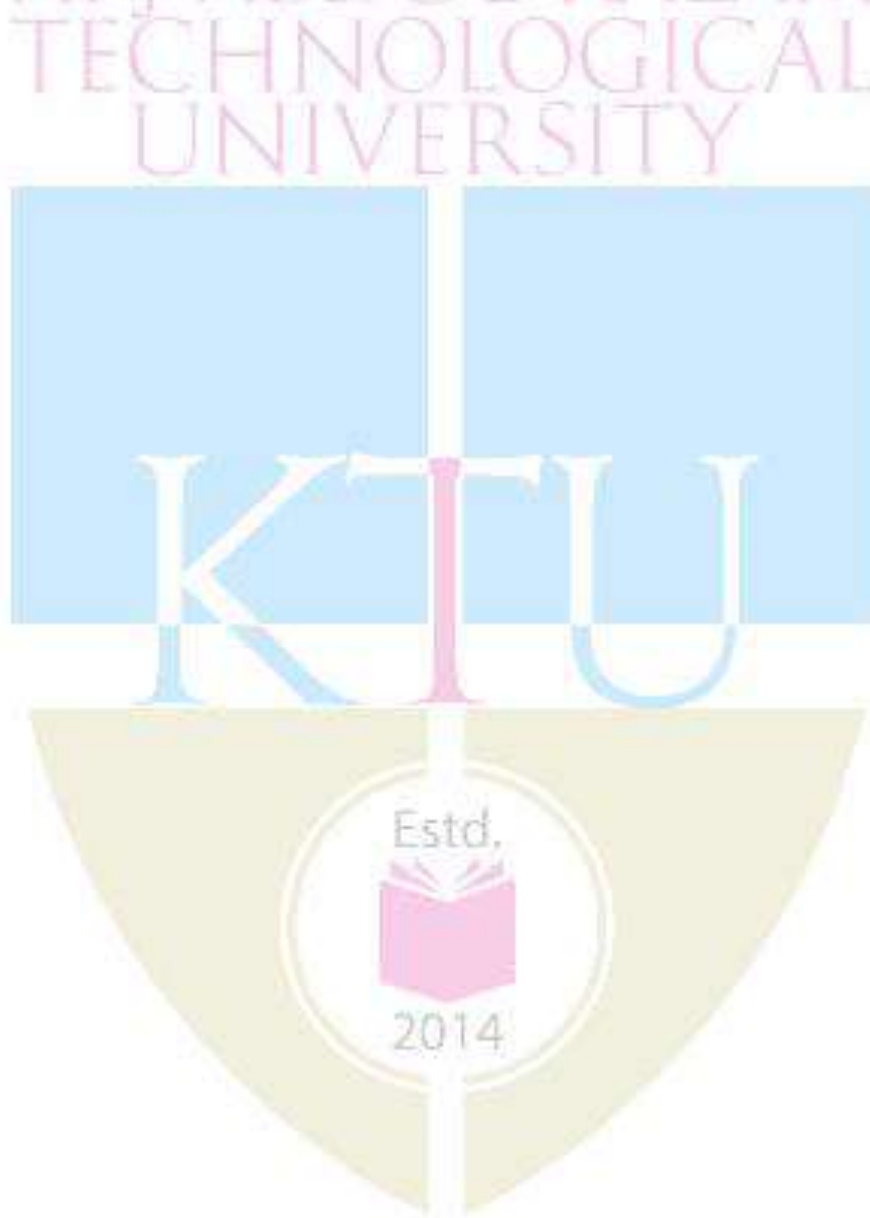
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Introduction: Engineering applications of optimization, Formulation of design problems as mathematical programming problems, objective function, constraints, classification of optimization problems/techniques.	2	15
	Optimization techniques: Classical optimization, unconstrained single and multivariable minimization- necessary and sufficient conditions for optimality, uni-modality, convexity.	5	
II	Linear programming problems-I: Mathematical formulation of LP Problems, slack, surplus and artificial variables. Reduction of a LPP to the standard form, feasible solutions. Graphical solution method, simplex algorithm and solution using tabular method, optimality conditions and degeneracy. Duality in linear programming	7	15
FIRST INTERNAL EXAM			
III	Transportation Problem: Formulation of transportation problem, Basic feasible solution using different methods- East West corner method, Vogel approximation method, Optimality methods, MODI method, Unbalanced transportation problem	7	15
IV	Game Theory: Introduction, 2- person zero – sum game; Saddle point; Mini-Max and Maxi-Min Theorems (statement only); Graphical solution (2x n, m x 2 game), dominance property. Network path Models: Tree Networks – Minimal Spanning Tree - Prim's Algorithm. Shortest path problems- solution methods – Dijkstra's Method.	7	15
SECOND INTERNAL EXAM			
V	Nonlinear unconstrained optimization: Single variable optimization methods- Fibonacci search method, Newton-Raphson method. Multi-variable methods- Hook-Jeeves pattern search method, Cauchy's (steepest descent) method.	7	20
VI	Modern methods of optimization: Introduction to Genetic algorithm, Cross over, Mutation, Reproduction, Simple examples of applications in electronics engineering	5	20
	Introduction to optimization tools and softwares. Solution of optimization Problems using MATLAB.	2	0
END SEMESTER EXAM			

Question Paper Pattern (End sem. Exam.)

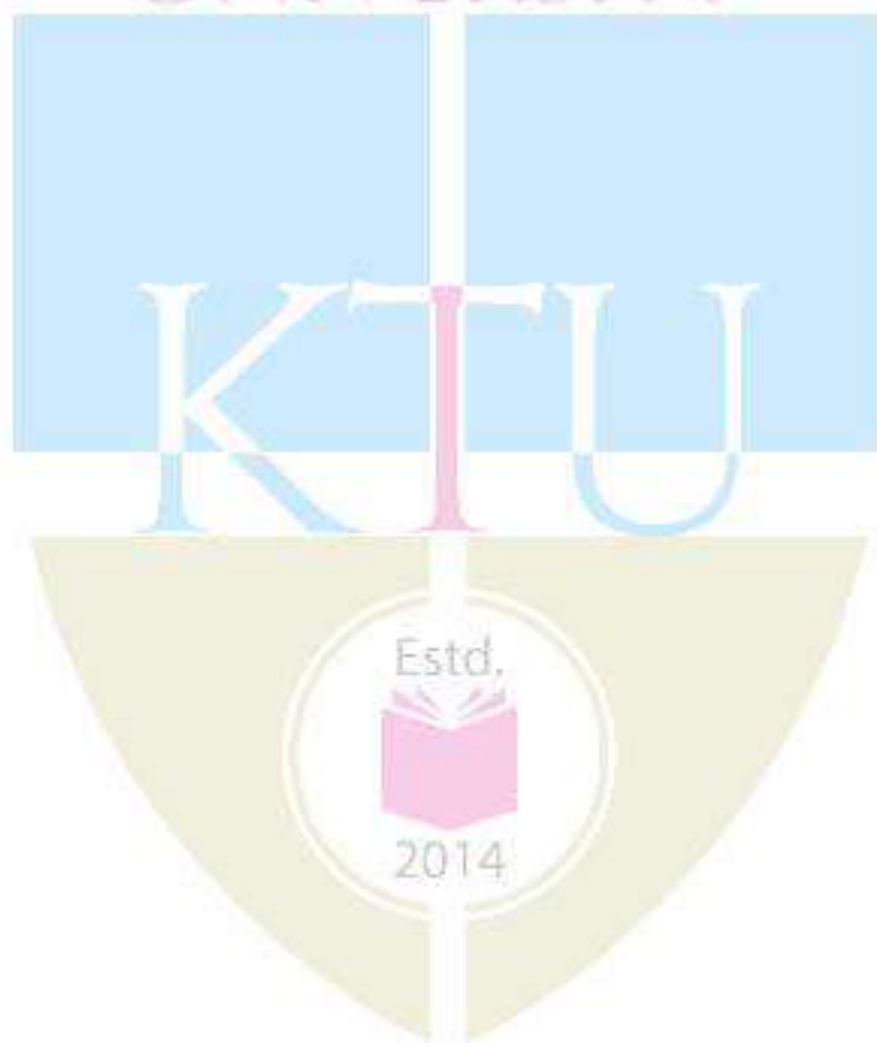
Max. Marks: 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 30 % for theory and 70% for logical/numerical problems, derivation and proof.



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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC365	Biomedical Engineering	3-0-0-3	2016
Prerequisite: Nil			
Course objectives: 1. To introduce student to basic biomedical engineering technology 2. To understand the anatomy & physiology of major systems of the body in designing equipment for medical treatments. 3. To impart knowledge about the principle and working of different types of bio-medical electronic equipment/devices.			
Syllabus: Human body-overview, Physiological systems of body, Measurement of physiological parameters, Assisting and therapeutic devices, Medical laboratory equipments, Telemetry in patient care, Patient safety, Medical imaging system			
Expected outcome: The students will be able: 1. To understand diagnosis and therapy related equipments. 2. To understand the problem and identify the necessity of equipment for diagnosis and therapy. 3. To understand the importance of electronics engineering in medical field. 4. To understand the importance of telemetry in patient care			
Text Books: 1. K S Kandpur, "Hand book of Biomedical instrumentation", Tata McGraw Hill 2nd e/d. 2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, PHI, 2nd Edition, 2004			
References: 1. Barbara Christe, Introduction to Biomedical Instrumentation, Cambridge University Press, 2008. 2. J. J. Carr, "Introduction to Biomedical Equipment Technology", Pearson Education 4th e/d. 3. John G Webster, "Medical Instrumentation application and design", John Wiley 3rd e/d. 4. Richard Aston, "Principle of Biomedical Instrumentation and Measurement". Merrill Education/Prentice Hall.			
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Introduction to bio-medical instrumentation system, overview of anatomy and physiological systems of the body.	1	15
	Sources of bio-electric potential: Resting and action potential, propagation of action potentials. Bioelectric potentials examples (ECG, EEG, EMG, ERG, EOG, EGG, etc introduction only.)	2	
	Electrode theory: Nernst relation Bio potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes.	1	

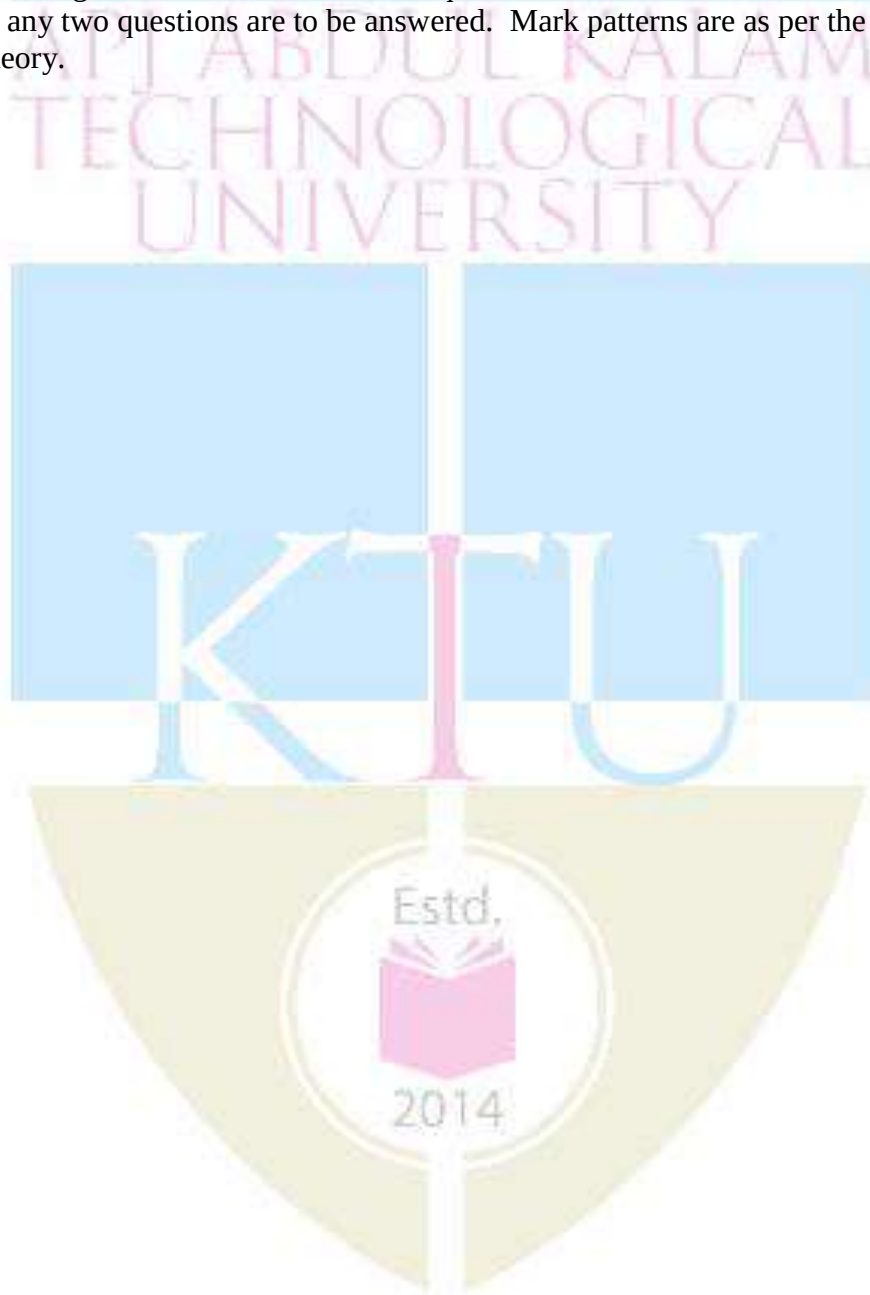
	Instrumentation for clinical laboratory: Bio potential amplifiers-instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers	2	
II	Heart and cardiovascular system (brief discussion), electro conduction system of the heart. Electrocardiography, ECG machine block diagram, ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals.	3	15
	Measurement of blood pressure: Direct, indirect and relative methods of blood pressure measurement, auscultatory method, oscillometric and ultrasonic non-invasive pressure measurements.	2	
	Measurement of blood flow: Electromagnetic blood flow meters and ultrasonic blood flow meters.	2	
FIRST INTERNAL EXAM			
III	The human nervous system. Neuron, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording, analysis of EEG.	2	15
	Electromyography: Nerve conduction velocity, instrumentation system for EMG.	1	
	Physiology of respiratory system (brief discussion), Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.	2	
	Instruments for clinical laboratory: Oxymeters, pH meter, blood cell counter, flame photometer, spectrophotometer	3	
IV	Therapeutic Equipments: Principle, block schematic diagram, working and applications of : pacemakers, cardiac defibrillators, heart–lung machine, dialyzers, surgical diathermy equipment, ventilators	6	15
SECOND INTERNAL EXAM			
V	Medical Imaging systems (Basic Principle only): X-ray imaging - Properties and production of X-rays, X-ray machine, applications of X-rays in medicine.	2	20
	Computed Tomography: Principle, image reconstruction, scanning system and applications.	2	
	Ultrasonic imaging systems: Basic pulse echo system, propagation of ultrasonic through tissues and reflections, display types, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes.	3	
VI	Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging	3	20
	Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine, single channel telemetry system for ECG and temperature	2	
	Patient Safety: Electric shock hazards, leakage current, safety codes for electro medical equipments	1	
END SEMESTER EXAM			

Question Paper Pattern (End Sem. Exam)

Maximum Marks: 100

Time : 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 100 % for theory.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC366	Real Time Operating Systems	3-0-0-3	2016
Prerequisite: EC206 Computer Organization			
Course objectives: - To understand the basics of operating systems tasks and basic OS architectures and develop these to RTOS - To understand concepts of task scheduling - To understand problems and issues related with multitasking - To learn strategies to interface memory and I/O with RTOS kernels - To impart skills necessary to develop software for embedded computer systems using a real-time operating system.			
Syllabus: Introduction to OS and RTOS, Process management of OS/RTOS, Process Synchronization, Memory and I/O management, Applications of RTOS			
Expected outcome: At the end of the course the students will be familiar with operating systems. They will have an in depth knowledge about the real time operating systems and its applications.			
Text Books: 1. C.M. Krishna and G.Shin, Real Time Systems, McGraw-Hill International Edition, 1997. 2. Jean J Labrosse, Embedded Systems Building Blocks Complete and Ready-to-use Modules in C, CMP books, 2/e, 1999.			
References: 1. Jean J Labrosse , Micro C/OS-II, The Real Time Kernel, CMP Books, 2011 2. Sam Siewert, V, Real-Time Embedded Components and Systems: With Linux and RTOS (Engineering), 2015 3. Tanenbaum, Modern Operating Systems, 3/e, Pearson Edition, 2007. 4. VxWorks: Programmer's Guide 5.4, Windriver, 1999 5. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, 2/e, Kindle Publishers, 2005.			
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Operating system objectives and functions, Virtual Computers, Interaction of O. S. & hardware architecture, Evolution of operating systems	2	15
	Architecture of OS (Monolithic, Microkernel, Layered, Exo-kernel and Hybrid kernel structures)	3	
	Batch, Multi programming, Multitasking, Multiuser, parallel, distributed & real –time O.S.	3	
II	Uniprocessor Scheduling: Types of scheduling	2	15
	Scheduling algorithms: FCFS, SJF, Priority, Round Robin	3	
	UNIX Multi-level feedback queue scheduling, Thread Scheduling, Multiprocessor Scheduling concept	3	
FIRST INTERNAL EXAM			

III	Concurrency: Principles of Concurrency, Mutual Exclusion H/W Support, software approaches, Semaphores and Mutex, Message Passing techniques	2	15
	Classical Problems of Synchronization: Readers-Writers Problem, Producer Consumer Problem, Dining Philosopher problem.	3	
	Deadlock: Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, An Integrated Deadlock Strategies.	3	
IV	Memory Management requirements, Memory partitioning: Fixed, dynamic, partitioning	3	15
	Memory allocation Strategies (First Fit, Best Fit, Worst Fit, Next Fit), Fragmentation, Swapping, Segmentation, Paging, Virtual Memory, Demand paging	2	
	Page Replacement Policies (FIFO, LRU, Optimal, clock), Thrashing, Working Set Model	3	
SECOND INTERNAL EXAM			
V	I/O Management and Disk Scheduling: I/O Devices, Organization of I/O functions	2	20
	Operating System Design issues, I/O Buffering, Disk Scheduling (FCFS, SCAN, C-SCAN, SSTF), Disk Caches	3	
VI	Comparison and study of RTOS: Vxworks and μ COS	3	20
	Case studies: RTOS for Control Systems.	3	
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

Maximum marks: 100

Time: 3 hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC368	Robotics	3-0-0-3	2016
Prerequisite: EC 307 Power Electronics & Instrumentation, EC 305 Microprocessors & Microcontrollers			
Course objectives: To impart knowledge about the engineering aspects of Robots and their applications.			
Syllabus: Robots: Introduction, anatomy, Robot specifications, Robot characteristics, Areas of application, classification of robots. Robotic arm, Sensors, Encoders, Tachometers, Robotic drive systems and actuators, Specification, principle of operation and areas of application of: DC motor, Stepper motor, Servo motor and brushless DC motor, Microprocessor control of electric motors, speed control using PWM and direction control using H- Bridge, Robotic vision systems, Image processing techniques, kinematics, inverse kinematics, Velocity kinematics, Application of velocity kinematics for all serial manipulators, Digital and Programmable Logic (PLC) controllers. Robot Programming, Industrial applications of Robots, Mobile robots, Micro robots, Recent developments in Robotics.			
Expected outcome: - The students will have a thorough understanding about Robots and their applications - The students will be able to analyse and design robotic structures.			
Text Books: - Mikell and Groover, Industrial Robotics – Technology, Programming and Applications, McGraw Hill, 2/e, 2012 - Saeed B. Niku Introduction to Robotics. Analysis and control, applications- Wiley student edition, 2010 - Spong and Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1990.			
References: - Ashitava Ghosal, Robotics, Fundamental concepts and analysis, OXFORD University Press, 2006 - Fu, K.S, Gonzalez, R.C, Lee, C.S.G., Robotics, Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987. - John. J. Craig, Introduction to Robotics: Mechanics and Control, PHI, 2005. - Klafter, R.D., Chmielewski, T.A, Negin, M, Robotic Engineering An Integrated Approach, PHI, 2007 - Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Pearson Education, 2000 S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, 1994.			

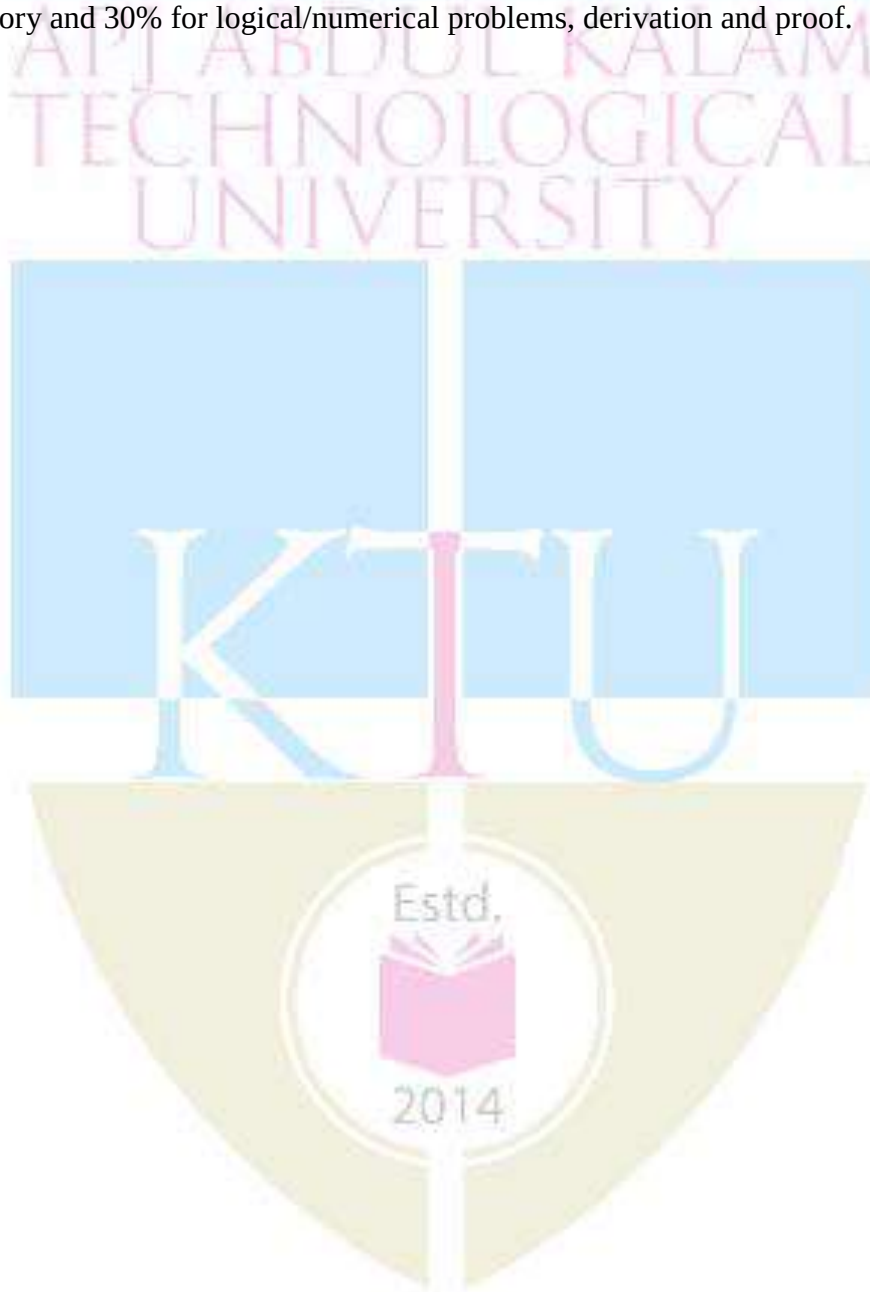
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Introduction – Definition and origin of robotics, Robot Anatomy, Robot specifications, Robot characteristics – accuracy, precision, and repeatability, Areas of application, classification of robots. Robotic arm – Components and structure, Types of joints and workspace, Common kinematic arrangements, Wrists, End effectors.	7	15
II	Sensors: Types and applications of sensors in Robotics, position and displacement sensors, Strain gauge based force-torque sensors, Tachometers. Robotic drive systems and actuators: Hydraulic, Pneumatic and Electric drives. Specification, principle of operation and areas of application of: Stepper motor, Servo motor and brushless DC motor. Microprocessor control of electric motors, speed control using PWM and direction control using H- Bridge	6	15
FIRST INTERNAL EXAM			
III	Robotic vision systems: Imaging, Sensing and Digitization, Image processing techniques, Areas of application in robotics. Introduction to kinematics: Position and orientation of objects, Rotation, Euler angles, Rigid motion representation using Homogenous Transformation matrix.	7	15
IV	Forward kinematics: Link coordinates, Denavit-Hartenberg Representation, Application of DH convention to different serial kinematic arrangements fitted with spherical wrist. Inverse kinematics – General properties of solutions, Kinematic Decoupling, Inverse kinematic solutions for all basic types of three-link robotic arms fitted with a spherical wrist.	9	15
SECOND INTERNAL EXAM			
V	Velocity kinematics – Derivation of the Jacobian, Application of velocity kinematics for serial manipulators, importance of Singularities. Manipulator Dynamics. Introduction to Lagrangian mechanics and Dynamic equation for 2 DOF robots, Introduction to position control and force control of robotic manipulators, Robot actuation and control using PID controllers.	6	20
VI	Robot Programming – Programming methods, Robot language classification, Robot language structure, elements and its functions. Motion, End-effector and Sensor commands in VAL programming language. Simple programs. Industrial applications of Robots in material handling and assembly. Mobile robots, Recent developments in Robotics.	7	20
END SEMESTER EXAM			

Question Paper Pattern (End Semester Examk Pattern)

Max. Marks : 100

Time : 3 Hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70 % for theory and 30% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC370	Digital Image Processing	3-0-0-3	2016
Prerequisite: EC301 Digital Signal Processing			
Course objectives:			
1. To study the image fundamentals and mathematical transforms necessary for image transform			
2. To study the image processing techniques like image enhancement, image reconstruction, image compression, image segmentation and image representation.			
Syllabus:			
Digital image fundamentals, 2D Transforms, Image enhancement, Image restoration, Image segmentation, Image compression			
Expected outcome:			
The students will be able to:			
1. Distinguish / Analyse the various concepts and mathematical transforms necessary for image processing			
2. Differentiate and interpret the various image enhancement techniques			
3. Illustrate image segmentation algorithm			
4. Analyse basic image compression techniques			
Text Books:			
1. Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009			
2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing ,Tata Mc Graw Hill, 2015			
References:			
1. Jain Anil K , Fundamentals of digital image processing: , PHI,1988			
2. Kenneth R Castleman , Digital image processing:, Pearson Education,2/e,2003			
3. Pratt William K , Digital Image Processing: , John Wiley,4/e,2007			
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Digital Image Fundamentals: Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model	3	15
	Vidicon and Digital Camera working principles	1	
	Brightness, contrast, hue, saturation, mach band effect,	1	
	Colour image fundamentals-RGB, CMY, HIS models	1	
	2D sampling, quantization.	1	
II	Review of matrix theory: row and column ordering- Toeplitz, Circulant and block matrix,	2	15
	2D Image transforms : DFT, its properties, Walsh transform, Hadamard transform, Haar transform,	3	
	DCT, KL transform and Singular Value Decomposition.	3	
FIRST INTERNAL EXAM			

III	Image Enhancement: Spatial domain methods: point processing- intensity transformations, histogram processing, image subtraction, image averaging	2	15
	Spatial filtering- smoothing filters, sharpening filters	1	
	Frequency domain methods: low pass filtering, high pass filtering, homomorphic filter.	2	
IV	Image Restoration: Degradation model, Unconstraint restoration- Lagrange multiplier and constraint restoration	2	15
	Inverse filtering- removal of blur caused by uniform linear motion, Weiner filtering,	2	
	Geometric transformations-spatial transformations	2	
SECOND INTERNAL EXAM			
V	Image segmentation: Classification of Image segmentation techniques, region approach, clustering techniques	2	20
	Segmentation based on thresholding, edge based segmentation	2	
	Classification of edges, edge detection, Hough transform, active contour	3	
VI	Image Compression: Need for compression, redundancy, classification of image compression schemes, Huffman coding, arithmetic coding, dictionary based compression, transform based compression,	5	20
	Image compression standards- JPEG& MPEG, vector quantization, wavelet based image compression.	3	
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

Maximum Marks : 100

Time : 3 hours

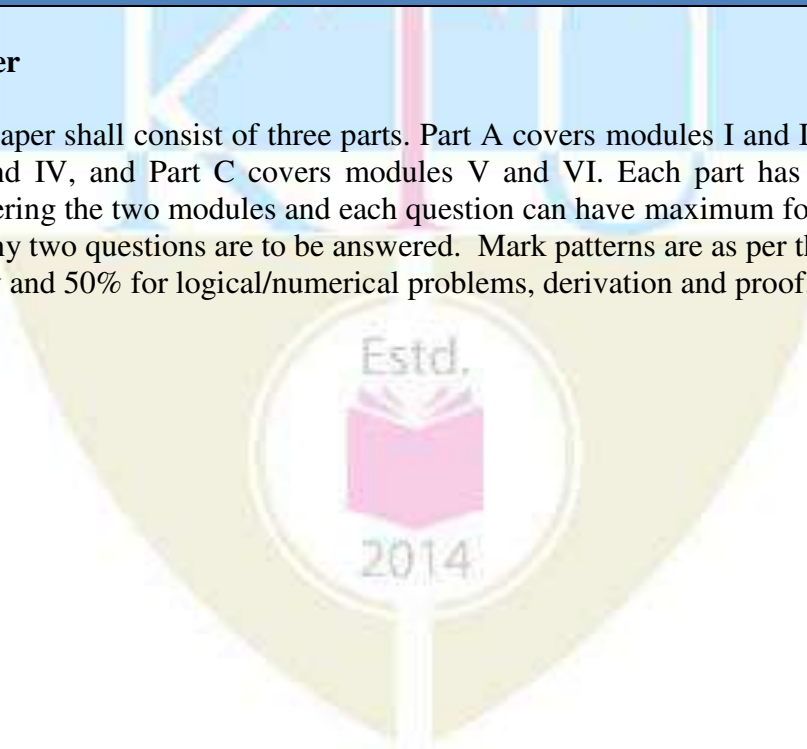
The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC401	INFORMATION THEORY & CODING	4-0-0-4	2016
Prerequisite: EC302 Digital Communication			
Course objectives: - To introduce the concept of information - To understand the limits of error free representation of information signals and the transmission of such signals over a noisy channel - To design and analyze data compression techniques with varying efficiencies as per requirements - To understand the concept of various theorems proposed by Shannon for efficient data compression and reliable transmission - To give idea on different coding techniques for reliable data transmission - To design an optimum decoder for various coding schemes used.			
Syllabus: Concept of amount of information, Entropy, Source coding, Channel Capacity, Shannon's Limit, Rate Distortion Theory, Channel Coding, Linear Block Codes, Cyclic codes, Cryptography, Convolutional Codes, Viterbi Algorithm			
Expected outcome: The students will be able to - Apply the knowledge of Shannon's source coding theorem and Channel coding theorem for designing an efficient and error free communication link. - Analyze various coding schemes - Design an optimum decoder for various coding schemes used.			
Text Books: - P S Sathya Narayana, Concepts of Information Theory & Coding, Dynaram Publications, 2005 - Simon Haykin: Digital Communication Systems, Wiley India, 2013.			
References: - Bose, Information theory coding and cryptography, 3/e McGraw Hill Education India , 2016 - D.E.R. Denning, Cryptography and Data Security, Addison Wesley, 1983. - J S Chitode, Information Theory and Coding, Technical Publications, Pune, 2009 - Kelbert & Suhov, Information theory and coding by examples, Cambridge University Press, 2013 - Shu Lin & Daniel J. Costello. Jr., Error Control Coding : Fundamentals and Applications, 2/e, Prentice Hall Inc., Englewood Cliffs, NJ,2004			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction to Information Theory. Concept of information, units, entropy, marginal, conditional and joint entropies, relation among entropies, mutual information, information rate. Source coding: Instantaneous codes, construction of instantaneous codes, Kraft's inequality, coding efficiency and redundancy	9	15%
II	Noiseless coding theorem , construction of basic source codes, Shannon – Fano Algorithm, Huffman coding, Channel capacity – redundancy and efficiency of a channel, binary	9	15%

	symmetric channel (BSC), Binary erasure channel (BEC) – capacity of band limited Gaussian channels		
FIRST INTERNAL EXAM			
III	Continuous Sources and Channels: Differential Entropy, Mutual information, Waveform channels, Gaussian channels, Shannon – Hartley theorem, bandwidth, SNR trade off, capacity of a channel of infinite bandwidth, Shannon's limit	9	15%
IV	Introduction to rings, fields, and Galois fields. Codes for error detection and correction – parity check coding – linear block codes – error detecting and correcting capabilities – generator and parity check matrices – Standard array and syndrome decoding	9	15%
SECOND INTERNAL EXAM			
V	Perfect codes, Hamming codes, encoding and decoding Cyclic codes, polynomial and matrix descriptions, generation of cyclic codes, decoding of cyclic codes BCH codes, Construction and decoding, Reed Solomon codes	9	20%
VI	Convolutional Codes – encoding – time and frequency domain approaches, State Tree & Trellis diagrams – transfer function and minimum free distance – Maximum likelihood decoding of convolutional codes – The Viterbi Algorithm. Sequential decoding.	9	20%
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50% for theory and 50% for logical/numerical problems, derivation and proof.

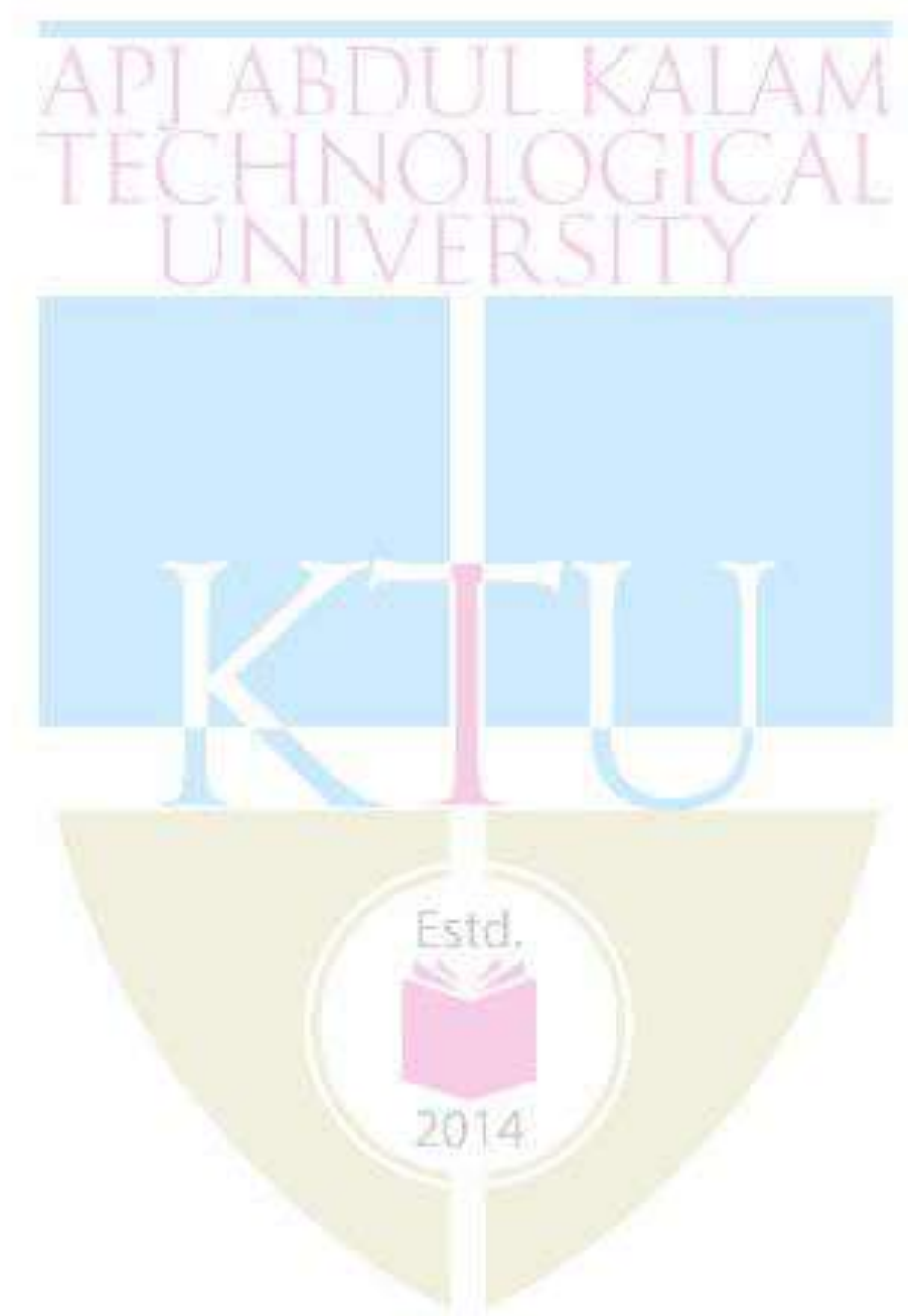


COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC402	NANOELECTRONICS	3-0-0 -3	2016
Prerequisite: EC203 Solid State Devices, EC304 VLSI			
Course objectives: To introduce the concepts of nanoelectronics.			
Syllabus:			
Introduction to nanotechnology, Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Schrodinger's Equation, wave function, Low dimensional structures Quantum wells, Basic properties of two dimensional semiconductor nanostructures, Quantum wires and quantum dots, carbon nano tube, grapheme, Introduction to methods of fabrication of nano-layers, Introduction to characterization of nanostructures, Principle of operation of Scanning Tunnelling Microscope, X-Ray Diffraction analysis, MOSFET structures, Quantum wells, modulation doped quantum wells, multiple quantum wells, The concept of super lattices, Transport of charge in Nanostructures under Electric field, Transport of charge in magnetic field, Nanoelectronic devices, principle of NEMS			
Expected outcome:			
The students will be able to understand basic concepts of nanoelectronic devices and nano technology.			
Text Books: - J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda Nanotechnology for Microelectronics and optoelectronics, Elsevier, 2006 - W.R. Fahrner, Nanotechnology and Nanoelctronics, Springer, 2005			
References:			
- Chattopadhyay, Banerjee, Introduction to Nanoscience & Technology, PHI, 2012 - George W. Hanson, Fundamentals of Nanoelectronics, Pearson Education, 2009. K. Gosser, P. Glosekotter, J. Dienstuhl, Nanoelectronics and nanosystems, Springer 2004. - Murty, Shankar, Text book of Nanoscience and Nanotechnology, Universities Press, 2012. - Poole, Introduction to Nanotechnology, John Wiley, 2006. - Supriyo Dutta, Quantum Transport- Atom to transistor, Cambridge, 2013.			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction to nanotechnology, Impacts, Limitations of conventional microelectronics, Trends in microelectronics and optoelectronics	1	15%
	Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence	2	
	Classification of Nano structures, Low dimensional structures Quantum wells, wires and dots, Density of states and dimensionality	1	

	Basic properties of two dimensional semiconductor nanostructures, square quantum wells of finite depth, parabolic and triangular quantum wells,	2	
	Quantum wires and quantum dots, carbon nano tube, graphene	1	
II	Introduction to methods of fabrication of nano-layers, different approaches, physical vapour deposition, chemical vapour deposition	2	15%
	Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide- dry and wet oxidation methods.	2	
	Fabrication of nano particle- grinding with iron balls, laser ablation, reduction methods, sol gel, self assembly, precipitation of quantum dots.	2	
FIRST INTERNAL EXAM			
III	Introduction to characterization of nanostructures, tools used for of nano materials characterization, microscope-optical, electron, and electron microscope.	2	15%
	Principle of operation of Scanning Tunnelling Microscope, Atomic Force Microscope, Scanning Electron microscope, Specimen interaction. Transmission Electron Microscope	2	
	X-Ray Diffraction analysis, PL & UV Spectroscopy, Particle size analyser.	2	
IV	Two dimensional electronic system, two dimensional behaviour, MOSFET structures, Heterojunctions	2	15%
	Quantum wells, modulation doped quantum wells, multiple quantum wells	2	
	The concept of super lattices Kronig - Penney model of super lattice.	2	
V	Transport of charge in Nanostructures under Electric field - parallel transport, hot electrons, perpendicular transport.	2	20%
	Quantum transport in nanostructures, Coulomb blockade	2	
	Transport of charge in magnetic field - Effect of magnetic field on a crystal. Aharonov-Bohm effect, the Shubnikov-de Hass effect, the quantum Hall effect.	3	
VI	Nanoelectronic devices- MODFETS, heterojunction bipolar transistors	1	20%
	Resonant tunnel effect, RTD, RTT, Hot electron transistors	2	
	Coulomb blockade effect and single electron transistor, CNT transistors	2	
	Heterostructure semiconductor laser	1	
	Quantum well laser, quantum dot LED, quantum dot laser	2	
	Quantum well optical modulator, quantum well sub band photo detectors, principle of NEMS.	2	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70% for theory and 30% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC403	MICROWAVE & RADAR ENGINEERING	3-0-0-3	2016
Prerequisite: EC303 Applied Electromagnetic Theory, EC306 Antenna & Wave Propagation			
Course objectives: - To introduce the various microwave sources, their principle of operation and measurement of various parameters - To study the various microwave hybrid circuits and formulate their S matrices. - To understand the basic concepts, types, working of radar and introduce to radar transmitters and receivers.			
Syllabus: Microwaves: introduction, advantages, Cavity Resonators, Microwave vacuum type amplifiers and sources, Klystron Amplifiers, Reflex Klystron Oscillators, Magnetron oscillators, Travelling Wave Tube, Microwave measurements, Microwave hybrid circuits, Directional couplers, Solid state microwave devices, Gunn diodes, Radar, MTI Radar, Radar Transmitters, Radar receivers.			
Expected outcome: The students will be able to understand the basics of microwave engineering and radar systems.			
Text Books: - Merrill I. Skolnik, Introduction to Radar Systems, 3/e, Tata McGraw Hill, 2008. - Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.			
References: - Das, Microwave Engineering, 3/e, McGraw Hill Education India Education, 2014 - David M. Pozar, Microwave Engineering, 4/e, Wiley India, 2012. - Kulkarni M, Microwave and Radar Engineering, 4/e, Umesh Publications, 2012. - Rao, Microwave Engineering, 2/e, PHI, 2012. - Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012.			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Microwaves: introduction, advantages, Cavity Resonators - Rectangular and Circular wave guide resonators- Derivation of resonance frequency of Rectangular cavity.	4	15%
	Microwave vacuum type amplifiers and sources: Klystron Amplifiers - Re-entrant cavities, Velocity modulation, Bunching (including analysis), Output power and beam	4	
II	Reflex Klystron Oscillators: Derivation of Power output, efficiency and admittance	2	15%
	Magnetron oscillators: Cylindrical magnetron, Cyclotron angular frequency, Power output and efficiency.	3	
FIRST INTERNAL EXAM			
III	Travelling Wave Tube: Slow wave structures, Helix TWT, Amplification process, Derivation of convection current, axial electric field, wave modes and gain.	4	15%
	Microwave measurements: Measurement of impedance, frequency and power	2	

IV	Microwave hybrid circuits: Scattering parameters, Waveguide tees- Magic tees, Hybrid rings, Corners, Bends, and Twists. Formulation of S-matrix.	5	15%
	Directional couplers: Two hole directional couplers, S-matrix of a directional coupler. Circulators and isolators.	4	
SECOND INTERNAL EXAM			
V	Solid state microwave devices: Microwave bipolar transistors, Physical structures, Power frequency limitations equivalent circuit. Principle of Tunnel diodes and tunnel	4	20%
	Gunn diodes: Different modes, Principle of operation Gunn Diode Oscillators.	2	
VI	Radar: The simple Radar equation. Pulse Radar, CW Radar, CW Radar with non zero IF, Equation for doppler frequency FM-CW Radar using sideband super heterodyne receiver. MTI Radar -Delay line canceller, MTI Radar with power amplifier & power oscillator, Non coherent MTI Radar, Pulse	5	20%
	Radar Transmitters: Radar Modulator-Block diagram, Radar receivers - noise figure, low noise front ends, Mixers, Radar Displays	3	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 60% for theory and 40% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC404	ADVANCED COMMUNICATION SYSTEMS	3-0-0 -3	2016
Prerequisite: EC302 Digital Communication, EC403 Microwave & Radar Engineering			
Course objectives:			
To impart the basic concepts of various communication system.			
Syllabus: Microwave Radio Communications, Diversity, protection switching arrangements, Digital TV, Satellite communication systems, Satellite sub systems, Evolution of mobile radio communications, Introduction to Modern Wireless Communication Systems, wireless networks, Over view of WIMAX technologies, Cellular concept, Wireless propagation mechanism, Introduction to Multiple Access GSM system architecture, Introduction to new data services			
Expected outcome:			
The students will be able to understand the basics and technology of advanced communication system			
Text Books: - Dennis Roody, Satellite communication, 4/e, McGraw Hill, 2006. - Herve Benoit, Digital Television Satellite, Cable, Terrestrial, IPTV, Mobile TV in the DVB Framework, 3/e, Focal Press, Elsevier, 2008 - Simon Haykin, Michael Mohar, Modern wireless communication, Pearson Education, 2008 - Theodore S. Rappaport: Wireless communication principles and practice, 2/e, Pearson Education, 1990			
References: - Jochen Schiller, Mobile Communications, Pearson, 2008. - Mishra, Wireless communications and Networks, McGraw Hill, 2/e, 2013. - Nathan, Wirelesscommunications, PHI, 2012. - Singal, Wireless communications, Mc Graw Hill, 2010. - Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson, 2015. - W.C.Y.Lee, Mobile Cellular Telecommunication, McGraw Hill, 2010.			
Course Plan			
Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	Microwave Radio Communications : Introduction, Advantages and Disadvantages, Analog vs digital microwave, frequency vs amplitude modulation	1	15%
	Frequency modulated microwave radio system, FM microwave radio repeaters	1	
	Diversity, protection switching arrangements, FM microwave radio stations, microwave repeater station, line of sight path characteristics	2	
II	Digital TV: Digitized Video, Source coding of Digitized Video, Compression of Frames, DCT based (JPED), Compression of Moving Pictures (MPEG). Basic blocks of MPEG2 and MPE4, Digital Video Broadcasting (DVB)	4	15%
	Modulation: QAM (DVB-S, DVB-C), OFDM for Terrestrial Digital TV (DVB -T). Reception of Digital TV Signals (Cable, Satellite and	4	

	terrestrial). Digital TV over IP, Digital terrestrial TV for mobile		
	Display Technologies: basic working of Plasma, LCD and LED Displays	2	
FIRST INTERNAL EXAM			
III	Satellite Communication systems, introduction, Kepler's laws, orbits, orbital effects, orbital perturbations	2	15%
	Satellite sub systems, Antennas, Transponders, earth station technology, Link calculation,	2	
	Satellite systems- GEO systems, non-GEO communication systems, Satellite Applications- Global Positioning System, Very Small Aperture Terminal system, Direct to Home Satellite Systems	3	
IV	Evolution of mobile radio communications, paging systems, Cordless telephone systems, comparison of various wireless systems	2	15%
	Introduction to Modern Wireless Communication Systems, Second generation cellular networks, third generation wireless networks, fourth generation wireless technologies	1	
	Wireless in local loop, wireless local area networks, Blue tooth and Personal Area networks, Over view of WIMAX Technologies, architecture, spectrum allocation	2	
SECOND INTERNAL EXAM			
V	Cellular concept, hand off strategies, Interference and system capacity: Cell splitting, Sectoring, Repeaters, and Microcells. Cellular System Design Fundamentals: Frequency Reuse, channel assignment strategies, handoff Strategies, Interference and system capacity, tracking and grade off service, improving coverage and capacity	3	20%
	Wireless propagation mechanism, free space propagation model, ground reflection model, knife edge diffraction model, path loss prediction in hilly terrain, introduction to fading and diversity techniques, Introduction to MIMO system	3	
VI	Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum multiple Access, space division multiple access, CDMA, OFDM	2	20%
	Wireless Networking, Difference between wireless and fixed telephone networks, development of wireless networks, fixed network transmission hierarchy, traffic routing in wireless networks, wireless data services, Wireless standards,	2	
	GSM system architecture, radio link aspects, network aspects	1	
	Introduction to new data services like High Speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), Digital Enhanced Cordless Telecommunications (DECT) , Enhanced Data Rate for Global Evolution (EDGE), Ultra wideband systems (UWB), Push To Talk (PTT) technology, Mobile IP	5	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 60% for theory and 40% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC405	OPTICAL COMMUNICATION	3-0-0-3	2016
Prerequisite: EC203 Solid State Devices, EC205 Electronic Circuits			
Course objectives: - To introduce the concepts of light transmission through optical fibers, optical sources and detectors. - To compare the performance of various optical transmission schemes. - To impart the working of optical components and the principle of operation of optical amplifiers. - To give idea on WDM technique.			
Syllabus: General light wave system, advantages, classification of light wave systems, fibre types, linear and non linear effects in fibres, Fibre materials, fabrication of fibres, Optical sources, LEDs and LDs Optical detectors, Optical receivers, Digital transmission systems, Optical Amplifiers, WDM concept, Introduction to free space optics, Optical Time Domain Reflectometer (OTDR).			
Expected outcome: The students will be able to:- - Know the working of optical source and detectors. - Compare the performance of various optical modulation schemes. - Apply the knowledge of optical amplifiers in the design of optical link. - Analyse the performance of optical amplifiers. - Know the concept of WDM - Describe the principle of FSO and LiFi.			
Text Books: - Gerd Keiser, Optical Fiber Communications, 5/e, McGraw Hill, 2013. - Mishra and Ugale, Fibre optic Communication, Wiley, 2013.			
References: - Chakrabarthi, Optical Fibre Communication, McGraw Hill, 2015. - Hebbar, Optical fibre communication, Elsevier, 2014 - John M Senior- Optical communications, 3/e, Pearson, 2009. - Joseph C. Palais, Fibre Optic Communications, 5/e Pearson, 2013. - Keiser, Optical Communication Essentials (SIE), 1/e McGraw Hill Education New Delhi, 2008.			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	General light wave system, advantages, classification of light wave systems. Fibres: types and refractive index profiles, mode theory of fibres: modes in SI and GI fibres, linear and non linear effects in fibres, dispersion, Group Velocity Dispersion, modal, wave guide and Polarization, Modes, Dispersion, attenuation- absorption, bending and scattering losses.	8	15%
II	Fibre materials, fabrication of fibres, photonic crystal fibre, index guiding PCF, photonic bandgap fibre, fibre cables. Optical sources, LEDs and LDs, structures, characteristics,	7	15%

	modulators using LEDs and LDs. coupling with fibres, noise in Laser diodes, Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications		
FIRST INTERNAL EXAM			
III	Optical detectors, types and characteristics, structure and working of PIN and AP, noise in detectors, comparison of performance. Optical receivers, Ideal photo receiver and quantum limit of detection.	6	15%
IV	Digital transmission systems, design of IMDD links- power and rise time budgets, coherent Systems, sensitivity of a coherent receiver, comparison with IMDD systems. Introduction to soliton transmission, soliton links using optical amplifiers, GH effect, soliton-soliton interaction, amplifier gain fluctuations, and design guide lines of soliton based links.	8	15%
SECOND INTERNAL EXAM			
V	Optical Amplifiers ,basic concept, applications, types, doped fibre amplifiers, EDFA, basic theory, structure and working, Semiconductor laser amplifier, Raman amplifiers, TDFA, amplifier configurations, performance comparison.	6	20%
VI	The WDM concept, WDM standards, WDM components, couplers, splitters, Add/ Drop multiplexers, gratings, tunable filters, system performance parameters. Introduction to optical networks. Introduction to free space optics, LiFi technology and VLC. Optical Time Domain Reflectometer (OTDR) – fault detection, length and refractive index measurements.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC407	COMPUTER COMMUNICATION	3-0-0-3	2016
Prerequisite: NIL			
Course objectives: - To give the basic concepts of computer network and working of layers, protocols and interfaces in a computer network. - To introduce the fundamental techniques used in implementing secure network communications and give them an understanding of common threats and its defences.			
Syllabus: Introduction to computer communication, Transmission modes, Networks, Interconnection of Networks: Internetwork, Network models: OSI model, TCP/IP protocol suite. Physical Layer, Data Link Layer, Media access control, Ethernet(802.3), Logical link control, Logical addressing: IPV4, IPV6, Subnetting, CIDR, ICMP, IGMP, DHCP, Routing, Transport Layer, Congestion Control & Quality of Service, Application Layer, Introduction to system and network security, security attacks, Firewalls, Intrusion detection systems.			
Expected outcome: The students will have a thorough understanding of: - Different types of network topologies and protocols. - The layers of the OSI model and TCP/IP with their functions. - The concept of subnetting and routing mechanisms. - The basic protocols of computer networks, and how they can be used to assist in network design and implementation. - Security aspects in designing a trusted computer communication system.			
Text Books: - Behrouz A. Forouzan, Cryptography & Network Security , , IV Edition, Tata McGraw-Hill, 2008 - J F Kurose and K W Ross, Computer Network A Top-down Approach Featuring the Internet, 3/e, Pearson Education, 2010			
References: - Behrouz A Forouzan, Data Communications and Networking, 4/e, Tata McGraw-Hill, 2006. - Larry Peterson and Bruce S Davie: Computer Network- A System Approach, 4/e, Elsevier India, 2011. S. Keshav, An Engineering Approach to Computer Networking, Pearson Education, 2005. - Achyut S.Godbole, Data Communication and Networking, 2e, McGraw Hill Education New Delhi, 2011			
Course Plan			
Module	Course content (42 hrs)	Hours	End Sem. Exam Marks
I	Introduction to computer communication: Transmission modes - serial and parallel transmission, asynchronous, synchronous, simplex, half duplex, full duplex communication. Switching: circuit switching and packet switching	2	15%

	Networks: Network criteria, physical structures, network models, categories of networks, Interconnection of Networks: Internetwork	2	
	Network models: Layered tasks, OSI model, Layers in OSI model, TCP/IP protocol suite.	2	
II	Physical Layer: Guided and unguided transmission media (Co-axial cable, UTP,STP, Fiber optic cable)	2	15%
	Data Link Layer: Framing, Flow control (stop and wait , sliding window flow control)	2	
	Error control, Error detection(check sum, CRC), Bit stuffing, HDLC	2	
	Media access control: Ethernet (802.3), CSMA/CD, Logical link control, Wireless LAN (802.11), CSMA/CA	2	
FIRST INTERNAL EXAM			
III	Network Layer Logical addressing : IPv4 & IPV6	2	15%
	Address Resolution protocols (ARP, RARP)	2	
	Subnetting, Classless Routing(CIDR), ICMP, IGMP, DHCP	3	
	Virtual LAN, Networking devices (Hubs, Bridges & Switches)	1	
IV	Routing: Routing and Forwarding, Static routing and Dynamic routing	1	15%
	Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm)	2	
	Routing Protocols: Routing Information protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), MPLS	3	
SECOND INTERNAL EXAM			
V	Transport Layer –UDP, TCP	1	20%
	Congestion Control & Quality of Service – Data traffic, Congestion, Congestion Control, QoS and Flow Characteristics	4	
	Application Layer – DNS, Remote Logging (Telnet), SMTP, FTP, WWW, HTTP, POP3, MIME, SNMP	3	
VI	Introduction to information system security, common attacks	1	20%
	Security at Application Layer (E-MAIL, PGP and S/MIME). Security at Transport Layer (SSL and TLS). Security at Network Layer (IPSec).	3	
	Defence and counter measures: Firewalls and their types. DMZ, Limitations of firewalls, Intrusion Detection Systems -Host based, Network based, and Hybrid IDSs	2	
END SEMESTER EXAM			

Question Paper Pattern

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC409	CONTROL SYSTEMS	3-0-0-3	2016

Prerequisite: EC202 Signals & Systems

Course objectives:

- To introduce the elements of control system and its modelling
- To introduce methods for analyzing the time response, the frequency response and the stability of systems.
- To design control systems with compensating techniques.
- To introduce the state variable analysis method.
- To introduce basic concepts of digital control systems.

Syllabus:

Control system, types and application, feedback system, mathematically modelling of control systems, block diagram representation, signal flow graph, Mason's formula, test signals, time response analysis, frequency analysis, stability concepts and analysis, state variable analysis, Observability and controllability, digital control systems, state space analysis, Jury's test

Expected outcome:

The Students will be able to

- Represent mathematically a systems and deriving their transfer function model.
- Analyse the time response and frequency response of the systems for any input
- Find the stability of system
- Design a control system with suitable compensation techniques
- Analyse a digital control system.

Text Books

1. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India.
2. Gopal, Control Systems, 4/e, McGraw Hill Education India Education, 2012.
3. Ogata K., Discrete-time Control Systems, 2/e, Pearson Education.

References

1. Gopal, Digital Control and State Variable Method, 4/e, McGraw Hill Education India 2012.
2. Norman S. Nise, Control System Engineering, 5/e, Wiley India
3. Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, Pearson Education, 2002.
4. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 9/e, Pearson Education, 2001.

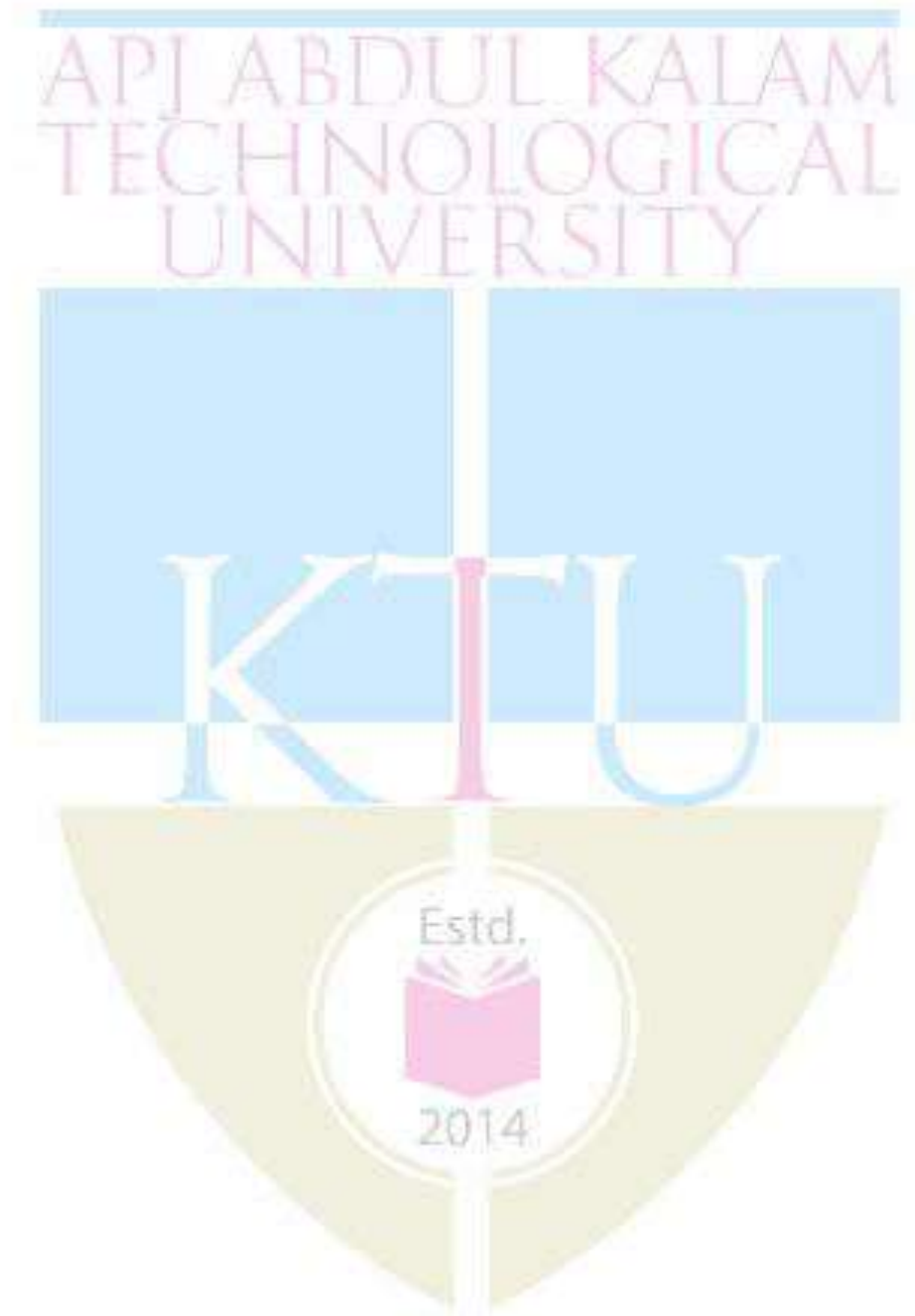
Course Plan

Module	Course contents	Hours	End Sem Exam Marks
I	Basic Components of a Control System, Applications, Open-Loop Control Systems and Closed-Loop Control Systems, Examples of control system	1	15%
	Effects of Feedback on Overall Gain, Stability, External, disturbance or Noise	1	

	Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems.	1	
	Overview of solving differential equations using Laplace transforms	1	
	Mathematical modelling of control systems - Electrical Systems and Mechanical systems.	2	
	Block diagram representation and reduction methods	2	
	Signal flow graph and Mason's rule formula.	2	
II	Standard test signals. Time response specifications.	1	15%
	Time response of first and second order systems to unit step input, ramp inputs, time domain specifications	2	
	Steady state error and static error coefficients.	1	
	Dynamic error coefficient.	1	
FIRST INTERNAL EXAM			
III	Stability of linear control systems: methods of determining stability, Routh's Hurwitz Criterion.	2	15%
	Root Locus Technique: Introduction, properties and its construction.	2	
	Frequency domain analysis: Frequency domain specifications, correlation between time and frequency responses.	1	
IV	Nyquist stability criterion: fundamentals and analysis	2	15%
	Relative stability: gain margin and phase margin. Stability analysis with Bode plot.	2	
	Design of Control Systems: PI,PD and PID controllers	2	
	Design with phase-lead and phase-lag controllers (frequency domain approach), Lag-lead	2	
SECOND INTERNAL EXAM			
V	State variable analysis: state equation, state space representation of Continuous Time systems	2	20%
	Transfer function from State Variable Representation, Solutions of the state equations, state transition matrix	2	
	Concepts of Controllability and Observability, Kalman's Test, Gilbert's test	2	
VI	Discrete Control systems fundamentals: Overview of Z transforms. State space representation for Discrete time systems.	2	20%
	Sampled Data control systems, Sampling Theorem, Sample & Hold, Open loop & Closed loop sampled data systems.	2	
	State space analysis : Solving discrete time state space equations, pulse transfer function, Discretization of continuous time state space equations	3	
	Stability analysis of discrete time systems Jury's test	1	
END SEMESTER EXAM			

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC431	COMMUNICATION SYSTEMS LAB (OPTICAL & MICROWAVE)	0-0-3-1	2016
Prerequisite: EC403 Microwave & Radar Engineering, EC405 Optical Communication			
Course objectives: To provide practical experience in design, testing, and analysis of few electronic devices and circuits used for microwave and optical communication engineering.			
List of Experiments Microwave Experiments: (Minimum Six experiments are mandatory) - GUNN diode characteristics. - Reflex Klystron Mode Characteristics. - VSWR and Frequency measurement. - Verify the relation between Guide wave length, free space wave length and cut off wave length for rectangular wave guide. - Measurement of E-plane and H-plane characteristics. - Directional Coupler Characteristics. - Unknown load impedance measurement using smith chart and verification using transmission line equation. - Measurement of dielectric constant for given solid dielectric cell. - Antenna Pattern Measurement. - Study of Vector Network Analyser Optical Experiments: (Minimum Six Experiments are mandatory) - Measurement of Numerical Aperture of a fiber, after preparing the fiber ends. - Study of losses in Optical fiber - Setting up of Fiber optic Digital link. - Preparation of a Splice joint and measurement of the splice loss. - Power vs Current (P-I) characteristics and measure slope efficiency of Laser Diode. - Voltage vs Current (V-I) characteristics of Laser Diode. - Power vs Current (P-I) characteristics and measure slope efficiency of LED. - Voltage vs Current (V-I) characteristics of LED. - Characteristics of Photodiode and measure the responsivity. - Characteristics of Avalanche Photo Diode (APD) and measure the responsivity. - Measurement of fiber characteristics, fiber damage and splice loss/connector loss by OTDR.			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC461	MICROWAVE DEVICES AND CIRCUITS	3-0-0-3	2016
Prerequisite: EC403 Microwave & Radar Engineering			
Course objectives: - To study microwave semiconductor devices & applications. - To study microwave sources and amplifiers. - To analyse microwave networks. - To introduce microwave integrated circuits.			
Syllabus: Limitation of conventional solid state devices at Microwave, Gunn – effect diodes, Microwave generation and amplification, IMPATT and TRAPATT diodes, Bipolar transistors, MESFET, Microwave amplifiers and oscillators, Microwave Network Analysis, Signal flow graphs, Microwave filters, Filter design by image parameter method, Filter transformation and implementation, Introduction to MICs, Distributed and lumped elements of integrated circuits, Diode control devices			
Expected outcome: The Students will be able to understand with active & passive microwave devices & components used in microwave communication systems and analyse microwave networks.			
Text Books: 1. David M. Pozar, Microwave Engineering, 4/e, Wiley India, 2012 2. Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012. 3. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.			
References: 1. Bharathi Bhat and Shibani K. Koul: Stripline-like Transmission Lines for MIC, New Age International (P) Ltd, 1989. 2. I Kneppo, J. Fabian, et al., Microwave Integrated Circuits, BSP, India, 2006. 3. Leo Maloratsky, Passive RF and Microwave Integrated Circuits, Elsevier, 2006.			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction, Characteristic, features of microwaves, Limitation of conventional solid state devices at Microwave.	1	15%
	Gunn – effect diodes – Gunn effect, Ridley – Watkins-Hilsum theory, Modes of operation, Limited space – Charge accumulation (LSA) mode of Gunn diode.	2	
	Microwave generation and amplification. Structure, Operation, Power output and efficiency of IMPATT and TRAPATT diodes	2	
II	Bipolar transistors – biasing, FET – biasing, MESFET – Structure, Operation.	4	15%
	Microwave amplifiers and oscillators – Amplifiers – Gain and stability, Single stage transistor amplifier design.	4	
	Oscillator design – One port negative resistance oscillators.	2	
FIRST INTERNAL EXAM			

III	Microwave Network Analysis – Equivalent voltages and currents, Impedance and Admittance matrices, Scattering matrix, The transmission matrix.	3	15%
	Signal flow graphs. Impedance matching and tuning – Matching with lumped elements, Single stub tuning, Double stub tuning. Quarter wave transformer, Theory of small reflections.	4	
IV	Microwave filters – Periodic structures – Analysis of infinite periodic structures and terminated periodic structures, Filter design by image parameter method – Constant k, m-derived and composite. Filter design by insertion loss method. Filter transformation and implementation.	7	15%
SECOND INTERNAL EXAM			
V	Introduction to MICSS:-Technology of hybrid MICs, monolithic MICs. Comparison of both MICs.	4	20%
	Planar transmission lines such as stripline, microstrip line, and slotline.	3	
VI	Distributed and lumped elements of integrated circuits - capacitors, inductors, resistors, terminations, attenuators, resonators and discontinuities.	5	20%
	Diode control devices – switches, attenuators, limiters. Diode phase shifter. Circulators and isolators.	2	
END SEMESTER EXAM			

Question Paper Pattern

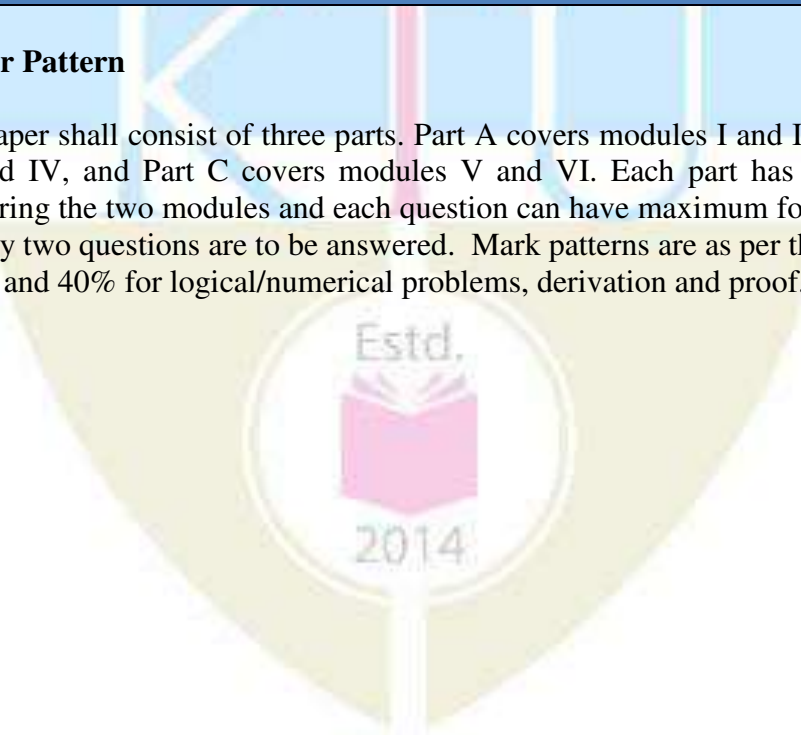
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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC462	MIXED SIGNAL CIRCUIT DESIGN	3-0-0 -3	2016
Prerequisite: EC 304 VLSI, EC308 Embedded Systems			
Course objectives: - To give the knowledge about various analog and digital CMOS circuits - To impart the skill in analysis and design of analog and digital CMOS circuits.			
Syllabus: CMOS Amplifiers: CS,CG,CD stages, Cascoded stages, Folded cascode Amplifier, MOS Current Mirror, MOSFET cascode current mirror, Differential Amplifiers, MOS telescopic cascode amplifier,CMOS OP AMPS, Design of classical Two Stage OP AMP, Comparator, Band gap References, Phase Locked Loop, Dynamic analog circuits, Data Converters, Switched Capacitor Circuits, Data Converters- Specifications, DAC, ADC Architecture			
Expected outcome: The students will be able to design and analyse various analog and digital CMOS circuits.			
Text Books: - Phillip E. Allen, Douglas R. Holbery, CMOS Analog Circuit Design, Oxford, 2004. - Razavi B., Fundamentals of Microelectronics, Wiley student Edition 2014.			
References: - Baker, Li, Boyce, CMOS: Circuits Design, Layout and Simulation, Prentice Hall India, 2000 - Razavi B., Design of Analog CMOS Integrated Circuits, Mc Graw Hill, 2001.			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	CMOS Amplifiers- Common Source with diode connected loads and current source load, CS stage with source degeneration, CG stage and Source Follower (Only Voltage Gain and Output impedance of circuits)	4	15%
	Cascoded stages - Cascoded amplifier, Cascoded amplifier with cascoded loads , Folded cascode Amplifier	4	
II	MOS Current Mirror- Basic circuit, PMOS and NMOS current mirrors Current mirror copying circuits, MOSFET cascode current mirror circuits	3	15%
	Differential Amplifiers- Differential Amplifier with MOS current source Load, with cascaded load and with current mirror load, MOS telescopic cascode amplifier. (Only Voltage Gain and Output impedance of circuits)	4	
FIRST INTERNAL EXAM			
III	CMOS OP AMPS- Two Stage Operational Amplifiers - Frequency compensation of OPAMPS - miller compensation,	3	15%

	Design of classical Two Stage OP AMP		
	Comparator- Characterization of a comparator-static and dynamic, A Two stage open loop comparator (analysis not required)	3	
IV	Band gap References- Supply Independent Biasing, Temperature independent references –band gap reference	5	15%
	Phase Locked Loop – Simple PLL ,Basic PLL Topology, Charge Pump PLL, Basic Charge Pump PLL	3	
SECOND INTERNAL EXAM			
V	Dynamic analog circuits – charge injection and capacitive feed through in MOS switch, Reduction technique	3	20%
	Switched Capacitor Circuits- sample and hold circuits, Switched Capacitor Integrator, Ladder filters	3	
VI	Data Converters- DAC Specifications-DNL, INL, latency, SNR, Dynamic Range ADC Specifications-Quantization error, Aliasing, SNR, Aperture error	4	20%
	DAC Architecture - Resistor String, Charge Scaling and Pipeline types.	3	
	ADC Architecture- Flash and Pipe line types		
END SEMESTER EXAM			

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC463	SPEECH AND AUDIO SIGNAL PROCESSING	3-0-0-3	2016
Prerequisite: EC301 Digital Signal Processing			
Course objectives: - To familiarize the basic mechanism of speech production and the basic concepts of methods for speech analysis and parametric representation of speech. - To give an overall picture about various applications of speech processing - To impart ideas of Perception of Sound, Psycho-acoustic analysis, Spatial Audio Perception and rendering. - To introduce Audio Compression Schemes.			
Syllabus: Speech production, Time domain analysis, Frequency domain analysis, Cepstral analysis, LPC analysis, Speech coding, Speech recognition, Speech enhancement, Text to speech conversion. Signal Processing Models of Audio Perception, Psycho-acoustic analysis, Spatial Audio Perception and rendering, Audio compression methods, Parametric Coding of Multi-channel audio, Transform coding of digital audio, audio quality analysis.			
Expected outcome: The students will be able to - Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications - Develop systems for various applications of speech processing - Learn Signal processing models of sound perception and application of perception models in audio signal processing. - Implement audio compression algorithms and standards.			
Text Books: - Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 1999; ISBN: 0780334493. - Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547			
References: - Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999; ISBN: 0471349593 - Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994. - Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978. - Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1/e			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Speech Production: Acoustic theory of speech production. Speech Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF). Parametric representation of speech: AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method).	5	15%

II	Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis, MFCC. Fundamentals of Speech recognition and Text-to-speech conversion	8	15%
FIRST INTERNAL EXAM			
III	Speech coding, speech enhancement, Speaker Verification, Language Identification	7	15%
IV	Signal Processing Models of Audio Perception: Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model.	6	15%
SECOND INTERNAL EXAM			
V	Audio compression methods: Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Transform coding of digital audio: MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, Loss less coding methods.	7	20%
VI	Spatial Audio Perception and rendering: The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score	6	20%
END SEMESTER EXAM			

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC464	LOW POWER VLSI	3-0-0 -3	2016
Prerequisite: EC 304 VLSI, EC308 Embedded Systems			
Course objectives: - To identify the power dissipation mechanisms in various MOS logic styles - To familiarize suitable techniques to reduce power dissipation			
Syllabus: Physics of Power dissipation in MOSFET devices, Sources of power dissipation in CMOS, Circuit techniques for leakage power reduction, Design and test of low voltage CMOS, Non clocked circuit design style, Adiabatic switching.			
Expected outcome: The students will be able to: - Identify the sources of power dissipation in digital IC systems. - Understand the impact of power on system performance and reliability - Understand leakage sources and reduction techniques - Recognise advanced issues in VLSI systems, specific to the deep-submicron silicon technologies - Identify the mechanisms of power dissipation in CMOS integrated circuits			
Text Books: - Gray Yeap, Practical low power digital VLSI design, Springer, 1998 - Kaushik Roy, Sharat C Prasad, Low power CMOS VLSI circuit design, Wiley India, 2000			
References: - Abdellatif Bellaouar, Mohamed I Elmasry, Low power digital VLSI design, Kluwer Academic, 1995 - Anatha P Chandrakasan, Robert W Brodersen, Low power digital CMOS Design, Kluwer Academic, 1995 - Christian Piguet, Low power CMOS circuits, Taylor & Francis, 2006 - Kiat Seng Yeo, Kaushik Roy, Low voltage, low power VLSI sub systems, Tata McGraw Hill, 2004			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Physics of Power dissipation in MOSFET devices MIS structure, Need for low power circuit design	2	15%
	Threshold voltage, body effects,	1	
	Short channel effects-surface scattering, punch through, velocity saturation, impact ionization	2	
	Hot electron effects, drain induced barrier lowering, narrow width effects	2	
II	Sources of power dissipation in CMOS-Switching power dissipation,	2	15%
	Short circuit power dissipation, glitching power dissipation	2	
	Leakage power dissipation, Transistor leakage mechanisms of	3	

	deep submicron transistors		
FIRST INTERNAL EXAM			
III	Circuit techniques for leakage power reduction – standby leakage control using transistor stacks	2	15%
	multiple V_{th} techniques, Dynamic V_{th} techniques	2	
	supply voltage scaling techniques, Deep submicron devices design issues	2	
	Minimizing short channel effect	2	
IV	Design and test of low voltage CMOS – Circuit design style- clocked design style- Basic concept	2	15%
	Domino logic (domino NAND gate)	1	
	Differential Current Switch Logic.	2	
SECOND INTERNAL EXAM			
V	Non clocked circuit design style -fully complementary logic	2	20%
	NMOS and pseudo –NMOS logic	2	
	differential cascade voltage switch logic(DCVS),	2	
	pass transistor logic	2	
VI	Adiabatic switching – Adiabatic charging, adiabatic amplification	2	20%
	One stage and two stage adiabatic buffer	2	
	fully adiabatic system	1	
	Adiabatic logic gates, pulsed power supplies	2	
END SEMESTER EXAM			

Question Paper Pattern

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC465	MEMS	3-0-0 -3	2016
Prerequisite : NIL			
Course objectives: - To understand the operation of major classes of MEMS devices/systems - To give the fundamentals of standard micro fabrication techniques and processes - To understand the unique demands, environments and applications of MEMS devices			
Syllabus:			
MEMS and Microsystems applications, Review of Mechanical concepts, Actuation and Sensing techniques, Scaling laws in miniaturization, Materials for MEMS, Micro System fabrication techniques, Micro manufacturing, Micro system Packaging, Bonding techniques for MEMS, Overview of MEMS areas.			
Expected outcome: The student will be able to: - Understand the working principles of micro sensors and actuators - Understand the application of scaling laws in the design of micro systems - Understand the typical materials used for fabrication of micro systems - Understand the principles of standard micro fabrication techniques - Appreciate the challenges in the design and fabrication of Micro systems			
Text Books:			
- Chang Liu, Foundations of MEMS, Pearson 2012 - Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002			
References:			
- Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000 - Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994 - Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997 - Stephen D. Senturia, Microsystem design, Springer (India), 2006. - Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001			
Course Plan			
Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	MEMS and Microsystems: Applications – Multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators – micro accelerometer –comb drives - Micro grippers – micro motors, micro valves, micro pumps, Shape Memory Alloys.	4	15%
	Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	3	

II	Flexural beams: Types of Beams, longitudinal strain under pure bending – Deflection of beams – Spring constant of cantilever – Intrinsic stresses	3	15%
	Actuation and Sensing techniques : Thermal sensors and actuators, Electrostatic sensors and actuators , Piezoelectric sensors and actuators, magnetic actuators	4	
FIRST INTERNAL EXAM			
III	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector, scaling in electrostatic and electromagnetic forces, scaling in electricity and fluidic dynamics, scaling in heat conducting and heat convection.	5	15%
IV	Materials for MEMS – Silicon – Silicon compounds – Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon, GaAs , Silicon Piezo resistors,	4	
	Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films, Micro System fabrication – Photolithography – Ion implantation- Diffusion – Oxidation – Chemical vapour deposition – Etching	5	15%
SECOND INTERNAL EXAM			
V	Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining , LIGA process –Microstereo lithography	6	20%
	Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging	3	
VI	Bonding techniques for MEMS : Surface bonding , Anodic bonding , Silicon - on - Insulator , wire bonding , Sealing – Assembly of micro systems	3	20%
	Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS	2	
END SEMESTER EXAM			

Question Paper Pattern

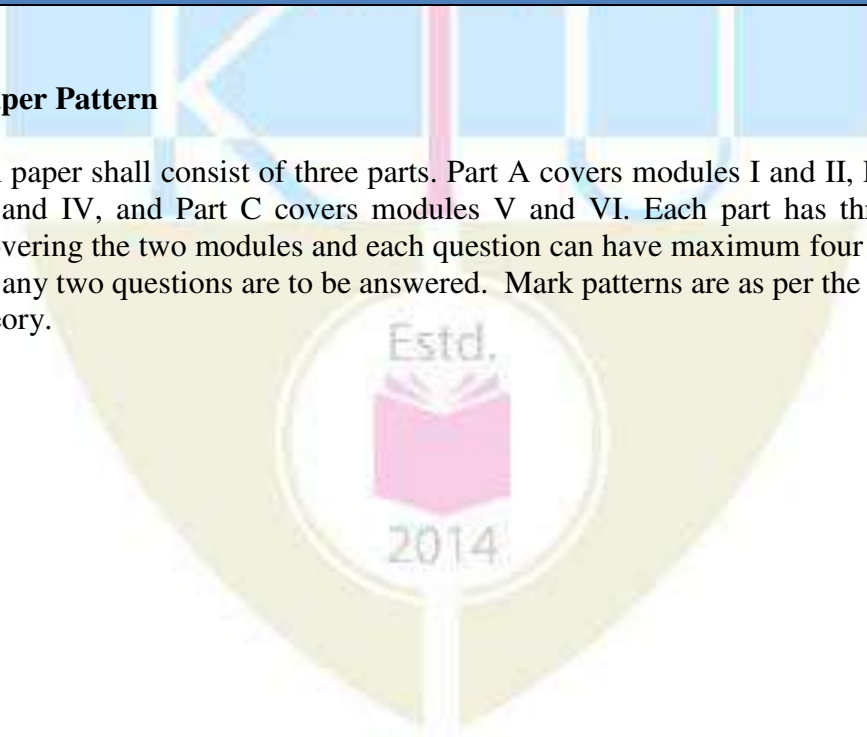
The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70% for theory and 30% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC466	CYBER SECURITY	3-0-0 -3	2016
Prerequisite: EC407 Computer Communication			
Course objectives: - To familiarize various types of cyber-attacks and cyber-crimes. - To give an overview of the cyber laws - To study the defensive techniques against these attacks			
Syllabus:			
Vulnerability scanning, tools for scanning, Network defense tools, Firewalls and Intrusion Detection Systems, Virtual Private Networks, Scanning for web vulnerabilities tools, Cyber crimes and law, cyber crime investigation			
Expected outcome: The students will be able to understand cyber-attacks, types of cybercrimes, cyber laws and also how to protect them self and ultimately the entire Internet community from such attacks			
Text Books: - Mike Shema , Anti-Hacker Tool Kit, Mc Graw Hill - Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley			
References: - Achyut S.Godbole Data Communication and Networking,2e, McGraw –Hill Education New Delhi,2011 - Forouzan, Data Communication and Networking (Global Edition) 5/e, McGraw Hill Education India, 2013. - Forouzan,TCP/IP Protocol Suite 4e, McGraw Hill Education India, 2010			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction to Vulnerability Scanning Overview of vulnerability scanning, Open Port / Service Identification, Banner / Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples, OpenVAS, Metasploit.	7	15%
II	Network Vulnerability Scanning Networks Vulnerability Scanning - Netcat, Socat, understanding Port and Services tools - Datapipe, Fpipe, WinRelay, Network Reconnaissance – Nmap, THC-Amap and System tools, Network Sniffers and Injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping, Kismet	7	15%
FIRST INTERNAL EXAM			
III	Network Defense tools Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, How a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Introduction Detection	8	15%

IV	Web Application Tools Scanning for web vulnerabilities tools: Nikto, W3af, HTTP utilities - Curl, OpenSSL and Stunnel, Application Inspection tools – Zed Attack Proxy, Sqlmap. DVWA, Webgoat, Password Cracking and Brute-Force Tools – John the Ripper, L0htcrack, Pwdump, HTC-Hydra	6	15%
SECOND INTERNAL EXAM			
V	Introduction to Cyber Crime and law Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Computer Language, Network Language, Realms of the Cyber world, A Brief History of the Internet, Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data, Indian IT ACT 2000.	8	20%
VI	Introduction to Cyber Crime Investigation Firewalls and Packet Filters, password Cracking, Keyloggers and Spyware, Virus and Worms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQL injection, Buffer Overflow, Attack on wireless Networks	6	20%
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 100% for theory.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC468	SECURE COMMUNICATION	3-0-0 -3	2016
Prerequisite: EC407 COMPUTER COMMUNICATION			
Course objectives: •To impart the students about the theory and technology behind the secure communication.			
Syllabus: Introduction on Security, Security Goals, Types of Attacks, Modular arithmetic: Groups, Ring, Fields. The Euclidean algorithm, Finite fields of the form $GF(p)$, Polynomial arithmetic, Symmetric Ciphers, Symmetric Cipher Model, Substitution Techniques, Transposition techniques, Block Ciphers, Data encryption Standards, Differential and Linear Crypt analysis Advanced Encryption standard, The AES Cipher, Public key cryptosystem, RSA algorithm, Intruders, Password management			
Expected outcome: The student will be - Exposed to the different approaches that handle security and the algorithms in use for maintaining data integrity and authenticity. - Enabled student to appreciate the practical aspects of security features design and their implementation			
Text Books: - Behrouz A. Forouzan , Cryptography and Network security Tata McGraw-Hill, 2008 - William Stallings, Cryptography and Network security: principles and practice", 2nd Edition, Prentice Hall of India, New Delhi, 2002			
References: - David S. Dummit & Richard M Foote, Abstract Algebra, 2nd Edition, Wiley India Pvt. Ltd., 2008. - Douglas A. Stinson, Cryptography, Theory and Practice, 2/e, Chapman & Hall, CRC Press Company, Washington, 2005. - Lawrence C. Washington, Elliptic Curves: Theory and Cryptography, Chapman & Hall, CRC Press Company, Washington, 2008. N. Koblitz: A course in Number theory and Cryptography, 2008 - Thomas Koshy: Elementary Number Theory with Applications, 2/e, Academic Press, 2007 - Tyagi and Yadav , Cryptography and network security, Dhanpatrai, 2012			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction on security, security goals and types of attacks: Passive attack, active attack, attacks on confidentiality, attacks on integrity and availability, Security services and mechanisms.	5	15%
II	Modular arithmetic: Groups, Ring, Fields. The Euclidean algorithm, Finite fields of the form $GF(p)$	4	15%
	Polynomial arithmetic: Finite fields of the form $GF(2^n)$.	4	
FIRST INTERNAL EXAM			
III	Symmetric Ciphers, Symmetric Cipher Model	3	15%

	Substitution Techniques, Caesar Cipher, Mono alphabetic Cipher, Play fair cipher, Hill cipher, Poly alphabetic Cipher, one time pad	4	
IV	Transposition techniques ,Block Ciphers, Data encryption Standards, DES Encryption, DES decryption	3	15%
	Differential and Linear Crypt analysis Advanced Encryption standard	2	
	The AES Cipher, substitute bytes transformation, Shift row transformation, Mix Column transformation.	2	
SECOND INTERNAL EXAM			
V	Public key cryptosystem, Application for Public key cryptosystem requirements	2	20%
	RSA algorithm, Key management, Distribution of public key, public key certificates, Distribution of secret keys.	5	
VI	Intruders: Intrusion techniques, Intrusion detection, Statistical anomaly detection, Rule based intrusion detection, Distributed intrusion detection, Honey pot, Intrusion detection exchange format.	5	20%
	Password management: Password protection, password selection strategies.	2	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50% for theory and 50% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC469	OPTO ELECTRONIC DEVICES	3-0-0-3	2016
Prerequisite: NIL			
Course objectives: - To know the physics of absorption, recombination and photoemission from semiconductors. - To analyse different types of photo detectors based on their performance parameters. - To discuss different LED structures with material properties and reliability aspects. - To explain optical modulators and optical components - To illustrate different types of lasers with distinct properties.			
Syllabus: Optical processes in semiconductors – LASERS- Nitride light emitters- White-light LEDs- Optical modulators - optical switching and logic devices, optical memory- Optical detection - Optoelectronic ICs - Introduction to optical components			
Expected outcome: The students will be able to: - Explain the property of absorption, recombination and photoemission in semiconductors. - Illustrate different types of lasers with distinct properties. - Explain different LED structures with material properties. - Analyse different types of photo detectors. - Explain optical modulators and optical components.			
Text Books: - Pallab Bhattacharya: Semiconductor Optoelectronic Devices, Pearson, 2009 - Yariv, Photonics Optical Electronics in modern communication, 6/e ,Oxford Univ Press,2006.			
References: - Alastair Buckley, Organic Light-Emitting Diodes, Woodhead, 2013. - B E Saleh and M C Teich, Fundamentals of Photonics:, Wiley-Interscience, 1991 - Bandyopadhyay, Optical communication and networks, PHI, 2014. - Mynbaev, Scheiner, Fiberoptic Communication Technology, Pearson, 2001. - Piprek, Semiconductor Optoelectronic Devices, Elsevier, 2008. - Xun Li, Optoelectronic Devices Design Modelling and Simulation, Cambridge University Press, 2009			
Course Plan			
Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	Optical processes in semiconductors – electron hole recombination, absorption, Franz-Keldysh effect, Stark effect, quantum confined Stark effect, deep level transitions, Auger recombination heat generation and dissipation, heat sources.	7	15%
II	Lasers – threshold condition for lasing, line broadening mechanisms, axial and transverse laser modes, heterojunction lasers, distributed feedback lasers, DBR lasers, quantum well lasers, tunneling based lasers, modulation of lasers.	7	15%

FIRST INTERNAL EXAM			
III	Nitride light emitters, nitride material properties, InGaN/GaN LED, structure and working, performance parameters, InGaN/GaN Laser Diode, structure and working, performance parameters. White-light LEDs, generation of white light with LEDs, generation of white light by dichromatic sources, generation of white light by trichromatic sources, temperature dependence of trichromatic, generation of white light by tetrachromatic and pentachromatic sources, white-light sources based on wavelength converters.	9	15%
IV	Optical modulators using pn junction, electro-optical modulators, acousto-optical modulators, Raman-Nath modulators, Franz-Keldysh and Stark effect modulators, quantum well electro-absorption modulators, optical switching and logic devices, optical memory.	5	15%
SECOND INTERNAL EXAM			
V	Optical detection – PIN, APD, modulated barrier photodiode, Schottky barrier photodiode, wavelength selective detection, micro cavity photodiodes. Optoelectronic ICs, advantages, integrated transmitters and receivers, guided wave devices. Working of LDR, liquid crystal display, structure, TFT display, structure, polymer LED, organic LED.	7	20%
VI	Introduction to optical components, directional couplers, multiplexers, attenuators, isolators, circulators, tunable filters, fixed filters, add drop multiplexers, optical cross connects, wavelength convertors, optical bistable devices.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50% for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC472	INTEGRATED OPTICS & PHOTONIC SYSTEMS	3-0-0 -3	2016
Prerequisite: EC303 Applied Electromagnetic Theory, EC405 Optical Communication			
Course objectives: - To discuss basic goals, principles and techniques of integrated optical devices and photonic systems - To explain operation and integration of various optoelectronic devices in an integrated optical system - To study about various components like optical waveguides, optical couplers, design tools, fabrication techniques, and the applications of optical integrated circuits. - To introduce some of the current state-of-the-art devices and systems.			
Syllabus: Review of Electromagnetics: Maxwell's equations, optical waveguides and devices, Waveguide Fabrication Techniques, Electro-Optic Waveguides, Polymer Waveguide Device, Losses in optical wave guide, Wave guide input and output couplers, coupled mode theory, Light Propagation in Waveguides, FFT-BPM, FD-BPM, Electro-Optic Modulators: Types, Integrated semiconductor laser, integrated semiconductor optical amplifier, integrated optical detectors, applications of optical integrated circuits, devices and systems for telecommunications, microwave carrier generation by optical techniques, photonic crystals, nanophotonic device.			
Expected outcome: The student will have an in depth knowledge of - Devices that are basic components of integrated optics and photonic systems including Optical wave guides, optical couplers, Lasers, Detectors and modulators - Light propagation in waveguides - The fabrication process of Optical Integrated devices - Applications of Optical Integrated devices - Nano photonic devices			
Text Books: - Lifante, Integrated Photonics: Fundamentals, John Wiley 2003 - Robert Hunsperger, Integrated optics :Theory and technology 6/e Springer, 2009			
References: H. Nishihara, M. Haruna, and T. Suhara, Optical Integrated Circuits, McGraw-Hill Professional, 1989. - Keicolizuka, Elements of photonics, John Wiley, 2002 . - Pappannareddy, Introduction to light wave systems, Artech House, 1995			
RELATED LINKS Website of IEEE photonics society: www.ieee.org/photonics .			
Course Plan			
Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	Review of Electromagnetics , Maxwell's equations - Wave equation	3	15%
	Analysis of optical waveguides and devices- Planar waveguides, chanel waveguides, graded index waveguides.	4	

II	Waveguide Fabrication Techniques -substrate materials for optical IC , Epitaxially Grown Waveguides- Electro-Optic Waveguides	4	15%
	Types of Polymers-Polymer Waveguide Devices, Optical Fiber Waveguide Devices	3	
FIRST INTERNAL EXAM			
III	Losses in optical wave guide, measurement of losses. Wave guide input and output couplers, types of couplers, coupling between wave guides,	4	15%
	Optical Fiber Couplers and Splitters, coupled mode theory	3	
IV	Light Propagation in Waveguides: The Beam Propagation Method- Fresnel Equation - Fast Fourier Transform Method (FFT-BPM) - Solution based on discrete fourier transform - Method Based on Finite Differences (FD-BPM), Boundary Conditions	7	15%
SECOND INTERNAL EXAM			
V	Electro-Optic Modulators - Basic Operating Characteristics- The Electro-Optic Effect,Mach-Zehnder Modulator, acousto-optic modulator,	4	20%
	Integrated semiconductor laser, integrated semiconductor optical amplifier, integrated optical detectors, structures.	3	
VI	Applications of Optical Integrated Circuits-Spectrum Analyser-Temperature and High Voltage Sensors,	3	20%
	Devices and Systems for Telecommunications- Microwave Carrier Generation by Optical Techniques, - Photonic Crystals- Nanophotonic Device.	4	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50% for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC474	COMPUTER VISION	3-0-0-3	2016
Prerequisite: EC301 Digital Signal Processing			
Course objectives: - To review image processing techniques for computer vision - To understand shape and region analysis - To understand three-dimensional image analysis techniques and motion analysis - To study some applications of computer vision algorithms - To introduce methods and concepts which will enable the student to implement computer vision systems with emphasis on applications and problem solving			
Syllabus:			
Review of Image processing operations, Image formation models, Image processing and feature extraction, Motion Estimation, Shape representation and Object recognition.			
Expected outcome:			
The students will be able to: - Implement fundamental image processing techniques required for computer vision - Perform shape analysis and boundary tracking techniques - Implement motion related techniques - To develop applications using computer vision techniques			
Text Books: - B K P Horn , Robot Vision, McGraw-Hill,1986 - D Forsyth and J Ponce, Computer Vision - A modern approach, Prentice Hall of India, 2002			
References: - E R Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012. R. Szeliski, Computer Vision: Algorithms and Applications, Springer 2011 - Simon J D Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.			
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Review of image processing techniques : filtering, thresholding	1	15
	Mathematical morphology, Texture	1	
	Binary shape analysis, connectedness, object labelling and counting	2	
	Boundary descriptors	1	
II	Monocular and binocular imaging system	2	15
	Orthographic & Perspective Projection	2	
	Camera models	2	

	Camera Calibration, Stereo vision: introduction; concept of disparity and its relationship with depth	3	
FIRST INTERNAL EXAM			
III	Image Processing for Feature Detection and Image Synthesis, Edge detection	1	15
	Corner detection, Harris corner detection algorithm, Line and curve detection, Hough transform	3	
	SIFT operator, Mosaics, snakes	2	
IV	Shape from X - Shape from shading, Photometric stereo, Texture, Occluding contour detection.	3	15
	Motion Analysis- Regularization theory, Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method	4	
	Structure from motion.	2	
SECOND INTERNAL EXAM			
V	Object recognition: Hough transforms and other simple object recognition methods	3	20
	Shape correspondence and shape matching, Principal Component Analysis	3	
	Shape priors for recognition	1	
VI	Application: Photo album, Face detection, Face recognition, Eigen faces, Active appearance and 3D shape models of faces	3	20
	Application: In-vehicle vision system: locating roadway, road markings, identifying road signs, locating pedestrians	3	
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70% for theory and 30% for logical/numerical problems, derivation and proof.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME201	MECHANICS OF SOLIDS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To acquaint with the basic concepts of stress and deformation in solids.
2. To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

Syllabus

Analysis of deformable bodies : stress, strain, material behaviour, deformation in axially loaded bars, biaxial and triaxial deformation. Torsion of elastic circular members, design of shafts. Axial force, shear force and bending moment in beams. Stresses in beams: flexure and shear stress formulae, design of beams. Deflection of beams. Transformation equations for plane state of stress and strain, principal planes and stresses, Mohr's circle. Compound stresses: combined axial, flexural and shear loads – eccentric loading. Buckling: Euler's theory and Rankine's formula for columns.

Expected outcomes: At the end of the course students will be able to

1. Understand basic concepts of stress and strain in solids.
2. Determine the stresses in simple structural members such as shafts, beams, columns etc. and apply these results in simple design problems.
3. Determine principal planes and stresses, and apply the results to combined loading case.

Text Books:

1. Rattan, Strength of Materials, 2e McGraw Hill Education India, 2011
2. S.Jose, Sudhi Mary Kurian, Mechanics of Solids, Pentagon, 2015

References Books:

- 1.S. H. Crandal, N. C. Dhal, T. J. Lardner, An introduction to the Mechanics of Solids, McGraw Hill, 1999
2. R. C. Hibbeler, Mechanics of Materials, Pearson Education, 2008
3. I.H. Shames, J. H. Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India, 2006
4. James M.Gere, Stephen Timoshenko, Mechanics of Materials, CBS Publishers & Distributors, New Delhi, 2012
5. F. Beer, E. R. Johnston, J. T. DeWolf, Mechanics of Materials, Tata McGraw Hill, 2011
6. A. Pytel, F. L. Singer, Strength of Materials, Harper & Row Publishers, New York, 1998
7. E. P. Popov, T. A. Balan, Engineering Mechanics of Solids, Pearson Education, 2012
8. R. K. Bansal, Mechanics of solids, Laxmi Publications, 2004
9. P. N. Singh, P. K. Jha, Elementary Mechanics of Solids, Wiley Eastern Limited, 2012

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to analysis of deformable bodies – internal forces – method of sections – assumptions and limitations. Stress – stresses due to normal, shear and bearing loads – strength design of simple members. Definition of linear and shear strains.	3	15%
	Material behavior – uniaxial tension test – stress-strain diagrams concepts of orthotropy, anisotropy and inelastic behavior – Hooke's law for linearly elastic isotropic material under axial and shear deformation	3	
	Deformation in axially loaded bars – thermal effects – statically indeterminate problems – principle of superposition - elastic strain energy for uniaxial stress.	4	
II	Definition of stress and strain at a point (introduction to stress and strain tensors and its components only) – Poisson's ratio – biaxial and triaxial deformations – Bulk modulus - Relations between elastic	4	15%
	Torsion: Shafts - torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – economic cross-sections – statically indeterminate problems – shaft design for torsional load.	4	
FIRST INTERNAL EXAM			
III	Beams- classification - diagrammatic conventions for supports and loading - axial force, shear force and bending moment in a beam	2	15%
	Shear force and bending moment diagrams by direct approach	3	
	Differential equations between load, shear force and bending moment. Shear force and bending moment diagrams by summation approach – elastic curve – point of inflection.	5	
IV	Stresses in beams: Pure bending – flexure formula for beams assumptions and limitations – section modulus - flexural rigidity - economic sections – beam of uniform strength.	4	15%
	Shearing stress formula for beams – assumptions and limitations – design for flexure and shear.	4	
SECOND INTERNAL EXAM			
V	Deflection of beams: Moment-curvature relation – assumptions and limitations - double integration method – Macaulay's method - superposition techniques – moment area method and conjugate beam ideas for simple cases.	6	20%
	Transformation of stress and strains: Plane state of stress - equations of transformation - principal planes and stresses.	4	
VI	Mohr's circles of stress – plane state of strain – analogy between stress and strain transformation – strain rosettes	3	20%
	Compound stresses: Combined axial, flexural and shear loads – eccentric loading under tension/compression - combined bending and twisting loads.	4	

Theory of columns: Buckling theory –Euler’s formula for long columns – assumptions and limitations – effect of end conditions - slenderness ratio – Rankin’s formula for intermediate columns.	3	
END SEMESTER EXAM		

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

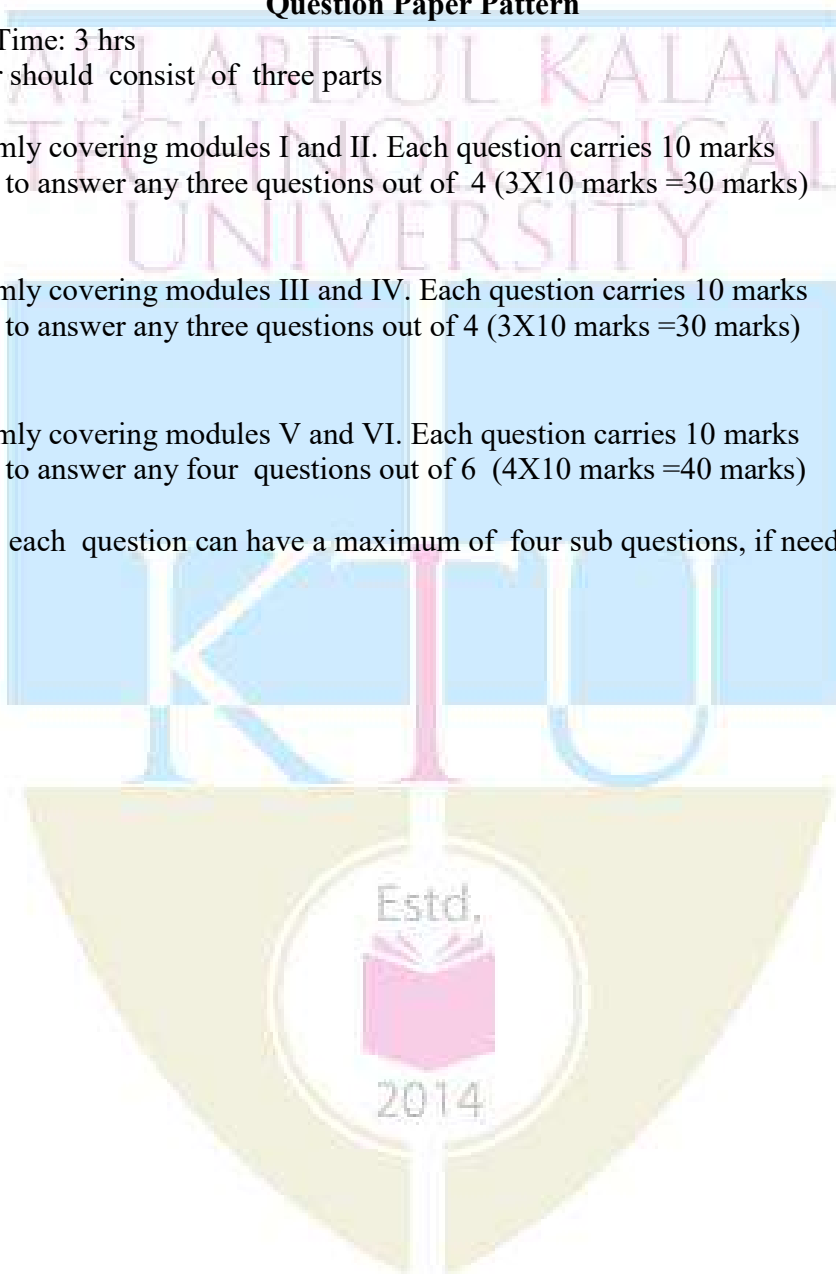
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
ME202	ADVANCED MECHANICS OF SOLIDS	3-1-0-4	2016
Prerequisite: ME201 Mechanics of solids			
Course Objectives: The main objectives of the course are 1. To impart concepts of stress and strain analyses in a solid. 2. To study the methodologies in theory of elasticity at a basic level. 3. To acquaint with the solution of advanced bending problems. 4. To get familiar with energy methods for solving structural mechanics problems.			
Syllabus Introduction, concepts of stress, equations of equilibrium, strain components, strain-displacement relations, compatibility conditions, constitutive relations, boundary conditions, 2D problems in elasticity, Airy's stress function method, unsymmetrical bending of straight beams, bending of curved beams, shear center, energy methods in elasticity, torsion of non-circular solid shafts, torsion of thin walled tubes.			
Expected outcome: At the end of the course students will be able to 1. Apply concepts of stress and strain analyses in solids. 2. Use the procedures in theory of elasticity at a basic level. 3. Solve general bending problems. 4. Apply energy methods in structural mechanics problems.			
Text Books: 1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill, 2008 2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill, 2008 3. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services, 2013 4. L. Govindaraju, TG Sitharaman, Applied elasticity for Engineers, NPTEL 5. U. Saravanan, Advanced Solid Mechanics, NPTEL 6. S. Anil Lal, Advanced Mechanics of Solids, Siva Publications and Distributions, 2017 References Books: 1. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill, 1970 2. R.J. Atkin, and N. Fox, An introduction the theory of elasticity, Longman, 1980 3. J. P. Den Hartog, Advanced Strength of Materials, McGraw Hill, 1987 4. C. K. Wang, Applied Elasticity, McGraw Hill, 1983 5. www.solidmechanics.org/contents.htm - Free web book on Applied Mechanics of Solids by A.F. Bower.			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to stress analysis in elastic solids - stress at a point – stress tensor – stress components in rectangular and polar coordinate systems - Cauchy’s equations – stress transformation – principal stresses and planes - hydrostatic and deviatoric stress components, octahedral shear stress - equations of equilibrium	6	15%
	Displacement field – engineering strain - strain tensor (<i>basics only</i>) – analogy between stress and strain tensors - strain-displacement relations (<i>small-strain only</i>) – compatibility conditions	4	
II	Constitutive equations – generalized Hooke’s law – equations for linear elastic isotropic solids - relation among elastic constants – Boundary conditions – St. Venant’s principle for end effects – uniqueness theorem	4	15%
	2-D problems in elasticity - Plane stress and plane strain problems – stress compatibility equation - Airy’s stress function and equation – polynomial method of solution – solution for bending of a cantilever with an end load	4	
FIRST INTERNAL EXAM			
III	Equations in polar coordinates (2D) – equilibrium equations, strain-displacement relations, Airy’s equation, stress function and stress components (<i>only short derivations for examination</i>)	3	15%
	Application of stress function to Lamé’s problem and stress concentration problem of a small hole in a large plate (<i>only stress distribution</i>)	3	
	Axisymmetric problems – governing equations – application to thick cylinders, rotating discs.	4	
IV	Unsymmetrical bending of straight beams (<i>problems having c/s with one axis of symmetry only</i>) – curved beams (<i>rectangular c/s only</i>) - shear center of thin walled open sections (<i>c/s with one axis of symmetry only</i>)	6	15%
	Strain energy of deformation – special cases of a body subjected to concentrated loads, moment or torque - reciprocal relation – strain energy of a bar subjected to axial force, shear force, bending moment and torque	3	
SECOND INTERNAL EXAM			
V	Maxwell reciprocal theorem – Castigliano’s first and second theorems – virtual work principle – minimum potential energy theorem.	5	20%

	Torsion of non-circular bars: Saint Venant's theory - solutions for circular and elliptical cross-sections	4	
VI	Prandtl's method - solutions for circular and elliptical cross-sections - membrane analogy.	4	20%
	Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections	6	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3 x 10 marks = 30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

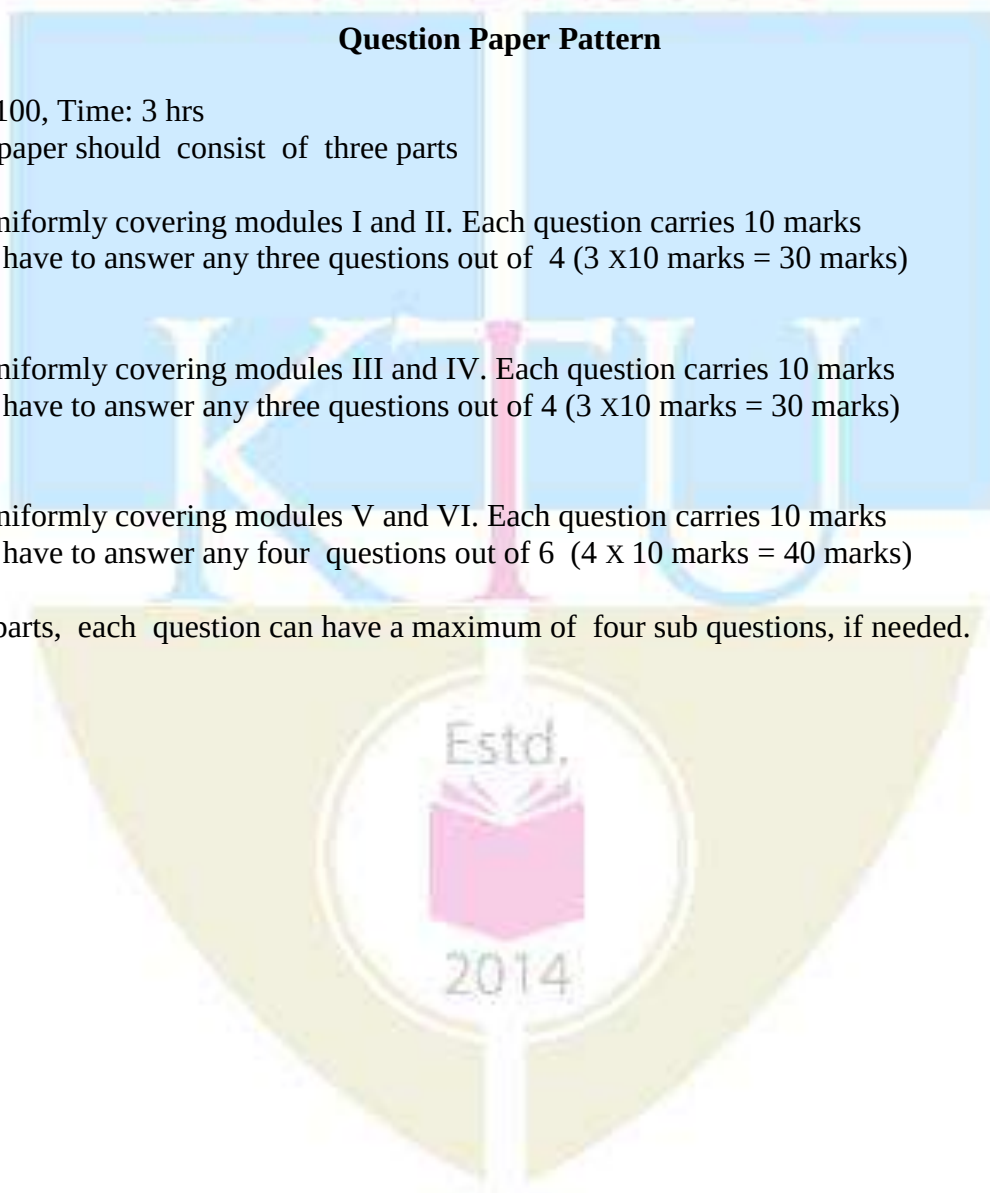
Students will have to answer any three questions out of 4 (3 x 10 marks = 30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4 x 10 marks = 40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME203	MECHANICS OF FLUIDS	3-1-0-4	2016
Prerequisite: nil			
Course Objectives: 1. To study the mechanics of fluid motion. 2. To establish fundamental knowledge of basic fluid mechanics and address specific topics relevant to simple applications involving fluids 3. To familiarize students with the relevance of fluid dynamics to many engineering systems			
Syllabus Fluid Properties, Kinematics of fluid flow, Fluid Statics, Dynamics of fluid flow, Flow through pipes, Concept of Boundary Layer, Dimensional Analysis and Hydraulic similitude			
Expected outcome: At the end of the course students will be able to 1. Calculate pressure variations in accelerating fluids using Euler's and Bernoulli's equations 2. Become conversant with the concepts of flow measurements and flow through pipes 3. Apply the momentum and energy equations to fluid flow problems. 4. Evaluate head loss in pipes and conduits. 5. Use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity			
Text Books: 1. Balachandran.P, Engineering Fluid Mechanics, PHI,2012 2. A S Saleem, Fluid Mechanics, Fathima Books,2016			
References Books: 1. Cengel, Fluid Mechanics, McGraw Hill Education India 2014 2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005 3. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002 4. Streeter V. L., E. B. Wylie and K. W. Bedford, Fluid Mechanics, Tata McGraw Hill, Delhi, 2010. 5. Joseph Karz, Introductory Fluid Mechanics, Cambridge University press,2010 6. Fox R. W. and A. T. McDonald, Introduction to Fluid dynamics, 5/e, John Wiley and Sons, 2009. 7. Shames I. H, Mechanics of Fluids, McGraw Hill, 1992. 8. White F.M., Fluid Mechanics, 6/e, Tata McGraw Hill, 2008			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.	8	15%
II	Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines flow nets, uses and limitations,	8	15%
FIRST INTERNAL EXAM			
III	Dynamics of Fluid flow: Fluid Dynamics: Energies in flowing fluid, head, pressure, dynamic, static and total head, Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in rectangular and cylindrical co-ordinates, Bernoulli's equation and its applications: Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot-static tube.	10	15%
IV	Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen Poiseuille equation. Turbulent flow: Darcy- Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.	12	15%
SECOND INTERNAL EXAM			
V	Concept of Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control.	10	20%

VI	Dimensional Analysis and Hydraulic similitude: Dimensional analysis, Buckingham's theorem, important dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynold, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

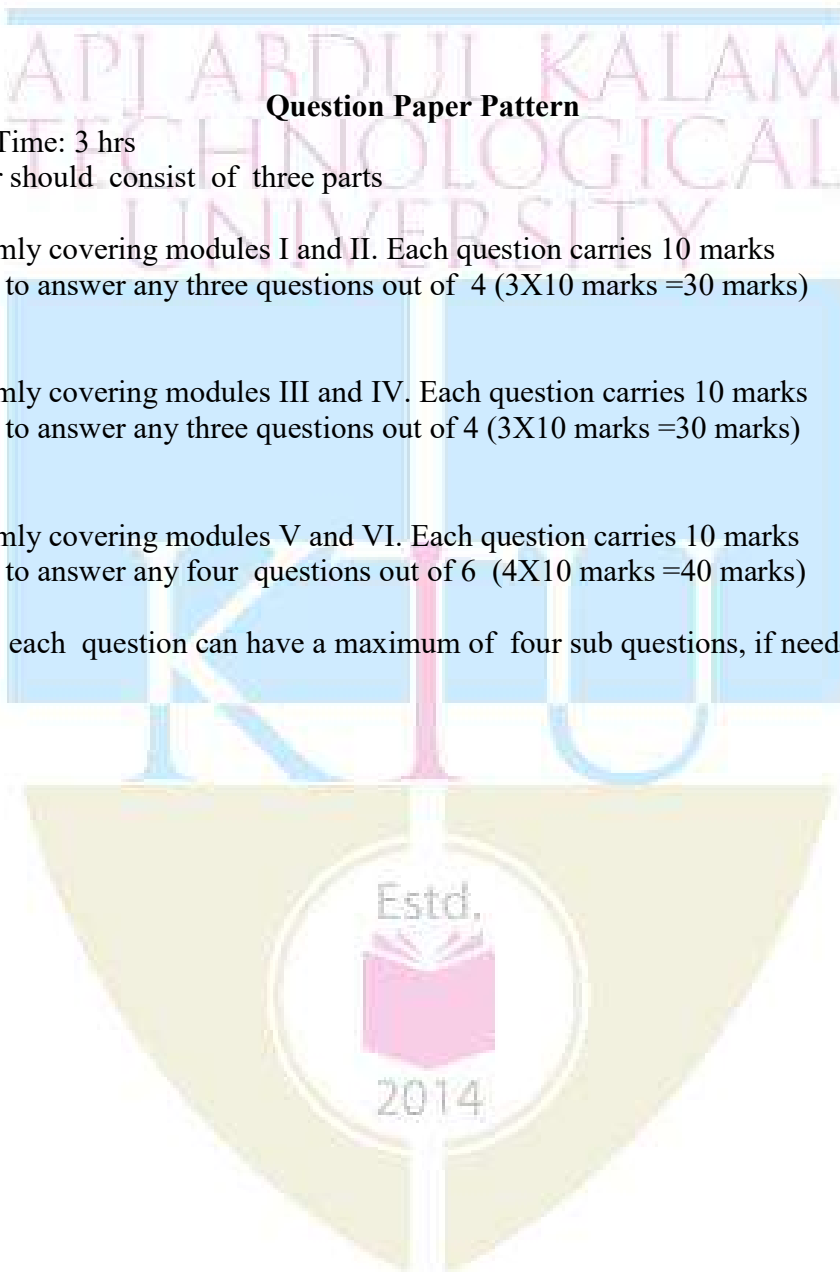
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME204	THERMAL ENGINEERING	3-1-0-4	2016
Prerequisite: ME205 Thermodynamics			
Course Objectives: 1. To acquire knowledge on the working of steam turbines, IC engines and gas turbines 2. To introduce the combustion process in IC engines 3. To understand air pollution from IC engines and its remedies.			
Syllabus Steam engineering, boilers, steam nozzles, steam turbines, internal combustion engines, performance testing of IC Engines, fuels and fuel combustion, air pollution from IC engines and remedies, combustion in I.C. engines, gas turbines			
Expected outcome: At the end of the course the students will be able to 1. Integrate the concepts, laws and methodologies from the course in thermodynamics into analysis of cyclic processes 2. To apply the thermodynamic concepts into various thermal application like IC engines, steam turbines, compressors.			
Text Books: 1. Rudramoorthy , Thermal Engineering, McGraw Hill Education India,2003 2. R.K Rajput, Thermal Engineering, Laxmi publications,2010 References Books: 1. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill,2002 2. T.D. Eastop and A McConkey, Applied thermodynamics for engineering technology, Pearson education,1996 3. J.B.Heywood, I.C engine fundamentals. McGraw-Hill,2011 4. Gill, P.W., Smith, JR., J.H., and Ziurys, E.J Fundamentals of internal combustion engines Oxford and IBH,1959 5. Rathore, Thermal Engineering, McGraw Hill Education India, 2010 Steam Tables 6. R.S.Khurmi, Steam table with Mollier chart,S.Chand,2008			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Steam engineering- T- S diagram, Mollier chart, Steam cycles- Rankine cycle, Modified Rankine cycle, Relative efficiency, Improvement in steam cycles-Reheat, Regenerative and Binary vapor cycle Steam Boilers: Types of boilers –Cochran boiler, Babcock and Wilcox boiler, Benson boiler, La Mont boiler, Loeffler boiler, Velox boiler, Boiler Mountings and Accessories Steam nozzles:-Types of nozzle- Velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, super saturated flow	8	15%
II	Steam turbines: classification, compounding of turbines-pressure velocity variation, velocity diagrams, work done, efficiency, condition for maximum efficiency, multistage turbines-condition line, stage efficiency. Steam turbine performance-reheat factor, degree of reaction, cycles with reheating and regenerative heating, governing of turbines	8	15%
FIRST INTERNAL EXAM			
III	Internal combustion engines: classification of I.C. Engines- four stroke and two stroke I.C. Engines, Comparison of four stroke and two stroke Engine. Wankel Engine, Air standard cycle-Carnot cycle, Otto cycle; Diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles. Stirling and Ericsson cycles, air standard efficiency, specific work output, work ratio, Actual cycle analysis, deviation of actual engine cycle from ideal cycle. Rotary engines, Stratified charge engine, super charging of SI and CI Engines – turbo charging. Variable specific heats.	10	15%
IV	Performance Testing of I C Engines: Indicator diagram, mean effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency-mechanical efficiency, volumetric efficiency, thermal efficiency and relative efficiency, Specific fuel consumption. Testing of I C engines-Morse test, Heat balance test and Retardation test Fuels and fuel combustion: flash point and fire point, calorific value, Fuels for SI and CI engine, Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas. Analysis of fuel combustion-A/F ratio, equivalence ratio, minimum quantity of air, flue gas analysis, excess air.	10	15%
SECOND INTERNAL EXAM			
V	Air pollution from I.C. Engine and its remedies: Pollutants from S.I. and C.I. Engines, Methods of emission control, alternative fuels for I.C. Engines; the blending of fuels, Bio fuels. Combustion in I.C. Engines: Combustion phenomena in S.I. engines; Ignition limits, stages of combustion in S.I. Engines, Ignition lag, velocity of flame propagation, auto ignition, detonation; effects of engine variables on detonation; theories of detonation, octane rating of fuels;	10	20%

	pre-ignition; S.I. engine combustion chambers. Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.		
VI	Gas turbines: classification, Thermodynamic analysis of gas turbine cycles-open , closed and semi closed cycle; ideal working cycle- Brayton cycle-P-v and T-s diagram, thermal efficiency. Effect of compressor and turbine efficiencies. Optimum pressure ratio for maximum specific work output with and without considering machine efficiencies. Comparison of gas turbine and IC engines, Analysis of open cycle gas turbine, Improvements of the basic gas turbine cycles-regeneration, intercooling and reheating-cycle efficiency and work output-Condition for minimum compressor work and maximum turbine work. Combustion chambers for gas turbines. pressure loss in combustion process and stability loop.	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME205	THERMODYNAMICS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To understand basic thermodynamic principles and laws
2. To develop the skills to analyze and design thermodynamic systems

Syllabus

Basic concepts, zeroth law of thermodynamics and thermometry, energy, first law of thermodynamics, second law of thermodynamics, entropy, irreversibility and availability, third law of thermodynamics pure substances, equations of state, properties of gas mixtures, Introduction to ideal binary solutions, general thermodynamic relationships, combustion thermodynamics

Expected outcome: At the end of the course the students will be able to

1. Understand the laws of thermodynamics and their significance
2. Apply the principles of thermodynamics for the analysis of thermal systems

Text Books

1. P.K.Nag, Engineering Thermodynamics, McGraw Hill, 2013
2. E.Rathakrishnan Fundamentals of Engineering Thermodynamics, PHI, 2005

References Books:

- 1 Y. A. Cengel and M. A. Boles, Thermodynamics an Engineering Approach, McGraw Hill, 2011
- 2 G. Van Wylen, R. Sonntag and C. Borgnakke, Fundamentals of Classical Thermodynamics, John Wiley & Sons, 2012
3. Holman J.P, Thermodynamics, McGraw Hill, 2004
4. M. Achuthan, Engineering Thermodynamics, PHI, 2004

Steam Tables/Data book

5. R.S. Khurmi, Steam table with Mollier chart, S. Chand, 2008



Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Role of Thermodynamics in Engineering and Science -- Applications of Thermodynamics Basic Concepts - Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe, Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function. (Review only- self study) Zeroth Law of Thermodynamics, Measurement of Temperature- Thermometry, reference Points, Temperature Scales, Ideal gas temperature scale, Comparison of thermometers-Gas Thermometers, Thermocouple, Resistance thermometer Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity.	7	15%
II	Joule's Experiment- First law of Thermodynamics - First law applied to Non flow Process- Enthalpy- specific heats- PMM1, First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE, Transient flow –Filling and Emptying Process. (Problems), Limitations of the First Law.	8	15%
FIRST INTERNAL EXAM			
III	Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump - Performance factors, Kelvin-Planck and Clausius Statements, Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility, Corollaries of second law, PMM2, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale. Clausius Inequality, Entropy- Causes of Entropy Change, Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation in open and closed system, Entropy and Disorder, Reversible adiabatic process- isentropic process	10	15%
IV	Available Energy, Availability and Irreversibility- Useful work, Dead state, Availability function, Availability and irreversibility in open and closed systems - Gouy-Stodola theorem , Third law of thermodynamics. Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface, Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables.	10	15%
SECOND INTERNAL EXAM			

V	The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances- Vander Waals Equation of State, Berthelot, Dieterici, and Redlich-Kwong equations of state , Virial Expansion, Compressibility factor, Law of corresponding state, Compressibility charts Mixtures of ideal Gases – Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Amagat's Laws of additive volumes, Gibbs-Dalton's law -Equivalent Gas constant and Molecular Weight, Properties of gas mixtures: Internal Energy, Enthalpy, specific heats and Entropy, Introduction to real gas mixtures- Kay's rule. *Introduction to ideal binary solutions, Definition of solution, ideal binary solutions and their characteristics, Deviation from ideality, Raoult's Law, Phase diagram, Lever rule(*in this section numerical problems not)	11	20%
VI	General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations, Tds Equations. The Clapeyron Equation, equations for internal energy, enthalpy and entropy, specific heats, Throttling process, Joule Thomson Coefficient, inversion curve. #Introduction to thermodynamics of chemically reacting systems, Combustion, Thermochemistry – Theoretical and Actual combustion processes- Definition and significance of equivalence ratio, enthalpy of formation , enthalpy of combustion and heating value (#in this section numerical problems not included)	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

Approved steam tables permitted

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME206	FLUID MACHINERY	2-1-0-3	2016
Prerequisite: ME203 Mechanics of Fluids			
Course Objectives: 1. To acquire knowledge on hydraulic machines such as pumps and turbines 2. To understand the working of air compressors and do the analysis			
Syllabus Impact of jets, Hydraulic Turbines, Rotary motion of liquids, Rotodynamic pumps, Positive displacement pumps, , Compressors			
Expected outcome: At the end of the course the students will be able to 1. Discuss the characteristics of centrifugal pump and reciprocating pumps 2. Calculate forces and work done by a jet on fixed or moving plate and curved plates 3. Know the working of turbines and select the type of turbine for an application. 4. Do the analysis of air compressors and select the suitable one for a specific application			
Text Books: 1. Som, Introduction to Fluid Mechanics and Fluid Machines ,McGraw Hill Education India 2011 2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications,2005.			
Reference Books: 1. Cengel Y. A. and J. M. Cimbala, Fluid Mechanics, Tata McGraw Hill, 2013 2. Yahya S. M, Fans, Blower and Compressor, Tata McGraw Hill, 2005. 3. Shepherd D. G, Principles of Turbo Machinery, Macmillan, 1969. 4. Stepanoff A. J, Centrifugal and Axial Flow Pumps, John Wiley & Sons, 1991. 5. Rajput R. K, Fluid Mechanics and Hydraulic Machines, S. Chand & Co.,2006. 6. Subramanya, Fluid mechanics and hydraulic machines, 1e McGraw Hill Education India,2010			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Impact of jets: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat and curve),– Series of vanes - work done and efficiency Hydraulic Turbines : Impulse and Reaction Turbines – Degree of reaction – Pelton Wheel – Constructional features - Velocity triangles – Euler's equation – Speed ratio, jet ratio and work done , losses and efficiencies, design of Pelton wheel – Inward and outward flow reaction turbines- Francis Turbine – Constructional features – Velocity triangles, work done and efficiencies.	7	15%
II	Axial flow turbine (Kaplan) Constructional features – Velocity triangles- work done and efficiencies – Characteristic curves of turbines – theory of draft tubes – surge tanks – Cavitation in turbines – Governing of turbines – Specific speed of turbine , Type Number– Characteristic curves, scale Laws – Unit speed – Unit discharge and unit power.	7	15%
FIRST INTERNAL EXAM			
III	Rotary motion of liquids – free, forced and spiral vortex flows Rotodynamic pumps- centrifugal pump impeller types,-velocity triangles-manometric head- work, efficiency and losses, H-Q characteristic, typical flow system characteristics, operating point of a pump. Cavitation in centrifugal pumps- NPSH required and available- Type number-Pumps in series and parallel operations. Performance characteristics- Specific speed-Shape numbers – Impeller shapes based on shape numbers.	7	15%
IV	Positive displacement pumps- reciprocating pump – Single acting and double acting- slip, negative slip and work required and efficiency- indicator diagram- acceleration head - effect of acceleration and friction on indicator diagram – speed calculation- Air vessels and their purposes, saving in work done to air vessels multi cylinder pumps. Multistage pumps-selection of pumps-pumping devices-hydraulic ram, Accumulator, Intensifier, Jet pumps, gear pumps, vane pump and lobe pump.	7	15%
SECOND INTERNAL EXAM			
V	Compressors: classification of compressors, reciprocating compressor-single stage compressor, equation for work with and without clearance volume, efficiencies, multistage compressor, intercooler, free air delivered (FAD)	7	20%
VI	Centrifugal compressor-working, velocity diagram, work done, power required, width of blades of impeller and diffuser, isentropic efficiency, slip factor and pressure coefficient, surging and chocking. Axial flow compressors:- working, velocity diagram, degree of reaction, performance. Roots blower, vane compressor, screw compressor.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

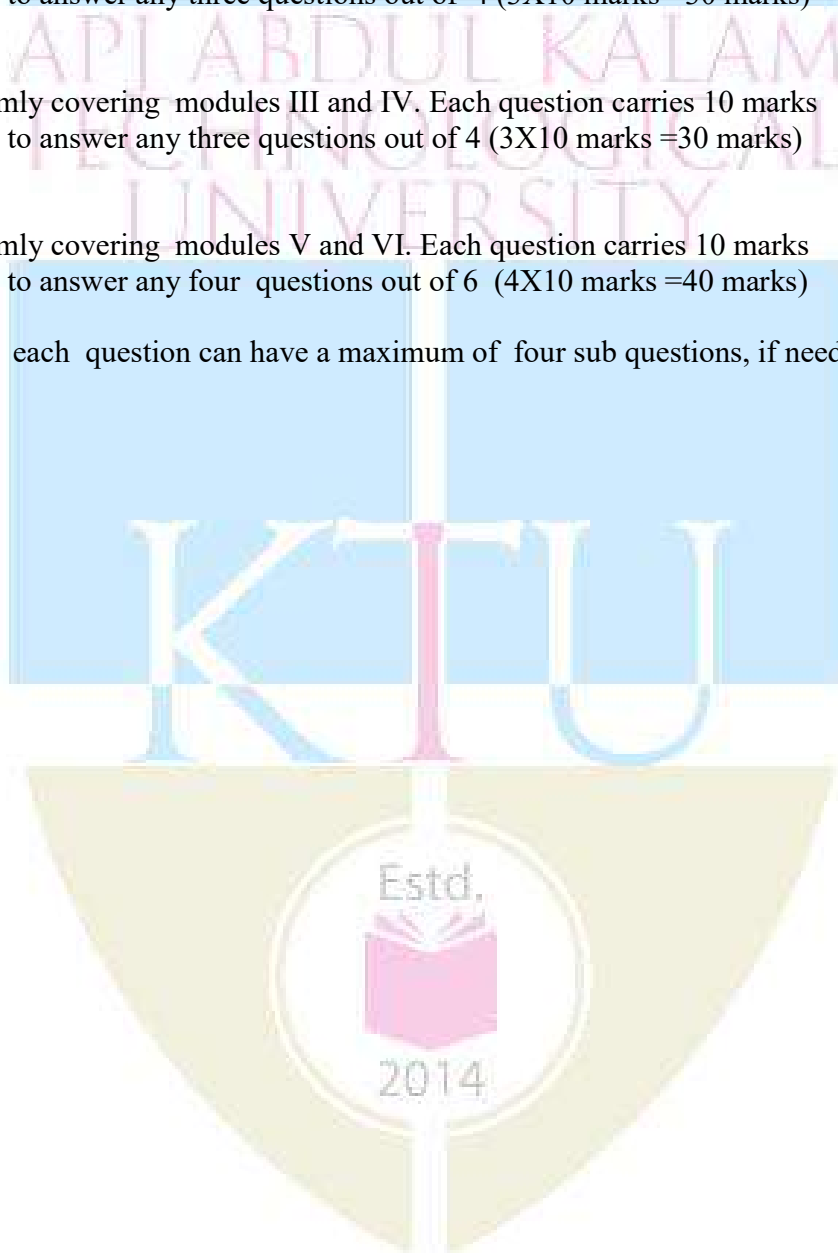
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P - Credits	Year of Introduction
ME207	THERMAL ENGINEERING-I	3-1-0-4	2016
Prerequisite : Nil			
Course Objectives - To impart the basic knowledge of the properties of steam and its application. - To give knowledge on the analysis of air compressors and gas turbines - To provide ideas on modes of heat transfer and heat transfer equations			
Syllabus Review of Thermodynamic laws and corollaries- Thermodynamic relations -Steam Engineering- Rankine cycle, steam boilers, steam nozzle, steam turbines-Air compressors- Gas turbines- Heat transfer – rate equations – laws of radiation heat transfer..			
Expected outcome . At the end of the course the students will be able to - Integrate the concepts, laws and methodologies of thermodynamics in the analysis of cyclic processes - Apply the thermodynamic concepts in applications like Steam Turbines, Compressors, Gas turbines.			
Text Books: - Rudramoorthy , Thermal Engineering, McGraw Hill Education India,2003 - R.K Rajput, Thermal Engineering, Laxmi publications,2013 - Rathore, Thermal Engineering 1e, McGraw Hill Education India, 2010 - Ballaney P.L, Thermal Engg, Khanna Publishers, 2007			
Data Book (Approved for use in the examination): Steam Tables			
References: - Kearton WJ, Steam turbines theory and practice- A text book for engineering students, Aristophanes press, 2011 - Cohen, Rogers and Saravanamuttoo, Gas turbine Theory, Longman, 1996. - Nag P K, Thermodynamics, Tata McGrawhill, 2011			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Review of thermodynamic laws and corollaries: Transient flow analysis, second law of thermodynamics, Availability and unavailability. Thermodynamic relations.	8	15%
II	Steam engineering- Entropy of steam, temperature-entropy diagram, Rankine cycle, modified Rankine cycle, Improvement in steam cycles, binary vapour cycle, Steam condensers.	8	15%
FIRST INTERNAL EXAMINATION			
III	Steam boilers- Working of high pressure boilers- Babcock and Wilcox boiler, Benson boiler. Steam turbines – different types,	10	15%

	velocity diagrams, condition for maximum efficiency, Cycles with reheating and regenerative heating. Steam nozzle- Flow through steam nozzles, super saturated flows.		
IV	Compressors- reciprocating air compressors- work done and efficiency, volumetric efficiency, effect of clearance, Rotary compressors, centrifugal and axial compressors.	10	15%
SECOND INTERNAL EXAMINATION			
V	Gas turbines-open and closed cycles. Ideal gas turbine cycle, compressor and turbine efficiencies, simple cycle with regeneration, intercooling and reheating.	10	20%
VI	Heat transfer- Different modes of heat transfer, Derivation of heat transfer equations for all modes of heat transfer (Fourier law, Newtons law of cooling, Planck's law, Kirchoff's law, Wiens displacement law and Stefan Boltzmanns law)- Simple problems.	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hours

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME209	MECHANICAL PROPERTIES OF STRUCTURAL MATERIALS	3-1-0-4	2016
Prerequisite : Nil			
Course Objectives - To know about different materials, their structure and property relationships - To study about crystalline and amorphous materials, crystal defects, grain size, strengthening mechanisms, alloying, phase diagrams and heat treatment of metals - To enable students to understand about the behavior of materials for engineering applications and select the materials for various engineering applications. - To understand the causes behind fracture and various failure mechanisms			
Syllabus: Crystallography- imperfections- Mechanical properties- plastic deformation- fracture- fatigue-creep- crystallization- diffusion- phase diagrams- heat treatment – strengthening mechanisms- hot and cold working –ferrous and non ferrous alloys.			
Expected outcome . The students will - understand crystal structure and various imperfections in materials. - acquire a knowledge about alloying and phase diagrams - know the relationship between structure, properties, processing and performance of metals. - study about various fracture and failure mechanisms in structural components. - be able to select materials for specific applications.			
Text Books: Raghavan V, Material Science and Engineering, Prentice Hall,2004			
References: - Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009 - Callister William. D., Material Science and Engineering, John Wiley,2014 - Dieter George E, Mechanical Metallurgy, Tata McGraw Hill,1976 - Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998 - Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008 - Van Vlack -Elements of Material Science - Addison Wesley,1989 - Askland and Phule- The Science and Engineering of Materials, Thompson publishers, 2007 - Anderson J.C. <i>et.al.</i>, Material Science for Engineers, Chapman and Hall,1990 - Clark and Varney,Physical metallurgy for Engineers, Van Nostrand,1964 - Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning,2009 http://nptel.ac.in/courses/113106032/1 http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2 http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/syllabus/ http://www.msm.cam.ac.uk/teaching/partIA.php			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Material science. Materials ad types of materials: metals, polymers, ceramics, composites, and electronic materials. Crystal structures and geometry: Crystal lattices and the unit cell. Principal metallic crystal structures: the body-centered cubic, the face-centered cubic, and the hexagonal close-packed structures. Miller's indices of planes and directions in the cubic system. Atomic packing. Density calculation. Planar and linear atomic densities. Polymorphism. Crystal imperfections: Point defects, solid solutions, vacancies and interstitialcies, line defects (dislocations), Burger's vector, edge and screw dislocations. Grain boundaries and grain size.	9	15%
II	Stresses, strains and Mechanical testing: Normal and shear stresses. Elastic and plastic deformation. The tensile test and the engineering stress-strain diagrams. Young's modulus, the yield strength, the ultimate tensile strength, the percent elongation and percent reduction in area. True stress and true strain. Compression testing, Hardness and hardness testing. Plastic deformation in single crystals. The slip mechanism and dislocations. Slip systems and the critical resolved shear stress. Schmidt's law. Twinning. Effects of plastic deformation on the microstructure and mechanical properties of metals. Cold work and strain hardening. Mechanism of crystallization: Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity. Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems.	9	15%
FIRST INTERNAL EXAMINATION			
III	Strengthening by solid solutions, cold-working. Recovery, recrystallization and grain growth. Fracture of metals. Ductile and brittle fracture. Toughness and impact testing. Fracture toughness. Ductile to brittle transition temperature (DBTT) in steels and structural changes during DBTT. Fatigue of metals. The S/N diagram. Mechanisms of fatigue. Stress raisers and stress concentration. Initiation and growth of fatigue cracks. Factors affecting fatigue behavior of metals. Creep and stress rupture in metals. Stages of creep. Effect of stress and temperature on creep behavior. Creep mechanisms, The Larsen-Miller parameter. Stress relaxation.	9	15%

	Diffusion : Atomic diffusion and diffusion mechanisms. Substitutional and interstitial diffusion. Steady state diffusion and Fick's first law. Transient diffusion and Fick's second law. Effect of temperature on diffusion rate. Industrial applications of diffusion.		
IV	Phase diagrams of pure substances (Unary systems). Gibb's phase rule of heterogeneous equilibrium. Binary Systems: Systems with unlimited solid solubility (isomorphous). The lever rule. Binary eutectic systems with no solid solubility and eutectic systems with limited solid solubility. Systems with compound and intermediate phases. Systems with peritectics. The invariant reactions, eutectics (and eutectoids) and peritectics (and peritectoids). Applications to typical binary phase diagrams. Copper-Zinc diagram and the Aluminum-Copper diagram. The Iron-iron carbide equilibrium diagram	11	15%
SECOND INTERNAL EXAMINATION			
V	Heat treatment of eutectoid steel: The eutectoid reaction in the iron-iron carbide system. The isothermal decomposition of austenite. The T.T.T. diagram. Formation pearlite and bainite. Decomposition of austenite on continuous cooling. Formation of martensite and the martensite lines. The structure of martensite. Annealing, quench hardening, and austempering. The hardness of martensite. Tempering of martensite. Heat treatment of noneutectoid plain carbon steel. T.T.T. diagrams of alloy steels. Hardenability of steel and the end-quench test. The process of precipitation (or Age) hardening and its application to the aluminum-copper alloys. Solution treatment, quenching and aging. Artificial (or forced) aging and over-aging. Surface hardening methods:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes- change in surface composition methods :carburizing and Nitriding; applications.	11	20%
VI	Alloy steels:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties Nickel steels, Chromium steels etc. - Enhancement of steel properties by adding alloying elements: - Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead. High speed steels:- Mo and W types, effect of different alloying elements in HSS	7	20%

	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications. Principal Non ferrous Alloys: - Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.		
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hours

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME210	METALLURGY AND MATERIALS ENGINEERING	3-0-0-3	2016
Prerequisite: nil			
Course Objectives: 1. To provide fundamental science relevant to materials 2. To provide physical concepts of atomic radius, atomic structure, chemical bonds, crystalline and non-crystalline materials and defects of crystal structures, grain size, strengthening mechanisms, heat treatment of metals with mechanical properties and changes in structure 3. To enable students to be more aware of the behavior of materials in engineering applications and select the materials for various engineering applications. 4. To understand the causes behind metal failure and deformation 5. To determine properties of unknown materials and develop an awareness to apply this knowledge in material design.			
Syllabus:- Chemical bonds – crystallography- imperfections- crystallization- diffusion- phase diagrams-heat treatment – strengthening mechanisms- hot and cold working – alloying- ferrous and non ferrous alloys- fatigue-creep- basics, need, properties and applications of modern engineering materials.			
Expected outcome: At the end of the course students will be able to 1. Identify the crystal structures of metallic materials. 2. Analyze the binary phase diagrams of alloys Fe-Fe₃C, etc. 3. Correlate the microstructure with properties, processing and performance of metals. 4. Recognize the failure of metals with structural change. 5. Select materials for design and construction. 6. Apply core concepts in materials science to solve engineering problems.			
Text Books 1. Raghavan V, Material Science and Engineering, Prentice Hall,2004 2. Jose S and Mathew E V, Metallurgy and Materials Science, Pentagon, 2011			
Reference 1 Anderson J.C. <i>et.al.</i>, Material Science for Engineers, Chapman and Hall,1990 2 Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964 3. Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning,2009 4. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009 5. Callister William. D., Material Science and Engineering, John Wiley,2014 6. Dieter George E, Mechanical Metallurgy, Tata McGraw Hill,1976 7. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998 8. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008 9. Van Vlack -Elements of Material Science - Addison Wesley,1989 10. http://nptel.ac.in/courses/113106032/1 11. http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2 12. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-			

Course Plan

Module	Contents	Hours	Semester Exam. Marks
I	Earlier and present development of atomic structure; attributes of ionization energy and conductivity, electronegativity and alloying; correlation of atomic radius to strength; electron configurations; electronic repulsion Primary bonds: - characteristics of covalent, ionic and metallic bond: attributes of bond energy, cohesive force, density, directional and non-directional and ductility. properties based on atomic bonding:- attributes of deeper energy well and shallow energy well to melting temperature, coefficient of thermal expansion - attributes of modulus of elasticity in metal cutting process -Secondary bonds:- classification- hydrogen bond and anomalous behavior of ice float on water, application- atomic mass unit and specific heat, application. <i>(brief review only, no University questions and internal assessment from these portions).</i>	2	15%
	Crystallography:- Crystal, space lattice, unit cell- BCC, FCC, HCP structures - short and long range order - effects of crystalline and amorphous structure on mechanical properties.	1	
	Coordination number and radius ratio; theoretical density; simple problems - Polymorphism and allotropy.	1	
	Miller Indices: - crystal plane and direction <i>(brief review)</i> - Attributes of miller indices for slip system, brittleness of BCC, HCP and ductility of FCC - Modes of plastic deformation: - Slip and twinning.	1	
	Schmid's law, equation, critical resolved shear stress, correlation of slip system with plastic deformation in metals and applications.	1	
II	Mechanism of crystallization: Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity.	1	15%
	Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems	1	
	Classification of crystal imperfections: - types of dislocation – effect of point defects on mechanical properties - forest of dislocation, role of surface defects on crack initiation.	1	

	Burgers vector –dislocation source, significance of Frank Read source in metals deformation - Correlation of dislocation density with strength and nano concept, applications.	1	
	Significance high and low angle grain boundaries on dislocation – driving force for grain growth and applications during heat treatment.	1	
	Polishing and etching to determine the microstructure and grain size.	1	
	Fundamentals and crystal structure determination by X – ray diffraction, simple problems –SEM and TEM.	1	
	Diffusion in solids, Fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.	1	
	FIRST INTERNAL EXAMINATION		
III	Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery's rule - equilibrium diagram of common types of binary systems: five types.	2	15%
	Coring - lever rule and Gibb's phase rule - Reactions: - monotectic, eutectic, eutectoid, peritectic, peritectoid.	1	
	Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties changes in austenite, ledeburite, ferrite, cementite, special features of martensite transformation, bainite, spheroidite etc.	1	
	Heat treatment: - Definition and necessity – TTT for a eutectoid iron-carbon alloy, CCT diagram, applications - annealing, normalizing, hardening, spheroidizing.	1	
	Tempering:- austempering, martempering and ausforming - Comparative study on ductility and strength with structure of pearlite, bainite, spherodite, martensite, tempered martensite and ausforming.	1	
	Hardenability, Jominy end quench test, applications-Surface hardening methods:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes- change in surface composition methods :carburizing and Nitriding; applications.	2	

IV	Types of Strengthening mechanisms: - work hardening, equation - precipitation strengthening and over ageing-dispersion hardening.	1	15%
	Cold working: Detailed discussion on strain hardening; recovery; re-crystallization, effect of stored energy; re-crystallization temperature - hot working Bauschinger effect and attributes in metal forming.	1	
	Alloy steels:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties	1	
	Nickel steels, Chromium steels etc. - Enhancement of steel properties by adding alloying elements: - Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead.	1	15%
	High speed steels:- Mo and W types, effect of different alloying elements in HSS	1	
	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications.	1	
	Principal Non ferrous Alloys: - Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.	1	
SECOND INTERNAL EXAMINATION			
V	Fatigue: - Stress cycles – Primary and secondary stress raisers - Characteristics of fatigue failure, fatigue tests, S-N curve.	1	20%
	Factors affecting fatigue strength: stress concentration, size effect, surface roughness, change in surface properties, surface residual stress.	1	
	Ways to improve fatigue life – effect of temperature on fatigue, thermal fatigue and its applications in metal cutting	1	
	Fracture: – Brittle and ductile fracture – Griffith theory of brittle fracture – Stress concentration, stress raiser – Effect of plastic deformation on crack propagation.	1	
	transgranular, intergranular fracture - Effect of impact loading on ductile material and its application in forging, applications - Mechanism of fatigue failure.	1	

	Structural features of fatigue: - crack initiation, growth, propagation - Fracture toughness (definition only) - Ductile to brittle transition temperature (DBTT) in steels and structural changes during DBTT, applications.	1	
V1	Creep: - Creep curves – creep tests - Structural change:- deformation by slip, sub-grain formation, grain boundary sliding	1	20%
	Mechanism of creep deformation - threshold for creep, prevention against creep - Super plasticity: need and applications	1	
	Composites:- Need of development of composites - geometrical and spatial Characteristics of particles – classification - fiber phase: - characteristics, classifications - matrix phase:- functions – only need and characteristics of PMC, MMC, and CMC – applications of composites: aircraft applications, aerospace equipment and instrument structure, industrial applications of composites, marine applications, composites in the sporting goods industry, composite biomaterials..	2	
	Modern engineering materials: - only fundamentals, need, properties and applications of, intermetallics, maraging steel, super alloys, Titanium – introduction to nuclear materials, smart materials and bio materials.	2	
	Ceramics:-coordination number and radius ratios- AX, A_mX_p , $A_mB_mX_p$ type structures – applications.	1	

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME216	MECHANICAL TECHNOLOGY	4-0-0-4	2016
Prerequisite : Nil			
Course Objective The main objectives of this course are - To make the students aware of the area of heat transfer and allied fields. - To give students knowledge of mechanical power generation devices and its applications - To impart knowledge of low temperature and its applications. - To analyse the aspects of engineering problems solvable by applying the subject.			
Syllabus Heat transfer - Field of application- Modes of heat transfer- conduction, convection and radiation. Combined conduction and convection. Buckingham's Pi theorem and its application. Heat exchangers- Parallel flow and counter flow heat exchangers - I C Engines- mean effective pressure- Brake power, Indicated power, efficiencies. Performance test- Morse test – Retardation test – Heat balance test. Gas turbine – open and closed cycles – thermodynamics cycles. Compressors - Classifications- reciprocating compressor- Introduction to Rotary compressors, Roots blowers and vane compressors. Principles of refrigeration-unit of refrigeration- Vapour compression system, Vapour Absorption refrigeration. Air conditioning – Psychrometry- Summer and Winter Air conditioning Window type Air conditioning system			
Expected Outcome After successful completion of the course, the student will be able to (i) identify heat transfer equipment and the theory behind them. (ii) understand working principles and performances of I C engines, which leads him to know more about automobiles and to search for improved performances. (iii) understand the working of different type of compressors. (iv) know the principles and working of refrigerators and air conditioning equipments.			
References - Rajput R K, Heat and Mass Transfer, S. Chand publishing., 2015. , - Eastop T. D. and A. McConkay, Applied Thermodynamics , Pearson Education, 5th Ed - Thermal Engineering, Ballaney P. L., Khanna publishers, 1994. , - Arora C. P., Refrigeration and Air conditioning, Tata McGraw Hill, 2000 - Sachdeva R. C., Fundamentals of Engineering Heat and Mass Transfer, New Age Science Ltd., 2009. - Rajput R. K., Thermal Engineering, Laxmi Publications, 2010.			

Course Plan			
Module	Contents	Hours	Sem. exam marks
I	Heat transfer - Field of application- Modes of heat transfer- Conduction- Fourier law of heat conduction, heat flux and thermal conductivity-Factors affecting conductivity- General Heat Conduction Equation in Cartesian Coordinate- thermal diffusivity, One-dimensional steady state conduction through plane walls, hollow cylinders, hollow spheres and their composites with constant conductivity- thermal resistance and equivalent thermal resistance. Transient heat conduction- lumped heat capacity method. Critical radius of insulation and its significance	9	15%
II	Convection - classification-Newton law of cooling, heat transfer coefficient, laminar and turbulent flow. Dimensionless numbers and its significance. Buckingham's Pi theorem and its application to Natural and forced convection heat transfer. Combined conduction and convection-overall heat transfer coefficient, Critical radius of insulation and its significances. Heat exchangers - Classifications- temperatures variation in Parallel flow, counter flow HE- Analysis of Heat Exchangers – Derivation of LMTD and simple problems with NTU method.	6 5	15%
First Internal Exam			
III	Radiation heat transfer - Basic theory of radiation-Spectrum of electromagnetic radiation, Reflection, Absorption and Transmission of radiation - absorptivity, reflectivity and transmissivity-Monochromatic radiation-Laws of radiations-Stefan Boltzman law, Planck's law, Kirchoff's law and Wien's displacement law, Total emissive power-. Black body, Grey body and emissivity Heat exchange between non black bodies- surface and shape resistances- electrical network analogy- heat transfer between parallel surfaces – radiation shields. Simple problems	4 6	15%
IV	I C Engines – Classification - two-stroke and four stroke engines(Working), theoretical and actual working cycles– SI and CI engines – mean effective pressure– Brake power , Indicated power, efficiencies. Performance test- Morse test – Retardation test – Heat balance test. Combustion phenomena in SI and CI engines- detonation, knocking and alternate fuels.	5 4	15%

Second Internal Exam			
V	Gas turbine – open and closed cycles – thermodynamics cycles – regeneration – reheating – intercooling – efficiency and performance of gas turbines .	4	20%
	Compressors - Classifications- reciprocating compressor-p-v diagram, work done, effect of Clearance, efficiencies, volumetric efficiency and free air delivered (FAD), two stage compressions, optimum pressure ratio, effect of intercooling. Introduction to rotary compressors, Roots blowers and vane compressors	4	
VI	Principles of refrigeration-unit of refrigeration - capacity - Coefficient of Performance – reversed Carnot cycle , Bell-Coleman cycle-Vapour compression system-thermodynamic analysis on T-S diagram and p-h diagram-refrigerants - thermodynamic, physical and chemical properties of refrigerants - selection criteria of refrigerants –designation of refrigerants, eco friendly refrigerants	5	20%
	Vapour Absorption refrigeration – Layout Ammonia –water system and Electrolux system. Air conditioning – Psychrometry - basic definitions, psychrometric chart, psychrometric processes - human comfort - comfort chart and limitations (brief discussion only) Summer and Winter Air conditioning Window type Air conditioning system	4	
End Semester Exam			

Question Paper Pattern

Max. marks: 100, Time: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

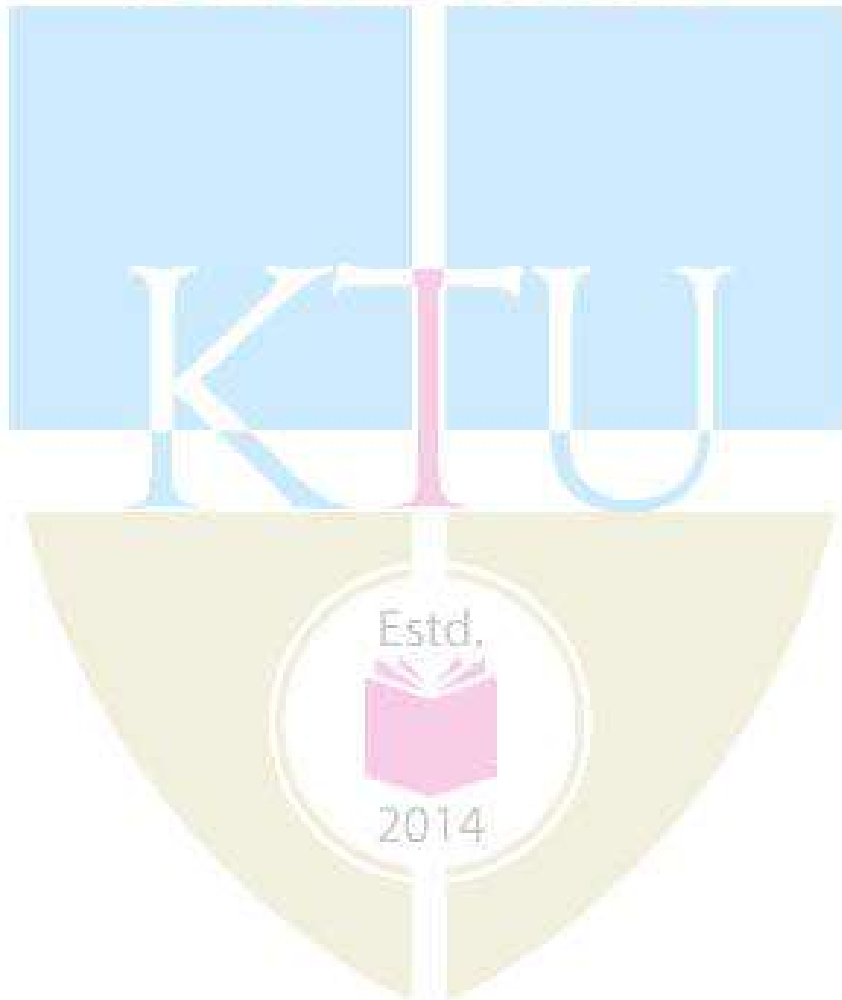
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME220	MANUFACTURING TECHNOLOGY	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives:- 1. To give an exposure to different techniques of casting and molds required. 2. To provide an exposure to different rolling processes and different rolled products 3. To familiarize with different forging methods, cautions to be adopted in die design. 4. To give an introduction to various work and tool holding devices used in manufacturing. 5. To introduce to the bending, shearing and drawing processes of sheet metal working and allied machines, 6. To give an understanding of welding metallurgy and weldability and to introduce various metal joining techniques.			
SYLLABUS Casting –patterns - Cores – Gating – Riser – Defects in Castings - Rolling –Defects in Rolled parts- forging – Coining – Heading – Piercing –Die Design– Extrusion Process– Extrusion Defects – Drawing Process -Principles of Location –Principles of Clamping – Types of Clamp -Sheet metal characteristics –Deep drawing –Spinning –Definition of Welding – Weldability – Solidification of Weld Metal – Heat Affected Zone – Welding Defects - Gas Welding -Arc Welding - Ultrasonic Welding – Friction Welding – Resistance Welding — Brazing- Soldering.			
Expected outcomes: At the end of the course the students will be able to 1. Acquire knowledge in various casting processes and technology related to them. 2. Understand the rolling passes required for getting required shapes of rolled products. 3. Discuss important aspects of forging techniques 4. Discuss sheet metal working processes and their applications to produce various shapes and products. 5. Acquire knowledge in various types of welding processes.			
Text books:- 1. Amitabha Ghosh and Ashok Kumar Mallick, Manufacturing Science Affiliated East West Press Ltd, New Delhi, 2002 2. S.Kalpajian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson,2001 Reference books:- 1. RAO, Manufacturing Technology-Vol 2 3e, McGraw Hill Education India, 2013 2. RAO, Manufacturing Technology-Vol 1 4e, McGraw Hill Education India, 2013 3. Cyril Donaldson and George H LeCain, Tool Design,TMH 4. Handbook of Fixture Design – ASTM 5. Campbell J. S., Principles of Manufacturing Materials and Processes, Tata McGraw Hill, 1999 6. P R Beeley, Foundry Technology, Elsevier, 2001 7. Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, Principles of Metal Casting,			

- Tata McGraw-Hill Education, 2001
8. Paul Degarma E and Ronald A. Kosher ,Materials and Processes in Manufacturing, Wiley,2011
 9. P. N. Rao,Manufacturing Technology Foundry, Forming and Welding, Tata McGraw-Hill Education,2011
 10. HMT Production Technology, 1e McGraw Hill,2001

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Course Plan			
Module	Contents	Hours	Semester Examination Marks
I	Sand Casting – Sand Molds-Types of Molding Sands and Testing	1	15%
	Type of patterns - Pattern Materials	1	
	Cores –Types and applications –Sand Molding Machines	1	
	Gating System – Riser	1	
	Shell Mold Casting – Ceramic Mold Casting	1	
	Investment Casting – Vacuum Casting – Slush Casting	1	
	Pressure Casting – Die Casting – Centrifugal Casting	1	
	Design Considerations based on Various Shapes - Defects in Castings – simple problems in casting	1	
II	Principles of Rolling –Types of rolling mills, Mechanics of Flat Rolling	1	15%
	Roll Force and Power Requirement - Neutral Point	1	
	Hot and Cold Rolling	1	
	Defects in Rolled Plates - Rolling Mills	1	
	Ring Rolling – Thread Rolling	1	
	Applications- Rolling of tubes, wheels, axles and I-beams	1	
FIRST INTERNAL EXAM			
III	Classification of forging – Forging methods – Forging under sticking condition	1	15%
	Precision Forging – Coining – Heading – Piercing	1	
	Die Design:- Preshaping, Design Features, Draft Angles – Die Materials and Lubrication	1	
	Forging Machines – Forging Defects and tests	1	
	Extrusion Process - Hot Extrusion – Cold Extrusion	1	
	Impact Extrusion – Extrusion Defects – Drawing Process, wire drawing process	1	

IV	Principles Location - Degrees of Freedom, 3-2-1 principle of locating	1	15%
	Locating from Planes - Locating from Circular Surfaces	1	
	Concentric Locating - Principles of Clamping	1	
	Types of Clamps - Strap Clamps Slide Clamps - Swing Clamps - Hinge Clamps	1	
	Vacuum Clamping - Magnetic Clamping	1	
SECOND INTERNAL EXAM			
V	Sheet metal characteristics – Typical shearing	1	20%
	Bending Sheet and Plate – Spingback - Bending Force	1	
	Press Brake Forming - Tube Bending	1	
	Stretch Forming - Deep Drawing	1	
	Rubber forming - Spinning Shear Spinning - Tube Spinning	1	
	Definition of Welding - Weldability – Solidification of the Weld Metal	1	
	Heat Affected Zone – correlation of strength of welded joint with structure - Welding Defects	1	
VI	Gas Welding: – Flame Characteristics	1	20%
	Equipment, fluxes and filler rods	1	
	Arc Welding – Applications and Equipment	1	
	Electrodes	1	
	Shielded Metal Arc Welding – Submerged Arc Welding	1	
	GTAW – Plasma Arc Welding	1	
	Ultrasonic Welding – Friction Welding	1	
	Resistance Spot Welding	1	
	Resistance Seam Welding – Stud Welding – Percussion Welding - simple problems in welding	1	
	Brazing:- Filler Metals, Methods - Soldering:- Techniques, Types of Solders and Fluxes	1	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

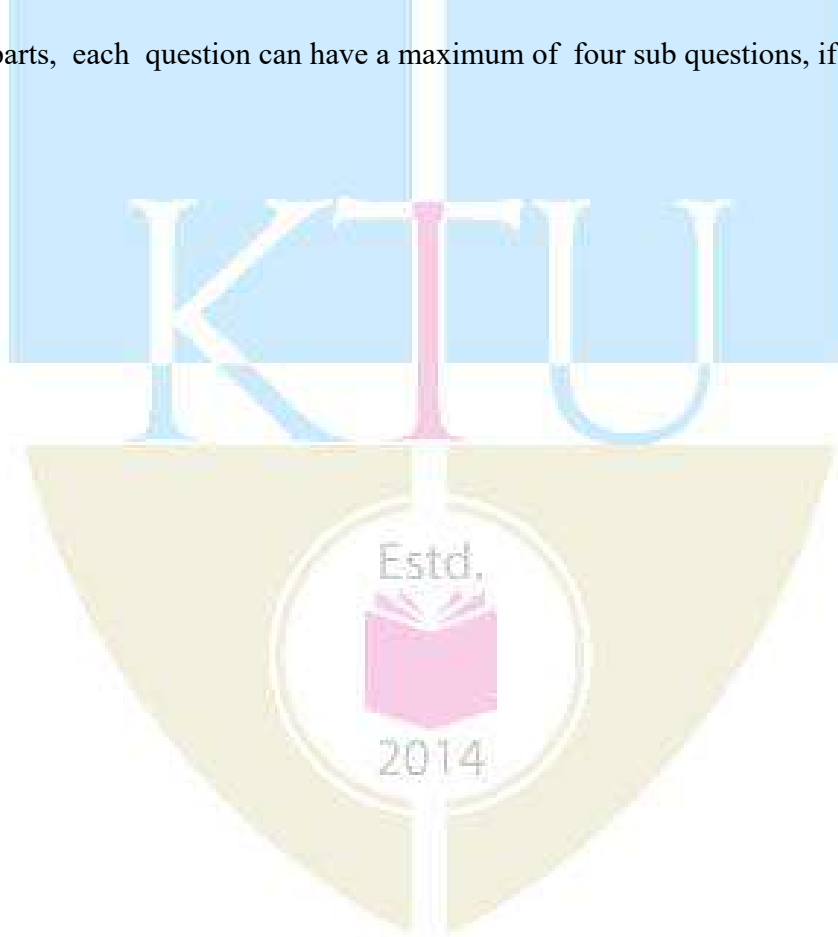
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME230	FLUID MECHANICS AND MACHINES LABORATORY	0-0-3-1	2016
Prerequisite: ME203 Mechanics of fluids			
Course Objectives: The main objectives of this course is to demonstrate the applications of theories of basic fluid mechanics and hydraulic machines and to provide a more intuitive and physical understanding of the theory.			
Syllabus Study: 1. Study of flow measuring equipments - water meters, venturi meter, orifice meter, current meter, rotameter 2. Study of gauges - pressure gauge, vacuum gauge, manometers. 3. Study of valves - stop valve, gate valve and foot valve. 4. Study of pumps – Centrifugal, Reciprocating, Rotary, Jet. 5. Study of Turbines - Impulse and reaction types. 6. Study of Hydraulic ram, accumulator etc. List of Experiments: 1. Determination of coefficient of discharge and calibration of Notches 2. Determination of coefficient of discharge and calibration of Orifice meter 3. Determination of coefficient of discharge and calibration of Venturimeter. 4. Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus 5. Determination of hydraulic coefficients of orifices 6. Determination of metacentric height and radius of gyration of floating bodies. 7. Experiments on hydraulic ram 8. Reynolds experiment 9. Bernoulli's experiment 10. Experiment on Torque converter 11. Performance test on positive displacement pumps 12. Performance test on centrifugal pumps, determination of operating point and efficiency 13. Performance test on gear pump 14. Performance test on Impulse turbines 15. Performance test on reaction turbines (Francis and Kaplan Turbines) 16. Speed variation test on Impulse turbine 17. Determination of best guide vane opening for Reaction turbine 18. Impact of jet Note: 12 experiments are mandatory			
Expected outcome: At the end of the course the students will be able to 1. Discuss physical basis of Bernoulli's equation, and apply it in flow measurement (orifice, Nozzle and Venturi meter), and to a variety of problems 2. Determine the efficiency and plot the characteristic curves of different types of pumps and turbines.			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME231	COMPUTER AIDED MACHINE DRAWING LAB	0-0-3-1	2016

Course Objectives:

1. To introduce students to the basics and standards of engineering drawing related to machines and components.
2. To teach students technical skills regarding assembly, production and part drawings.
3. To familiarize students with various limits, fits and tolerances.
4. To help students gain knowledge about standard CAD packages on modeling and drafting.

Syllabus

Introduction to Machine Drawing, Drawing Standards, Fits, Tolerances, Production drawings. Introduction to CAD, assembly drawings, etc.

Expected outcome

At the end of the course students will be able to

1. Acquire the knowledge of various standards and specifications about standard machine components.
2. Make drawings of assemblies with the help of part drawings given.
3. Ability to select, configure and synthesize mechanical components into assemblies.
4. Apply the knowledge of fits and tolerances for various applications.
5. Able to model components of their choice using CAD software.
6. Get exposure to advanced CAD packages.

Text Books:

1. N. D. Bhatt and V.M. Panchal, Machine Drawing, Charotar Publishing House, 2014
2. K C John, Machine Drawing, PHI, 2009
3. P I Vargheese and K C John, Machine Drawing, VIP Publishers, 2011
4. K.L.Narayana, P.Kannaiah & K. Venkata Reddy, Machine Drawing, New Age Publishers, 2009
5. Ajeet Singh, Machine Drawing Includes AutoCAD, Tata McGraw-hill, 2012
6. P S Gill, Machine Drawing, Kataria & Sons, 2009

Course Plan		
Module	Contents	Hours
0	Introduction Principles of drawing, free hand sketching, manual drawing, CAD drawing etc.	01
I	Drawing standards: 2 exercises Code of practice for Engineering Drawing, BIS specifications – lines, types of lines, dimensioning, sectional views, Welding symbols, riveted joints, keys, fasteners –bolts, nuts, screws, keys etc.	05
II	Fits ,Tolerances and Surface Roughness: 2 exercises Limits, Fits – Tolerances of individual dimensions – Specification of Fits – basic principles of geometric & dimensional tolerances. Preparation of production drawings and reading of part and assembly drawings, surface roughness, indication of surface roughness, etc.	06
FIRST INTERNAL EXAM		
III	Introduction to drafting package: Introduction, input, output devices, introduction to drafting software like Auto CAD, basic commands and development of simple 2D and 3D drawings. Drawing, Editing, Dimensioning, Plotting Commands, Layering Concepts, Matching, Detailing, Detailed drawings.	06
IV	Assembly drawings(2D): 10 exercises Preparation of assembled views. (Manually): Shaft couplings – Connecting rod - Machine Vice – Stuffing box – Plummer block. (Using software package, 2D Drawing) :- Universal joint - Screw jack – Lathe Tailstock – Rams Bottom Safety Valve – Steam stop valve. Preparation of Bill of materials and tolerance data sheet.	24
SECOND INTERNAL EXAM		
Note: 50% of assembly drawings (Module IV) must be done manually and remaining 50% of assembly drawings must be done using any 2D drafting package.		
FINAL INTERNAL EXAM		

Examination scheme

- (1) End semester examination shall be for 30 marks and of 2 hours duration.
- (2) End semester exam shall be based on Module IV. It shall be conducted as a CAD examination
- (3) 50 marks are allotted for internal evaluation: first internal exam 25 marks, second internal exam 25 marks and class exercises 20 marks.
- (4) The first internal exam will be based on modules I and II and the second internal exam will be a based on Module IV alone. (Both will be conducted as manual drawing examinations)

Course Number	Course Name	L-T-P-Credits	Year of Introduction
ME200	Fluid mechanics and Machinery	3-1-0-4	2016
Prerequisite : Nil			
Course Objectives: - To introduce students, the fundamental concepts related to the mechanics of fluids. - To understand the basic principles of fluid machines and devices. - To apply acquired knowledge on real life problems. - To analyze existing fluid systems and design new fluid systems.			
Syllabus Fundamental Concepts, fluid statics and dynamics, fluid kinematics, boundary layer theory, hydraulic turbines, positive displacement pumps, rotary motion of liquids, centrifugal pump, pumping devices.			
Expected Outcome Up on completion of course the students might be in a position to: - Analyze flow problems associated with statics, kinematics and dynamics of fluids. - Design and analyze fluid devices such as water turbines and pumps. - Understand and rectify problems faced in practical cases of engineering applications.			
Text Book: - Modi P. N. and S. M. Seth, <i>Hydraulics & Fluid Mechanics</i>, S.B.H Publishers, New Delhi, 2002. - Kumar D. S., <i>Fluid Mechanics and Fluid Power Engineering</i>, S. K. Kataria & Sons, New Delhi, 1998.			
References: J. F. Douglas, "Fluid Mechanics", Pearson education. - Cengel Y. A. and J. M. Cimbala, <i>Fluid Mechanics</i>, Tata McGraw Hill, 2013 - Robert W. Fox and Mc Donald, "Introduction to fluid dynamics", John Wiley and sons K. Subrahmanya, "Theory and applications of fluid mechanics", (TMH) - Shames. I. H, "Mechanics of fluids". - Jagadish Lal, "Fluid mechanics and Hydraulic machines". - R K Bansal, "Hydraulic Machines"			
Course Plan			
Module	Contents	Hours	Sem. exam marks
I	Fundamental concepts: Properties of fluid - density, specific weight, viscosity, surface tension, capillarity, vapour pressure, bulk modulus, compressibility, velocity, rate of shear strain, Newton's law of viscosity, Newtonian and non-Newtonian fluids, real and ideal fluids, incompressible and compressible fluids.	6	15%

II	Fluid statics: Atmospheric pressure, gauge pressure and absolute pressure. Pascal's Law, measurement of pressure - piezo meter, manometers, pressure gauges, energies in flowing fluid, head - pressure, dynamic, static and total head, forces on planar and curved surfaces immersed in fluids, centre of pressure, buoyancy, equilibrium of floating bodies, metacentre and metacentric height.	10	15%
First Internal Exam			
III	Fluid kinematics and dynamics: Classification of flow -1D, 2D and 3D flow, steady, unsteady, uniform, non-uniform, rotational, irrotational, laminar and turbulent flow, path line, streak line and stream line. Continuity equation, Euler's equation, Bernoulli's equation. Reynolds experiment, Reynold's number. Hagen- Poiseuille equation, head loss due to friction, friction, Darcy- Weisbach equation, Chezy's formula, compounding pipes, branching of pipes, siphon effect, water hammer transmission of power through pipes (simple problems)	8	15%
IV	Boundary layer theory: Basic concepts, laminar and turbulent boundary layer, displacement, momentum, energy thickness, drag and lift, separation of boundary layer. Flow rate measurements- venturi and orifice meters, notches and weirs (description only for notches, weirs and meters), practical applications, velocity measurements- Pitot tube and Pitot –static tube.	10	15%
Second Internal Exam			
V	Hydraulic turbines : Impact of jets on vanes - flat, curved, stationary and moving vanes - radial flow over vanes. Impulse and Reaction Turbines – Pelton Wheel constructional features - speed ratio, jet ratio & work done , losses and efficiencies, inward and outward flow reaction turbines- Francis turbine constructional features, work done and efficiencies – axial flow turbine (Kaplan) constructional features, work done and efficiencies, draft tubes, surge tanks, cavitation in turbines.	10	20%
VI	Positive displacement pumps: reciprocating pump, indicator diagram, air vessels and their purposes, slip, negative slip and work required and efficiency, effect of acceleration and friction on indicator diagram (no derivations), multi cylinder pumps. Rotary motion of liquids: – free, forced and spiral vortex flows, (no derivations), centrifugal pump, working principle, impeller, casings, manometric head, work, efficiency and losses, priming, specific speed, multistage pumps, selection of pumps, pump characteristics.	10	20%
End Semester Exam			

Question Paper Pattern

Max. marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

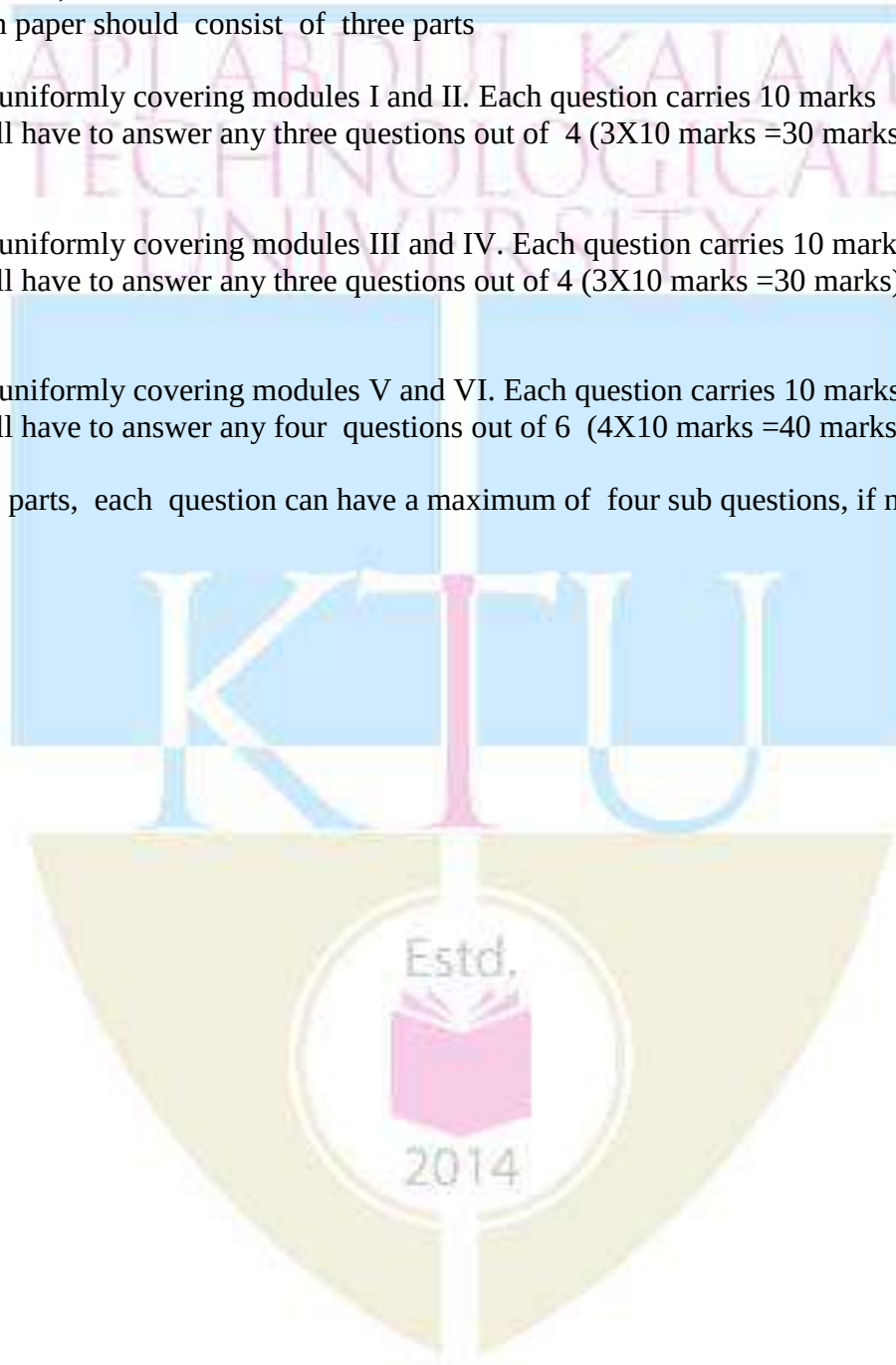
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME232	THERMAL ENGINEERING LABORATORY	0-0-3-1	2016
Prerequisite : Should have registered for ME204 Thermal Engineering			
Course Objectives: 1. To study the various types IC engines and their parts 2. To conduct the performance test on IC engines, compressors and blowers 3. To familiarize equipment used for measuring viscosity, flash and fire point and Calorific value of petroleum products			
Syllabus List of experiments: Study of I.C engines :- a) Diesel engines - all systems and parts b) Petrol engines - all systems and parts Experiments 1. Determination of flash and fire points of petroleum products -flash and fire point apparatus 2. Determination of viscosity of lubricating oil- viscometer 3. Determination of calorific value of solid and liquid fuels- calorimeter 4. Determination of calorific value of and gaseous fuels - calorimeter 5. Performance test on petrol engines with various types of loading systems 6. Performance test on Diesel engines with various types of loading systems 7. Heat Balance test on petrol/Diesel engines 8. Cooling curve of IC engines 9. Valve timing diagram of IC engines 10. Economic speed test on IC engines 11. Retardation test on IC engines 12. Determination volumetric efficiency and Air-fuel ratio of IC engines 13. Morse test on petrol engine 14. Performance test on reciprocating compressor 15. Performance test on rotary compressor/blower 16. Draw velocity profile in a pipe flow using Prandtl -Pitot tube 17. Analysis of automobile exhaust gas and flue gas using exhaust gas analyser Note: 12 experiments are mandatory			
Expected outcome: At the end of the course the students will be able to 1. Determine the efficiency and plot the characteristic curves of different types of Internal Combustion engines, compressors and blowers 2. Conduct experiments for the determination of viscosity, calorific value etc of petroleum products			

Course code	Course Name	L-T-P -Credits	Year of Introduction
ME211	MECHANICS OF SOLIDS AND MECHANICS OF MACHINES	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

- To introduce various behavior of structural components under various loading conditions
- To impart the basics of machines and mechanisms.

Syllabus

Definition of stress, strain and their relations -Mechanisms –Cam -Spur gear –Gear trains- Sliding and Rolling Friction –friction drives - Applied and Constrained Forces - Dynamic force analysis – Balancing - Vibration

Expected outcome.

The student will be able to

- understand the principles in the formation of mechanisms and their kinematics.
- understand the effect of friction in different machine elements.
- analyse the forces and toques acting on simple mechanical systems
- understand the importance of balancing and vibration.

Text Books:

1. Ambekar A.G., “Mechanism and Machine Theory” Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., “Theory of Machines and Mechanisms”, Oxford University Press, 2003
3. 4. R.S.Khurmi, J.K.Gupta, “Theory of Machines” S.Chand Publications.

References:

- 1.Martin, J.W., "Engineering Materials, Their properties and Applications", Wykedham Publications (London) Ltd., 1987.
2. Van Vlack.L.H., "Materials Science for Engineers", Addison Wesley, 1985.
- 3.Thomas Bevan, “Theory of Machines”, CBS Publishers and Distributors, 1984.
- 4.Ghosh.A, and A.K.Mallick, “Theory and Machine”, Affiliated East-West Pvt. Ltd., New Delhi, 1988.
- 5.Rao.J.S. and Dukkippatti R.V. “Mechanisms and Machines”, Wiley-Eastern Ltd., New Delhi, 1992.
- 6.Ramamurthi. V, "Mechanisms of Machine", Narosa Publishing House, 2002
7. Robert L. Norton, "Design of Machinery", McGraw-Hill, 2004.
8. Titterton.G.,”Aircraft Materials and Processes”, V Edition, Pitman Publishing Co., 1995.

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	Definition of stress, strain and their relations relations between material constants – axial loading	4	15%
	statically determinate and indeterminate problems in tension & compression -plane truss analysis	4	
	Method of joints – method of sections – 3-D trusses – thermal stresses – impact loading.	4	

II	Mechanisms – Terminology and definitions	2	15%
	kinematics inversions of 4 bar and slider crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons	4	
	Analytical methods– computer approach.	2	
FIRST INTERNAL EXAMINATION			
III	Cams – classifications – displacement diagrams - layout of plate cam profiles– derivatives of follower motion – circular arc and tangent cams.	3	15%
	Spur gear – law of toothed gearing – involute gearing – Interchangeable gears	3	
	Gear tooth action interference and undercutting – nonstandard teeth	2	
IV	Gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.	2	15%
	Sliding and Rolling Friction angle – friction in threads	2	
	Friction Drives – Friction clutches – Belt and rope drives – brakes – Tractive resistance.	3	
SECOND INTERNAL EXAMINATION			
V	Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members - Static Force analysis in simple machine members	4	20%
	Dynamic Force Analysis –Inertia Forces and Inertia Torque	3	
	D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members.	3	
VI	Static and Dynamic balancing – Balancing of revolving and reciprocating masses- Balancing machines	4	20%
	Free vibrations – Equations of motion – natural Frequency	3	
	Damped Vibration – critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation.	4	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100,

Exam duration: 3 hrs

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME212	FLUID MECHANICS	3-1-0-4	2016
Prerequisite : Nil			
Course Objectives - To establish fundamental knowledge of basic fluid mechanics and address specific topics relevant to simple applications involving fluids - To familiarize students with the relevance of fluid dynamics to many engineering systems			
Syllabus Fluid Properties, Kinematics of fluid flow, Fluid Statics, Dynamics of fluid flow, Flow through pipes, Concept of Boundary Layer, Dimensional Analysis and Hydraulic similitude			
Expected outcome At the end of the course students will - Become conversant with the concepts of flow measurements and flow through pipes - Be able to apply the momentum and energy equations to fluid flow problems. - Be able to evaluate head loss in pipes and conduits. - Be able to use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity			
Text Books: - Balachandran.P, Engineering Fluid Mechanics, PHI,2012 - A S Saleem, Fluid Mechanics, Fathima Books,2016			
References: - Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005 - Cengel, Fluid Mechanics, McGraw Hill Education India 2014 - Fox R. W. and A. T. McDonald, Introduction to Fluid dynamics, 5/e, John Wiley and Sons, 2009. - Joseph Karz, Introductory Fluid Mechanics, Cambridge University press,2010 - Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002 . Streeter V. L., E. B. Wylie and K. W. Bedford, Fluid Mechanics, Tata McGraw Hill, Delhi, 2010. - Shames I. H, Mechanics of Fluids, McGraw Hill, 1992. - White F.M., Fluid Mechanics, 6/e, Tata McGraw Hill, 2008			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure	8	15%
II	Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational	8	15%

	flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines flow nets, uses and limitations		
FIRST INTERNAL EXAMINATION			
III	Dynamics of Fluid flow: Fluid Dynamics: Energies in flowing fluid, head, pressure, dynamic, static and total head, Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in rectangular and cylindrical co-ordinates, Bernoulli's equation and its applications: Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients,	9	15%
IV	Pipe Flow: Viscous flow: Reynolds experiment, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen Poiseuille equation. Turbulent flow: Darcy- Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.	10	15%
SECOND INTERNAL EXAMINATION			
V	Concept of Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von-Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control.	10	20%
VI	Dimensional Analysis and Hydraulic similitude: Dimensional analysis, Buckingham's theorem, important dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynold, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100,

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P -Credits	Year of Introduction
ME213	THEORY OF MACHINES	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives - To understand the layout of linkages in the assembly of a system/machine. - To study the principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism. - To analyse the motion resulting from a specified set of linkages in a mechanism. - To study the application of friction in different devices. - To study the power transmission devices. - To study the use of gyroscopic couples. - To understand the principles in mechanisms used for governing of machines.			
Syllabus Kinematics – velocity and acceleration- Friction – Brakes – Gear – Cams- Gyroscope - Flywheel Governors- Static and dynamic balancing - Vibration			
Expected outcome. After this programme, students are expected to have a thorough understanding of different mechanisms and theories which will help in optimising design of machines and equipments and also to solve practical problems in the area of machines and mechanisms.			
Text Book: - P L Ballaney, Theory of Machines and Mechanisms, Khanna Publishers - S S. Rattan-Theory of machines, McGraw Hill			
References: - Bevan, Theory of Machines, Pearson Education, 1986 - Rao J S and Dukupati R V, Mechanism and Machine Theory, Wiley Eastern Ltd. - Malhotra, D.R and Gupta, H C, Theory of Machines, Satya Prakasam Tech. India Publications Ltd. - Gosh A and Mallick A K, Theory of Machines and Mechanisms, Affiliated East West Press . - Shigley J E. and Uicker J J, Theory of Machines and Mechanisms, McGraw–Hill.			
Course Plan			
Module	Contents	Hours	Sem.ExamMarks
I	Kinematics - links, mechanism, Degrees of freedom, Grashoff's law, four-bar chain, Slider crank chain, inversions and practical applications. Velocity and acceleration diagrams of simple mechanisms. Coriolis acceleration (Theory only). Friction - Pressure and wear theories, pivot and collar friction, Single and multiple disc clutches.	7	15%
II	Brakes - block and band brakes, self energizing and self-locking in braking. Gear – Different types of gears- Nomenclature of spur and helical gears, Law of gearing, Gear trains - Simple, compound gear trains and epicyclic gear	7	15%

	trains.		
FIRST INTERNAL EXAMINATION			
III	Cams - types of cams, cam profiles for knife edged and roller followers with and without offsets for SHM, constant acceleration-deceleration, constant velocity and cycloidal motion	7	15%
IV	Gyroscope –Gyroscopic torque, gyroscopic stabilization of ships and aeroplanes. Flywheel - Turning moment diagrams, fluctuation of energy.	7	15%
SECOND INTERNAL EXAMINATION			
V	Governors - types of governors, simple watt governor - Porter, Proell governors-. Isochronisms, hunting, sensitivity and stability. Hartnell governor(Theory only). Static and dynamic balancing of rotating mass- Single and several masses in different planes, balancing of reciprocating mass, Dynamic analysis of slider crank mechanism(Theory only).	7	20%
VI	Vibration - kinematics of vibrating motion, vibration systems having single degree of freedom, free and force vibration, damped vibration. Torsional vibrations -Transverse vibration. whirling of shaft (Theory only).	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hours

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME214	Theory of Machines	4-0-0-4	2016
Prerequisite : Nil			
Course Objectives - To impart basic knowledge on kinematics of mechanisms and machines. - To understand kinematic synthesis of mechanisms. - To analyse the motion resulting from a specified set of linkages in a mechanism. - To study the principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism. - To study the application of friction in different devices. - To study the power transmission devices			
Syllabus Kinematics – velocity and acceleration- Friction – Brakes – Gear – Cams- Gyroscope - Flywheel Governors- Static and dynamic balancing - Vibration			
Expected outcome. After the course, students will understand the various aspects of mechanisms and machines and will be able to solve design problems in the area of mechanisms and machines.			
Text Books - P L Ballaney, Theory of Machines and Mechanisms, Khanna Publishers - S S. Rattan-Theory of machines, McGraw Hill			
References: J. E. Shigley and J.J Uicker, Theory of Machines and Mechanisms, McGraw–Hill. T. Bevan T., Theory of Machines- A Text Book for Engineering Students, Pearson. - Wilson C. E. and J. P. Sadler, Kinematics and Dynamics of Machinery, Pearson. - Ambekar A. G., Mechanism and Machine Theory, PHI Learning. - Gosh A. and A. K. Mallick, Theory of Machines and Mechanisms, Affiliated East West Press. - V.P. Singh, Theory of machines, Dhanpat Rai.			
Course Plan			
Module	Contents	Hours	Sem.ExamMarks
I	Kinematics - links, mechanism, Degrees of freedom, Grashoff's law, four-bar chain, Slider crank chain, inversions and practical applications. Automobile steering mechanisms: Davis and Ackermann steering mechanisms. Velocity and acceleration diagrams of simple mechanisms. Coriolis acceleration (Theory only). Friction - Pressure and wear theories, pivot and collar friction, Single and multiple disc clutches..	10	15%

II	Brakes - block and band brakes, self energizing and self-locking in braking. Gear – Different types of gears- Nomenclature of spur and helical gears, Law of gearing, Gear trains - Simple, compound gear trains and epicyclic gear trains.	9	15%
FIRST INTERNAL EXAMINATION			
III	Cams - types of cams, cam profiles for knife edged and roller followers with and without offsets for SHM, constant acceleration-deceleration, constant velocity and cycloidal motion.	8	15%
IV	Gyroscope –Gyroscopic torque, gyroscopic stabilization of ships and aeroplanes. Flywheel - Turning moment diagrams, fluctuation of energy.	8	15%
SECOND INTERNAL EXAMINATION			
V	Governors - types of governors, simple watt governor - Porter, Proell governors-. Isochronisms, hunting, sensitivity and stability. Hartnell governor. Static and dynamic balancing of rotating mass- Single and several masses in different planes, balancing of reciprocating mass, Dynamic analysis of slider crank mechanism.	10	20%
VI	Vibration - kinematics of vibrating motion, vibration systems having single degree of freedom, free and force vibration, damped vibration. Torsional vibrations -Transverse vibration. whirling of shaft (Description only).	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100,

Exam duration: 3 hrs

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME218	ELEMENTS OF MACHINE DESIGN	3-1-0-4	2016
Prerequisite : ME213 Theory of machines			
Course Objectives: To develop an ability to design a system to meet the desired needs by choosing proper machine elements and mechanisms within the realistic constraints			
Syllabus: Introduction to design – design process – material behaviour – stress and strain – stress concentration - theories of failure - Welded joints – Design of keys and cotters-Design of Shaft couplings–Design of Bearing- Design of Gears-Design of Shafts			
Expected outcome . After completion of this course, students are expected to have an understanding of the design of various machine elements. They will be able to select appropriate mechanisms.			
Data Book (Approved for use in the examination): - P.S.G., Tech., Machine Design Data Handbook K. Mahadevan , Design data Book – C.B.S Pub.			
References: - Shigley J.E., Mechanical Engineering Design, McGraw Hill Book Company - Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company - Phelan R.M., Fundamentals of Mechanical Design, TMH, Ltd. - Doughtie V.L & Vallance A.V., Design of Machine Elements, McGraw Hill Book Company - Juvinall R.C. & Marshek K.M., Fundamentals of Machine Component Design, John Wiley - Machine Design Robert L Norton , Prentice Hall India - Design of machine elements M.F.Spotts, Prentice Hall India - Machine Design – Wentzell, Thomson Learning - Kulkarni S.G, Machine Design, THM			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to design - steps in design process - design factors - tolerances and fits - principles of standardisation. Materials and their properties - Elastic and plastic behaviour of metals - ductile and brittle behaviour. True stress and true strain - stress - strain curves - Selection of materials - stresses in machine parts - tension, compression, shear, bending and torsional stresses, combined stress. Stress concentration, stress intensity factor - Fracture toughness -factor of safety, margin of safety - variable stress - endurance limit - Theories of failure	9	15%
II	Combined steady and variable stress - Gerber, Goodman, Soderberg method - impact load - fatigue loading	9	15%
FIRST INTERNAL EXAMINATION			

III	Welded joints - types of joints, strength of welds, fillet welds-eccentric loading. Design of keys and cotters. Shaft couplings, - stresses in couplings -design of couplings-Muff and flanged coupling	9	15%
IV	Gears - spur and helical gears - Design for static and dynamic loading and wear - Lewis and Buckingham equations for design.	10	15%
SECOND INTERNAL EXAMINATION			
V	Bearing- Journal bearing -Introduction to lubrication - Hydrodynamic bearings - Sommerfield Number, Petroff's number, L/D ratio, Clearance ratio - minimum film thickness - bearing materials. Rolling contact bearings - bearing types - Ball & roller bearings - Static and dynamic load capacity - Equivalent dynamic load - Bearing life - Selection of bearing.	10	20%
VI	Shaft - stresses in shafts - design for static loads - reversed bending and steady torsion -- design for fatigue loading	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME222	THERMAL ENGINEERING II	4-0-0-4	2016
Prerequisite : ME207 Thermal engineering - I			
Course Objectives: - To acquire knowledge on the working of IC engines, Refrigerators, Air conditioners and heat exchangers. - To introduce the combustion process in IC engines - To understand air pollution from IC engines and its remedies.			
Syllabus: Fuels and combustion- Normal and abnormal combustion in IC engines- Alternate fuels in IC engines- Performance testing of IC engines -IC engine pollution- Heat exchangers- Refrigeration and Air conditioning.			
Expected outcome: At the end of the course the students will be able to - Integrate the concepts, laws and methodologies from the course in thermodynamics into analysis of cyclic processes - To apply the thermodynamic concepts into various thermal application like IC engines, Refrigeration and air conditioning, Heat exchangers.			
Text Books: - Rudramoorthy , Thermal Engineering, Tata McGraw Hill Education India, 2003 - R.K Rajput, Thermal Engineering, Laxmi publications,2010 - Rathore, Thermal Engineering 1e, Tata McGraw Hill Education India, 2010			
References Books: V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill,2002 - T.D. Eastop and A McConkay, Applied thermodynamics for engineering technology, Pearson education,1996 - J.B.Heywood, I.C engine fundamentals. McGraw-Hill,2011 - Gill, P.W., Smith, JR., J.H., and Ziurys, E.J Fundamentals of internal combustion engines Oxford and IBH,1959			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Fuels and combustion- Stoichiometry, calculation of A/F ratio and equivalence ratios, volumetric and gravimetric analysis, fuel properties.	9	15%
II	Combustion in IC engines- Normal and abnormal combustion in SI and CI engines, auto ignition- pre ignition and detonation- factors affecting detonation, knocking in engine.	9	15%
FIRST INTERNAL EXAMINATION			

III	Performance testing of IC Engines, Alternate fuels in IC engines- biodiesel, hydrogen, natural gas, LPG, Alcohol- IC engine pollution and control, Emission norms	9	15%
IV	Heat Exchangers- Different types- LMTD and effectiveness. Problems	9	15%
SECOND INTERNAL EXAMINATION			
V	Refrigeration- Vapor compression refrigeration system, Vapor absorption refrigeration system, simple cycle- TS and PH diagrams- COP- Refrigerants and their properties- Eco friendly refrigerants. Application of refrigeration- Domestic refrigerators, Water coolers, ice plants	9	20%
VI	Air conditioning- Psychrometry-Comfort and industrial air conditioning, Working of room air conditioners- Use of psychrometric charts- Split and packaged system- Automobile airconditioning.	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100

Time: 3 hours

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME233	Mechanical Engineering Lab	0-0-3-1	2016
Prerequisite : Nil			
Course Objective - To develop engineering related skills of fluid mechanics and prime movers - To provide necessary practical knowledge related to the theory of fluid mechanics and energy conversion systems. - To familiarize with various apparatus and machines in fluid mechanics and IC engines and conduct experiments.			
List of Experiments - Determination of coefficient of discharge and calibration of rectangular notch - Determination of coefficient of discharge and calibration of triangular notch. - Determination of coefficient of discharge and calibration of venturI meter - Determination of coefficient of discharge and calibration of orifice meter. - Determination of hydraulics coefficient using orifice apparatus. - Determination of meta-centric height and radius of gyration of floating body. - Pipe friction apparatus to find Darcy's frictional coefficient and Chezy's constant. - Performance test on positive displacement pump - Performance test on centrifugal pump - Performance test on impulse turbine. - Performance test on reaction turbine. - Performance test on hydraulic ram - Performance test on two stroke diesel engine. - Performance test on four stroke diesel engine. - Performance test on four stroke petrol engines - Performance test on two stroke petrol engines - Calibration of pressure gauge Note: It is mandatory to conduct at least 12 experiments.			

Course code.	Course Name	L-T-P - Credits	Year of Introduction
ME236	Machine shop	0-0-3-1	2016
Prerequisite: ME220 Manufacturing Technology			
Course Objectives - To acquaint with the basic operations of lathe, shaping, slotting, grinding and milling machines. - To conduct the exercise involving plane turning, groove cutting, taper turning, facing, thread cutting, gear cutting and grinding operations.			
List of exercises - Demonstration of construction and operations of general purpose machines :– lathe, drilling machine, milling machine, shaper, planing machine, slotting machine, cylindrical grinder, surface grinder, and tool and cutter grinder. - Plane turning and Step turning on lathe. - Groove turning (cup and ball) and taper turning on lathe. - Thread cutting and knurling operations on lathe. - Exercise on machining flat surfaces, grooving keyways using shaping machines. - Machining of V –block using shaper machines. - Machining grooves and key slots using slotting machine. - Experiment on drilling machines –drilling and boring operations. - Reaming, counter sinking and tapping operations using drilling machines. - Experiment on milling machine – Plane milling, keyway cutting, and cutting of splines. - Experiment on vertical milling. - Cutting of spur gear on milling machine. - Grinding of plane surface using surface grinding machine. - Cylindrical grinding using cylindrical grinding machine.			
Expected outcome. The students will be able to - operate different machine tools using proper work holders - produce different part features to the desired quality.			
Text Books: - R.K. Jain, Production Technology, Khanna Publishers. - HMT, Production Technology, Tata McGraw Hill. - Chapman, Workshop Technology Vol II, ELBS. - S.K. Hajra Choudhury, Workshop Technology Vol II, Media Promoters & Publishers.			

Course code	Course Name:	L-T-P-Credits	Year of Introduction
ME237	WELDING AND MACHINE TOOLS LAB	0-0-3-1	2016
Prerequisite: Nil			
Course Objectives: • Provide practical experience on various machining operations using Lathe. • Familiarization with basics of welding. • Provide practical experience in carrying out welding.			
List of Exercises/ Experiments (Minimum 10 are mandatory)			
(a). Machine Tools: 1. Study of Precision Tools and Measuring Instruments. <u>Equipment:</u> Vernier Calliper, Micrometer, Surface Plate, Surface Gauge, Slip Gauge, Screw Pitch Gauge, Feeler Gauge, Dial Gauge, Sine Gauge, Plug Gauge, Straight edge Gauge. 2. Study of Nomenclature of Single Point Cutting Tool. <u>Equipment:</u> HSS Single point cutting tool. 3. Study of Centre Lathe. <u>Equipment:</u> Centre Lathe.			
To perform following lathe operations on a work piece for given dimensions :			
4. Plane Turning. <u>Equipment:</u> HSS Single point cutting tool (V-tool), Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, and Vernier calliper. 5. Step Turning. <u>Equipment:</u> HSS Single point cutting tool (V-tool), Parting tool, Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, and Vernier calliper. 6. Grooving. <u>Equipment:</u> HSS Single point cutting tool (V-tool), Parting tool, Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, and Vernier calliper. 7. Taper Turning. <u>Equipment:</u> HSS Single point cutting tool (V-tool), Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, Vernier calliper and double end spanner. 8. Thread Cutting. <u>Equipment:</u> HSS Single point cutting tool (V-tool), Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, Vernier calliper Centre gauge and thread pitch gauge.			

(b) Welding:

9. Study of Welding Equipment and Procedures.

Equipment: MMAW, MIG, TIG, SAW.

10. To study various types of welding joints and practice edge preparation.

Equipment: Butt joint, Lap joint, T-Joint, Corner joint, Workpiece, File/Grinder, Wirebrush.

11. To Prepare a Single V-Butt Joint using Arc Welding Process.

Equipment: Arc welding machine, Mild steel work pieces, Mild steel Electrodes, Electrode holder, Ground clamp, Flat nose tong, Face shield, Apron, Hand gloves, work table, Bench vice, Rough flat file, steel rule, wire brush, Try square, Bell peen hammer, chipping hammer, chisel, grinding machine.

12. To Prepare a Lap Joint using Arc Welding Process.

Equipment: Arc Welding Machine, Mild Steel Work Pieces, Mild Steel Electrodes, Electrode Holder, Ground Clamp, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

13. To Prepare a T Joint using Arc Welding Process

Equipment: Arc Welding Machine, Mild Steel Work Pieces, Mild Steel Electrodes, Electrode Holder, Ground Clamp, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

14. To prepare a Butt Joint Using TIG Welding Process.

Equipment: TIG Welding Machine, Welding Cable With Earth Clamps, Gas Cooled TIG Welding Torch, Inert Argon Gas Hose Pipe, Tungsten Rod, Flow Meter, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Ball Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

15. To prepare a Lap Joint Using TIG Welding Process.

Equipment: TIG Welding Machine, Welding Cable With Earth Clamps, Gas Cooled TIG Welding Torch, Inert Argon Gas Hose Pipe, Tungsten Rod, Flow Meter, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

16. To Prepare a Butt Joint using MIG Welding Process.

Equipment: MIG Welding Machine, Welding Cable With Earth Clamps, MIG Welding Torch, CO₂ Gas Flow Meter with Preheater, Contact Tips, Input Gas Hose Pipes, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

17. To Prepare a Lap Joint using MIG Welding Process.

Equipment: MIG Welding Machine, Welding Cable With Earth Clamps, MIG Welding Torch,

CO₂ Gas Flow Meter With Preheater, Contact Tips, Input Gas Hose Pipes, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

18. To Prepare a T Joint using MIG Welding Process.

Equipment: *MIG Welding Machine, Welding Cable With Earth Clamps, MIG Welding Torch, CO₂ Gas Flow Meter With Preheater, Contact Tips, Input Gas Hose Pipes, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.*

19. Demonstration of Submerged Arc Welding Process.

Equipment: *Power Source, Welding Head Trolley, Welding Clamp With Earth Clamp, Welding Cable With Earth Lug, Control Cable, Track, Contact Tip, Contact Pole, Flux Hose, Flux Hopper .*

Expected Outcome:

After successful completion of the course, the student will be able to:

- i. Machine the given specimen to required dimension using Lathe.
- ii. Demonstrate the principle of operation of MMAW, TIG, MIG & SAW.
- iii. Prepare specified type of joint using various welding processes.

Text Book(s):

1. O.P Khanna; Welding Technology; Dhanpat Rai Publications.
2. Acharkan. N.; Machine Tool Design Vol. 1 to 4, MIR Publication.
3. Chapman; Workshop Technology, Vol II, ELBS.



Course code	Course Name:	L-T-P-Credits	Year of Introduction
ME238	ADVANCED MACHINE TOOLS LAB	0-0-3-1	2016
Prerequisite: Nil			
Course Objectives: • Introduction to various Machining process. • To familiarization with the fundamentals of CNC Machine. • To introduce the student to CNC operations.			
List of Exercises/ Experiments (Minimum 10 are mandatory) 1. Bolt Making on Lathe Machine <i>Equipment: Cutting Saw, Center Lathe, Pedestal Grinder, HSS Tool Bit And Straight Or Right Hand Tool Holder, Center Drill, Live Center, Stock and Die, Metal Work Vice.</i> 2. Study of Drilling Machines. <i>Equipment: Radial Drilling Machine.</i> 3. Study of Nomenclature of Drill Bit. <i>Equipment: Drill Bit.</i> 4. To Drill the Given Work Piece as Required. <i>Equipment: Mild Steel Work Piece, Drill Bit, Lot Drill Bit, Drill Chuck.</i> 5. Study of Shaping Machines. <i>Equipment: Shaper Machine.</i> 6. To Perform V- Machining on the Given Work Piece. <i>Equipment: Shaper Machine, Punching Machine, Steel Rule, Hammer, Shaper Tool, Try Square.</i> 7. To Perform U-Cut on the Given Work Piece. <i>Equipment: Shaper machine, Steel rule, Hammer, Shaper tool, Try Square.</i> 8. Study of Slotting Machines <i>Equipment: Slotter.</i> 9. To make a Slot on the Given Work Piece. <i>Equipment: Slotting Machine, Steel rule, Hammer, Shaper tool, Try Square.</i> 10. To Cut External Key Way Using Slotter. <i>Equipment: Slotting Machine, Steel Rule, Hammer, Shaper Tool, Try Square.</i> 11. Study of Milling Machines. <i>Equipment: Milling Machine.</i>			

12. To Perform Plane Milling Operation on the Given Specimen.

Equipment: Milling Machine, Work Piece, Steel Ruler.

13. To Make Spur Gear on a Given Work Piece.

Equipment: Steel Rule, Milling Cutter, Spanner, Mandrel, Dog Carrier.

14. To make Bevel Gear on a Work Piece.

Equipment: Steel Rule, Milling Cutter, Spanner, Mandrel, Dog Carrier.

15. Study and Demonstration of CNC Machine.

Equipment: CNC Machine.

16. To Program and Run Milling Operation Using CNC Machine.

Equipment: CNC Machine, Computer.

17. To Program and Execute Turning Operation Using CNC Lathe.

Equipment: CNC Machine, Computer.

18. Study of Cutting Process.

Equipment: Variety of Cutting Equipment.

19. Study of CNC Plasma Arc Cutting (working principle and procedure only).

Course Outcome:

Upon successful completion of the course, the student will be able to :

- i. Machine the given work piece to specified dimensions.
- ii. Understand the fundamentals of CNC machining.

Text Book(s):

- Chapman; Workshop Technology, Vol II; ELBS.
- HMT; Production Technology; Tata McGraw Hill.
- Yoram Koren; Numerical Control of Machine Tools; McGraw-Hill.
- Acharkan. N.; Machine Tool Design Vol. 1 to 4; MIR Publication.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME301	MECHANICS OF MACHINERY	3-1-0-4	2016
Prerequisite : Nil			
Course Objectives To provide knowledge on kinematics of selected mechanisms, design of cams, theory and analysis of gears, gear trains and synthesis of mechanisms.			
Syllabus Introduction to kinematics and mechanisms - different mechanisms, displacement, velocity, and acceleration analysis. Cam and followers - displacement, velocity, and acceleration analysis, cam profile synthesis. Gears – law of gearing, interference, gear trains, applications. Kinematic synthesis - dimensional synthesis, graphical synthesis, position synthesis, analytical synthesis, case study.			
Expected outcome . The students will be able to solve practical problems related to kinematics of mechanisms			
Text Books: 1. Ballaney P. L., Theory of Machines and Mechanisms, Khanna Publishers,2005 2. S. S. Rattan, Theory of Machines, Tata Mc Graw Hill,2009			
References: 1. C. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education,2005 2. D. H. Myszka, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education,2013 3. G. Erdman, G. N. Sandor, Mechanism Design: Analysis and synthesis Vol I & II, Prentice Hall of India,1984. 4. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press,1988 5. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,2010			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to kinematics and mechanisms - various mechanisms, kinematic diagrams, degree of freedom- Grashof's criterion, inversions, coupler curves	3	15%
	straight line mechanisms exact, approximate – Ackerman Steering Mechanism - Hooke's joint - Geneva mechanism - mechanical advantage, transmission angle	4	
	Displacement, velocity and acceleration analysis - relative motion - relative velocity - instant centre -Kennedy's theorem	4	
II	Relative acceleration - Coriolis acceleration - graphical and analytical methods – complex number methods - computer oriented methods.	4	15%
	Cams - classification of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion	4	
FIRST INTERNAL EXAMINATION			
III	Graphical cam profile synthesis, pressure angle	2	15%

	Analysis of tangent cam with roller follower and circular cam with flat follower	6	
	Introduction to polynomial cams.	2	
IV	Gears – terminology of spur gears – law of Gearing - involute spur gears involutometry - contact ratio - interference - backlash - gear standardization - interchangeability	4	15%
	Non-standard gears, centre distance modification, long and short addendum system. - internal gears - theory and details of bevel, helical and worm gearing	4	
SECOND INTERNAL EXAMINATION			
V	Gear trains - simple and compound gear trains - planetary gear trains – differential -solution of planetary gear train problems - applications	5	20%
	Kinematic synthesis (planar mechanisms) - tasks of kinematic synthesis – type, number and dimensional synthesis – precision points	4	
VI	Graphical synthesis for motion - path and prescribed timing - function generator	3	20%
	2 position and 3 position synthesis – overlay Method	3	
	Analytical synthesis techniques, Freudenstein's equation – complex number methods - one case study in synthesis of mechanism.	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME302	Heat and Mass Transfer	3-1-0-4	2016
Prerequisites : ME203 Mechanics of fluid			
Course Objectives: - To introduce the various modes of heat transfer and to develop methodologies for solving a wide variety of practical heat transfer problems - To provide useful information concerning the performance and design of simple heat transfer systems - To introduce mass transfer			
Syllabus: Modes of Heat Transfer: Conduction: Most general heat conduction equation, One dimensional steady state conduction with and without heat generation, Critical radius of insulation, Elementary ideas of hydrodynamics and thermal boundary layers, Convection heat transfer: Newton's law of cooling, Dimensionless numbers, Dimensional analysis, Problems. Fins: Types of fins : Fin efficiency and effectiveness. Boiling and condensation heat transfer, Introduction to heat pipe. Transient heat conduction. Heat exchangers, LMTD and NTU methods. Radiation: laws of radiation, Electrical analogy, Radiation shields. Mass Transfer :Mass transfer by molecular diffusion, Convective mass transfer.			
Expected outcome: The students will be able to 1. Apply principles of heat and mass transfer to engineering problems 2. Analyse and obtain solutions to problems involving various modes of heat transfer 3. Design heat transfer systems such as heat exchangers, fins, radiation shields etc..			
Text Books: 1. Sachdeva R C, Fundamentals of Engineering Heat and Mass Transfer, New Age Science Limited, 2009 2. R.K.Rajput. Heat and mass transfer, S.Chand& Co.,2015 3. Nag P K., Heat and Mass Transfer, McGraw Hill,2011 4. Kothandaraman, C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 2006			
Data Book: Heat and Mass Transfer data book: C.P. Kothandaraman, S. Subramanya, New age International publishers,2014			
References Books: 1. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill,2015 2. Holman J P, Heat Transfer, McGraw Hill, 2011 3. Frank P. Incropera and David P. Dewitt, Heat and Mass Transfer, John Wiley and sons, 2011			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Modes of Heat Transfer: Conduction: Fourier law of heat conduction-Thermal conductivity of solids, liquids and gases-Factors affecting thermal conductivity- Most general heat conduction equation in Cartesian, cylindrical and spherical coordinates One dimensional steady state conduction with and without heat generation conduction through plane walls, cylinders and spheres-variable thermal conductivity conduction shape factor- heat transfer through corners and edges. Critical radius of insulation.	12	15%
II	Elementary ideas of hydrodynamics and thermal boundary layers-Thickness of Boundary layer-Displacement, Momentum and Energy thickness (description only). Convection heat transfer: Newton's law of cooling- Laminar and Turbulent flow, Reynolds Number, Critical Reynolds Number, Prandtl Number, Nusselt Number, Grashoff Number and Rayleigh's Number. Dimensional analysis Buckingham's Pi theorem- Application of dimensional analysis to free and forced convection- empirical relations- problems using empirical relations	10	15%
FIRST INTERNAL EXAMINATION EXAM			
III	Transient heat conduction-lumped heat capacity method. Fins: Types of fins - Heat transfer from fins of uniform cross sectional area- Fin efficiency and effectiveness. Boiling and condensation heat transfer(elementary ideas only),Introduction to heat pipe.	8	15%
IV	Combined conduction and convection heat transfer-Overall heat transfer coefficient - Heat exchangers: Types of heat exchangers, AMTD, Fouling factor, Analysis of Heat exchangers- LMTD method, Correction factor, Effectiveness-NTU method, Special type of heat exchangers (condenser and evaporator, simple problems only)	8	15%
SECOND INTERNAL EXAMINATION			
V	Radiation- Nature of thermal radiation-definitions and concepts- monochromatic and total emissive power-Intensity of radiation- solid angle- absorptivity, reflectivity and transmissivity-Concept of black body- Planck's law- Kirchoff's law- Wein's displacement law-Stefan Boltzmann's law- black, gray and real surfaces-Configuration factor (derivation for simple geometries only)- Electrical analogy- Heat exchange between black/gray surfaces- infinite parallel plates, equal and parallel opposite plates-perpendicular rectangles having common edge- parallel discs (simple problems using charts and tables). Radiation shields(no derivation).	10	20%

VI	Mass Transfer :Mass transfer by molecular diffusion- Fick's law of diffusion- diffusion coefficient Steady state diffusion of gases and liquids through solid- equimolar diffusion, Isothermal evaporation of water through air- simple problems. Convective mass transfer- Evaluation of mass transfer coefficient- empirical relations- simple problems- analogy between heat and mass transfer.	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Use of approved data book permitted

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

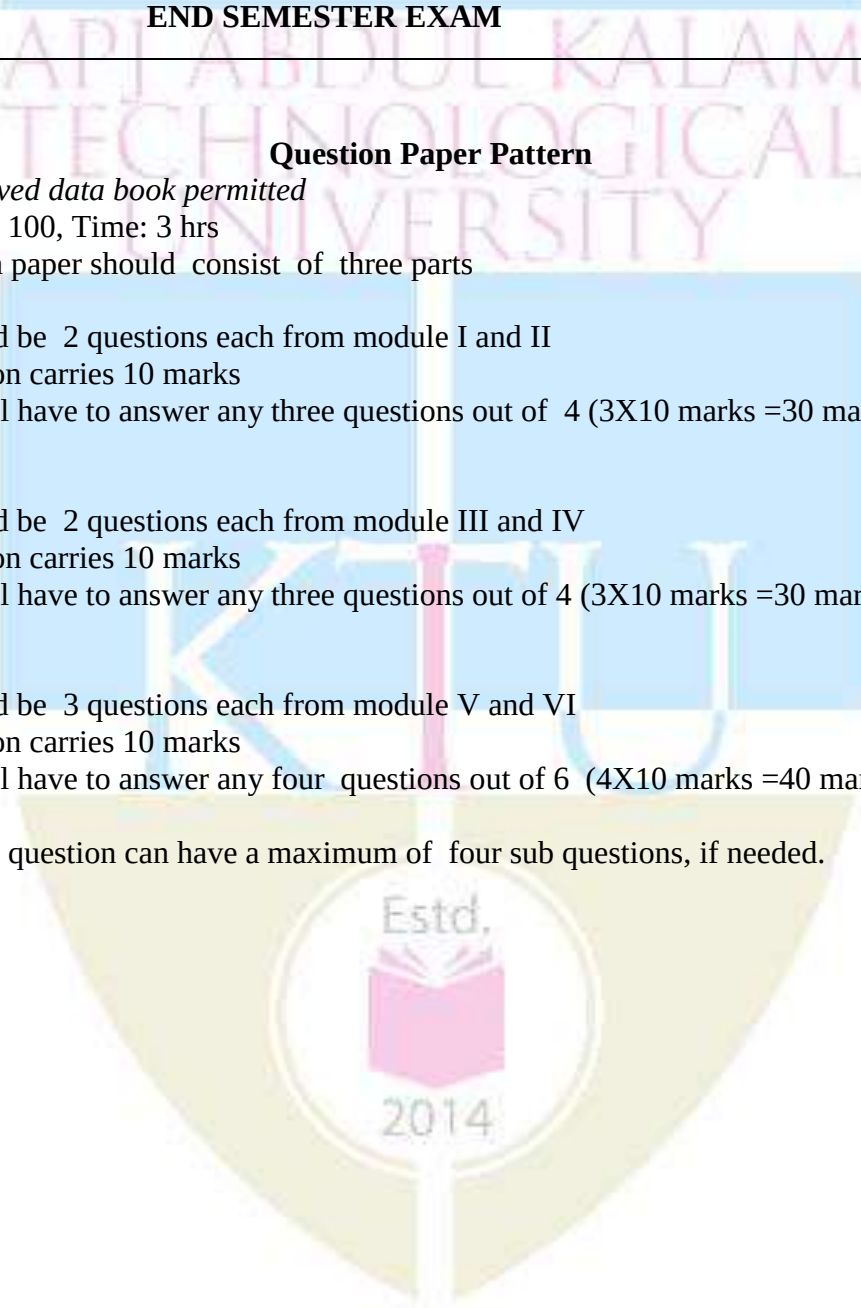
Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
ME303	MACHINE TOOLS AND DIGITAL MANUFACTURING	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives: The main objectives of this course are 1. To introduce students to the scientific principles underlying material behavior during manufacturing processes so as to enable them to undertake calculations of forces, tool stresses and material removal rates. 2. To understand various machine tools such as lathe, drilling machine, reciprocating machines etc. and their operations. 3. To impart knowledge of appropriate parameters to be used for various machining operations. 4. To develop knowledge on the importance of milling grinding and super finishing in metal cutting process. 5. To introduce the fundamentals of digital manufacturing.			
Syllabus Introduction to metal cutting, Mechanism of metal removal, Merchant's theory, Frictional forces in metal cutting, Thermal aspects of machining, General purpose machine tools, Principle and operation of lathe, Drilling machines, Reciprocating machines, Milling machines, Grinding machines, Super finishing operations, Semi-automatic machine tools, Single and multi-spindle machines, Introduction to digital manufacturing and digital manufacturing science.			
Expected outcomes: The students will be able to 1. Analyze various machining process and calculate relevant quantities such as velocities, forces and powers. 2. Identify and explain the function of the basic components of a machine tool. 3. Understand the limitations of various machining process with regard to shape formation and surface texture. 4. Apply cutting mechanics to metal machining based on cutting force and power consumption. 5. Understand the use of various machine tools and their fields of application. 6. Understand the principle and applications of grinding and super finishing operations. 7. Get a basic knowledge on the importance of digital manufacturing.			
Text books 1. Chapman W. A. J., Workshop Technology, Viva books (P) Ltd, 1988 2. HMT, Production Technology, Tata McGraw-Hill, 2001 3. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012			

Reference books

1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication, 2000
2. Chernov, Machine Tools, MIR Publication, 1984
3. Ghosh A. And Malic A. K., Manufacturing Science, East West Press, 2010
4. Hajra Choudary, Elements of workshop technology, Vol I & II, Media Publishers, 2010
5. Lihui Wang and Andrew Yeh Ching Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009
6. Malkin Stephen, Grinding Technology: Theory and Applications of Machining with Abrasives, Industrial press, 2008
7. Poul De Garmo, J.T.Black, R.A.Kosher, Materials and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., 1997.

Course Plan

Course Plan			
Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to metal cutting: Tool nomenclature – Attributes of each tool nomenclature – Attributes of feed and tool nomenclature on surface roughness obtainable	1	15%
	Orthogonal and oblique cutting - Mechanism of metal removal – Primary and secondary deformation shear zones	1	
	Mechanism of chip formation – Types of chips, need and types of chip breakers – Merchant’s theory	1	
	Analysis of cutting forces in orthogonal cutting– Work done, power required (simple problems)	1	
	Friction forces in metal cutting – development of cutting tool materials	1	
	Thermal aspects of machining -Tool wear and wear mechanisms	1	
	Factors affecting tool life– Economics of machining (simple problems) Cutting fluids	1 1	
II	General purpose machine tools – Principle and operation of lathe – Types of lathes and size specification	1	15%
	Work holding parts of lathes and their functions – Main operations	1	
	Taper turning and thread cutting – Attachments	1	
	Feeding mechanisms, Apron mechanisms	1	
	Drilling Machines – Types – Work holding devices	1	
	Tool holding devices – Drill machine operations	1	
	Drilling machine tools – Twist drill nomenclature- cutting forces in drilling.	1	
FIRST INTERNAL EXAMINATION			
III	Reciprocating machines: Shaping machines – Types – Size – Principal parts – Mechanism	1	15%
	Work holding devices – Operations performed – Tools	1	

	Cutting speed, feed and depth of cut – Machining time.	1	
	Slotting machines – Types – Size – Principal parts – Mechanism – Work holding devices	1	
	Operations performed – Tools – Cutting speed, feed and depth of cut	1	
	Planing machines – Types – Size – Principal parts – Mechanism – Work holding devices	1	
	Operations performed – Tools – Cutting speed, feed and depth of cut – Machining time- Surface roughness obtainable.	1	
IV	Milling machines – Types – Principal parts – Milling mechanism	1	15%
	Work holding devices – Milling machine attachments	1	
	Types of milling cutters – Elements of plain milling cutters	1	
	Nomenclature - Cutting forces in milling – Milling cutter materials	1	
	Up milling, down milling and face milling operations	1	
	Calculation of machining time	1	
	Indexing – Simple indexing – Differential indexing	1	
SECOND INTERNAL EXAMINATION			
V	Grinding machines – Classification – Operations – Surface, cylindrical and centreless grinding	1	20%
	Grinding mechanisms – Grinding wheels: Specification – types of abrasives, grain size	1	
	Types of bond, grade, structure – Marking system of grinding wheels – Selection of grinding wheels	1	
	Glazing and loading of wheels – Dressing and Truing of grinding wheels, surface roughness obtainable	1	
	Superfinishing operations: Lapping operation– Types of hand lapping – Lapping machines – Types of honing –Methods of honing	1	
	Types of honing stones – Honing conditions – Cutting fluids – Types of broaches – Force required for broaching – Surface roughness obtainable in lapping, honing and broaching operations.	1	
	Semi-automatic machine tools – Turret and capstan lathes. Automatic machine tools – Single and multi-spindle machines.	1	
VI	Introduction to Digital Manufacturing: Concepts and research and development status of digital manufacturing	1	20%
	Definition of digital manufacturing – Features and development of digital manufacturing.	1	
	Theory system of digital manufacturing science: Operation Mode and Architecture of Digital Manufacturing System	1	
	Operation reference mode of digital manufacturing system – Architecture of digital manufacturing system	1	
	Modeling theory and method of digital manufacturing science	1	
	Critical modeling theories and technologies of digital manufacturing science	1	
	Theory system of digital manufacturing science – Basic	1	

	architecture model of digital manufacturing system.		
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME304	DYNAMICS OF MACHINERY	2-1-0-3	2016
Prerequisite: ME301 Mechanics of Machinery			
Course Objectives: - To impart knowledge on force analysis of machinery, balancing of rotating and reciprocating masses, Gyroscopes, Energy fluctuation in Machines. - To introduce the fundamentals in vibration, vibration analysis of single degree of freedom systems. - To understand the physical significance and design of vibration systems with desired conditions			
Syllabus Force analysis of machinery - static and dynamic force analysis of plane motion mechanisms. Flywheel analysis - static and dynamic balancing - balancing of rotating masses, gyroscopic couples. Vibrations – free vibrations of single degree freedom systems, damping, forced vibration, torsional vibration.			
Expected outcome: The students will be able to - Develop the design and practical problem solving skills in the area of mechanisms - Understand the basics of vibration and apply the concepts in design problems of mechanisms.			
Text Books: - Ballaney P.L. Theory of Machines, Khanna Publishers,1994 S. S. Rattan, Theory of Machines, Tata McGraw Hill, 2009 V. P. Singh, Theory of Machines, Dhanpat Rai,2013			
References : E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education, 2003 - Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press, 2003 H. Myszka, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education, 4e, 2012 - Holowenko, Dynamics of Machinery, John Wiley, 1995 J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,1995 - W.T.Thompson, Theory of vibration, Prentice Hall,1997			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to force analysis in mechanisms - static force analysis (four bar linkages only) - graphical methods	4	15%
	Matrix methods - method of virtual work - analysis with sliding and pin friction	3	
II	Dynamic force analysis: Inertia force and inertia torque. D'Alemberts principle, analysis of mechanisms (four bar linkages only), equivalent dynamical systems	4	15%
	Force Analysis of spur- helical - bevel and worm gearing	3	
FIRST INTERNAL EXAM			
III	Flywheel analysis - balancing - static and dynamic balancing - balancing of masses rotating in several planes	4	15%
	Balancing of reciprocating masses - balancing of multi-cylinder in line engines - V engines - balancing of machines	3	
IV	Gyroscope – gyroscopic couples	3	15%
	Gyroscopic action on vehicles-two wheelers, four wheelers, air planes and ships. Stability of an automobile – stability of a two wheel vehicle –Stabilization of ship.	4	
SECOND INTERNAL EXAM			
V	Introduction to vibrations – free vibrations of single degree freedom systems – energy Method	2	20%
	Undamped and damped free vibrations – viscous damping – critical damping - logarithmic decrement - Coulomb damping – harmonically excited vibrations	3	
	Response of an undamped and damped system – beat phenomenon - transmissibility	2	
VI	Whirling of shafts – critical speed - free torsional vibrations – self excitation and stability analysis - vibration control - vibration isolation – vibration absorbers	4	20%
	Introduction to multi-degree freedom systems - vibration measurement - accelerometer – seismometer – vibration exciters	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME305	COMPUTER PROGRAMMING & NUMERICAL METHODS	2-0-1-3	2016
Prerequisite: Nil			
Course Objectives: - To equip students with fundamentals of computer programming - To provide fundamental idea about the use of computer programming and numerical methods for analyzing the basic engineering problems.			
Syllabus Introduction to computer programming concept, control statements, basics pointers, Introduction to Class and Object, Errors and approximations, curve fitting, Solution of Partial differential equations, Numerical problems and preparation of computer programs.			
Expected outcomes: The students will be able to write computer programs for numerical solutions for engineering problems like system of equations and heat equations..			
Text Books - Balagurusamy, Computer Programming 1e McGraw Hill Education , 2013 - Balagurusamy, Numerical Methods 1e McGraw Hill Education, 1999 - Jose S., Computer Programming and Numerical Methods, Pentagon, 2015. - Ravichandran D., Programming with C++, Tata McGraw Hill, 2007.			
Reference Books - Balaguruswamy E., Object Oriented Programming with C++, Tata McGraw Hill, 1992. - Barkakati N., Object Oriented Programming in C++, SAMS, 1991. - Gerald C. F. and P. O. Wheatley, Applied Numerical Analysis, Pearson, 2004. - Kamthane A. M., Object Oriented Programming with ANSI & Turbo C++, - Lippman S. B. and J. Lajoie, C++ Primer, Pearson Education, 2005. - Pearson Education, 2009.			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Computer programming concept –internal representation of data - Algorithm and flow chart, Basics of procedure oriented and object oriented programming. Introduction to C++: Structure of C++ program; Keywords; Identifiers; Data types – integer, real, character, string, boolean, enumeration, Constant and Variables; Operators – assignment, arithmetic, relational, logical, increment, decrement and conditional operators; Statements – simple & compound, declaration statements. Input and output streams.	5	15%
II	Control statements: if , if-else , switch , for , while , do-while , break and continue statements, Arrays – one dimensional & two dimensional; Functions: inline functions, function over loading, Functions with default arguments, recursion.	7	15%
FIRST INTERNAL EXAM			

III	Basics of Pointers. Function call by value, call by reference. Preparation of programs for evaluation of Factorial of a number, infinite series, Sorting, Searching and Matrix multiplication.	8	15%
IV	Introduction to Class and Object- definition, data members, member function. private & public member functions, member access, friend declaration, class objects, predefined classes, initialization. Inheritance- base class and derived class. Simple programs using the above features. (No programming questions for University examination and internals)	7	15%
SECOND INTERNAL EXAM			
V	Errors and approximations, sources of errors. Solution of linear system of equations: Gauss elimination, Gauss-Jordan and Gauss-Seidel methods. Interpolation: Lagrange and Aitken techniques.	7	20%
VI	Curve fitting: method of least squares, non-linear relationships, Linear correlation, measures of correlation. Solution of Partial differential equations: classification, Laplace equation, Finite difference method. Numerical problems and preparation of computer programs for the above methods	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME306	ADVANCED MANUFACTURING TECHNOLOGY	3-0-0-3	2016
Pre requisite: ME 220 Manufacturing Technology, ME303 Machine Tools and Digital Manufacturing			
Course Objectives 1. To introduce machining principles and processes in the manufacturing of precision components and products that use conventional and nonconventional technologies. 2. To give basic understanding of the machining capabilities, limitations, and productivity of advanced manufacturing processes. 3. To describe how PLC's operate and how they control automated equipment and systems 4. To demonstrate tool path simulations with CNC powered equipment 5. To introduce CNC programming			
Syllabus:- Powder Metallurgy- Programmable Logic Controllers- CNC- non-traditional and micro machining process - high velocity forming of metals-material additional process.			
Expected outcome: The students will be able to i. Become conversant with the non- traditional machining process and to appreciate the effect of process parameters on the surface integrity aspects during the non- traditional machining process. ii. Appreciate the use of an EDM as a non traditional method of machining complex and hard materials. iii. Prescribe a laser materials processing technique suitable for a given product with material, size, precision, and surface quality requirements. iv. Program and operate a CNC mill and lathe. v. Select the tool material and machining process parameters.			
Text books/References 1. ASTME, High velocity forming of metals, PHI, 1968. 2. Davies K and Austin E.R, Developments in high speed metal forming, the machinery publishing Co, 1970. 3. Ibrahim Zeid, R Sivasubrahmanian CAD/CAM: Theory & Practice, McGraw Hill Education, 2009 4. Jain V.K., Introduction to Micromachining, Narosa publishers, 2014 5. M.P. Groover, E.M. Zimmers, Jr. CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987 6. Petruzella Frank.D., Programmable logic controllers, McGraw Hill, 2016 7. Yoram Koren, Computer control of manufacturing systems, TMH, 2006			

Course Plan			
Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction: Need and comparison between traditional, non-traditional and micro & nano machining process.	1	15%
	Powder Metallurgy: Need of P/M - Powder Production methods:- Atomization, electrolysis, Reduction of oxides, Carbonyls (Process parameters, characteristics of powder produced in each method).	1	
	Powder characteristics: properties of fine powder, size, size distribution, shape, compressibility, purity etc.	1	
	Mixing – Compaction:- techniques, pressure distribution, HIP & CIP.	1	
	Mechanism of sintering, driving force for pore shirking, solid and liquid phase sintering - Impregnation and Infiltration Advantages, disadvantages and specific applications of P/M.	1	
	Programmable Logic Controllers (PLC): need – relays - logic ladder program –timers, simple problems only.	1	
	Point to point, straight cut and contouring positioning - incremental and absolute systems – open loop and closed loop systems - control loops in contouring systems: principle of operation.	1	
II	DDA integrator:-Principle of operation, exponential deceleration –liner, circular and complete interpolator.	1	15%
	NC part programming: part programming fundamentals - manual programming –	1	
	NC coordinate systems and axes — sequence number, preparatory functions, dimension words, speed word, feed world, tool world, miscellaneous functions –	1	
	Computer aided part programming:– CNC languages – APT language structure: geometry commands, motion	1	
	commands, postprocessor commands, compilation control commands	1	
	Programming exercises: simple problems on turning and drilling etc - machining centers- 5 axis machining (At least one programming exercise must be included in the end semester University examination).	2	
	FIRST INTERNAL EXAMINATION		

III	Electric Discharge Machining (EDM):- Mechanism of metal removal, dielectric fluid, spark generation, recast layer and attributes of process characteristics on MRR, accuracy, HAZ etc, Wire EDM, applications and accessories.	3	15%
	Ultrasonic Machining (USM) :-mechanics of cutting, effects of parameters on amplitude, frequency of vibration, grain diameter, slurry, tool material attributes and hardness of work material, applications.	2	
	Electro chemical machining (ECM):- Mechanism of metal removal attributes of process characteristics on MRR, accuracy, surface roughness etc, application and limitations.	1	
IV	Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma arc Machining (PAM), Ion beam Machining(IBM) - Mechanism of metal removal, attributes of process characteristics on MRR, accuracy etc and structure of HAZ compared with conventional process; application, comparative study of advantages and limitations of each process.	3	15%
	Abrasive Jet Machining (AJM), Abrasive Water Jet Machining (AWJM) - Working principle, Mechanism of metal removal, Influence of process parameters, Applications, Advantages & disadvantages.	3	
	SECOND INTERNAL EXAMINATION		
V	High velocity forming of metals:-effects of high speeds on the stress strain relationship steel, aluminum, Copper – comparison of conventional and high velocity forming methods- deformation velocity, material behavior, stain distribution.	3	20%
	Stress waves and deformation in solids – types of elastic body waves- relation at free boundaries- relative particle velocity.	2	
	Sheet metal forming: - explosive forming:-process variable, properties of explosively formed parts, etc.	2	
	Electro hydraulic forming: - theory, process variables, etc, comparison with explosive forming.	1	
V1	Micromachining: Diamond turn mechanism, material removal mechanism, applications.	1	20%
	Advanced finishing processes: - Abrasive Flow Machining, Magnetic Abrasive Finishing.	2	
	Magnetorheological Abrasive Flow Finishing, Magnetic Float Polishing, Elastic Emission Machining.	3	
	Material addition process:- stereo-lithography, selective laser sintering, 3D Printing, fused deposition modeling, laminated object manufacturing, , laser engineered net-shaping, laser welding, LIGA process.	2	

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

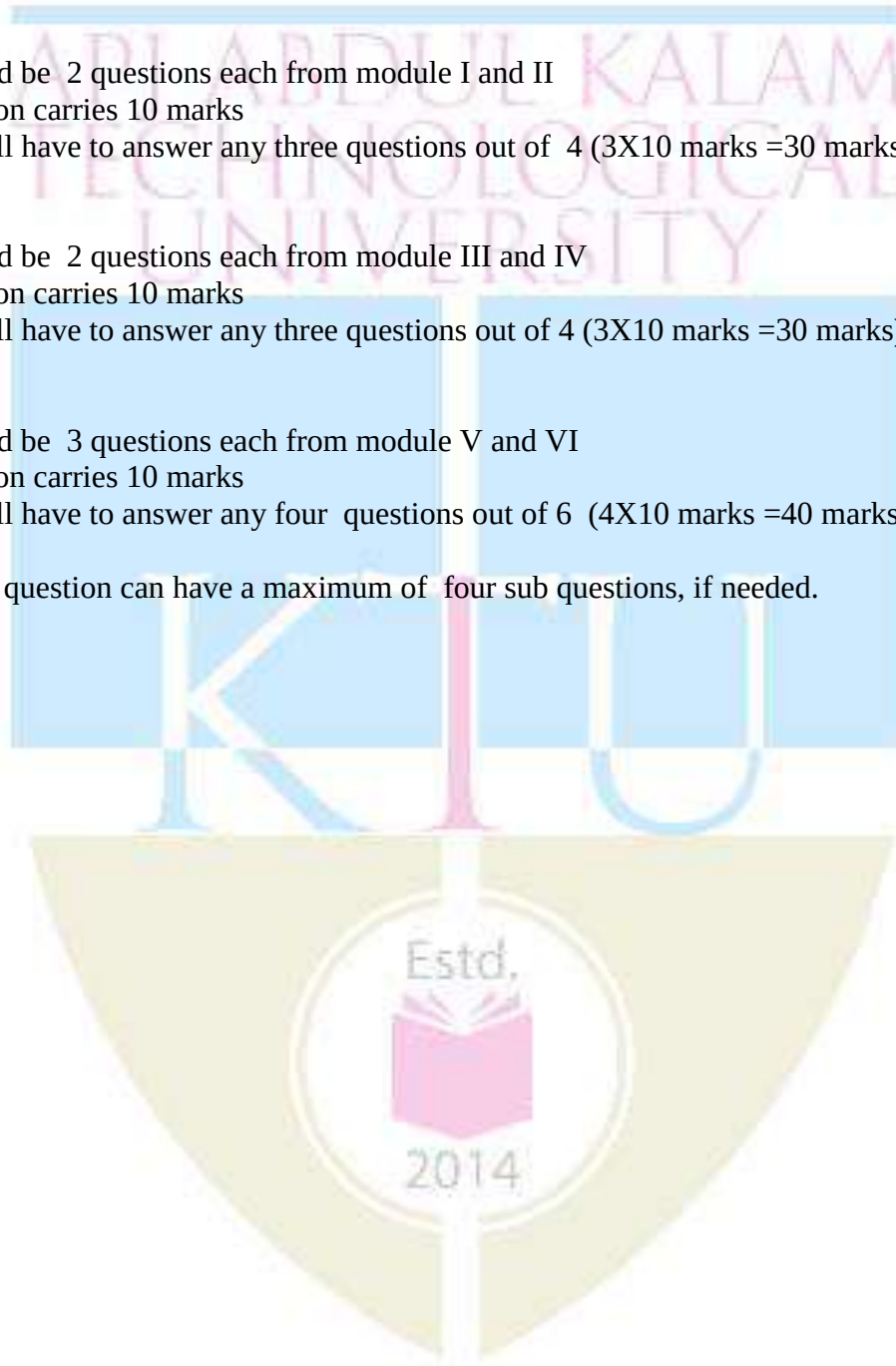
Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P – Credits	Year of Introduction
ME307	MACHINE DESIGN - I	3-1-0-4	2016
Prerequisite : Nil			
Course Objectives To understand the basic components and layout of linkages in the assembly of a system/machine.			
Syllabus Introduction to design of riveted, threaded, and welded joints – springs and design –Design laws – stresses in components and machines.			
Expected outcome. The students will become aware of the machine components, forces, stresses affecting them and the aspects of designing them.			
Text Books: - R L Norton, Kinematics and Dynamics of Machinery, 1st ed., Tata McGraw Hill Education Private Limited, Delhi, 2004 - S .S Rattan Theory of Machines, 3rd ed., Tata McGraw Hill Education Private Limited, Delhi, 2009			
References: J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, Oxford University Press, 2016 A. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press, 3e, 2006 C. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, 3rd edition, Pearson Education, 2003 - Holowenko, Dynamics of Machinery, John Wiley & Sons, 1995			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law –Kinematic inversions of four-bar chain, slider crank chains and double slider crank chains – Limit positions –Mechanical advantage – Transmission Angle -Coupler curves – Description of some common Mechanisms – Quick return mechanisms, Straight line generators	10	15%
II	Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method – Velocity and acceleration polygons Force analysis of machinery - static and dynamic force analysis of plane motion mechanisms - graphical method - principle of superposition –matrix methods - method of virtual work.	10	15%
FIRST INTERNAL EXAMINATION			
III	Governors: - terminology and classification ; Watt, Porter, Proel, Hartnell, Hartung, quality of governors,inertia governors- governor speed control Gyroscope: - Principle-Angular acceleration-Effect of gyroscopic	8	15%

	couple airplanes, and ships, stability of automobile and two wheel vehicles, Rigid disc at an angle fixed to a rotating shaft		
IV	Turning moment diagram and Flywheel: - coefficient of fluctuation of energy and speed- energy saved in a flywheel- force analysis, piston effort-crankpin effort- crank effort-turning moment diagrams for I.C. engines.	8	15%
SECOND INTERNAL EXAMINATION			
V	Cams and Followers: - types-follower motion-SHM-uniform velocity and acceleration- Cycloidal - displacement, velocity and acceleration curves-Cam profile-Reciprocating and oscillating followers-Tangent cams-Convex and concave cams with footed followers. Introduction to Polynomial cams. (Numerical problems)	10	20%
VI	Law of toothed gearing – Involute and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting Gear trains – Speed ratio, train value – Parallel axis gear trains– Epicyclic Gear Trains (Numerical problems)	10	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks :100

Exam Duration: 3 Hours

PART A

4 Questions uniformly covering modules 1 and 2. Each question carries 10 marks. Students will have to answer any three questions out of four. (3X10=30 marks)

PART B

4 Questions uniformly covering modules 3 and 4. Each question carries 10 marks. Students will have to answer any three questions out of four. (3X10=30 marks)

PART C

6 Questions uniformly covering modules 5 and 6. Each question carries 10 marks. Students will have to answer any four questions out of six. (4X10=40 marks)

Note: Each question can have maximum of 4 sub questions (a, b, c, d)

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME308	COMPUTER AIDED DESIGN AND ANALYSIS	3-0-0-3	2016
Prerequisite: ME201 Mechanics of solids			
Course Objectives: 1. To impart basic knowledge on Computer Aided Design methods and procedures 2. To introduce the fundamentals of solid modelling 3. To introduce the concepts of finite element analysis procedures.			
Syllabus Introduction to CAD/CAM, Basics of geometric and solid modeling, transformation, representation points, lines, surfaces and solid models. Introduction to finite element analysis, solution procedures, interpolation, isoparametric formulation, applications.			
Expected outcome: The students will be able to 1. Gain a basic knowledge on Computer Aided Design methods and procedures 2. Understand the fundamentals of solid modelling 3. Have a basic knowledge in finite element analysis procedures.			
Text Books: 1. M.P. Groover, E.M. Zimmers, Jr. CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987 2. T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2001			
References: 1. Chris McMahon and Jimmie Browne - CAD/CAM – Principle Practice and Manufacturing Management, Addison Wesley England, 1998 2. D. F. Rogers and J. A. Adams, Mathematical Elements in Computer Graphics, McGraw-Hill, 1990 3. Daryl Logan, A First course in Finite Element Method, Thomson Learning, 2007 4. David V Hutton, Fundamentals of Finite Element Analysis, THM, 2003 5. Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with open GL, Pearson Education, 2001 6. Grigore Burdea, Philippe Coiffet, Virtual Reality Technology, John Wiley and sons, 2003 7. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill, 2007 8. P. Radhakrishnan and S. Subramanyan, CAD / CAM / CIM, New Age Int. Ltd., 2008			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to CAD , Historical developments, Industrial look at CAD, Comparison of CAD with traditional designing, Application of computers in Design	2	15%
	Basics of geometric and solid modeling, Packages for CAD/CAM/CAE/CAPP	1	
	Hardware in CAD components, user interaction devices, design database, graphic Standards, data Exchange Formats, virtual Reality.	4	
II	Transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling.	4	15%
	Shearing,rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects.	3	
FIRST INTERNAL EXAM			
III	Algebraic and geometric forms, tangents and normal, blending functions, reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves.	4	15%
	Plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, bezier surface, B-spline surfaces and their modeling techniques.	3	
IV	Solid models and representation scheme, boundary representation, constructive solid geometry.	3	15%
	Sweep representation, cell decomposition, spatial occupancy enumeration, coordinate systems for solid modeling.	4	
SECOND INTERNAL EXAM			
V	Introduction to finite element analysis - steps involved in FEM-Preprocessing phase – discretisation - types of elements	2	20%
	Formulation of stiffness matrix (direct method, 1-D element) - formulation of load vector - assembly of global equations - implementation of boundary conditions - solution procedure - post processing phase	3	
	Simple problems with axial bar element (structural problems only)	2	
VI	Interpolation – selection of interpolation functions - CST element - isoparametric formulation (using minimum PE theorem) – Gauss-quadrature	4	20%

	Solution of 2D plane stress solid mechanics problems (linear static analysis)	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

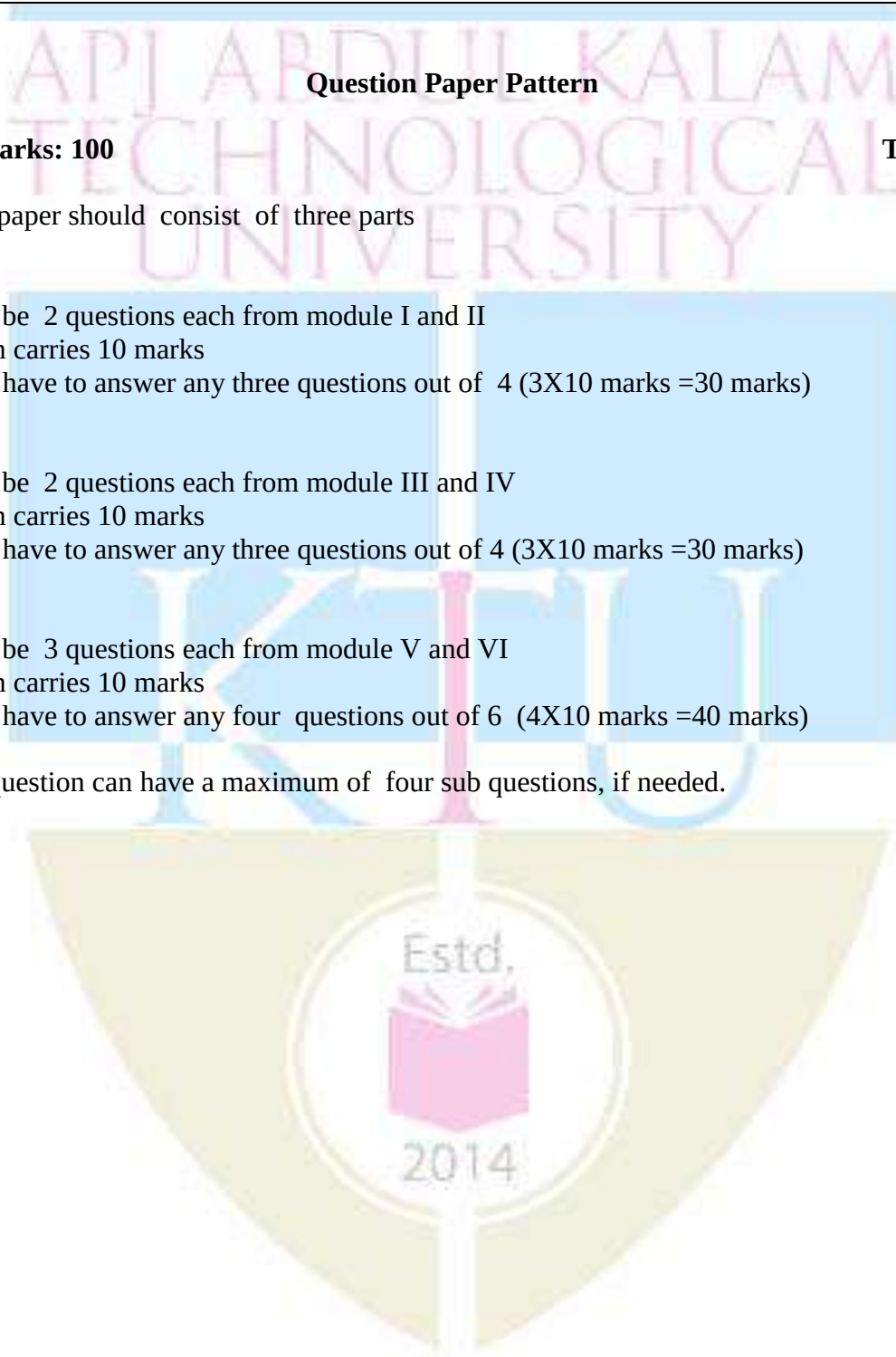
Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
ME309	METALLURGY AND MATERIALS SCIENCE	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: - To provide physical concepts of atomic radius, atomic structure, chemical bonds, crystalline and non-crystalline materials and defects of crystal structures, grain size, strengthening mechanisms, heat treatment of metals with mechanical properties and changes in structure - To make aware of the behavior of materials in engineering applications and select the materials for various engineering applications. - To understand the causes behind metal failure and deformation - To determine properties of unknown materials and develop an awareness to apply this knowledge in material design			
Syllabus Chemical bonds – crystallography- imperfections- crystallization- diffusion- phase diagrams-heat treatment – strengthening mechanisms- hot and cold working – alloying- ferrous and non ferrous alloys- fatigue-creep- basics, need, properties and applications of modern engineering materials.			
Expected outcome: The students will be able to - Identify the crystal structures of metallic materials. - Analyze the binary phase diagrams of alloys Fe-Fe₃C, etc. - Correlate the microstructure with properties, processing and performance of metals. - Recognize the failure of metals with structural change. - Select materials for design and construction. - Apply core concepts in materials science to solve engineering problems.			
Text Books - Jose S and Mathew E V, Metallurgy and Materials Science, Pentagon, 2011 - Raghavan V, Material Science and Engineering, Prentice Hall,2004			
References - Anderson J.C. <i>et.al.</i>, Material Science for Engineers, Chapman and Hall,1990 - Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill, 2009 - Callister William. D., Material Science and Engineering, John Wiley, 2014 - Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964 - Dieter George E, Mechanical Metallurgy, Tata McGraw Hill,1976 - Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998 - Myers Marc and Krishna Kumar Chawla, Mechanical behaviour of materials, Cambridge University press,2008 - Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning, 2009 - Van Vlack -Elements of Material Science - Addison Wesley,1989 http://nptel.ac.in/courses/113106032/1 http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2 http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/syllabus/ http://www.msm.cam.ac.uk/teaching/partIA.php			

COURSE PLAN			
Module	Contents	Hours	End Sem. Exam Marks
I	Earlier and present development of atomic structure; attributes of ionization energy and conductivity, electronegativity and alloying; correlation of atomic radius to strength; electron configurations; electronic repulsion Primary bonds: - characteristics of covalent, ionic and metallic bond: attributes of bond energy, cohesive force, density, directional and non-directional and ductility, properties based on atomic bonding:- attributes of deeper, energy well and shallow energy well to melting, temperature, coefficient of thermal expansion - attributes of modulus of elasticity in metal cutting process – Secondary bonds:- classification- hydrogen bond and anomalous behavior of ice float on water, application- atomic mass unit and specific heat, application. <i>(brief review only, no University questions and internal assessment from these portions.)</i>	2	15%
	Crystallography:- Crystal, space lattice, unit cell- BCC, FCC, HCP structures - short and long range order – effects of crystalline and amorphous structure on mechanical properties.	1	
	Coordination number and radius ratio; theoretical density; simple problems - Polymorphism and allotropy.	1	
	Miller Indices: - crystal plane and direction (brief review) - Attributes of miller indices for slip system, brittleness of BCC, HCP and ductility of FCC - Modes of plastic deformation: - Slip and twinning.	1	
	Schmid's law, equation, critical resolved shear stress, correlation of slip system with plastic deformation in metals and applications.	1	
II	Mechanism of crystallization: Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity.	1	15%
	Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems	1	
	Classification of crystal imperfections: - types of dislocation – effect of point defects on mechanical properties - forest of dislocation, role of surface defects on crack initiation.	1	
	Burgers vector –dislocation source, significance of Frank Read source in metals deformation - Correlation of dislocation density with strength and nano concept, applications.	1	
	Significance high and low angle grain boundaries on dislocation – driving force for grain growth and applications during heat treatment.	1	
	Polishing and etching to determine the microstructure and grain size.	1	
	Fundamentals and crystal structure determination by X – ray diffraction, simple problems –SEM and TEM.	1	
	Diffusion in solids, Fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.	1	
FIRST INTERNAL EXAMINATION			

III	Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery's rule - equilibrium diagram of common types of binary systems: five types.	2	15%
	Coring - lever rule and Gibb's phase rule - Reactions: monotectic, eutectic, eutectoid, peritectic, peritectoid.	1	
	Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties changes in austenite, ledeburite, ferrite, cementite, special features of martensite, transformation, bainite, spheroidite etc.	1	
	Heat treatment: - Definition and necessity – TTT for eutectoid iron-carbon alloy, CCT diagram, applications - annealing, normalizing, hardening, spheroidizing.	1	
	Tempering:- austempering, martempering and ausforming- Comparative study on ductility and strength with structure of pearlite, bainite, spheroidite, martensite, tempered martensite and ausforming.	1	
	Hardenability, Jominy end quench test, applications- Surface hardening methods:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes-change in surface composition methods :carburizing and Nitriding; applications.	2	
IV	Types of Strengthening mechanisms: - work hardening, equation - precipitation strengthening and over ageing- Dispersion hardening.	1	15%
	Cold working: Detailed discussion on strain hardening; recovery; recrystallization, effect of stored energy; re-crystallization temperature - hot working, Bauschinger effect and attributes in metal forming.	1	
	Alloy steels:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties	1	
	Nickel steels, Chromium steels etc. - Enhancement of steel properties by adding alloying elements: Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead.	1	
	High speed steels:- Mo and W types, effect of different alloying elements in HSS	1	
	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, Microstructure, properties and applications.	1	
	Principal Non ferrous Alloys: - Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.	1	
SECOND INTERNAL EXAMINATION			
V	Fatigue: - Stress cycles – Primary and secondary stress raisers - Characteristics of fatigue failure, fatigue tests, S-N curve.	1	20%
	Factors affecting fatigue strength: stress concentration, size effect, surface roughness, change in surface properties, surface residual stress.	1	

	Ways to improve fatigue life – effect of temperature on fatigue, thermal fatigue and its applications in metal cutting	1	
	Fracture: – Brittle and ductile fracture – Griffith theory of brittle fracture – Stress concentration, stress raiser – Effect of plastic deformation on crack propagation.	1	
	Transgranular, intergranular fracture - Effect of impact loading on ductile material and its application in forging, applications - Mechanism of fatigue failure.	1	
	Structural features of fatigue: - crack initiation, growth, propagation - Fracture toughness (definition only) – Ductile to brittle transition temperature (DBTT) in steels and structural changes during DBTT, applications.	1	
VI	Creep: - Creep curves – creep tests - Structural change: deformation by slip, sub-grain formation, grain boundary sliding	1	20%
	Mechanism of creep deformation - threshold for creep, prevention against creep - Super plasticity: need and applications	1	
	Composites:- Need of development of composites - geometrical and spatial Characteristics of particles – classification - fiber phase: - characteristics, classifications -composites:- Need of development of composites -	2	
	Modern engineering materials: - only fundamentals, need, properties and applications of, intermetallics, maraging steel, super alloys, Titanium – introduction to nuclear materials, smart materials and bio materials.	2	
	Ceramics:-coordination number and radius ratios- AX, AmXp, AmBmXp type structures – applications.	1	
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN

Maximum Marks : 100

Exam Duration: 3 Hrs

PART A

4 Questions uniformly covering modules 1 and 2. Each question carries 10 marks. Students will have to answer any three questions out of four. (3X10=30 marks)

PART B

4 Questions uniformly covering modules 3 and 4. Each question carries 10 marks. Students will have to answer any three questions out of four. (3X10=30 marks)

PART C

6 Questions uniformly covering modules 5 and 6. Each question carries 10 marks. Students will have to answer any four questions out of six. (4X10=40 marks)

Note: In all parts, each question can have a maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P – Credits	Year of Introduction
ME311	MANUFACTURING PROCESSES	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives To introduce the different types of manufacturing processes used to create different forms of metals/alloys/composites.			
Syllabus Introduction to material casting processes - welding process and the physics of welding - mathematical/ physical description of forming processes – rolling and types – forging processes – advanced manufacturing – non-traditional machining – design for manufacturing			
Expected outcome. The students will become aware of the types of processes used for the manufacturing the parts of automobile.			
Text Books: - Helmi A Youssef, Hassan A El-Hofy and Mahmoud H Ahmed, Manufacturing Technology (materials, processes and equipments) , CRC Press, 2017 - Kalapakjian and Schmid , Manufacturing Engineering and Technology, Pearson, 7e, 2013			
References: - Hine and Rosenthal, Principles of Metal Casting , Tata McGraw Hill India, 1995 - P.R.Beeley, Foundry Technology, Butterworths Publication, 1972			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Casting of metallic materials – introduction – expendable mold casting processes – sand casting, shell, vacuum, slurry, plaster and ceramic molding, expandable pattern casting – permanent mold castings – die and centrifugal casting – melting furnaces – cupolas and crucible furnace –cleaning and finishing of castings – quality of castings – defects & method of inspection of defects	7	15%
II	Bulk forming of metallic materials – Classification – Forging processes – open die, close die, special forging processes – forging equipment and defects Rolling processes – flat, section, tube , and special rolling processes and rolling defects – Extrusion – classification – equipment & defects Drawing – rod, wire and tube – classification and drawing die	7	15%
FIRST INTERNAL EXAMINATION			
III	Sheet metal forming processes – Classification – Shearing processes and mechanism – Bending processes – parameters – springback and residual stresses – bending equipment – stretch forming – Deep drawing – blank holding pressure, ironing, deep drawing force, redrawing – hydroforming – spinning –	8	15%

	conventional, flow tunneling and tube spinning.		
IV	Joining processes – Fusion welding – gas, thermit, electric arc, resistance and high energy beam welding – Solid state welding – cold, diffusion, explosion, forge, friction, hot pressure, roll, and ultrasonic welding – Solid-liquid state welding – brazing, soldering and adhesive bonding – welding of plastics – metallurgy of welded joints – welding defects – quality control – destructive and non-destructive tests – mechanical joining.	8	15%
SECOND INTERNAL EXAMINATION			
V	Non-traditional machining – Jet machining – abrasive, water jet, and abrasive water jet – ultrasonic machining – USM equipment and process capabilities – Chemical milling & photochemical machining - ECM – elements, equipment and process capabilities – electrochemical grinding – EDM – sinking, milling and wire cutting – EBM – LBM – plasma arc cutting	8	20%
VI	Advanced manufacturing techniques – near net shape manufacturing – metal injection molding and rapid prototyping – microfabrication technology – microcutting, microfinishing, and nonconventional micromachining – application of nano technology – sustainable and green manufacturing. Manufacturing process capabilities – process selection factors – process information maps – ranking strategy – design for manufacturing – casting, sheet metal forming, die forging, welding, and assembly.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100

Exam Duration: 3 Hrs

PART A

4 Questions uniformly covering modules 1 and 2. Each question carries 10 marks. Students will have to answer any three questions out of four. (3X10=30 marks)

PART B

4 Questions uniformly covering modules 3 and 4. Each question carries 10 marks. Students will have to answer any three questions out of four. (3X10=30 marks)

PART C

6 Questions uniformly covering modules 5 and 6. Each question carries 10 marks. Students will have to answer any four questions out of six. (4X10=40 marks)

Note: In all parts, each question can have a maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME312	METROLOGY AND INSTRUMENTATION	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives: - To understand the working of linear and angular measuring instruments. - To familiarize with the working of optical measuring instruments and fundamentals of limits and limit gauges. - To give basic idea about various methods for measurement of screw thread and surface finish parameters. - To give an exposure to advanced measuring devices and machine tool metrology. - To provide students an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement. - To provide basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.			
Syllabus Introduction to Metrology - Errors in Measurement- Basic standards of length - Linear Measurement, Comparators - Angular Measurement - Limits and Limit gauges - Optical Measuring Instruments - Screw thread measurement - Measurement of surface texture - Machine tool metrology - Coordinate Measuring Machine (CMM) and Machine Vision. Introduction to Mechanical Measurement - Motion and Dimension measurement, Strain and Stress Measurement - Measurement of Force, Torque and Temperature Measurement.			
Expected outcome: The students will be able to - Understand the working of linear and angular measuring instruments. - Know the fundamentals of limits and limit gauges, various methods for measurement of screw thread and surface roughness parameters and the working of optical measuring instruments. - Get an exposure to advanced measuring devices and machine tool metrology. - Acquire an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement. - Get basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.			
Text books - Anand K Bewoor, Vinay A Kulkarni, Metrology & Measurement, McGraw-Hill, 2009 - Ernest O. Doebelin, Dhanesh N. Manik, Measurement Systems Application and Design, McGraw-Hill, 2004 - Galyer J.F.W., Schotbolt C.R., Metrology for Engineers, ELBS, 1990 - Thomas G. Beckwith, John H. L., Roy D. M., Mechanical Measurements, 6/E, Pearson Prentice Hall, 2007			

Reference books

1. ASME, Hand book of Industrial Metrology,1998
2. Hume K. J., Engineering Metrology, Macdonald &Co. Ltd.,1990
3. J.P.Holman, Experimental Methods for Engineers,Mcgraw-Hill, 2007
4. Sharp K.W.B., Practical Engineering Metrology, Sir Isaac Pitman & Sons Ltd.,1958

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Concept of measurement:-Introduction to Metrology; Need for high precision measurements; Terminologies in Measurement-Precision, accuracy, sensitivity, calibration.	1	15%
	Errors in Measurement, types of errors, Abbe’s Principle.	1	
	Basic standards of length- Line standard, End standards, Wavelength standard; Various Shop floor standards.	1	
	Linear Measurement – Slip gauges, wringing, grades; Surface plate; Dial indicators; Height gauges and Vernier calipers.	1	
	Comparators- mechanical, electrical, optical and pneumatic.	1	
	Angular Measurement – Bevel protractor; Sine Bar, principle and use of sine bar, sine centre; Angle gauges.	1	
	Sprit level; Angle Dekkor; Clinometers.	1	
II	Limits and Limit gauges – Making to suit, selective assembly, systems of limits and fits; Types of fits; Hole basis system and Shaft basis system.	1	15%
	Standard systems of limits and fits; Shaft and Hole system; Tolerance, allowance and deviation (as per BIS).	1	
	Simple problems on tolerance and allowance, shaft and hole system.	1	
	Limit Gauges – GO and NO GO gauges; types of limit gauges.	1	
	Gauge design - Taylor’s principle of gauging; Gauge tolerance, disposition of gauge tolerance, wear allowance.	1	
	Optical Measuring Instruments: - Benefits of using light waves as standards; Monochromatic light; Principle of Interference.	1	
	Interference band using optical flat, application in surface measurement.	1	
	Interferometers – NPL flatness interferometer, Pitter-NPL gauge interferometer.	1	
FIRST INTERNAL EXAMINATION			
	Screw thread measurement – Screw thread terminology; Measurement of major diameter; Measurement of minor or root diameter.	1	
	Measurement of pitch; Measurement of effective diameter with two wire method and three wire method.	1	
	Measurement of flank angle and form by profile projector and	1	

III	microscope.		15%
	Measurement of surface texture – Meaning of surface texture, roughness and waviness; Analysis of surface traces, peak to valley height, R.M.S. value, Centre Line Average and R _a value, R _t , R _z etc.	1	
	Methods of measuring surface roughness – Stylus probe, Tomlinson surface meter, Talysurf; Terms used in surface roughness measurement – assessment length, roughness width cut-off, sampling length and evaluation length.	1	
	Interference method for measuring surface roughness – using optical flat and interferometers.	1	
	Autocollimator, principle and use of autocollimator.	1	
IV	Machine tool metrology – Alignment testing of machine tools like lathe, milling machine, drilling machine.	1	15%
	Advanced measuring devices – Laser interferometers.	1	
	Coordinate Measuring Machine (CMM) – Introduction to CMM; Components and construction of CMM.	1	
	Types of CMM; Advantages and application of CMM	1	
	CMM probes, types of probes – contact probes and non contact probes	1	
	Machine Vision – Introduction to machine vision, functions, applications and advantages of machine vision.	1	
	Steps in machine vision	1	
SECOND INTERNAL EXAMINATION			
V	Introduction to Mechanical Measurement – significance of mechanical measurement; Fundamental methods of measurement; Classification of measuring instrument.	1	20%
	Stages in generalized measuring system – Sensor-Transducer stage, Signal-Conditioning stage, Readout-Recording stage; Types of input quantities; Active and Passive transducers.	1	
	Performance characteristic of measuring devices – Static characteristics – Accuracy, Precision, Repeatability, Sensitivity, Reproducibility, Drift, Resolution, Threshold, Hysteresis, Static calibration.	1	
	Dynamic characteristics- different order systems and their response-, Measuring lag, Fidelity, Dynamic error; Types of errors in measurement.	1	
	Transducers – Working, Classification of transducers.	1	
	Motion and Dimension measurement – LVDT – Principle, applications, advantages and limitations.	1	
VI	Strain and Stress Measurement - Electrical resistance strain gauge - Principle, operation.	1	
	Measurement of Force and Torque – Strain-Gauge Load Cells, Hydraulic and Pneumatic load cells – basic principle and three component force measurement using piezoelectric quartz crystal.	1	
	Torque Measurement – Dynamometers – Mechanical, Hydraulic and Electrical.	1	
	Vibration measurement – Vibrometers and Accelerometers – Basic principles and operation.	1	

	Temperature Measurement – Use of Thermal Expansion – Liquid-in-glass thermometers, Bimetallic strip thermometer, Pressure thermometers.	1	20%
	Thermocouples – Principle, application laws for Thermocouples, Thermocouple materials and construction, measurement of Thermocouple EMF.	1	
	Resistance Temperature Detectors (RTD); Thermistors; Pyrometers (Basic Principles).	1	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P – Credits	Year of Introduction
ME314	MACHINE DESIGN - II	3-0-0-3	2016
Prerequisite : ME307 Machine design - II			
Course Objectives To introduce the design considerations needed for different types of machine components and			
Syllabus Introduction to design of different types of bearings, clutches, brakes – IC engine parts design – Design recommendations			
Expected outcome. The students will become aware of the machine components, forces, stresses affecting them and aspects of designing them.			
Text Books: - C.S,Sarma, KamleshPurohit, Design of Machine Elements Prentice Hall of India Ltd NewDelhi M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 8e, 2003 T. Krishna Rao, Design of machine Elements volume 2 I K International Publishing House Pvt. Ltd New Delhi, 2011 - V.B.Bhandari, Design of Machine Elements McGraw Hill Book Company, 4e, 2016			
Data book (permitted for reference in the University examination) K. Lingaiah , Machine Design Data hand book, Suma Publishers, Bangalore/ Tata McGraw Hill			
References: - Doughtie V.L., &Vallance A.V., Design of Machine Elements, McGraw Hill Book Company, 1964 J. E. Shigley, Mechanical Engineering Design, McGraw Hill Book Company, 5e, 1986 - Juvinall R.C &Marshak K.M., Fundamentals of Machine Component Design, John Wiley, 5e, 2011 - Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Classification of design - Different phases in design process - design factors and considerations Engineering materials and their physical properties as applied to design - Selection of materials - Factors of safety in design – Endurance limit of materials- theories of failure - Guest's theory - Rankine's theory - St. Venant's theory - Haigh's theory - Von Mises&Hencky theory - shock and impact loads - fatigue loading - endurance limit stress- Factors affecting endurance limit - Factor of safety - creep and thermal stresses	8	15%
II	Design of shafts on the basis of strength - Design of shaft on the basis of rigidity - Design of hollow shafts -design for static and fatigue loads- repeated loading- reversed bending Design of welded joints- Representation of welds - stresses in fillet and butt welds- design for static loads - bending and torsion in welded	7	15%

	joints- eccentrically loaded welds - design of welds for variable loads.		
FIRST INTERNAL EXAMINATION			
III	Clutches - friction clutches- design considerations-multiple disc clutches-cone clutch- centrifugal clutch Brakes- Classification, internal expanding shoe brake, disc brake Spring- Design of leaf spring, coil spring , torsion bar	6	15%
IV	Design of bearings - Types - Selection of a bearing type - bearing life - Rolling contact bearings – static and dynamic load capacity - axial and radial loads - selection of bearings - dynamic equivalent load - lubrication and lubricants – viscosity Journal bearings - hydrodynamic theory - design considerations - heat balance - bearing characteristic number - hydrostatic bearings.	6	15%
SECOND INTERNAL EXAMINATION			
V	Gears- classification- Gear nomenclature - Tooth profiles - Materials of gears - design of spur, helical, bevel gears and worm & worm wheel - Law of gearing - virtual or formative number of teeth- gear tooth failures- Beam strength - Lewis equation- Buckingham's equation for dynamic load	8	20%
VI	Design of Internal Combustion Engine parts- Piston, Cylinder, Connecting rod, Crank shaft, Flywheel & valves	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100

Exam Duration: 3 Hrs

PART A

3 Questions uniformly covering modules 1 and 2. Each question carries 15 marks. Students will have to answer any two questions out of four. (2X15=30 marks)

PART B

3 Questions uniformly covering modules 3 and 4. Each question carries 15 marks. Students will have to answer any two questions out of four. (2X15=30 marks)

PART C

3 Questions uniformly covering modules 5 and 6. Each question carries 20 marks. Students will have to answer any two questions out of four. (2X20=40 marks)

Note: Each question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P – Credits	Year of Introduction
ME318	MACHINE DESIGN	3-1-0-4	2016
Prerequisite : NIL			
Course Objectives - To familiarize with the design of machine elements subjected to static and dynamic loading. - To impart the design procedure for joints and fasteners			
Syllabus Engineering design, different type of loading, safety consideration, theories of failures, fatigue failure, limit, fits and tolerance, ergonomics in design. Design of joints, riveted, welded, design of fasteners. Design of springs. Design of shaft- key ways- couplings – rigid and flexible. Design of bearing, journal bearing, hydrostatic, dynamic bearings with the theory of lubrication- life rating of bearing. Analysis of structures – optimisation - Finite element approach for simple structural problem			
Expected outcome. At the end of the course the students will be able to - Design simple components, joints and fasteners - Select bearings for supporting rotating parts - Apply finite element modeling for design analysis			
Text Book: V B Bhandari, Design of Machine Elements, Tata McGraw Hill, 2012.			
Data Book : PSG Design Data, DPV Printers, Coimbatore, 2012			
References: - Robert L Norton Machine Design-An integrated Approach, Pearson, 2002 - C S Sharma, Kamallesh Purohit, Design of Machine Elements, PHI Learning Pvt. Ltd, 2009 - Shigly J.E., Mechanical Engineering Design, McGraw Hill, 2003 - M.F Spotts, Design of Machine Elements, Prentice Hall India Pvt. Limited, 6e, 1991 - Doughter & Valance, Design of Machine Elements, McGraw Hill publishers - Johnson, Optimum Design of Mechanical Elements, John Wiley & Sons, 1980			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam Marks
I	Engineering design, different type of loading, safety consideration, theories of failures, fatigue failure, limit, fits and tolerances, ergonomics in design	9	15%
II	Design of joints- riveted & welded joints - stresses in welded joints - strength of welded joints - fatigue loading of welded joints - design of	8	15%

	bolts and screws		
FIRST INTERNAL EXAMINATION			
III	Design of springs - Mechanical springs - design of helical springs - helical torsion spring - critical frequency of helical springs - energy storage capacity - common types of leaf springs	8	15%
IV	Design of shaft- - stresses in shafts - equivalent twisting and bending moments - effect of keyways - transmission shafts - determination of shaft size for strength - design of shafts for deflection - critical speeds for shafts - operating speeds - shafts subjected to steady and alternating loads. Key ways- couplings – Couplings - rigid and flexible coupling - common types of keys, pins and retainers and their applications	9	15%
SECOND INTERNAL EXAMINATION			
V	Design of bearings, journal bearing, hydrostatic, dynamic bearings - the theory of lubrication- life rating of bearings	7	20%
VI	Analysis of structures – optimisation - Finite element approach for simple structural problem- modelling - elements selection – meshing	9	20%

Question paper pattern

Use of approved data book permitted

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 3 questions from module I and II and at least 1 question from each module

Each question carries 15 marks

Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part B

There should be 3 questions from module III and IV and at least 1 question from each module

Each question carries 15 marks

Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part C

There should be 3 questions from module V and VI and at least 1 question from each module

Each question carries 20 marks

Students will have to answer any 2 questions out of 3 (2X20 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME322	HEAT TRANSFER	2-1-0-3	2016
Prerequisite : Nil			
Course Objectives To introduce the concepts of heat transfer to enable the students to design components subjected to thermal loading.			
Syllabus One dimensional steady state heat conduction - Extended Surfaces- Unsteady state heat Conduction - Free convection- Forced convection – Radiation heat transfer – Heat exchangers – condensers - evaporators – boiling heat transfer – heat transfer in gas turbine combustion chamber – ablative heat transfer – aerodynamic heating – moving boundary problems.			
Expected Outcome The students will - Get idea about basic modes of Heat transfer. - Be able to solve practical heat transfer problems. - Be able to analyse heat exchangers.			
Text Books: - S.C. Sachdeva, “Fundamentals of Engineering Heat & Mass Transfer”, Wiley Eastern Ltd., New Delhi, 1981. - Yunus A. Cengel, Heat Transfer – A Practical Approach, Tata McGraw Hill Edition, 2003.			
Data Book (Approved for use in the examination) C P Kothandaraman and S Subramanyan, Heat and Mass Transfer Databook, New Age International, 2014			
References: - C.Y.Chow, “Introduction to Computational Fluid Dynamics”, John Wiley, 1979. - J.P. Holman, “Heat Transfer”, McGraw-Hill Book Co., Inc., New York, 6e, 1991. - John D. Anderson, JR” Computational Fluid Dynamics”, McGraw-Hill Book Co., Inc., New York, 1995. - John H. Lienhard, “A Heat Transfer Text Book”, Prentice Hall Inc., 1981. P. S. Ghoshdasidar , “Computer simulation of low and Heat transfer” McGraw-Hill Book Co, Inc, NewDelhi, 1998. - T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Basic Modes of Heat Transfer – One dimensional steady state heat conduction: Composite Medium – Critical thickness.	2	15%

	Effect of variation of thermal Conductivity – Extended Surfaces – Unsteady state.	2	
	Heat Conduction: Lumped System Analysis, Heat Transfer in Semi-infinite and infinite solids,	3	
	Use of Transient, Temperature charts	2	
II	Introduction, Free convection in atmosphere free convection on a vertical flat plate – Empirical relation in free convection.	2	15%
	Forced convection.	2	
	Laminar and turbulent convective heat transfer analysis in flows between parallel plates, over a flat plate and in a circular pipe.	2	
	Empirical relations, application of numerical techniques in problem solving.	3	
FIRST INTERNAL EXAM			
III	Introduction to Physical mechanism of radiation heat transfer	1	15%
	Radiation properties – Radiation shape factors.	2	
	Heat exchange between non – black bodies.	2	
	Radiation shields.	1	
IV	Heat exchangers-Classification.	1	15%
	Temperature Distribution – Overall heat transfer coefficient.	2	
	Heat Exchange Analysis – LMTD Method.	3	
	Heat Exchange Analysis –E-NTU Method.		
SECOND INTERNAL EXAM			
V	Special heat exchangers-condensers.	1	20%
	Special heat exchangers- evaporators.	1	
	Condensation heat transfer.	1	
	Boiling heat transfer phenomenon,boiling co- relations.	2	
VI	Heat transfer in gas turbine combustion chamber (descriptive only)	2	20%
	Ablative heat transfer.	1	
	Aerodynamic heating-Moving boundary problems.	1	
	Numerical treatment.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME331	MANUFACTURING TECHNOLOGY LABORATORY – I	0-0-3-1	2016
Prerequisite: ME220 Manufacturing Technology			
Course Objectives: 1. To practice on machine tools and identify, manipulate and control various process parameters during machining processes in manufacturing industry. 2. To practice arc and gas welding technologies. 3. To gain knowledge on the structure, properties, treatment, testing and applications of Steel, Cast Iron and Brass.			
List of Exercises/Experiments :			
Centre Lathe Study of lathe tools: - tool materials - selection of tool for different operations - tool nomenclature and attributes of each tool angles on cutting processes – effect of nose radius, side cutting edge angle, end cutting edge angle and feed on surface roughness obtainable – tool grinding. • Study the different methods used to observe how the work-piece is precisely fixed on lathe. • Study the optimum aspect ratio of work-piece to avoid vibration and wobbling during turning. • Machine tool alignment of test on the lathe. • Re-sharpening of turning tool to specific geometry			
1. Exercises on centre lathe:- Facing, plain turning, step turning and parting – groove cutting, knurling and chamfering - form turning and taper turning – eccentric turning, multi-start thread, square thread and internal thread etc.			
2. Exercises on lathe: - Measurement of cutting forces in turning process and correlation of the surface roughness obtainable by varying feed, speed and feed.			
3. Measurement of cutting temperature and tool life in turning and machine tool alignment test on lathe machine.			
4. Exercises on Drilling machine- drilling, boring, reaming, tapping and counter sinking etc.			
5. Exercises on drilling machine: - Measurement of cutting forces in drilling process and correlate with varying input parameters.			
6. Exercises on Shaping machine Exercises on shaping machine: - flat surfaces, grooves and key ways.			
7. Exercises on Slotting machine Exercises on slotting machine: - flat surfaces, grooves and key ways.			
Exercises on Milling machine 8. Exercises on milling machine: - face milling, end milling – spur and helical gear cutting – milling of keyways etc. 9. Exercises on milling machine: - Measurement of cutting forces in milling process and			

correlate the surface roughness obtainable by varying input parameters. 10 Machine tool alignment test on milling machine
Planing and Broaching machine 11. Study and demonstration of broaching machine. 12. Exercises on planing machine
Exercises on Welding 13. Exercises on arc and gas welding: - butt welding and lap welding of M.S. sheets.
Exercises on Grinding machine 14. Exercise on surface grinding, cylindrical grinding and tool grinding etc. 15. Measurement of cutting forces and roughness in grinding process and correlate with varying input parameters.
Metallurgy 16. Specimen preparation, etching & microscopic study of Steel, Cast iron and Brass and Grain size measurement.
17. Heat treatment study: –Effect on mechanical properties and microstructure of Steel, Cast Iron and Brass.
18. Studies of various quenching mediums, Carryout heat treatments on steel based on ASM handbook vol.4 and observe the hardness obtained.
A minimum of 12 experiments are mandatory out of total 18 experiments but all the experiments mentioned in metallurgy are mandatory. Besides to the skill development in performing the work, oral examination should be conducted during end semester examination. The student's assessment, continuous evaluation, awarding of sessional marks, oral examination etc. should be carried out by the assistant professor or above.
Expected outcomes: The students will be able to 1. Identify various process parameters and their influence on surface properties of various metals. 2. Recommend appropriate speed, feed and depth of cut for various processes on lathe machine. 3. Position, hold and locate work material and cutting tools in various basic machine tools. 4. Choose suitable welding process for different metals. 5. Choose appropriate heat treatment process for different metals
Text Books: 1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication, 2000. 2. HMT, Production Technology, Tata McGraw Hill, 2001 3. W. A. J. Chapman, Workshop Technology Part I, ELBS & Edward Arnold Publishers, 1956

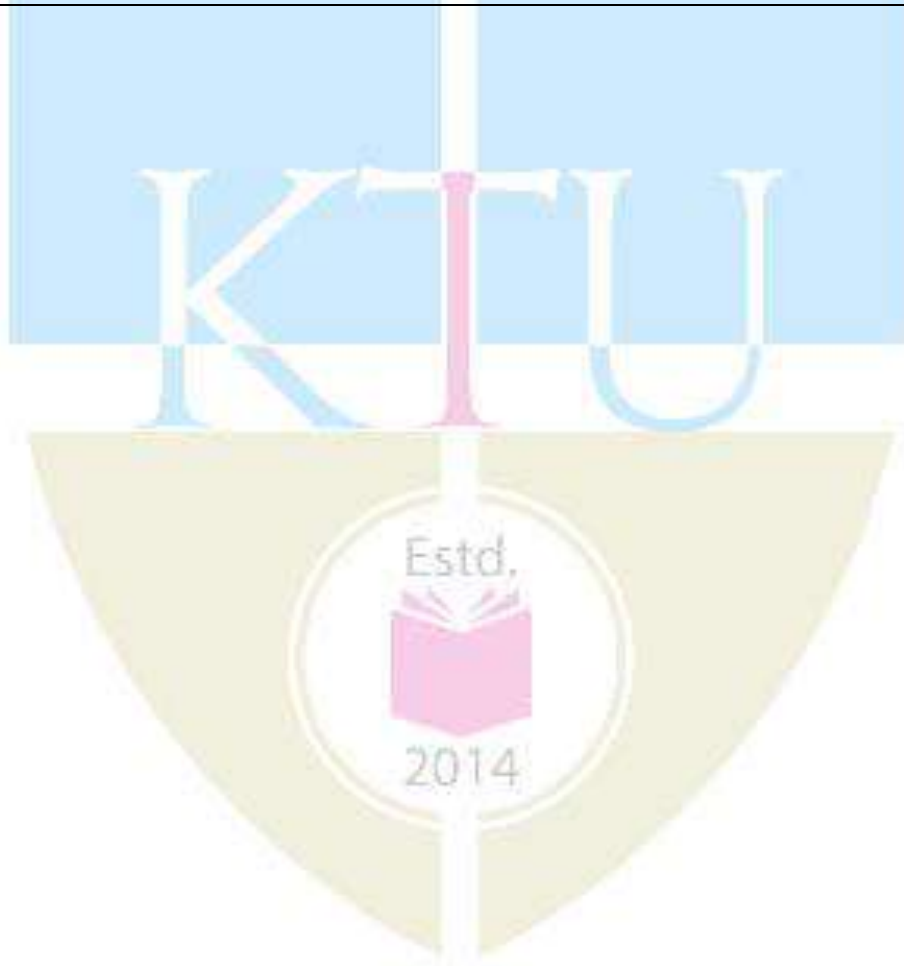
Course code	Course Name	L-T-P-Credits	Year of Introduction						
ME332	COMPUTER AIDED DESIGN AND ANALYSIS LAB	0-0-3-1	2016						
Prerequisite: ME308 Computer aided design and analysis									
Course Objectives: - To provide working knowledge on Computer Aided Design methods and procedures - To impart training on solid modelling software - To impart training on finite element analysis software									
Syllabus Introduction to solid modeling and Finite Element Analysis software. Exercises on modeling and assembly. a. Creation of higher end 3D solid models.(minimum 3 models) b. Creation of assembled views of riveted joints, cotter joints and shaft couplings. (minimum 3 models) Exercises on the application of Finite Element Method/Finite Volume Method to engineering systems:- a. Structural analysis. (minimum 3 problems) b. Thermal analysis. (minimum 2 problems) c. Fluid flow analysis. (minimum 1 problem)									
Expected outcome: The students will be able to i. Gain working knowledge in Computer Aided Design methods and procedures ii. Solve simple structural, heat and fluid flow problems using standard software									
Points to note: - Any appropriate solid modeling software (like CATIA, Solids Works, ProE, IDEAS, Siemens Solid Edge and NX, free software, etc.) and package (like ANSYS, Comsol Multi Physics, NASTRAN, ABAQUS, ADINA, Siemens Femap Nastran,free software etc.) may be used. Evaluation<table><tr><td>Class exercises</td><td>60 marks</td></tr><tr><td>Regular class viva</td><td>10 marks</td></tr><tr><td>Final internal exam using software</td><td>30 marks</td></tr></table> All the above three evaluations are mandatory.				Class exercises	60 marks	Regular class viva	10 marks	Final internal exam using software	30 marks
Class exercises	60 marks								
Regular class viva	10 marks								
Final internal exam using software	30 marks								
References Books: - Daryl Logan, A First course in Finite Element Method, Thomson Learning, 2007 - David V Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill,2003 - Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill, 2007 - Mikell P. Groover and Emory W. Zimmer, CAD/ CAM – Computer aided design and manufacturing, Pearson Education,1987 T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2012									

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME333	HEAT ENGINES LAB	0-0-3-1	2016
Prerequisite : Nil			
Course Objectives - To give hands on experience in testing different properties of fuels & lubricants - To perform characteristic tests on petrol and diesel engines.			
List of Exercises/Experiments : - Determination of viscosity using Saybolt Viscometer. - Determination of viscosity using Redwood Viscometer. - Determination of Flash point and Fire point using Pensky Marten's Apparatus. - Fuel Injection Pump Testing and Calibration of Fuel Injection pump. - Performance Test on Multi cylinder Four Stroke Diesel Engine. - Performance Test on Multi cylinder Four Stroke Petrol Engine. - Retardation Test on Twin cylinder Four Stroke Diesel Engine. - Morse Test on Multi cylinder Four Stroke Petrol engine. - Heat Balance Test on Multi cylinder Four Stroke Diesel Engine. - Volumetric Efficiency Test on Multi cylinder Four Stroke Diesel Engine. - Volumetric Efficiency Test on Multi cylinder Four Stroke Petrol Engine. - Cooling curve Test on Twin cylinder Four stroke Diesel Engine. - Valve Timing on Four stroke Diesel/ Petrol Engine - Determination of calorific value of liquid fuel using bomb calorimeter - Determination of calorific value of gaseous fuel using Junker's calorimeter Note: Minimum 12 experiments are mandatory			
Expected outcome: The students will be able to - Test different Properties of fuels and lubricants. - Test petrol and diesel engines to evaluate their performance			
List of Equipments - Saybolt viscometer - Redwood viscometer - Pensky Marten's flash & fire point apparatus - Fuel pump testing and calibrating machine - Single/multicylinder engine (petrol/diesel) for valve timing - Single/Twin cylinder 4 stroke diesel engine with rope drum/electrical dynamometer - Multi cylinder petrol engine with eddycurrent/hydraulic dynamometer - Multi cylinder diesel engine with eddycurrent/hydraulic dynamometer - Bomb Calorimeter - Junker's gas calorimeter			

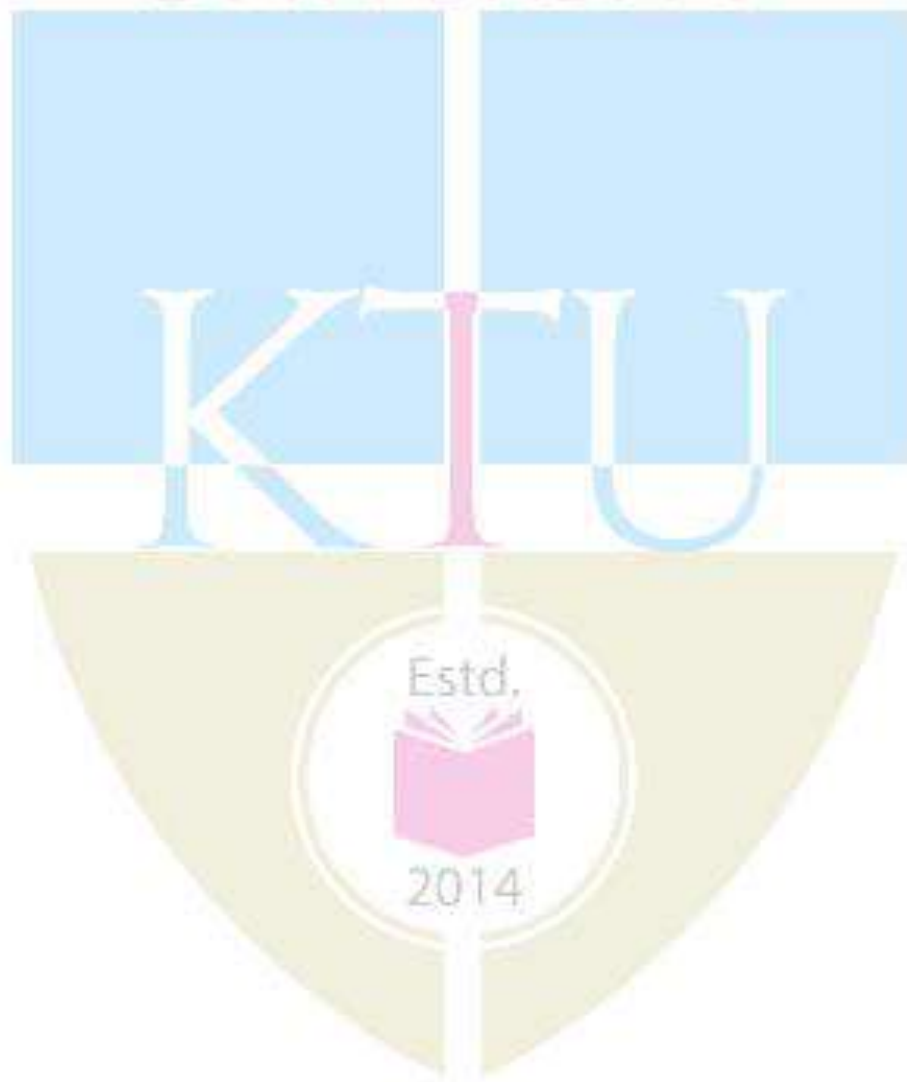
Course code	Course Name	L-T-P-Credits	Year of Introduction
ME334	MANUFACTURING TECHNOLOGY LABORATORY – II	0-0-3-1	2016
Prerequisite: ME312 Metrology and Instrumentation			
Course Objectives: - To provide programming practice on CNC machine tools - To impart knowledge on the fundamental concepts and principles of metrology - To explain the need of various modern measuring instruments and precision measurements			
List of Experiments/Exercises:			Sessions
Exercise on grinding machine			1
Study and preparation of program, simulation and exercise on CNC lathe:-turning, step turning, taper turning, thread cutting, ball and cup turning etc.			2
Study and preparation of program, simulation and exercise on CNC milling machine:- surface milling, pocket milling, contour milling etc.			2
Basics for mechanical measurements Calibration of vernier caliper, micrometer and dial gauge etc. Determination of dimensions of given specimen using vernier caliper, micrometer, height gauge, bore dial gauge etc. Determination of dimensions of a rectangular, square, cylindrical specimens using slip gauges and comparing with height gauge/vernier caliper etc			1
Experiments on Limits, Fits and Tolerance Determine the class of fits between given shaft and hole. etc.			
Linear measurements Study of different linear measuring instruments. Calibration of LVDT using slip gauges.			1
Straightness error measurement Study of different straightness error measuring instruments – basic principle of auto collimator and spirit level. Measurement of straightness error of a CI surface plate using auto collimator and comparing with spirit level. laser interferometer used to determine straightness error To check straightness error of a straight edge by the wedge method using slip gauges.			1
Angle measurements Angular measurements using bevel protractor, combination sets, clinometers, angle dekkor etc. Measurement of angle and width of a V-block and comparing with combination sets. Measurement of angle using sine bar of different samples.			1

Out of roundness measurement Study of different methods used for measurement out of roundness Measurement of out of roundness using form measuring instrument Measurement of out of roundness using V-block and dial gauge Measurement of out of roundness using bench centre and dial gauge etc.	1
Screw thread measurement Measurement of screw thread parameters using two wire and three wire method. Measurement of screw thread parameters using tool maker's microscope etc. Measurement of screw thread parameters using thread ring gage, thread plug gage, thread snap gage, screw thread micrometer, optical comparator etc.	1
Bore measurement Measurement of a bore by two ball method. Measurement of a bore by four ball method. Bore measurement using slip gauges and rollers. Bore measurement using bore dial gauge etc.	1
Calibration and determination of uncertainties Strain measurement using strain gauge load cells. Calibration of a cantilever strain gauge load cell. Rotation measurement Determination of rpm using tachometer, optical tachometer and stroboscope, etc.	1
Area determination Study of planimeter and Green's theorem Determination of given irregular area using planimeter.	1
Gear metrology Types of gears – gear terminology – gear errors - study of Profile Projector. Measurement of profile error and gear parameters using profile projector etc. Use of Comparators Exercise on comparators: mechanical, optical, pneumatic and electronic comparators.	1
Use of Tool makers microscope Study of tool maker's microscope – use at shop floor applications. Measurement of gear tooth parameters using tool maker's microscope. Measurement of different angles of single point cutting tool using tool maker's microscope.	1
Surface roughness measurement Measurement of surface roughness using surface profilometer /roughness measuring machine of turned, milled, grounded, lapped and glass etc specimens.	1
Squareness measurement Determination of squareness of a trisquare using angle plate and slip gauges.	1
Flatness measurement Study of optical flat and variation of fringe patterns for different surfaces. Determination of parallelism error between micrometer faces. Compare given surface using optical flat with interpretation chart.	1
Vibration measurement Measurement of displacement, velocity and acceleration of vibration.	1

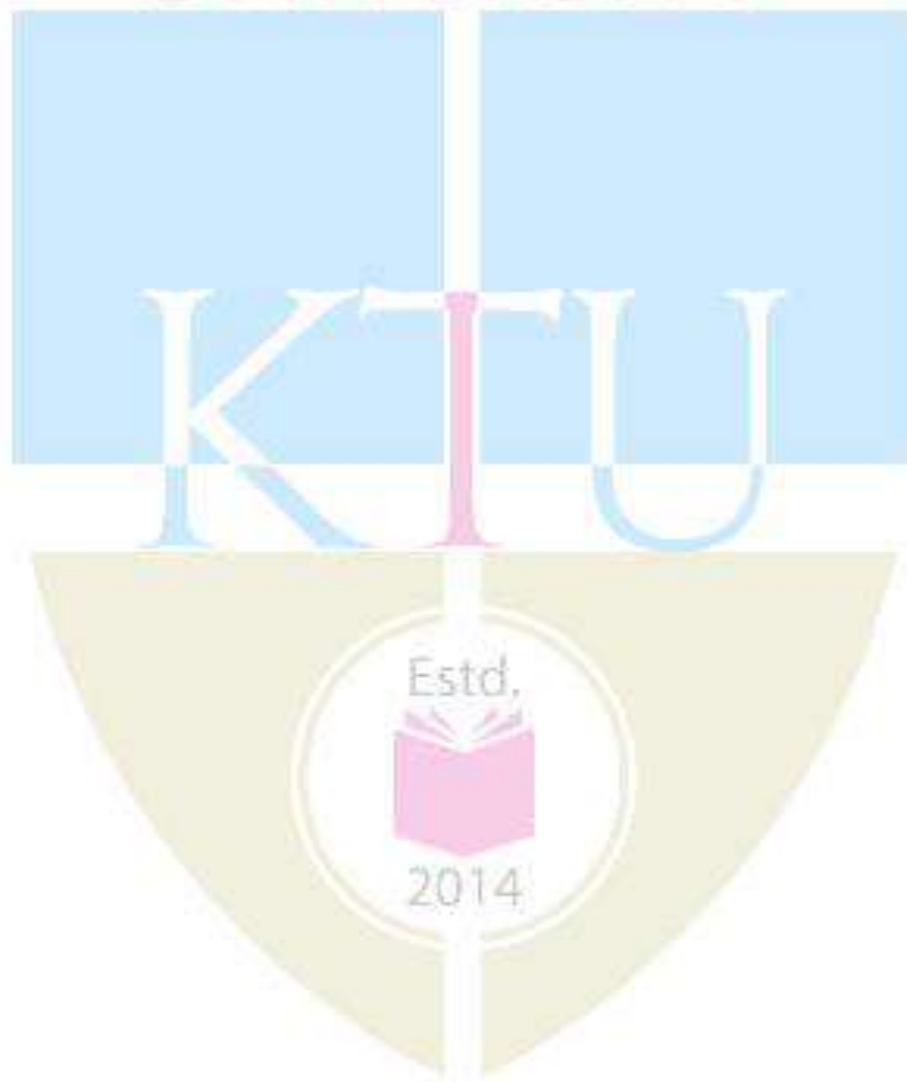
Use of Pneumatic comparator Checking the limits of dimensional tolerances using pneumatic comparator Calibration using air plug gauge etc	1
Reference books 1. Collett, C.V. and Hope, A.D, Engineering Measurements, Second edition, ELBS/Longman,1983 2. Sharp K.W.B. and Hume, Practical Engineering Metrology, Sir Isaac Pitman and sons Ltd, London,1958 3. Shotbolt C.R. and Gayler J.F.W, Metrology for Engineers, 5th edition, ELBS, London,1990 4. Yoram Koren, Numerical Control of Machine Tools, McGraw-Hill,1983	
A minimum of 12 experiments are mandatory but the experiments/exercises in CNC machines are mandatory. The academic evaluation shall be carried out by faculty.	



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Course code	Course Name	L-T-P - Credits	Year of Introduction
ME335	PRODUCTION ENGINEERING LAB	0-0-3-1	2016
Prerequisite: Nil			
Course Objectives To give an idea about different manufacturing processes and to perform different types of tests on various works.			
List of Exercises/Experiments : Experiment on arc/TIG/MIG welding: - - butt welding and - lap welding Experiment on lathe:- - Facing, - plain turning, - step turning, - parting – groove cutting, - knurling and chamfering - form turning and taper turning – - Eccentric turning. - Measurement of flank wear in turning process using tool makers microscope. Experiment on thread cutting: - - single and multi start external - single and multi start internal threads, - Square and V-threads. Experiment on drilling machine: - - Drilling, - boring, - reaming - counter sinking and tapping			
Expected outcome: - The students will be able to perform welding and machining operations in lathe and drilling machine List of Equipments 3 or 4 jaw Lathe - Arc / TIG / MIG welding machine - Drilling machine - Thread cutting tools.			

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME337	MACHINE TOOLS LAB	0-0-3-1	2016
Course Objectives: - To introduce various machining process & provide practical experience. - To familiarise the fundamentals of CNC machine. - To introduce the student to CNC, EDM operations.			
<u>List of Exercises/ Experiments (Minimum 12 are mandatory)</u> - Study of Lathes. Equipment: Centre lathe (Accessories & Attachments) - Plane and step turning on Lathe. Equipment: Cutting saw, Centre lathe, HSS tools, Tool holder, Center drill, Live center, Spanners, Vernier Caliper, Steel rule, Work piece. - Ball & curve , and Taper turning on lathe. Equipment: Cutting saw, Centre lathe, HSS tools, Form tools, Tool holder, Center drill, Live center, Spanners, Vernier Caliper, Steel rule, Work piece. - Thread Forming on Lathe. Equipment: Cutting saw, Centre lathe, HSS tools, Form tools, Tool holder, Center drill, Live center, Spanners, Thread pitch gauge ,Center gauge, Vernier Caliper, Steel rule, Work piece. - Study of Shaping Machine. Equipment: Shaping Machine - To perform V-Block on the given work piece Equipment: Shaping Machine, Cutting Tools, Try square, Parallel Block, Spanners, Marking and Measuring tools. - Study of Slotting Machine Equipment: Slotter - To perform a Slot on the given work piece Equipment: Slotting Machine, Steel rule, hammer, slotting tool, Try square. - To Perform Keyway using Slotter Equipment: Slotting Machine, Steel rule, hammer, slotting tool, Try square. - Study of Milling Machine(Horizontal & Vertical) Equipment: Horizontal Milling Machine & Vertical Milling Machine. - To Perform a Spur Gear on given work piece. Equipment: Horizontal Milling Machine Indexing Head Vernier caliper, Milling Cutter, Spanners, Mandrel , Try Square, Allen keys - To Perform a Bevel Gear on given work piece. Equipment: Horizontal Milling machine Universal Indexing Head Vernier caliper, Milling cutter, Spanners, Mandrel, Try Square, Allen keys. - To Perform Plane Milling Operation in given specimen. Equipment: Horizontal Milling Machine, Vernier caliper, Plane Milling Cutter, Spanners, Try Square, Parallel blocks, Marking Tools - To Perform Step Milling Operation in given specimens. Equipment: Vertical Milling Machine, Vernier caliper, End Milling Cutter, Spanners, Try Square, Parallel Blocks, Marking Tools - Study of Drilling Machine & Nomenclature of drill Bits			

16	Equipment; Radial Drilling Machine, Drill bits To perform drilling operation on given specimen in specified coordinate points. Equipment; Radial Drilling Machine, Drill bits, Punch , Hammer, Marking & Measuring Tools.
17	Study of Surface Grinding Machine. Equipment : Surface Grinding machine
18	To Perform Grinding operation (Mirror finish) on the given specimen. Equipment: Surface Grinding machine ,Magnetic chuck, cutting fluids, file.
19	Study of Cylindrical Grinding Machine. Equipment : Cylindrical Grinding Machine.
20	Study and Demonstration of CNC Machine. Equipment: CNC Machine.
21	To Program and run Milling operation using CNC machine. Equipment: CNC machine ,Computer, Vernier caliper
22	To program and execute turning operation using CNC Lathe. Equipment: CNC lathe , Computer, Vernier Caliper
24	Study and Demonstration of EDM Equipment: EDM
23	To program and execute wire cutting operation using EDM. Equipment: EDM, Copper wire, Cutting fluids, and computer.
24	Study of Cutting Process Equipment: Variety of cutting Equipments
25	Study of CNC Plasma arc Cutting (working Principle and Procedure only)
Course Outcome: The students will be able to i. Machine the given work piece to specified dimension. ii. Understand the fundamentals of CNC machines.	
Text Books: 1. Acharkan. N: Machine tool Design Vol. I to IV MIR Publication. 2. Chapman: Workshop Technology, Vol II: EL.BS 3. HMT: Production Technology: Tata McGraw Hill 4. Yoran Koren: Numerical control of Machine Tools.,Mc Graw Hill	

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME339	Mechanical Engineering Lab	0-0-3-1	2016
Prerequisite: MP303 Thermal Engineering			
Course Objectives 1. To study the basic concepts of Energy conversions and heat transfer. 2. To know conduct of the performance test on IC engines, Compressors and blowers. 3. To do tests on heat transfer equipment.			
List of Exercises/Experiments 1. Study of IC engines – Types, Parts and systems. 2. Study of Dynamometers – Types, working and applications. 3. Performance test on Diesel engine. 4. Performance test on Petrol engine. 5. Morse test on Multicylinder Petrol engine. 6. Heat balance test on Diesel/Petrol engine. 7. Determination of best cooling water temperature and Economic Speed of an IC engines. 8. Retardation test on Diesel engines. 9. Determination of Volumetric efficiency, Air-fuel ratio of IC engines. 10. Determination of Flash and Fire point of Petroleum Products. 11. Determination of Viscosity of Lubricating oils. 12. Determination of Calorific value of fuels. 13. Valve timing and Port timing diagram of IC engines. 14. Performance test on Rotary Compressors. 15. Performance test on Reciprocating Compressors. 16. Determination of Thermal Conductivity of solids. 17. Determination of Heat transfer coefficient in convection heat transfer (Free and Forced). 18. Determination of LMTD, effectiveness and overall heat transfer co efficient of parallel flow, counter flow and cross flow heat exchanger. 19. Performance test on Centrifugal Blower. 20. Performance tests on Refrigeration and Air conditioning unit.			
Expected outcome. The students will be able to i. Understand various types of engines, working of dynamometers and performance evaluation of engines. ii. Determine various efficiencies and plot the characteristic curves of different types of Internal Combustion Engines, compressors and blowers. iii. Conduct experiments for the determination of viscosity, calorific value, flash point, etc of petroleum products			
Text Book: 1. John B. Heywood , Internal Combustion Engines Fundamentals-, McGraw Hill. 2. R K Rajput, A Text Book of Thermal Engineering, Laxmi Publications. 3. R K Rajput, A Text Book of Internal Combustion engines, Laxmi Publications, 4. V Ganesan , Internal Combustion Engines –, Tata McGraw-Hill.			

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME361	Advanced Fluid Mechanics	3-0-0-3	2016
Prerequisite : ME203 Mechanics of fluids			
Course Objectives: The main objectives of this course are to - To provide knowledge regarding fluid-flow phenomena observed in mechanical engineering systems, such as potential flow, vortex flow, boundary-layer flows, etc. - To undertake sustained learning in fluid mechanics to advance their knowledge in this field. - To enhance the understanding of fluid mechanics, including the equations of motion in differential form and turbulence.			
Syllabus Basic Concepts and Fundamentals, Stream function and Potential function, Lagrangian and Eulerian approaches, Potential flow, Incompressible viscous flow, Boundary layer theory, Turbulent Flow.			
Expected Outcome: The students will be able to - Recognize the particular flow regime present in typical engineering system. - Demonstrate the concept of stream function, potential function and boundary layer. - Calculate the vorticity of a given velocity field and analyze the vorticity in idealized vortices: forced vortex and free vortex. - Choose the appropriate fluid mechanics principles needed to analyze the fluid-flow situations. - Recognize how fluid flow theory can be employed in a modern mechanical engineering design environment.			
Text books - Bansal R. K., A Text Book of Fluid Mechanics and Machines, Laxmi Publications, 2010. - Douglas J. F., Fluid Mechanics, Pearson Education, 2005. - Kumar D. S., Fluid Mechanics and Fluid Power Engineering, S. K. Kataria & Sons, 1987. - Muralidhar K., G. Biswas, Advanced Engineering Fluid Mechanics, Alpha Science International limited, 2005. - Rama D. D., Fluid Mechanics and Machines, New Age International, 2009.			
Reference books - Schlichting H., K. Gersten, Boundary Layer Theory, 8/e, Springer 2000. - Shames I. H., Mechanics of Fluids, 4/e, McGraw-Hill, 2002. - Streeter V. L. and E. B. Wylie, Fluid Mechanics, McGraw-Hill, 1979.			
Course Plan			
Module	Contents	Hours	End Sem. Exam. Marks

I	Basic Concepts and Fundamentals: Fluid statics, Cartesian Tensors, Fluid Kinematics, and Description of fluid motion – Types of motion of fluid elements, Vorticity and circulation – Concept of rotational and irrotational flows. Equation of motion of forced and free vortex flow. Stream function and Potential function. Stream function and its relation with velocity field. Relation between stream function and stream lines - Relation between stream function and velocity potential for a 2-D irrotational and incompressible flow.	7	15%
II	Relation between stream lines and lines of constant potential. Sketching of stream lines. Lagrangian and Eulerian approaches, acceleration, temporal acceleration, convective acceleration. Reynolds transport theorem, derivation of continuity and momentum equations using Reynolds transport theorem. Problems on the application of momentum equation	6	15%
FIRST INTERNAL EXAMINATION			
III	Potential flow: Uniform flow, source flow, sink flow, free vortex flow and super imposed flow-source and sink pair, doublet, plane source in a uniform flow(flow past a half body), source and sink pair in a uniform flow(flow past a Rankine oval body), doublet in a uniform flow(flow past a circular cylinder). Pressure distribution on the surface of the cylinder. Flow past a cylinder with circulation, Kutta-Juokowsky's law. Complex flow potential, complex flow potentials for source, sink, vortex and doublet. Potential flow between two parallel plates, potential flow in a sector. Introduction to conformal transformation, conformal mapping.	7	15%
IV	Incompressible viscous flow. Concepts of laminar and turbulent flows . Stokes viscosity law. Navier Stoke's equation and significance (Derivation not necessary).Simplification of Havier stock equation for steady incompressible flows with negligible body forces. Parallel flow through straight channel and couette flow. Hagen - Poiseuille flow. Derivation of Hagen Poissuille equations for velocity and discharge through a pipe, derivation of friction factor for laminar flow, Couette flow for negative, zero and positive pressure gradients, flow in a rotating annulus, Viscometer based on rotating annulus.	7	15%
SECOND INTERNAL EXAMINATION			
V	Boundary layer theory, Boundary layer thickness, Displacement thickness, momentum thickness, Energy thickness and their calculation. Laminar Boundary Layers, Boundary layer equations; Boundary layer on a flat plate, Prandtl boundary layer equations, Blasius solution for flow over a flat plate, Von- Karman momentum integral	8	20%

	equations, Pohlhausen approximation solution of boundary layer for non-zero pressure gradient flow, favorable and adverse pressure gradients, Entry flow into a duct, flow separation and vortex shedding.		
V1	Turbulent Flow: Introduction to turbulent flow, Governing equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Fully developed Turbulent pipe flow for moderate Reynold's number, Prandtl mixing hypothesis, Turbulence modeling. Boundary layer control.	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME362	Control System Engineering	3-0-0-3	2016
Course Objectives: : 1. To introduce the concepts of controls and modelling of physical systems. 2. To give idea on system response analysis and stability of systems. 3. To use different methods to analyse stability of control systems			
Syllabus: Control systems and components, Mathematical models, Block diagrams, Signal Flow graphs, Transient and Steady state response analysis, Stability , Routh's stability criterion, Root locus method. Frequency response analysis using polar plots ,Bode plots, Nyquist stability criterion			
Expected Outcomes: At the end of the course students will be able 1. To model and analyse physical systems. 2. To analyse the stability of feedback control systems			
Text books: 1. Kuo, B. C., Automatic Control Systems, Prentice Hall,2012 2. Thaler and Brown, Analysis and Design of Feedback Control Systems, McGraw Hill, 1960. 3. Nagrath I J and Gopal M, Control Systems Engineering, New Age India Pvt Limited, 2009			
References: 1. Ogata, K., Modern Control Engineering, Pearson Education, 2004 2. NPTEL courses, http://nptel.iitm.ac.in/courses.php, web and video courses on Control Engineering			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to control systems. Elementary ideas on types of control systems- Open loop and closed loop systems, Servo systems, Automatic regulating systems, Process control systems, Adaptive control systems, Learning control systems, Discrete control systems, Multivariable control systems, Linear and Non-linear systems. Elementary ideas on types of controls- proportional, integral, proportional integral, proportional integral derivative controls. Direct and indirect controls. Mathematical models of physical systems – typical examples of mechanical, thermal, electrical, hydraulic and pneumatic systems.	7	15%
II	Block diagram, transfer function, reduction of block diagrams, signal flow graphs :Manson's gain formula. Control system components – servomotors, stepper motor, synchros, hydraulic pumps and motors, hydraulic valves, pneumatic bellows, pneumatic valve, pneumatic relay, pneumatic actuator, gyroscopes (elementary ideas only. No derivations)	7	15%

	FIRST INTERNAL EXAMINATION		
III	System response- Time response of first and second order systems, steady state errors and error constants, specifications in time domain. Effect of pole locations, Concept of stability, Routh's stability criterion	7	15%
IV	Root locus method of analysis and design. Lead and lag compensation	7	15%
	SECOND INTERNAL EXAMINATION		
V	Frequency response analysis- relationship between time & frequency response, Bode's plot, stability in frequency domain, gain margin and Phase margin	7	20%
VI	Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin.	7	20%
	END SEMESTER EXAMINATION		

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME375	MECHANICAL TECHNOLOGY	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives To develop an understanding of the basic principles of machine design and machining technology and apply those principles to engineering applications.			
Syllabus General principles of engineering design - Design of Machine Elements -structural machine elements subjected to various types of loads, shafts, springs, Bearings. Metal Cutting Technology - Types of Tools, tool geometry, tool signature - Mechanism of chip formation - Methods of machining, Heat generation in machining, Tool life and tool failure – Machinability- Basic machine tools - Lathe, Shaper, planer and slotter machines, Milling, Hobbing, Broaching, Grinding machines, Drilling and boring machines, Work holding and tool holding devices, Selection of cutting tools, Fundamentals of NC & CNC machine tools Non-traditional Machining Technology - Abrasive jet machining, Ultrasonic machining, electro chemical machining, Electro discharge machining, Electron beam machining, Photo Chemical machining, Laser beam machining and plasma arc machining. Industrial Safety - General safety rules - Safety and health provisions - Fire and accident prevention - Principles of safe machine design - Safety in materials handling - Legislations on safety			
Course Expected Outcome. On completion of the course, the student will be able to: - Explain the concepts and methods of designing and classification of stresses in simple machine members and design of structural machine elements subjected to various types of loading - Define various failure modes, their endurance limit and their association with stress concentration. - Design of Springs and Bearings with appropriate materials selection. - Design of work holding and tool holding devices, Basic machine tools for shaper, planner, slotter milling, hobbing, broaching and grinding machines and select NC & CNC machine tools,. - Define the Non-traditional machining technology and design of various machines in this category. - Define the non-traditional unconventional machining technology and design of various machines in this category.			
References/Textbooks - Krishna Rao T., Design of machine Elements, I.K International publishing House Pvt. Ltd. - Bhandari V.B., Design of Machine Elements, McGraw Hill Book Company - Edward Trent and Paul Right, Metal Cutting, Butterworth- Heinemann - Jain R.K, Production Technology, Khanna publishers - Jain R.K., Industrial safety, Health and Environment, Khanna publishers - Budynas and Nisbett, Shigley's Mechanical Engineering Design, , 8th Ed., McGraw-Hill - Charles E.Wilson., Computer integrated machine design, Prentice-Hall. - Robert L.Norton., Machine design- an integrated approach, Prentice-Hall. - S.Md.Jalaludeen, Machine Design Volume – 1, Anuradha Publications - Collett. C.V and Hope A.D., Engineering measurements, Pitman publishing. - G.R.Nagpal, Machine Tool Engineering, Khanna Publishers			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Machine Design Concepts 1.1 General principles for engineering design: Factors influencing machine design, 1.2 Materials and properties, 1.3 Design considerations: Codes and standards, 1.4 Engineering stress and strain, Stress- strain diagrams, 1.5 Stresses in simple machine members: Axial, bending, torsional, bearing stress, 1.6 Principal stresses, Hoop stress, combined stresses, Simple problems, 1.7 Design considerations, Reliability based design	7	15%
II	Design of Machine Elements 2.1 Modes of failure, 2.2 Theories of failure. 2.3 Endurance limit. 2.4 Stress concentration. 2.5 Factor of safety. 2.6 Design of structural machine elements subjected to various types of loads: Static loading, Impact loading, Bending, Torsional loading, Fatigue loading; 2.7 Design of shafts - shafts subjected to pure torsion, pure bending, combined axial, bending and torsion – simple problems, 2.9 Design of springs and Material selection, 2.10 Design of Bearings and Material selection	9	15%
FIRST INTERNAL EXAMINATION			
III	Metal Cutting Technology 3.1 Introduction: Historical and Economic Context, 3.2 Types of Tools, tool geometry, tool signature, 3.3 Effect of tool geometry on machining, 3.4 Mechanism of chip formation, types of chips, 3.5 Methods of machining, machining tool diagram, 3.6 Heat generation in machining, 3.7 Tool life and tool failure, 3.8 Selection of cutting tools, cutting tool materials	6	15%
IV	Machining Technology 4.1 Machinability, Machinability index, 4.2 Basic machine tools, Lathe, Shaper, planer and slotter machines, 4.3 Milling. Hobbing. Broaching, Grinding machines, 4.4 Drilling and boring machines 4.5 Work holding and tool holding devices, 4.6 Selection of cutting tools, 4.7 Materials for cutting tools 4.8 Fundamentals of NC & CNC machine tools	6	15%
SECOND INTERNAL EXAMINATION			
V	Non-traditional Machining Technology 5.1 Introduction to unconventional machining processes, 5.2 Abrasive jet machining: Abrasive water jet machining, abrasive flow machining, water jet machining, 5.3 Ultrasonic machining, 5.4 electro chemical machining, 5.5 Electro discharge machining, 5.6 Electron beam machining, 5.7 Photo Chemical machining, 5.8 Laser beam machining and plasma arc machining.	7	20%
VI	Industrial Safety 6.1 Introduction, general safety rules, 6.2 Safety and health provisions of the Factories Act and Rules, 6.3 Reducing industrial noise, 6.4 Fire and accident prevention, 6.5 Principles of safe machine design, 6.6 Precautions to be taken by operators: Safety in materials handling, 6.7 Legislations on safety, 6.8 Role of OSHA	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100

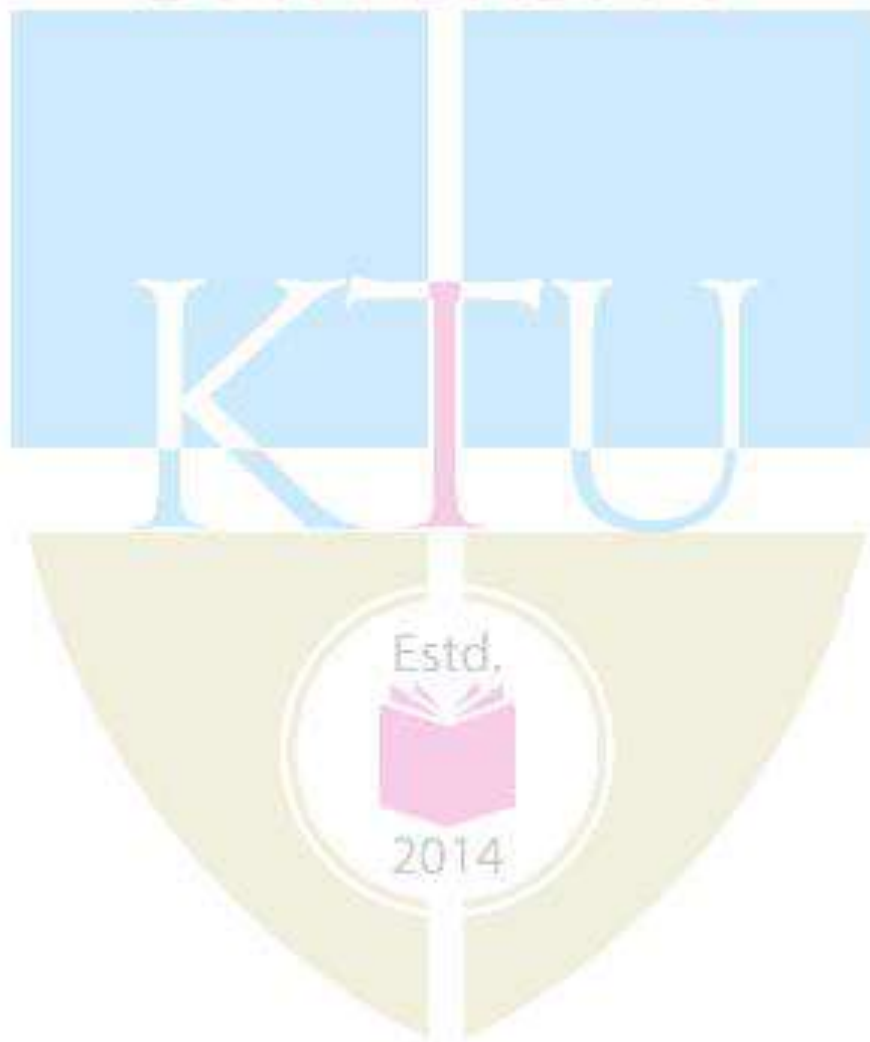
Exam Duration: 3 hours

PART A: 8 Questions from Module 1&2 (4+4). 6 questions to be answered. $6 \times 5 = 30$ Marks

PART B: 8 Questions from Module 3&4 (4+4). 6 questions to be answered. $6 \times 5 = 30$ Marks

PART C: 6 Questions from Module 5&6 (3+3). 4 questions to be answered. $4 \times 10 = 40$ Marks

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Course code	Course Name	L-T-P-Credits	Year of Introduction
ME376	Maintenance Engineering	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives: • To enable the student to understand the principles, functions and practices of maintenance activities. • To develop ability in formulating suitable maintenance strategies to achieve reliable manufacturing system. • To introduce the different maintenance categories and failure analysis tools. • To equip with essential system diagnosis techniques so as to identify and take appropriate actions on error symptoms and causes of failures. • To illustrate the techniques used for maintenance management. • To empower with the skills to manage a manufacturing system to achieve continuous system availability for production.			
Syllabus: Maintenance – reliability – maintainability – availability – maintenance systems – condition monitoring – monitoring systems – failure analysis – maintenance effectiveness – quality assured maintenance – maintenance planning and scheduling – maintenance organization – maintenance costs – maintenance budgeting – human factor in maintenance – computer-aided maintenance management system – maintenance integration.			
Expected outcome: The students will be able to - Understand the relationship of key concepts in reliability engineering and application to maintenance strategies in a manufacturing environment. - Establish maintenance strategies according to system characteristics and design transition programs to implement these strategies. - Manage the manufacturing organization with highest possible availability.			
Text Books: 1. Gupta A. K., Reliability, Maintenance and Safety Engineering, University Science Press, New Delhi, 2009. 2. Rao S. S., Reliability-Based Design, McGraw-Hill, Inc, New York, 1992. 3. Srivastava S. K., Maintenance Engineering and Management, S. Chand & Company Ltd., New Delhi, 1998. 4. Venkataraman, Maintenance Engineering and Management, Prentic-Hall of India Pvt. Ltd., New Delhi, 2007.			

Reference Books:

1. Davies, Handbook of Condition Monitoring, Chapman & Hall, 1996.
2. Garg M. R., Industrial Maintenance, S. Chand & Co., 1986.
3. Higgins L. R., Maintenance Engineering Hand book, McGraw Hill, 5th Edition, 1988.
4. Mishra R. C. and Pathak K., Maintenance Engineering and Management, PHI Learning Pvt. Ltd., New Delhi, 2009.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Maintenance – basic concepts, purpose, functions and objectives of maintenance.	1	15%
	Principles, benefits and effects of maintenance	1	
	Inter-relationship between productivity, quality, reliability and maintainability – maintenance productivity – quality in maintenance.	1	
	Reliability – basic concepts – bathtub curve – failure rate – mean time before failure.	1	
	System reliability – reliability of series and parallel systems.	1	
	Maintainability – mean time to failure – mean time to repair.	1	
	Availability – inherent, achieved and operational availability – reliability, availability and maintainability (RAM).	1	
II	Maintenance strategies / systems – types – basis for selection. Breakdown maintenance – corrective maintenance	1	15%
	Preventive maintenance – process flow – frequency in preventive maintenance.	1	
	Predictive maintenance – components – advantages and disadvantages.	1	
	Condition based maintenance and condition monitoring – monitoring systems.	1	
	Performance monitoring – visual, tactile and aural monitoring – leakage monitoring.	1	
	Temperature monitoring – thermography – advantages.	1	
	Thickness monitoring – acoustic monitoring – smell/odour monitoring.	1	
FIRST INTERNAL EXAMINATION			
III	Vibration monitoring – vibration fundamentals – vibration analysis.	1	15%
	Vibration transducers – types.	1	
	Machinery vibration trouble shooting – machinery vibration standard, severity chart and acceptable limits.	1	
	Lubricant monitoring – components and techniques – filter debris analysis & filtergrams.	1	
	Ferrography – spectroscopic oil analysis program.	1	

	Crack monitoring – techniques.	1	
	Corrosion monitoring – techniques.	1	
IV	Reliability centered maintenance (RCM) – steps – flow diagram – basic guidelines.	1	15%
	Defect and failure – definitions – basics of failures – failure generation – failure analysis.	1	
	Fault tree analysis (FTA)	1	
	Event tree analysis (ETA)	1	
	Root cause analysis (RCA)	1	
	Failure modes and effects analysis (FMEA)	1	
	Failure mode effect criticality analysis (FMECA)	1	
SECOND INTERNAL EXAMINATION			
V	Terotechnology – definitions – terotechnology system – terotechnology process – strategies.	1	20%
	Total productive maintenance (TPM) – features –methodology – basic systems of TPM – TPM and terotechnology.	1	
	Six sigma maintenance.	1	
	Lean maintenance – 5-zero maintenance concept – 5-S maintenance concept.	1	
	Business centered maintenance (BCM) – six pillars – success factors.	1	
	Maintenance effectiveness – overall equipment effectiveness – key performance indicators – maintenance performance measuring indices.	1	
	Quality assured maintenance – need – maintenance work quality – use of c-chart for quality control in maintenance.	1	
VI	Maintenance planning and scheduling.	1	20%
	Maintenance organization – objectives and characteristics – centralized and decentralized maintenance.	1	
	Maintenance costs – classification of maintenance costs – maintenance cost analysis – cost effectiveness analysis.	1	
	Maintenance budgeting – types of maintenance budget – preparation of maintenance budget.	1	
	Human factor in maintenance – manpower planning for maintenance – objectives and stages of manpower planning – training for maintenance personnel.	1	
	Computer-aided maintenance management system (CMMS) – functions, applications and advantages of CMMS.	1	
	Maintenance integration – various steps in integration – scheme of integration of maintenance function with other functions.	1	

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME401	DESIGN OF MACHINE ELEMENTS - I	3-1-0-4	2016
Prerequisite: ME201 Mechanics of Solids			
Course Objectives: - To review concepts of statics and strength of materials. - To introduce fundamental approaches to failure prevention of components. - To provide knowledge in the design of common machine elements such as fasteners, shafts, springs cotter joints and couplings.			
Syllabus Introduction to Design, Materials and their properties, Theories of Failure, Shock and impact loads, Threaded Joints, Bolted joints, Design of riveted joints, Cotter and Knuckle joints, Design of welded joints, Helical springs, Leaf springs, Shafting, Design of Coupling.			
Expected outcome: The students will be able to - Find out various stresses induced in a machine element under different type of loading conditions. - Devise machine components for its conceptual design.			
Text Books: - Jalaludeen , Machine Design, Anuradha Publications, Chennai, 2014 R. L. Norton, Machine Design – An Integrated Approach, Pearson Education, 2001 - V.B.Bhandari, Design of Machine elements, McGraw Hill, 2010			
Data books permitted for reference in the final examination: K. Mahadevan, K. Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013 - NarayanaIyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill/Suma Publications, 1984 - PSG Design Data, DPV Printers, Coimbatore, 2012			
References Books: J. E. Shigley, Mechanical Engineering Design, McGraw Hill, 2003 - Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley, 2003 M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006 - Rajendra Karwa, Machine Design, Laxmi Publications, 2006			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Design- Definition, steps in design process, preferred numbers, standards and codes in design	4	15%
	Materials and their properties- Elastic and plastic behaviour of metals, ductile and brittle behaviour, shear, bending and torsional stresses, combined stresses, stress concentration factor.	5	
II	Theories of Failure- Guest's Theory, Rankine's Theory, St. Venant's Theory, Haigh's Theory, and Von Mises and Hencky Theory.	5	15%
	Shock and impact loads, fatigue loading, endurance limit stress, factors affecting endurance limit, factor of safety	6	
FIRST INTERNAL EXAM			
III	Threaded Joints- Terminology, thread standards, types of threads, stresses in screw threads	3	15%
	Bolted joints- effect of initial tension, eccentric loading, design of bolts for static and fatigue loading, gasketed joints, power screws	4	
IV	Design of riveted joints- Material for rivets, modes of failure, efficiency of joint, design of boiler and tank joints, structural joints	4	15%
	Cotter and Knuckle joints- Gib and Cotter Joint, analysis of knuckle joint.	4	
	Design of welded joints- welding symbols, stresses in fillet and butt welds, Butt joint in tension, fillet weld in tension, fillet joint under torsion, fillet weld under bending, eccentrically loaded welds.	4	
SECOND INTERNAL EXAM			
V	Springs- classification, spring materials, stresses and deflection of helical springs, axial loading, curvature effect, resilience, static and fatigue loading, surging, critical frequency, concentric springs, end construction.	5	20%
	Leaf springs- Flat springs, semi elliptical laminated leaf springs, design of leaf springs, nipping	4	
VI	Shafting- material, design considerations, causes of failure in shafts, design based on strength, rigidity and critical speed, design for static and fatigue loads, repeated loading, reversed bending	5	20%
	Design of Coupling- selection, classification, rigid and flexible coupling, design of keys and pins	3	
END SEMESTER EXAM			

Question paper pattern

Use of approved data book permitted

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 3 questions from module I and II and at least 1 question from each module

Each question carries 15 marks

Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part B

There should be 3 questions from module III and IV and at least 1 question from each module

Each question carries 15 marks

Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part C

There should be 3 questions from module V and VI and at least 1 question from each module

Each question carries 20 marks

Students will have to answer any 2 questions out of 3 (2X20 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME 402	Design of Machine Elements-II	3-0-0-3	2016
Prerequisite: ME401 Design of Machine Elements-I			
Course Objectives: - To provide basic design methods for clutches, brakes, belt drives, bearings, gears and connecting rod. - To introduce the design modifications to be considered for ease of manufacturing.			
Syllabus Design of single plate clutches, multiple disc clutches, cone clutch, centrifugal clutch, block brake, band brake, band and block brake, internal expanding shoe brake, rolling contact bearing, sliding contact bearing, spur gear, helical gear, bevel gear, worm and worm wheel, design of flat belt, design of V-belt drives, selection of roller chains, connecting rod, design recommendations for forgings, castings, welded products, rolled sections, turned parts, screw machined products, parts produced on milling machines.			
Expected outcome: The students will be able to - Apply design procedures for industrial requirements. - Design machine components to ease the manufacturing limitations.			
Text Books: J. E. Shigley, Mechanical Engineering Design, McGraw Hill, 2003 - Jalaludeen, Machine Design, Anuradha Publications, 2016 - V.B.Bhandari, Design of Machine elements, McGraw Hill, 2016			
References Books: - Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley, 2011 M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006 - Rajendra Karwa, Machine Design, Laxmi Publications (P) LTD, New Delhi, 2006 - Siegel, Maleev & Hartman, Mechanical Design of Machines, International Book Company, 1983			
Data books permitted for reference in the examination: K. Mahadevan, K. Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013 - Narayana Iyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill, 1984 - PSG Design Data. DPV Printers. Coimbatore. 2012			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Clutches – friction clutches, design considerations, multiple disc clutches, cone clutch, centrifugal clutch	2	15%
	Brakes- Block brake, band brake, band and block brake, internal expanding shoe brake	3	
II	Rolling contact bearing- Design of bearings, Types, Selection of a bearing type, bearing life, static and dynamic load capacity, axial and radial loads, selection of bearings, dynamic equivalent load	4	15%
	Sliding contact bearing- lubrication, lubricants, viscosity, Journal bearings, hydrodynamic theory, Sommerfield number, design considerations, heat balance, bearing housing and mountings	4	
FIRST INTERNAL EXAM			
III	Gears- classification, Gear nomenclature, Tooth profiles, Materials of gears, Law of gearing (review only), virtual or formative number of teeth, gear tooth failures, Beam strength, Lewis equation, Buckingham’s equation for dynamic load, wear load, endurance strength of tooth, surface durability, heat dissipation – lubrication of gears – Merits and demerits of each type of gears.	3	15%
	Design of spur gear	3	
IV	Design of helical gear	2	15%
	Design of bevel gear	2	
	Design of worm & worm wheel	3	
SECOND INTERNAL EXAM			
V	Design of flat belt- materials for belts, slip of the belts, creep, centrifugal tension	3	20%
	Design of V-belt drives, Advantages and limitations of V-belt drive	3	
	Selection of roller chains, power rating of roller chains, galling of roller chains, polygonal action, silent chain.	3	
VI	Connecting rod – material, connecting rod shank, small end, big end, connecting rod bolts, inertia bending stress, piston	5	20%
	Pressure vessels, thin cylinders, Thick cylinder equation, open and closed cylinders.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Note : Use of approved data book is permitted

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 3 questions from module I and II and at least 1 question from each module

Each question carries 15 marks

Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part B

There should be 3 questions from module III and IV and at least 1 question from each module

Each question carries 15 marks

Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part C

There should be 3 questions from module V and VI and at least 1 question from each module

Each question carries 20 marks

Students will have to answer any 2 questions out of 3 (2X20 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
ME403	ADVANCED ENERGY ENGINEERING	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives: 1. To give an idea about global energy scenario and conventional energy sources 2. To understand solar, wind and Biomass energy 3. To know concepts of other renewable energy sources 4. To create awareness on the impacts of energy conversion and importance of sustainable energy			
Syllabus Global and Indian energy scenario, conventional energy sources, environmental effect of energy conversion, renewable energy sources- solar, wind, biomass, brief account of other renewable energy sources –geothermal, tidal, MHD, hydrogen, fuel cells, small scale hydro power plants. Environmental impact and Sustainability issues.			
Expected outcome: The students will be able to i. Understand energy scenario and the environmental effects of energy conversion. ii. Become aware of different renewable energy sources and choose sustainable energy for			
Text Books: 1. Jefferson W Tester et.al., Sustainable Energy: Choosing Among Options, PHI, 2006 2. P K Nag, Power Plant Engineering, TMH, 2002 3. Tiwari G N, Ghosal M K, Fundamentals of renewable energy sources, Alpha Science International Ltd., 2007			
References Books: 1. David Merick, Richard Marshall, Energy, Present and Future Options, Vol.I & II, John Wiley & Sons, 2001 2. Godfrey Boyle, Renewable Energy : Power for a Sustainable Future, Oxford University Press, 2012 3. Roland Wengenmayr, Thomas Buhrke, 'Renewable Energy: Sustainable energy concepts for the future, Wiley – VCH, 2012 4. Twidell J W and Weir A D, Renewable Energy Resources, UK, E&F.N. Spon Ltd., 2006			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to the course. Global and Indian energy resources. Energy Demand and supply. Components, layout and working principles of steam, hydro, nuclear, gas turbine and diesel power plants	7	15%
II	Solar Energy- passive and active solar thermal energy, solar collectors, solar thermal electric systems, solar photovoltaic systems. Economics of solar power. Sustainability attributes.	7	15%
FIRST INTERNAL EXAM			

III	Wind Energy-Principle of wind energy conversion system, wind data and energy estimation, wind turbines, aerodynamics of wind turbines, wind power economics. Introduction to solar-wind hybrid energy systems	7	15%
IV	Biomass Energy – Biomass as a fuel, thermo-chemical, bio-chemical and agro-chemical conversion of biomass- pyrolysis, gasification, combustion and fermentation, transesterification, economics of biomass power generation, future prospects.	6	15%
SECOND INTERNAL EXAM			
V	Other Renewable Energy sources – Brief account of Geothermal, Tidal , Wave, MHD power generation, Small, mini and micro hydro power plants. Fuel cells – general description, types, applications. Hydrogen energy conversion systems, hybrid systems- Economics and technical feasibility	8	20%
VI	Environmental impact of energy conversion – ozone layer depletion, global warming, greenhouse effect, loss of biodiversity, eutrophication, acid rain, air and water pollution, land degradation, thermal pollution, Sustainable energy, promising technologies, development pathways	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME404	INDUSTRIAL ENGINEERING	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives: - To impart theoretical knowledge about various tools and techniques of Industrial Engineering. - To create awareness about various safety procedures to be followed in carrying out different types of projects. - To get acquainted with the Inventory management Principles and Techniques. - To equip with the theoretical knowledge on Quality control practices and testing methods.			
Syllabus Introduction to Industrial Engineering, Plant layout and Material handling, Methods engineering, Industrial relations, Production planning and control, Quality control and Inspection			
Expected outcomes: The students will be able to - Know various tools and techniques in industrial Engineering. - Develop work procedure applying the principles of work study. - Apply inventory control techniques in materials management. - Formulate replacement and purchase decisions and arrive at conclusions			
Text Books: B. Kumar, Industrial Engineering Khanna Publishers, 2013 - M Mahajan, Industrial Engineering & Production Management, Dhanpat Rai, 2005 - Martand Telsang, Industrial Engineering & Production Management, S. Chand, 2006 O. P. Khanna, Industrial Engineering and Management, Dhanpat Rai, 2010			
References: E. S. Buffa, Modern Production management, John Wiley, 1983 - Grant and Ieven Worth, Statistical Quality Control, McGraw Hill, 2000 - Introduction to work study – ILO, Oxford And IBH Publishing, 2008 - Ralph M Barnes, Motion and Time Study, Wiley, 1980			
Course			
Module		Hours	End Sem. Exam Marks
I	Introduction to Industrial Engineering - Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering - Field of application of Industrial Engineering Product Development and research- Design function - Objectives of design, - Manufacturing vs purchase- Economic aspects- C-V-P analysis – simple problems-Development of designs- prototype, production and testing - Human factors in design- Value Engineering .	7	15%
II	Plant layout and Material handling- principles of material handling, Types of material handling equipments, Selection and application. Preventive and break- down maintenance - Replacement policy-- Methods of replacement analysis-Method of providing for depreciation- Determination of economic life - Simple problems.	7	15%

FIRST INTERNAL EXAM			
III	Methods engineering: Analysis of work methods using different types of process chart and flow diagrams- Critical examination-Micro motion study and therbligs- Principles of motion economy – Work measurement-Performance rating.-Determination of allowances and standard time. - Job evaluation and merit rating - Objectives and principles of job evaluation--Wages and Incentives-Primary wage systems- Wage incentive plans.	7	15%
IV	Industrial relations- Psychological attitudes to work and working conditions - fatigue- Methods of eliminating fatigue- Effect of Communication in Industry-Industrial safety-personal protective devices-, causes and effects of industrial disputes- Collective bargaining- Trade union - Workers participation in management.	7	15%
SECOND INTERNAL EXAM			
V	Production planning and control- Importance of planning - job, batch and mass production-Introduction and need for a new product-product life cycle. - Functions of production control - Routing , Scheduling, dispatching and follow up- Gantt charts. Inventory Control, Inventory models -Determination of EOQ and reorder level-simple problems- Selective inventory control techniques.	7	20%
VI	Quality control and Inspection- Destructive and non-destructive testing methods- process capability- Statistical quality control – causes of variation in quality- control charts for X and R. Reliability-causes of failures- Bath tub curve.-System reliability- life testing-Introduction to concepts of, TQM, ISO, Six Sigma and Quality circles (Brief description only).	7	20%
END SEMESTER EXAM			

Question paper pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI. Each question carries 10 marks. Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME 405	REFRIGERATION AND AIR CONDITIONING	2-1-0-3	2016
Prerequisite: ME205 Thermodynamics			
Course Objectives: 1. To introduce vapour compression and vapour adsorption systems 2. To impart knowledge on refrigeration cycles and methods to improve performance 3. To familiarize the components of refrigeration systems 4. To introduce air conditioning systems 5. To know the applications of refrigeration and air conditioning systems			
Syllabus Introduction, Thermodynamics of refrigeration, Air refrigeration systems, Vortex tube refrigeration, Adiabatic demagnetization of paramagnetic salts, Vapour compression systems, Refrigerants and their properties, Application of refrigeration, Refrigeration system components, Air conditioning, Psychrometry, Air conditioning systems.			
Expected outcome: The students will be able to i. Understand the principles refrigeration of air-conditioning and basic design considerations. ii. Carry out analysis of refrigeration cycles iii. Apply the concepts of indoor environmental comfort. iv. Perform psychrometric calculations, humidity control and analysis of air-conditioning processes v. Know the various applications of Refrigeration and air conditioning			
Text Books: 1. Arora C. P, Refrigeration and Air-Conditioning, McGraw-Hill, 2008 2. Arora S. C. and Domkundwar, Refrigeration and Air-Conditioning, Dhanpat Rai, 2010 3. Ballaney P. L, Refrigeration and Air-Conditioning, Khanna Publishers, New Delhi, 2014 4. Manohar Prasad, Refrigeration and Air-Conditioning, New Age International, 2011			
References Books: 1. ASHRAE Handbook 2. Dossat. R. J, Principles of Refrigeration, Pearson Education India, 2002 3. Stoecker W.F, Refrigeration and Air-Conditioning, McGraw-Hill Publishing Company, 2009			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction – Brief history and applications of refrigeration. Thermodynamics of refrigeration- reversed Carnot cycle- heat pump and refrigeration machines, Limitations of reversed Carnot cycle. Unit of refrigeration- Air refrigeration systems- Reversed Joule cycle, Air craft refrigeration systems, simple bootstrap- Regenerative and reduced ambient system	6	15%

II	Vortex tube refrigeration-Very low temperature refrigeration systems (concept only). Adiabatic demagnetization of paramagnetic salts Vapour compression systems-simple cycle - representation on T- s and P- h Diagrams. COP- Effect of operating parameters on COP – methods of improving COP of simple cycle- super- heating , under cooling, Liquid suction heat exchanger, actual cycle.	8	15%
FIRST INTERNAL EXAM			
III	Multi pressure systems - multi compression and multi evaporator, systems. Inter cooling - flash inter cooling and flash gas removal-Different combinations of evaporator and compressor for different applications, Cascade system Refrigerants and their properties-Eco-friendly Refrigerants, mixed refrigerants, selection of refrigerants for different applications Vapour absorption systems - Ammonia – water system - simple system- drawbacks-Lithium Bromide water system- Electrolux-comparison with vapour compression system- steam jet refrigeration.	7	15%
IV	Application of refrigeration- domestic refrigerators- water coolers-ice plants. Cold storages- food preservation methods- plate freezing , quick-freezing. Refrigeration system components- Compressors, condensers, expansion devices, evaporators. Cooling towers- Different types and their application fields- Refrigerant leakage and detection – charging of refrigerant – system controls.	6	15%
SECOND INTERNAL EXAM			
V	Air conditioning – meaning and utility, comfort and industrial air conditioning. Psychrometric properties- saturated and unsaturated air, dry, wet and dew point temperature – humidity, specific humidity, absolute humidity, relative humidity and degree of saturation-thermodynamic equations- enthalpy of moisture- adiabatic saturation process -psychrometers. Thermodynamic wet bulb temperature, psychrometric chart- Psychrometric processes- adiabatic mixing-sensible heating and cooling- humidifying and dehumidifying, air washer – bypass factor- sensible heat factor-RSHF and GSHF line-Design condition- Apparent dew point temperature – Choice of supply condition, state and mass rate of dehumidified air quantity – Fresh air supplied –air refrigeration. Comfort air conditioning- factors affecting human comfort. Effective temperature – comfort chart. Summer air conditioning- factors affecting-cooling load estimation.	8	20%
VI	Air conditioning systems- room air conditioner- split system-packaged system-all air system-chilled water system. Winter air conditioning – factors affecting heating system, humidifiers. Year round air conditioning AC system controls-thermostat and humidistat. Air distribution systems- duct system and design- Air conditioning of restaurants, hospitals, retail outlets, computer center, cinema theatre, and other place of amusement. Industrial applications of air conditioning.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Use of approved Refrigerant tables permitted

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

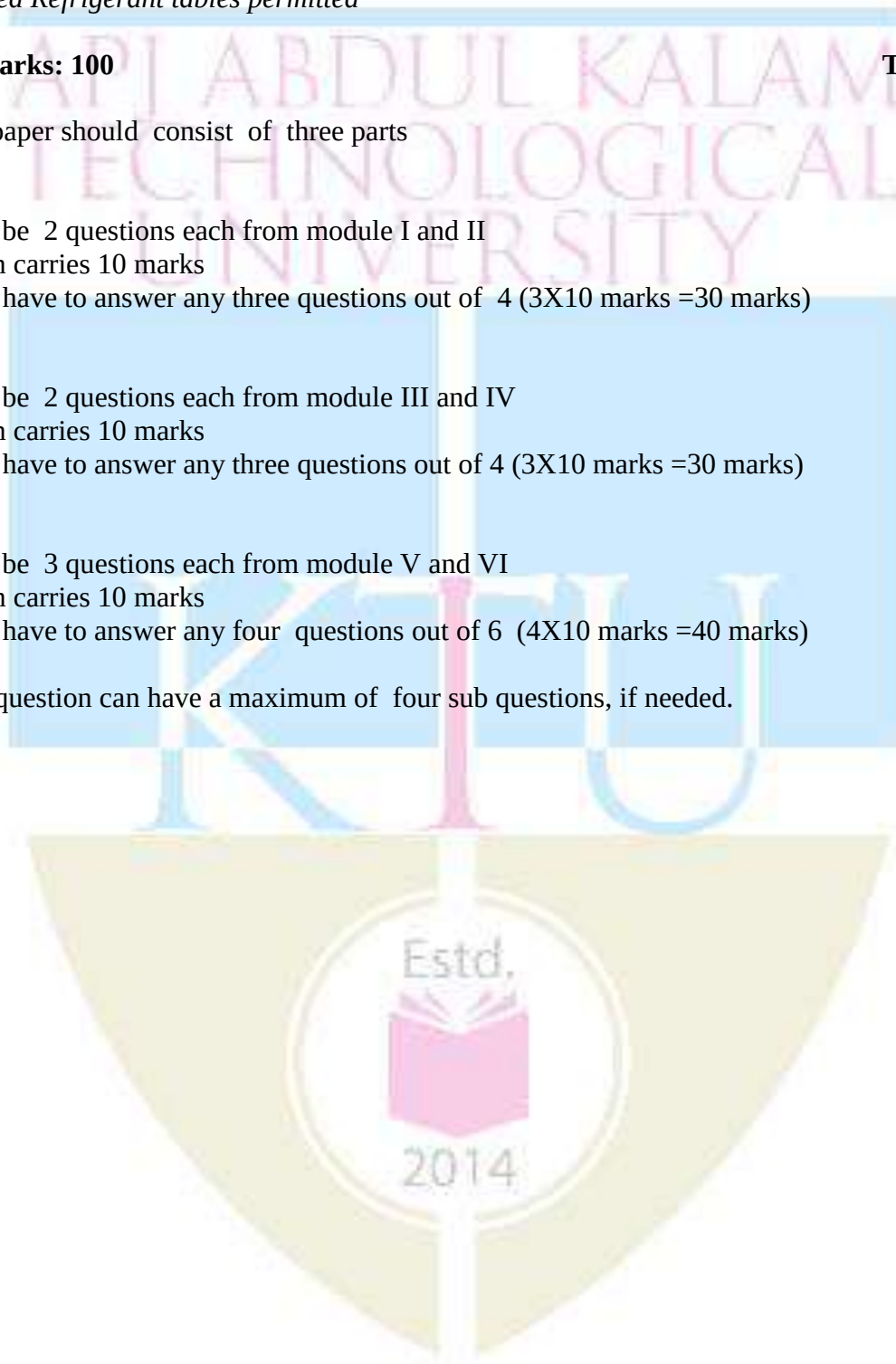
Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
ME407	MECHATRONICS	3-0-0- 3	2016
Prerequisite: Nil			
Course Objectives: - To introduce the features of various sensors used in CNC machines and robots - To study the fabrication and functioning of MEMS pressure and inertial sensors - To enable development of hydraulic/pneumatic circuit and PLC programs for simple applications			
Syllabus Introduction to Mechatronics, sensors, Actuators, Micro Electro Mechanical Systems (MEMS), Mechatronics in Computer Numerical Control (CNC) machines, Mechatronics in Robotics-Electrical drives, Force and tactile sensors, Image processing techniques, Case studies of Mechatronics systems.			
Expected outcome: The students will be able to - Know the mechanical systems used in mechatronics - Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems			
Text Books: - Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007 - Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008. - Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education, Inc., New Delhi, 2006.			
References Books: - David G. Aldatore, Michael B. Histan, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003. - Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998. - HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004. - Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England, 2006.			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Mechatronics: Structure of Mechatronics system. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute, gray coded encoder. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. Principle and types of vibration sensors.	8	15%

II	Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols.	7	15%
FIRST INTERNAL EXAM			
III	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.	6	15%
IV	Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Mechatronics elements - Machine structure: guide ways, drives. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws, pre-loading methods. Re-circulating roller screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.	8	15%
SECOND INTERNAL EXAM			
V	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Mechatronics in Robotics-Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive. Force and tactile sensors. Range finders: ultrasonic and light based range finders	6	20%
VI	Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding. Case studies of Mechatronics systems: Automatic camera, bar code reader, pick and place robot, automatic car park barrier system, automobile engine management system.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3X10 =30 marks)

Part B

There should be 2 questions each from module III and IV. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI. Each question carries 10 marks. Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME409	COMPRESSIBLE FLUID FLOW	2-1-0-3	2016
Prerequisite: ME205 Thermodynamics			
Course Objectives: - To familiarize with behavior of compressible gas flow. - To understand the difference between subsonic and supersonic flow - To familiarize with high speed test facilities			
Syllabus Introduction to Compressible Flow, Wave propagation, One dimensional steady isentropic flow, Irreversible discontinuity in supersonic flow, Flow in a constant area duct with friction (Fanno Flow), Flow through constant area duct with heat transfer (Rayleigh Flow), Compressible flow field visualization and measurement, measurement in compressible flow, Wind tunnels			
Expected outcome: The students will be able to - Formulate and solve problems in one -dimensional steady compressible flow including: isentropic nozzle flow, constant area flow with friction (Fanno flow) and constant area flow with heat transfer (Rayleigh flow). - Derive the conditions for the change in pressure, density and temperature for flow through a normal shock. - Determine the strength of oblique shock waves on wedge shaped bodies and concave corners - Know the various measuring instruments used in compressible flow			
Data book/Gas tables: - Yahya S. M., Gas Tables, New Age International, 2011 - Balachandran P., Gas Tables, Prentice-Hall of India Pvt. Limited, 2011			
Text Books: - Balachandran P., Fundamentals of Compressible Fluid Dynamics, PHI Learning. 2006 - Rathakrishnan E., Gas Dynamics, PHI Learning, 2014 - Yahya S. M., Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, New Age International Publishers, 2003			
References Books: - Anderson, Modern compressible flow, 3e McGraw Hill Education, 2012 - Shapiro, Dynamics and Thermodynamics of Compressible Flow – Vol 1., John Wiley & Sons, 1953			

Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Compressible Flow- Concept of continuum-system and control volume approach- conservation of mass, momentum and energy- stagnation state- compressibility-Entropy relations. Wave propagation- Acoustic velocity-Mach number-effect of Mach number on compressibility- Pressure coefficient-physical difference between incompressible, subsonic, sonic and supersonic flows- Mach cone-Sonic boom-Reference velocities- Impulse function-adiabatic energy equation-representation of various flow regimes on steady flow adiabatic ellipse.	8	15%
II	One dimensional steady isentropic flow- Adiabatic and isentropic flow of a perfect gas- basic equations- Area-Velocity relation using 1D approximation-nozzle and diffuser-mass flow rate-choking in isentropic flow-flow coefficients and efficiency of nozzle and diffuser- working tables-charts and tables for isentropic flow-operation of nozzle under varying pressure ratios –over expansion and under expansion in nozzles.	7	15%
FIRST INTERNAL EXAM			
III	Irreversible discontinuity in supersonic flow- one dimensional shock wave- stationary normal shock- governing equations- Prandtl- Meyer relations- Shock strength- Rankine- Hugoniot Relation- Normal Shock on T-S diagram- working formula- curves and tables-Oblique shock waves - supersonic flow over compression and expansion corners (basic idea only).	7	15%
IV	Flow in a constant area duct with friction (Fanno Flow) – Governing Equations- Fanno line on h-s and P-v diagram- Fanno relation for a perfect gas- Choking due to friction- working tables for Fanno flow- Isothermal flow(elementary treatment only)	6	15%
SECOND INTERNAL EXAM			
V	Flow through constant area duct with heat transfer (Rayleigh Flow)- Governing equations- Rayleigh line on h-s and P-v diagram- Rayleigh relation for perfect gas- maximum possible heat addition- location of maximum enthalpy point- thermal choking- working tables for Rayleigh flow.	6	20%
VI	Compressible flow field visualization and measurement- Shadowgraph-Schlieren technique- interferometer- subsonic compressible flow field -measurement (Pressure, Velocity and Temperature) – compressibility - correction factor- hot wire anemometer- supersonic flow measurement- Shock tube-Rayleigh Pitot tube- wedge probe- stagnation temperature probe- temperature recovery factor –Kiel probe - Wind tunnels – closed and open type-	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Use of approved gas tables permitted

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

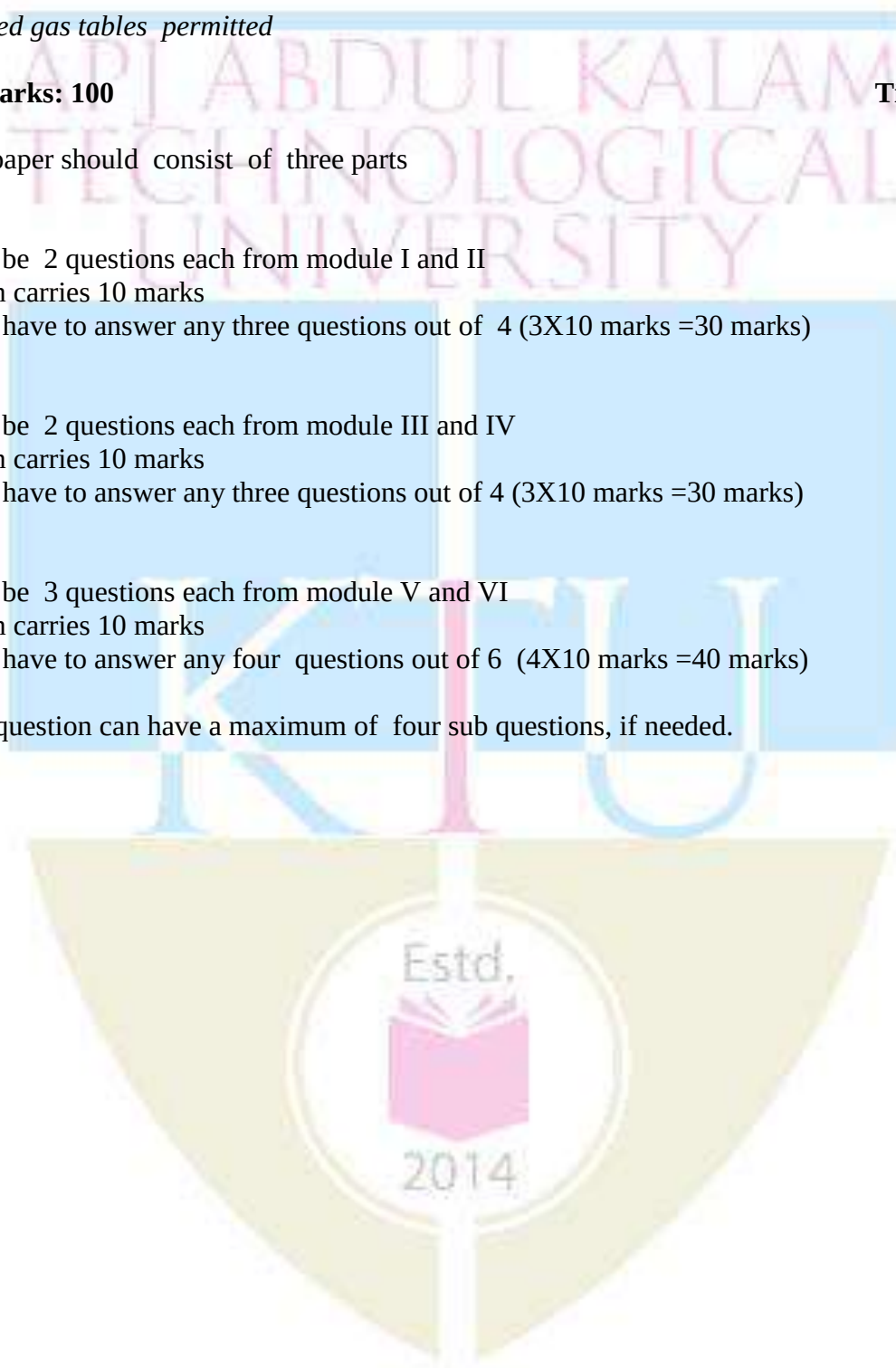
Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
ME431	MECHANICAL ENGINEERING LAB.	0-0-3-1	2016
Prerequisite : ME302 Heat and mass transfer, ME304 Dynamics of machinery			
Course Objectives: - To conduct the various heat transfer experiments - To practice calibration of thermometer and pressure gauges - To do experiments on dynamics			
Syllabus List of experiments: Heat transfer - Determination of LMTD and effectiveness of parallel flow, Counter flow and cross flow heat exchangers(double pipe heat exchanger) - Determination of heat transfer coefficients in free convection(free convection apparatus) - Determination of heat transfer coefficients in forced convection (forced convection apparatus) - Determination of thermal conductivity of solids(composite wall) - Determination of thermal conductivity of powder - Determination of Thermal conductivity of liquids - Determination of emissivity of a specimen (emissivity apparatus) - Determination of Stefan Boltzman constant (Stefan Boltzmann apparatus) - Study and performance test on refrigeration (Refrigeration Test rig) - Study and performance test air conditioning equipment(air conditioning test rig) - Performance study on heat pipe(Heat pipe) - Calibration of Thermocouples - Calibration of Pressure gauge Dynamics - Whirling of shaft - Gyroscope - Universal governor apparatus - Free vibration analysis - Forced vibration analysis Note: Minimum 9 experiments in heat transfer and 3 experiments in dynamics are mandatory			
Expected outcome: The students will be able to - Conduct experiments to determine thermal conductivity of materials - Determine heat transfer coefficient, LMTD etc.. - Do calibration of thermometers and pressure gauges - Demonstrate the effect of unbalances resulting from rotary motions - Visualise the effect of dynamics on vibrations in single and multi degree of freedom system - Demonstrate the working principle of governor /gyroscope and demonstrate the effect of forces and moments on their motion			

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME461	Aerospace Engineering	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: : - To understand the fundamentals of aerospace engineering - To provide an understanding of flight instruments			
Syllabus: The atmosphere, airfoil theory, 2D, 3D or Finite aero foils Propellers, Aircraft performance, Flight Instruments, stability of aircrafts, wind tunnel testing			
Expected Outcomes: The students will be able to i. Identify, formulate and solve aerospace engineering problems ii. Perform analysis of flight dynamics of aircrafts			
Text books: - A.C. Kermode, Mechanics of flight, Prentice Hall, 2007 - Anderson, Fundamentals of Aerodynamics, McGraw-Hill, 2010 - EHJ Pallett, Aircraft Instruments and Integrated systems, Longman,1992			
Reference books: Houghton and Brock, Aerodynamics for Engineering Student, Hodder & Stoughton,1977			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	The atmosphere-characteristics of troposphere , stratosphere , thermosphere, and ionosphere- pressure, temperature and density variations in the atmosphere. Application of dimensional analysis – aerodynamic force – model study and similitude. 2D aero foils -Nomenclature and classification- pressure distribution in inviscid and real flows- momentum and circulation theory of aerofoil- characteristics.	8	15%
II	3D or Finite aero foils – effect of releasing the wingtips- wing tip vortices- replacement of finite wing by horseshoe vortex system, lifting line theory-wing load distribution – aspect ratio, induced drag calculation of induced drag from momentum considerations. Skin friction and from drag- changes in finite wing plan shape	7	15%
FIRST INTERNAL EXAMINATION			

III	Propellers – momentum and blade element theories –propeller coefficients and charts. Aircraft performance-straight and level flight –power required and power available graphs for propeller and jet aircraft	6	15%
IV	Gliding and climbing –rate of climb-service and absolute ceilings-gliding angle and speed of flattest glide takeoff and landing performance – length of runway required- aircraft ground run- circling flight – radius of tightest turn-jet and rocket assisted take –off high lift devices-range and endurance of airplanes- charts for piston and jet engine aircrafts.	7	15%
SECOND INTERNAL EXAMINATION			
V	Flight Instruments-airspeed indicator, calculation of true air speed-altimeter, gyrohorizon -direction indicator-vertical speed indicator –turn and back indicator-air temperature indicator. (Brief description and qualitative ideas only). Ideas on stability-static and dynamic stability- longitudinal, lateral and directional stability- controls of an aero plane- aerodynamic balancing of control surfaces- mass balancing (Qualitative ideas only).	7	20%
VI	Principles of wind tunnel testing –open and closed type wind tunnels-wind tunnel balances supersonic wind tunnels. Study of subsonic, Transonic, and supersonic aircraft engines (Description with figures Only).Elementary ideas on space travel-calculation of earth orbiting and escape velocities ignoring air resistance and assuming circular orbit.	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME462	Propulsion Engineering	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives: - To give an overview of various air craft engines, rocket engines and their applications. - To provide knowhow on tools to analyze various rocket propulsion. - To know the testing of rocket engines .			
Syllabus: Fundamentals of Propulsion, Types of propulsive devices, Efficiencies, Thermodynamics analysis of turbojet, Turbojet engine components, Rocket propulsion, Types of rockets, Flight Performance, Testing of rockets			
Expected Outcomes: The students will be able to - Perform thermodynamic analysis of aircraft engines - Carry out performance analysis of aircraft systems and components - Formulate and solve rocket engine problems			
Text books: - K Ramamurthi, Rocket Propulsion, Laxmi Publications, 2016 - Saeed Farokhi, Aircraft Propulsion, Wiley, 2e, 2014			
Reference books: G. P. Sutton and Oscar Biblarz, Rocket Propulsion elements- John Wiley & Sons, 2013 - J Mattingly, H von Ohain, Elements of Propulsion: Gas Turbines and Rockets, AIAA, 2006 - Philip Hill, Carl Peterson: Mechanics and Thermodynamics of Propulsion, Pearson, 2014 - Ronald D Flack, Fundamentals of Jet Propulsion with Applications, Cambridge University Press, 2005			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	Fundamentals of Propulsion- Classification types of propulsive devices-Aircrow, Turbojet, Turboprop, turbofan, Turboshift, Ramjet, Scramjet, Pulsejet and Rocket engines. Comparative study of performance characteristics applications.	7	15%
II	Theory of propulsion – Thrust, thrust power and efficiencies of turbojet engine. Thermodynamics analysis of turbojet engine cycle, Propellers: Types of propellers	7	15%
FIRST INTERNAL EXAMINATION			

III	Turbojet engine components- air intakes, Compressors, Combustion chambers, turbines, nozzles turbine and compression matching – Thrust augmentation.	7	15%
IV	Rocket propulsion- general operating principles of chemical, electrical nuclear and solar rockets. Chemical Rockets-Classification. Performance parameters for chemical rockets and their relationship, Energy and efficiencies, simple problems, Solid propellants- Types- burning rate- grain Configurations, - Classification- Typical fuels and oxidizers, properties and specifications, Selection.	7	15%
SECOND INTERNAL EXAMINATION			
V	Liquid propellant feed systems, injectors, Starting and ignition, Igniters liquid propellant, Precautions in propellant handling. Hybrid Rockets combustion processes in SPR and LPR combustion instability- Control of instabilities –Cooling of Rocket motors	7	20%
V1	Flight Performance- Velocity and attitude in simplified vertical Refractory staging of rockets. Rocket Testing- Test facilities and safeguards. Measurement System Terminology, Flight Testing.	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

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2014

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME463	Automobile Engineering	3-0-0-3	2016
Pre requisites: Nil			
Course objectives - To know the anatomy of automobile in general - To understand the working of different automotive systems and subsystems - To update the latest developments in automobiles			
Syllabus:- Engine, clutch, transmission, steering, brakes, suspension and aerodynamics			
COURSE OUTCOMES: The students will be able to: - Practically identify different automotive systems and subsystems. - Understand the principles of transmission, suspension, steering and braking systems of an automobile - Develop a strong base for understanding future developments in the automobile industry			
Text Books - Gupta R.B. Auto design , Satya Prakash, New Delhi, 2015 - Heinz Heisler, Advanced engine technology, Butterworth-Heinemann,1995 - Heinz Heisler, Advanced vehicle technology, Society of Automotive Engineers Inc, 2002 - Hillier and Peter Coobes, Fundamentals of motor vehicle technology, Nelson Thornes, 2004 - Tom Denton, Automobile mechanical and electrical systems, Butterworth-Heinemann, 2011			
Course Plan			
Module	Contents	Hours	End Sem. Exam. Marks
I	Piston: - material for piston, clearances, piston rings, types, need for two compression rings, oil control ring, piston pin.	1	15%
	Piston for IC engine, piston rings, piston pin, connecting rod, crank shaft, crank pin, cam shaft, valves, fly wheel, fluctuation of energy and size of fly wheel, hub and arms, stress in a fly wheel rim, simple problems.	1	
		1	
	Petrol fuel injection systems: - comparison petrol injection and carbureted fuel supply systems- comparison –multiport fuel injection (MPFI) and common rail direct injection (CRDI) systems.	1	
		1	
	Super charging systems: fundamentals, naturally aspirated engines and supercharged engines– Turbo charger, turbo lag.	1	

	Hybrid cars, safety overview -Formula-I engine technology: overview, electrical technology, brakes, transmission technology.	1	
II	Friction clutch:- fundamentals, driven plate inertia, driven plate transmitted torque, driven plate wear –angular driven plate cushioning and torsional damping, clutch friction materials, when clutch is worn out.	1	15%
	Pull type diaphragm clutch, multiple diaphragm clutch, multi-plate hydraulically operated automatic transmission clutch, semi centrifugal clutch, fully automatic centrifugal clutch, and integral single plate diaphragm clutch.	1	
		1	
	Need of gear box, resistance to vehicle motion, power to weight ratio, speed operating range-five speed and reverse sliding mesh, constant mesh, and synchromesh gear boxes:- gear synchronization and engagement.	1	
		1	
	Over drives – hydrodynamic fluid couplings: - efficiency and torque capacity – fluid friction coupling- torque converters.	1	
		1	
FIRST INTERNAL EXAMINATION			
III	Steering:-basic principle of a steering system:- swinging beam system – Ackermann –over steer and under steer – slip angle, camber, caster etc.	1	15%
		1	
	Swivel axis inclination: centre point steering, camber, king pin inclination, negative offset, caster, toe-in and toe-out	1	
	Steering gear box: - fundamentals screw and nut steering gear mechanism-worm and roller type steering gear box – Re-circulating ball nut and rocker lever, re-circulating ball rack and sector steering gear box– need of power assisted steering.	1	
		1	
		1	
	External direct coupled and rack and pinion and integrated steering power cylinder, power assisted steering lock limitations	1	
IV	Suspension: - suspension geometry, terminology-Macpherson strut friction and spring offset - suspension roll centers:-roll centers, roll axis, roll centre height, short swing and long arm suspension, transverse double wishbone, parallel trailing double arm and vertical pill strut suspension, Macpherson strut suspension, semi-trailing arm rear suspension, telescopic suspension.	1	15%
		1	
	High load beam axle leaf spring, sprung body roll stability. Rear axle beam suspension- body roll stability analysis:- body roll couple, body roll stiffness, body over turning couple	1	

	Body weight transfer, body direct weight transfer couple, body roll couple distribution, body roll weight transfer, lateral force distribution.	1	15%
	Anti roll bars and roll stiffness:- anti roll bar function, operating principle, anti roll bar action caused by the body rolling, single wheel lift -rubber spring bumper:-bump stop function and characteristics, axis inclination.	1	
	Rear suspension: - live rigid axle suspension, non drive rear suspension- swing arm rear wheel drive independent suspension.	1	
	Low pivot split axle coil spring wheel drive independent suspension, trailing and semi trailing arm rear wheel drive independent suspension.	1	
	Transverse double link arm rear wheel drive independent suspension, De Dion axle rear wheel suspension - Hydrogen suspension, hydro-pneumatic automatic height correction suspension.	1	
SECOND INTERNAL EXAMINATION			
V	Brakes:- mechanical and hydraulic brakes (review only) – properties of friction lining and pad materials, efficiency, stopping distance, theory of internal shoe brake, equations – effect of expanding mechanism of shoes on total braking torque, equations.	1	20%
		1	
	Braking vehicles:- brakes applied on rear, front and all four wheels, equations –calculation of mean lining pressure and heat generation during braking operation, equations. – braking of vehicle moving on curved path, simple problems.	1	
		1	
	Anti Lock Braking system (ABS):- need and advantages of ABS – hydro-mechanical ABS - hydro-electric ABS - air-electric ABS.	1	
	Brake servos: - operating principle, vacuum servo - direct acting suspended vacuum assisted brake servo unit operation - hydraulic servo assisted brake systems.	1	
	Pneumatic operated disc brakes – air operated brake systems: - air over hydraulic brake system - Three line brake system-- electronic-pneumatic brakes.	1	
V1	Aerodynamic drag: pressure drag, air resistance, opposing motion of a vehicle, equations, after flow wake, drag coefficients, various body shapes, base drag, vortices, trailing vortex drag, attached transverse vortices.	1	20%
		1	
	Aerodynamic lift:-lift coefficients, vehicle lift, underbody floor height versus aerodynamic lift and drag, aerofoil lift and drag, front end nose shape.	1	
		1	
	Car body drag reduction:-profile edge chamfering, bonnet	1	

	slope and wind screen rake, roof and side panel chamfering, rear side panel taper, underbody rear end upward taper, rear end tail extension, underbody roughness.		
	Aerodynamic lift control:- underbody dams, exposed wheel air flow pattern, partial enclosed wheel air flow pattern, rear end spoiler, negative lift aerofoil wings.	1	
	After body drag: - square back drag, fast back drag, hatch back drag, notch back drag.	1	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME464	Robotics and Automation	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: : - To provide the concepts of vision system and image processing - To equip students to write programs for automatic functioning of a robot - To familiarise various robot sensors and their perception principles that enable a robot			
Syllabus: Definition ,Co-ordinate Systems, Work Envelope, types and classification, Robot drive systems, End Effectors, Grippers, Sensors and machine vision, Robot kinematics and robot programming, Application of robots in machining.			
Expected Outcomes: The students will be able to - Become familiar with the history, concept, development and key components of robotics technologies - Classify and characterize the robots based on the configuration and work volume - Solve the problems related to robot design and control			
Text books: - Industrial Robots, Yu.Kozyrev, Mir Publishers - Janakiraman.P.A., Robotics and Image Processing, Tata McGraw-Hill, 1995 - M.P.Groover, Industrial Robotics – Technology, Programming and Applications, McGraw-Hill, 2001 - Yoram Koren, Robotics for Engineers, McGraw-Hill Book Co., 1992			
References: - Fu.K.S. Gonzalz.R.C., and Lee C.S.G., Robotics Control, Sensing, Vision and Intelligence, McGraw-Hill Book Co., 1987 - K.S.Fu., R.C.Gonalez, C.S.G.Lee, Robotics Control sensing, Vision andIntelligence, McGraw Hill International Edition, 1987 - Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Robotic engineering- An Integrated Approach , Prentice Hall Inc, 1989			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	Definition – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Basic robot motions - Point to point control, Continuous path control. Robot Parts and Their Functions – Need for Robots Different Applications.	7	15%
II	Robot drive systems: Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications	7	15%

	and Comparison of all these Drives.		
FIRST INTERNAL EXAMINATION			
III	End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations	7	15%
IV	Sensors and machine vision: Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Laser Range Meters).	7	15%
SECOND INTERNAL EXAMINATION			
V	Proximity Sensors(Inductive, Capacitive, and Ultrasonic), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors. Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Robot kinematics and robot programming: Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two Degrees of Freedom (In 2 Dimensional) – Deviations and Problems.	7	20%
V1	Teach Pendant Programming, Lead through programming, Robot programming Languages –VAL Programming – Motion Commands, Sensor Commands, End effector commands, and Simple programs. Industrial Applications: Application of robots in machining, welding, assembly, and material handling.	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum **marks: 100**

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME465	Industrial Hydraulics	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: : - To introduce various fluid power systems - To get knowledge on fluid power circuits			
Syllabus: Introduction to fluid power, Properties of fluids. Selection of fluids, Pumps, Hydraulic cylinders and rams, Fluid power pumping systems and components, Hydraulic Actuators, Fluid temperature control, Piping systems, Control circuits			
Expected Outcomes: The students will be able - To understand the various components used in fluid power systems - To select the suitable system for a particular application - To know the various fluid circuits used in hydraulic systems			
Text books: B. Lall, Oil Hydraulics, International Literature Association D. A. Pease, Basic Fluid Power, Prentice Hall, 1986 J. J. Pipenger, <u>Tyler Gregory Hicks</u>, Industrial Hydraulics, McGraw Hill, 1979 - Pinches, Industrial Fluid Power, Prentice Hall, 1989 - R.K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd., 2017			
Reference: - ISO - 1219, Fluid Systems and components, Graphic Symbols - Andrew A. Parr, Hydraulics and Pneumatics, Elsevier, 1999 - Michael J. Pinches and Ashby J. G, Power Hydraulics, Prentice Hall, 1988 - Yeaple, Fluid Power Design Handbook, CRC Press, 1995			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to fluid power – Hydraulics and Pneumatics systems – Fluid power systems – Fundamentals of fluid mechanics, Properties of fluids. Selection of fluids, additives, effect of temperature and pressure on hydraulic fluids, Measurement of physical parameters – Hydraulic symbols	7	15%
II	Pumps: Types, classification, principle of working & constructional details of vane pump, gear pumps, radial and axial plunger pumps, Power and efficiency calculations, char, Curves, selection of pumps for hydraulic power transmission	7	15%
FIRST INTERNAL EXAMINATION			

III	Hydraulic cylinders and rams – Fluid power pumping systems and components. Pressure accumulators – Functions – Fluid reservoirs – Filter in hydraulic circuits. Loading and replacement of filter elements – Materials for filters.	7	15%
IV	Hydraulic Actuators (i) Linear and Rotary. (ii) Hydraulic motors - Types- Vane, Gear, Piston types, radial piston. (iii) Methods of control of acceleration, deceleration. (iv) Types of cylinders and mountings. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads. (vi) Design considerations for cylinders. Cushioning of cylinders.	7	15%
SECOND INTERNAL EXAMINATION			
V	Fluid temperature control – Fluid pressure control –control valves – Sequence -valve – Counterbalance valve-unloading valve – Friction control valve – Servo systems, Hoses & Pipes : Types , materials , pressure drop in hoses/pipes. Hydraulic piping connections.	7	20%
V1	Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit (Numerical treatment), motor breaking circuit	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME466	Computational Fluid Dynamics	3-0-0-3	2016
Prerequisite : ME203 Mechanics of fluids			
Course Objectives: : - To introduce governing equations of viscous fluid flows - To introduce numerical modelling and its role in the field of fluid flow and heat transfer - To enable the students to understand the various discretization methods, solution procedures and turbulence modelling. - To create confidence to solve complex problems in the field of fluid flow and heat transfer using high speed computers.			
Syllabus: Introduction to CFD, Governing equations, Steady and unsteady flows, Analytical solution of a one dimensional convection diffusion equation, Statistical representation of turbulent flows, Different types of turbulence models, Grid generation, Pressure-velocity decoupling for incompressible flows, Typical results of CFD analysis			
Expected Outcomes: The students will be able to - Grasp numerical modelling and its role in the field of fluid flow and heat transfer - Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems - Know established engineering methods to solve complex engineering problem			
Text books: - Patankar Suhas V., Numerical Heat Transfer and Fluid Flow, Taylor & Francis, 1980 - Versteeg H.K. & Malalasekera W., An introduction to Computational Fluid Dynamics, Longman, 2008			
Reference books: - Anderson Dale A., Tannehill John C. & Pletcher Richard H., Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 2016 - Fletcher C.A.J., Computational Techniques for Fluid Dynamics I, Springer Verlag, 1984			
Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to CFD, Historical background, applications, advantages. Basic steps of CFD. Meshes, Structured and unstructured mesh, Classification of structured grids. Governing equations: continuity and momentum equations. Equation of transport of a scalar. Potential, Euler and Navier-Stokes equations	7	15%
II	Steady and unsteady flows. Typical boundary conditions such as Dirichlets and Neumann conditions. TDMA method., Numerical	7	15%

	problem up to four unknowns using TDMA. Cell centred finite volume discretisation of terms of governing equations such as time derivative, convective and diffusion.		
FIRST INTERNAL EXAMINATION			
III	Analytical solution of a one dimensional convection diffusion equation. Upwind, central and blended difference approximations for convection term, QUICK scheme. Implicit, explicit and Crank-Nicolson schemes	7	15%
IV	Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence	7	15%
SECOND INTERNAL EXAMINATION			
V	Turbulence modeling, Different types of turbulence models: advantages and disadvantages. Structured Grid generation – Unstructured Grid generation– Mesh refinement – Adaptive mesh	7	20%
VI	Pressure-velocity decoupling for incompressible flows - SIMPLE and PISO algorithms. Density based solutions for compressible flow, TVD and Van-leerschemes for compressible flow. Typical results of CFD analysis. Stream lines, method for generating stream line, velocity contours and pressure contours, Method of drawing a velocity vector. Solution of Lagrangian coordinates of a fluid particle. Commercial CFD packages.	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME467	Cryogenic Engineering	3-0-0-3	2016
Prerequisite : NIL			
Course Objectives: : - To provide the knowledge of evolution of low temperature science - To provide knowledge on the properties of materials at low temperature - To familiarize with various gas liquefaction systems and to provide design aspects of cryogenic storage and transfer lines			
Syllabus: Introduction to Cryogenics, Applications of Cryogenics, Properties of materials at cryogenic temperature, Liquefaction systems, Gas liquefaction systems, Cryogenic Refrigeration systems, Cryogenic fluid storage and transfer systems, Cryogenic instrumentation, heat exchangers used in cryogenic systems			
Expected Outcomes: The students will be able to - Understand properties of material at cryogenic temperatures. - Know about various liquefaction systems - Get ideas on cryogenic refrigeration systems, cryogenic instrumentation and cryogenic heat exchangers			
Text books J. H. Boll Jr, Cryogenic Engineering R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959 - Randal F.Barron, Cryogenic systems, McGraw Hill, 1986			
Reference books: Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.			
Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Cryogenic Systems, Historical development, Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties. Applications of Cryogenics: Applications in space, Food Processing, super conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry. Low temperature properties of engineering materials	8	15%
II	Liquefaction systems ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers.	7	15%
FIRST INTERNAL EXAMINATION			

III	Gas liquefaction systems: Introduction-Production of low temperatures-General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium –Critical components of Liquefaction systems	6	15%
IV	Cryogenic Refrigeration systems: Ideal Refrigeration systems-Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media;,	6	15%
SECOND INTERNAL EXAMINATION			
V	Cryogenic fluid storage and transfer systems: Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems.	8	20%
V1	Cryogenic instrumentation, Pressure flow-level and temperature measurements. Types of heat exchangers used in cryogenic systems(only description with figure) Cryo pumping Applications	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME468	Nanotechnology	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: - To introduce nanotechnology and nanostructures - To introduce fabrication and characterization techniques used in nanotechnology			
Syllabus: Introduction and scope, nanostructures Effect of Nanoscale dimensions on various properties, Fabrication methods, Characterisation methods, Applications of Nanotechnology (nano materials and devices), Nanomachines, Nanofluids, Nanoswitches, nano computers, nanofilters			
Expected Outcomes: The students will be able to - Understand properties of materials at nanoscale - Know the fabrication and characterization methods used in nanotechnology - Acquaint with the various applications of nanotechnology			
Text books: - A.K. Bandyopdhyay, Nanomaterials, , New age international publishers,2008 - Bharat Bhushan, Springer Handbook of Nanotechnology, 2010 Charles P Poole, Frank J Owens, Introduction to Nanotechnology, John Wiley and Sons, 2003 - Jeremy Ramsden,Nanotechnology, William Andrew, Elsevier, 2011 - T Pradeep, Nano: The essentials, McGraw – Hill education,2 007 - V.S.Muralidharan, A Subramnya,Nano science and Technology, Ane books Pvt Ltd			
Reference books: - Gregory Timp, Nanotechnology, Springer-Verlag, 2009 - John Mongillo, Nano Technology, Greenwood Press, 2007 - Kelsall Robert. W, Ian Hamley, MarkGeoghegan, Nanoscale Science and Technology, Wiley Eastern,2005			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction and scope-Classification of nanostructures: Quantum dots, quantum wires, quantum wells, nanoclusters, nanotubes, super lattices, nanocrystalline materials-Effects of nanometer length scale – Changes to the system total energy, changes to the system structures.	7	15%
II	Effect of Nanoscale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties.	7	15%
FIRST INTERNAL EXAMINATION			

III	Fabrication methods: Top down and bottom up approaches-Top down processes: Milling, Lithographics, machining process, pulsed laser methods- Bottom up processes: Vapour phase deposition methods, PVD, CVD, electro deposition, plasma assisted deposition process, MBE, chemical methods, colloidal and solgel methods	7	15%
IV	Characterisation methods: General classification of characterization methods, Microscopy techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Diffraction Techniques-Spectroscopy Techniques – Raman Spectroscopy, Surface analysis and depth profiling- Mechanical Properties- Magnetic and Thermal properties.	7	15%
SECOND INTERNAL EXAMINATION			
V	Applications of Nanotechnology (nano materials and devices)-Applications of nanocomposites, nanocrystalline materials, nano layered structures, nanomagnetic materials-magneto resistance-Carbon nanotubes: SW, MW, nanostructured coatings- nano sensors: order from chaos, characterization, perception, nano sensor based on quantum size effect, Electrochemical sensors, Sensors based on physical properties, Nanobiosensors, smart dust	7	20%
V1	Nanomachines: covalent and non covalent approaches, Molecular motors and machines, molecular devices, single molecular devices, practical problems with molecular device- Nanofluids: nanoparticles, preparation of nanofluids, thermophysical properties of nanofluids in comparison with base fluid. Nanoswitches - nano computers- nanofilters	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME469	FINITE ELEMENT ANALYSIS	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives - To learn the mathematical background of finite element methods. - To understand the basics of finite element formulation. - To practice finite element methodologies through structural and heat transfer problems.			
Syllabus Introduction; Brief history; Review of elasticity; Direct approach; 1D bar element; Analogous problems; Beam elements; Plane truss; Coordinate transformations; Interpolation functions; Shape functions; Variational methods; Strong and weak form; Rayleigh Ritz method; FE formulation using minimization of potential; Consistent nodal loads; Higher order elements; Iso parametric elements; Weighted residual methods; FEA software packages.			
Expected outcome The students will be able to - understand the mathematical background of FEM . - solve real life problems using finite element analysis			
Text Books: - Chandrupatla T R., Finite Element Analysis for Engineering and Technology, University Press, 2004 - Hutton D V., Fundamentals of Finite Element Analysis, Tata McGraw-Hill, 2005 - Logan D L., A first course in the Finite Element Method, Thomson-Engineering, 2012 - Seshu P., Text Book of Finite Element Analysis, PHI Learning Pvt. Ltd., 2003			
References Books: - Cook R D., Malkus D S., Plesha M E., Witt R J., Concepts and Analysis of Finite Element Applications, John Wiley & Sons, 1981 - Reddy J N., An introduction to the Finite Element Method, McGraw- Hill, 2006			

Course			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Finite Element Method (FEM)- Brief history- Application of FEA- Advantages and disadvantages. Review of elasticity- Strain displacement relations- Compatibility-Stress strain relations- Boundary conditions- Plane stress, plane strain and axisymmetry.	2	15%

	Direct approach-1D bar element- element stiffness- Assembly of elements- properties of [K] matrix- Treatment of boundary conditions- Stress computation.	4	
II	Analogous problems of torsion, heat conduction and laminar pipe flow. Beam elements- FE formulation-element stiffness matrix- boundary conditions.	4	20%
	Plane truss- Element formulation-Co ordinate transformation- Local and global co ordinates- Stress calculations.	4	
FIRST INTERNAL EXAMINATION			
III	Interpolation functions-Shape functions- Lagrange interpolation- 1D linear and quadratic element	3	15%
	Variational methods: Functionals- Strong and weak form- Essential and natural boundary conditions.	3	
IV	Principle of stationary potential energy- Rayleigh Ritz method.	3	20%
	FE formulation using minimization of potential- B matrix- Element matrices for bar element- Consistent nodal loads.	4	
SECOND INTERNAL EXAMINATION			
V	Higher order elements- Quadratic and cubic elements-Pascal's triangle-Serendipity elements.	3	15%
	Iso parametric elements, Natural coordinates, Area co ordinates- Quadrilateral elements-Jacobian matrix-Gauss quadrature.	5	
VI	Weighted residual method: Galerkin FE formulation. Axially loaded bar-Heat flow in a bar	5	15%
	Structure of FEA software package. Introduction to Modal analysis, non linear analysis and coupled analysis.	2	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100,

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

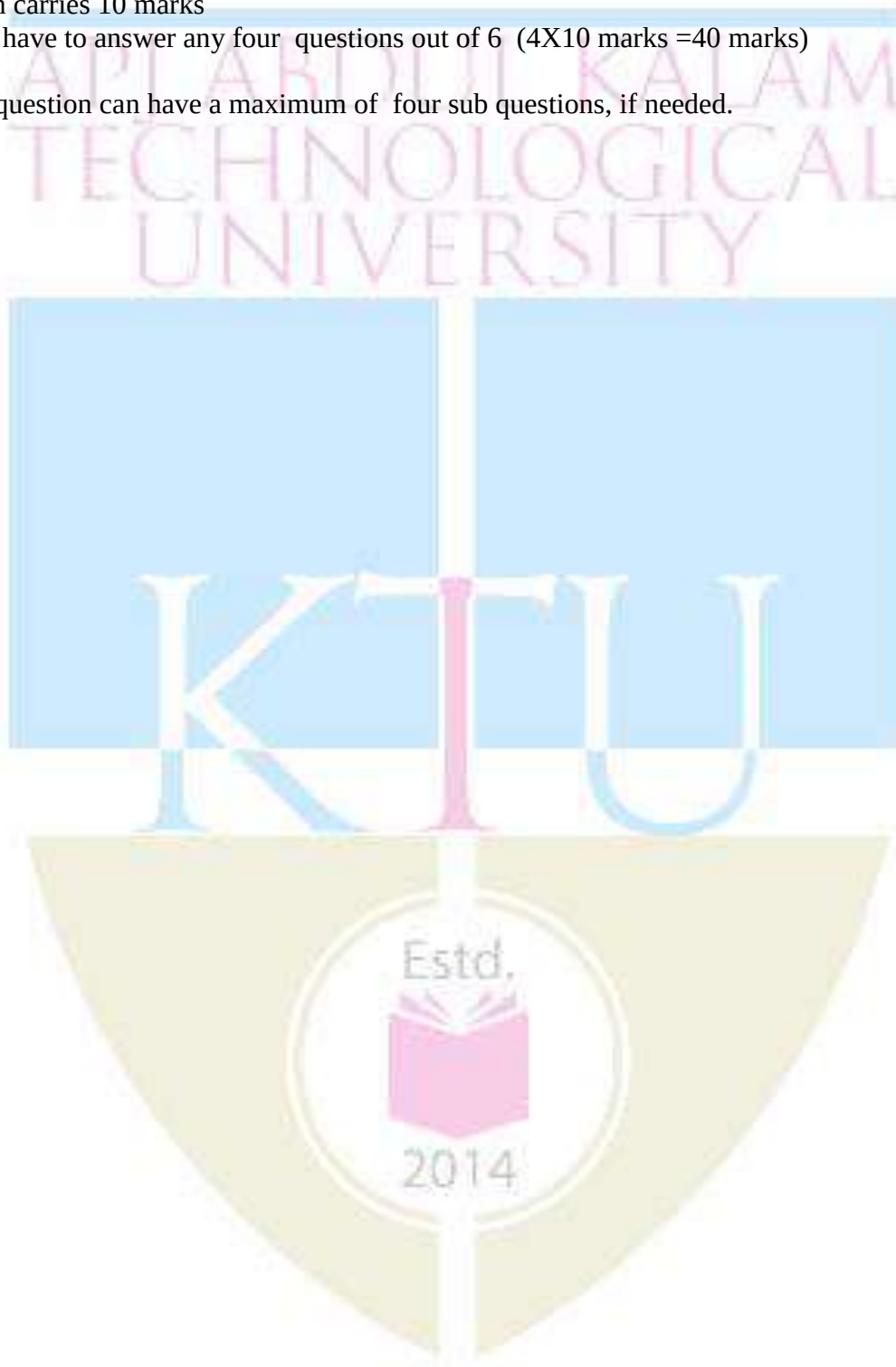
Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
ME471	Optimization Techniques	3-0-0-3	2016
Prerequisite - ME372 Operations Research			
Course Objective: To learn the various optimization techniques for effective decision making.			
Syllabus: Linear programming – integer programming– network models – goal programming – dynamic programming – nonlinear programming – nontraditional optimization.			
Expected Outcome: The students will be able to understand optimization techniques and apply them in solving practical problems			
Text Books:			
1. Miller, D. M. and Schmidt, J. W., Industrial Engineering and Operations Research, John Wiley & Sons, Singapore, 1990. 2. Paneerselvam, R., Operations Research, Prentice Hall of India, New Delhi, 2008. 3. Pannerselvam, R., Design and Analysis of Algorithms, Prentice Hall of India, New Delhi, 2007. 4. Taha, H. A., Operations Research, Pearson, 2004.			
Reference Books:			
1. Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., Discrete-Event System Simulation, Third Edition, Pearson Education, Inc., 2001 2. Goel, B. S. and Mittal, S. K., Operations Research, Pragati Prakashan, Meerut, 1999. 3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Willey & Sons, 1987 4. Srinivasan, G. “Operations Research-Principles and Applications”, latest edition, PHI Pvt. Ltd.			
Course Plan			
Module	Contents	Hours	End Sem. Exam. Marks
I	Review of linear programming– revised simplex method	1	15%
		1	
	Dual simplex method	1	

		1	
	Sensitivity analysis – changes affecting feasibility – changes affecting optimality	1	
		1	
		1	
II	Integer programming – importance – applications	1	15%
	Branch and bound technique	1	
		1	
	Gomory’s cutting plane method	1	
		1	
	Solution to travelling salesman problem	1	
FIRST INTERNAL EXAMINATION			
III	Network models – minimal spanning tree problem	1	15%
	PRIM’s algorithm	1	
	Kruskal’s algorithm	1	
	Shortest route problem –applications	1	
	Systematic method	1	
	Dijkstra’s algorithm	1	
	Floyd’s algorithm	1	
IV	Goal programming – goal programming formulation-application.	1	15%
		1	
		1	
	Simplex method for solving goal programming	1	
	Dynamic programming – terminologies – forward and backward recursion –applications	1	
		1	
Shortest path problems	1		
SECOND INTERNAL EXAMINATION			
V	Nonlinear programming – convex, quasi-convex, concave and unimodal functions – theory of constrained optimization	1	20%
		1	
		1	
	Lagrangean method	1	
		1	
		1	
VI	Nontraditional optimization – computational complexity- Introduction to metaheuristics – areas of application	1	20%
		1	
		Genetic algorithm (GA) – terminologies – steps and examples	
	Tabu search (TS) – steps and examples	1	
	Simulated annealing (SA) – steps and examples	1	
	Ant colony optimization (ACO) – steps and examples - Particle	1	
	Swarm Optimization (PSO)-Steps and examples	1	

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME472	FAILURE ANALYSIS AND DESIGN	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives - To understand the failure modes and theories of failure. - To include the effect of cyclic loading, fatigue and endurance limit in design. - To understand the methods for lifecycle prediction.			
Syllabus Material failure modes and their identification. Static loading, combined stress, theories of failure. Fatigue loading, high cycle fatigue, fatigue testing, S-N-P curves, endurance diagrams, influence factors, stress concentration factors and notch sensitivity, fatigue design for combined stress, cumulative damage and life prediction, low cycle fatigue, fracture mechanics principles in design practice, contact fatigue, high temperatures, corrosion. Shock and impact loading.			
Expected outcome The students will be able to - analyze real life failure modes and use of theories for failure prediction - design for fatigue and cyclic loading - make comprehensive life cycle prediction of designed products			
Text Books: - Collins. J. A., Failure of Materials in Mechanical Design, John Wiley & Sons, 1993 - Suresh S, Fatigue of Materials, Cambridge University Press, 1998			
References Books: - Prashant Kumar, Elements of Fracture Mechanics, Wheeler Publishing, 1999 - Withered C. E., Mechanical Failure Avoidance Strategies and Techniques, McGraw-Hill, 1994			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to material failure modes- Identification of failure modes	3	15%
	Combined stresses –Theories of failure	5	

II	Fatigue loading, high cycle fatigue, fatigue testing, S-N-P curves-factors affecting S-N-P curve- endurance diagrams	6	20%
FIRST INTERNAL EXAM			
III	Cumulative damage and life prediction- Fracture control	5	15%
	Fatigue design for combined stress	2	
IV	Low cycle fatigue – Cumulative damage in low cycle fatigue	4	20%
	Influence factors- Stress concentration factors and notch sensitivity	4	
SECOND INTERNAL EXAM			
V	Fracture mechanics principles in design practice	6	15%
VI	Contact fatigue, high temperatures, corrosion	4	15%
	Shock and impact loading.	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME474	Micro and Nano Manufacturing	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives 1. To give awareness of different techniques used in micro and nano manufacturing 2. To give in-depth idea of the conventional techniques used in micro manufacturing 3. To introduce Non-conventional micro-nano manufacturing and finishing approaches 4. To introduce Micro and Nanofabrication Techniques and other processing routes in Micro and nano manufacturing 5. To know different techniques used in Micro Joining and the metrology tools in micro and nano manufacturing.			
Syllabus Introduction to Precision engineering- Bulk micromachining – Micro-energy -Carbon Nanotubes - Molecular Logic Gates and Nanolevel Biosensors - Conventional Micro Machining - Non-conventional micro-nano manufacturing and finishing approaches - Micro and Nano Finishing Processes - Micro and Nanofabrication Techniques - Micro Joining - Characterization and metrology tools.			
Expected outcome The students will 1. get an awareness of different techniques used in micro and nano manufacturing. 2. get in-depth idea of the conventional techniques used in micro manufacturing. 3. become aware about non-conventional micro-nano manufacturing and finishing approaches. 4. get awareness on micro and nano finishing processes. 5. understand micro and nanofabrication techniques and other processing routes in micro and nano manufacturing. 6. know about different techniques used in micro joining and the metrology tools in micro and nano manufacturing.			
References: 1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006. 2. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006. 3. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, 2006. 4. V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.			
Course Plan			
Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Precision engineering, macro milling and micro drilling, Micro-electromechanical systems – merits and applications, Micro phenomenon in Electro-photography – applications	1	15%

	Introduction to Bulk micromachining, Surface micromachining-steps, Micro instrumentation – applications, Micro Mechatronics, Nanofinishing – finishing operations.	1	
	Laser technology in micro manufacturing- Practical Lasers, application of technology fundamentals	1	
	Introduction to Micro-energy and chemical system (MECS), Space Micro-propulsion, e-Beam Nanolithography – important techniques, Introduction to Nanotechnology	1	
	Carbon Nano-tubes – properties and structures, Molecular Logic Gates and Nano level Biosensors - applications	1	
II	Introduction to mechanical micromachining, Micro drilling – process, tools and applications	1	15%
	Micro turning- process, tools and applications, Diamond Micro turning – process, tools and applications	1	
	Micro milling and Micro grinding – process, tools and applications	1	
	Micro extrusion- process and applications	1	
	micro bending with Laser	1	
	Nano- Plastic forming and Roller Imprinting	1	
	FIRST INTERNAL EXAMINATION		
III	Introduction to Non-conventional micro-nano manufacturing	1	15%
	Process, principle and applications – Abrasive Jet Micro Machining, WAJMM	1	
	Micro EDM, Micro WEDM, Micro EBM – Process principle, description and applications	1	
	Micro ECM, Micro LBM - Process principle, description and applications	1	
	Focused ion beams - Principle and applications	1	
IV	Introduction to Micro and Nano Finishing Processes	1	15%
	Magnetorheological Finishing (MRF) processes, Magnetorheological abrasive flow finishing processes (MRAFF) – process principle and applications	1	
	Force analysis of MRAFF process,	1	
	Magnetorheological Jet finishing processes	1	
	Working principle and polishing performance of MR Jet Machine	1	
	Elastic Emission Machining (EEM) – machine description, applications	1	
	Ion Beam Machining (IBM) – principle, mechanism of material removal, applications	1	
	Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications	1	
	SECOND INTERNAL EXAMINATION		
V	Introduction to Micro Fabrication: basics, flowchart, basic chip	1	20%

	making processes		
	Introduction to Nanofabrication, Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp)	1	
	Manipulative techniques – process principle, applications	1	
	Introduction to Carbon nano materials – CN Tubes	1	
	CN Tubes – properties and applications	1	
	CN Tube Transistors – Description only	1	
	Diamond - Properties and applications	1	
	CVD Diamond Technology	1	
	LIGA Process	1	
V1	Laser Micro welding – description and applications, Defects	1	20%
	Electron Beam Micro-welding – description and applications	1	
	Introduction to micro and nano measurement, defining the scale, uncertainty	1	
	Scanning Electron Microscopy – description, principle	1	
	Scanning White-light Interferometry – Principle and application	1	
	Optical Microscopy – description, application	1	
	Scanning Probe Microscopy, scanning tunneling microscopy- description, application	1	
	Confocal Microscopy - description, application	1	
	Introduction to On-Machine Metrology	1	
	END SEMESTER EXAMINATION		

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME476	Material Handling & Facilities Planning	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: : - To understand the overall facilities planning process - To educate product, process and schedule design and their effects on the facility layout - To introduce concepts of material handling and safety in industries.			
Syllabus: Design of layout of factories, General equipment for amenities of working people, Computer applications in layout designs, Environmental aspects, Plant safety, Economical aspects			
Expected Outcomes: The students will be able to - Assess the value of facility planning on the strategy of a firm - Develop a systematic plant layout - Know the environmental and economical aspects in facilities planning - Understand various material handling systems			
Text books/Reference books: - A W Peymberton, Plant layout and Material Handling, John Wiley - James A Apple, Plant layout and Material Handlin, Krieger Pub Co,1998 - John A Sehbin, Plant layout and Material Handling- - K C Arora & Shinde, Aspects of Material handling, Lakshmi Publications. - P B Mahapatra, Operations Management, PHI, 2010			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	Design of layout of factories, Office, Storage area etc. on consideration of facilities of working people, Storage facilities and general equipment for amenities of working people – Product, Process and combination layout –Systematic layout planning, Design of Assembly lines, Line balancing methods.	8	15%
II	Computer applications in layout designs, Environmental aspects like lighting, Ventilation, dust control, humidity. Different type of Plant services like steam compressed air etc.	6	15%
FIRST INTERNAL EXAMINATION			
III	Plant safety, Elements off Industrial safety- Causes and prevention of accidents – Pollution and environmental consideration.	6	15%
IV	Introduction, Material Handling systems, Material Handling principles, Classification of Material Handling Equipment, Relationship of material handling to plant layout.	8	15%

SECOND INTERNAL EXAMINATION			
V	Basic Material Handling systems: Selection, Material Handling method- path, Equipment, function oriented systems.	7	20%
V1	Methods to minimize cost of material handling- Maintenance of Material Handling Equipments, Safety in handling, Ergonomics of Material Handling equipment. Design, Miscellaneous equipment	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME482	Energy Conservation and Management	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: : 1. To enable analysis of the energy data of industries, energy accounting and balancing 2. To know energy audit and methodologies for energy savings 3. To understand utilization of the available resources in optimal ways			
Syllabus: Energy, Power, Past & Present scenario of World; National Energy consumption Data, Components of EB billing, Boilers, Furnaces and Thermic Fluid Heaters, Pumps, Fans, Blowers, Energy audit, Energy Economics			
Expected Outcomes: The students will be able to i. carryout energy accounting and balancing ii. suggest methodologies for energy savings			
Text books: 1. Callaghn, P.W. Design and Management for Energy Conservation, Pergamon Press, Oxford,1981. 2. Witte. L.C., P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publ, Washington, 1988.			
References: 1. Dryden. I.G.C., The Efficient Use of Energy Butterworths, London, 1982 2. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com, a website of Bureau of Energy Efficiency (BEE), A statutory body under Ministry of Power, Government of India, 2004. 3. Murphy. W.R. and G. Mc KAY, Energy Managemen”, Butterworths, London 1987. 4. Turner. W.C., Energy Management Hand book, Wiley, New York, 1982.			
Module	Contents	Hours	End Sem. Exam. Marks
I	Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing	7	15%

II	Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.	7	15%
FIRST INTERNAL EXAMINATION			
III	Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories	7	15%
IV	Energy efficiency in Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets	7	15%
SECOND INTERNAL EXAMINATION			
V	Energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering	7	20%
VI	Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concepts	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME484	Finite Element Analysis	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: : 1. To introduce the concepts of Mathematical Modeling of Engineering Problems. 2. To appreciate the use of FEA to a range of Engineering Problems.			
Syllabus: Historical Background, Mathematical Modeling of field problems in Engineering ,Governing Equations, Basic concepts of the Finite Element Method, Solution of problems from solid mechanics and heat transfer, Fourth Order Beam Equation, Second Order 2D Equations involving Scalar Variable Functions, Equations of elasticity, Natural co-ordinate systems			
Expected Outcomes: • The students will be able to understand different mathematical techniques used in FEM analysis and use them in Structural and thermal problems			
Text books: 1. Reddy. J.N., An Introduction to the Finite Element Method, 3rd Edition, Tata McGraw-Hill, 2005 2. Seshu, P, Text Book of Finite Element Analysis, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.			
Reference books: 1. Bhatti Asghar M, Fundamental Finite Element Analysis and Applications, John Wiley & Sons,2005 (Indian Reprint 2013) 2. Chandrupatla & Belagundu, Introduction to Finite Elements in Engineering, 3rd Edition, Prentice Hall College Div, 1990 3. Logan, D.L., A first course in Finite Element Method, Thomson Asia Pvt. Ltd., 2002 4. Rao, S.S., The Finite Element Method in Engineering, 3rd Edition, Butterworth Heinemann, 2004 5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, Concepts and Applications of Finite Element Analysis, 4th Edition, Wiley Student Edition, 2002.			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique	7	15%
II	Basic concepts of the Finite Element Method. One Dimensional	7	15%

	Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices		
FIRST INTERNAL EXAMINATION			
III	Solution of problems from solid mechanics and heat transfer Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.	7	15%
IV	Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.	7	15%
SECOND INTERNAL EXAMINATION			
V	Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.	7	20%
VI	Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.