APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B. Tech. Syllabus

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

2016

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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, 10^{th} ed

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

- Aruldhas, 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 Chathurvedi, 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

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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 - measurment 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	

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	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,Optial 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 (Numaericals)	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 - Dulongs 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

1. To apply the principles of mechanics to practical engineering problems.
2. To identify appropriate structural system for studying a given problem and isolate it from its environment.
3. To develop simple mathematical model for engineering problems and carry out static analysis.
4. 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

1. Students will be able to apply and demonstrate the concepts of mechanics to practical engineering problems.
2. Students will be able to determine the properties of planes and solids.
3. 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 turbinesand 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

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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).

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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 Inductors- terminal V-I relations	1	15%
	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
- Boylested, 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

1. To learn basics of digital computers
2. To develop problem solving skills
3. 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

1. Ability to design algorithmic solution to problems.
2. Ability to convert algorithms to Python programs.
3. Ability to design modular Python programs using functions
4. Ability to design programs with Interactive Input and Output, utilizing arithmetic expression repetitions, decision making, arrays.
5. Ability to design programs using file Input and Output.
6. 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. *(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 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.)* **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. *(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.)*	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. *(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.)* **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%

	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.)		
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		

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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 6 20% 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.		
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		

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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

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- 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

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Course Plan

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.

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.

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

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 Srivasthava, 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. CengageLearing,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	CREDITS:4	
MODULE	CONTENT	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, Homogenous linear ODEs with constant Coefficients (Higher Order) (For practice and submission as assignment only: Modelling of free oscillations of a mass – spring system)	3 4	17
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 Legendre's Linear equations Method of variation of parameters for finding PIs (For practice and submission as assignments only: Modelling forced oscillations, resonance, electric circuits)	7 2 3	17
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 Fourier cosine series and Fourier sine series (Fourier series of even and Odd functions) Half range expansions (All results without proof)	3 3 3	17

	(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/ftmsc/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	
	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	20%
	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. Lissajeous 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. Meldes 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.

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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 ^{1}H 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

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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.

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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.

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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

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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.

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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 Ritche D.M., The C. Programming Language, PHI.

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COURSE PLAN

Module	Contents	Contact Hours	Sem.ExamMarks;%
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 code	Course Name	L-T-P-Credits	Year of Introduction
CS120	Computer Programming Lab		2016

Course Objective:

To implement algorithms studied in the course ComputerProgramming

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.

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 *(basics only)* – analogy between stress and strain tensors - strain-displacement relations *(small-strain only)* – 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 *(only short derivations for examination)*	3	15%
	Application of stress function to Lame's problem and stress concentration problem of a small hole in a large plate *(only stress distribution)*	3	
	Axisymmetric problems – governing equations – application to thick cylinders,, rotating discs.	4	
IV	Unsymmetrical bending of straight beams *(problems having c/s with one axis of symmetry only)* – curved beams *(rectangular c/s only)* - shear center of thin walled open sections *(c/s with one axis of symmetry only)*	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 X10 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 X10 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			

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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.VanWylen, 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.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

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-Fe_3C, 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. *et.al*., 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-

solid-state-chemistry-fall-2010/syllabus/
13. http://www.msm.cam.ac.uk/teaching/partIA.php

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. *(brief review only, no University questions and internal assessment from these portions).*	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 a eutectoid iron–carbon alloy, CCT diagram, applications - annealing, normalizing, hardening, spheroidizing.	1	
	Tempering:- austermpering, 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-rystallization, 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

1. Rajput R K, Heat and Mass Transfer, S. Chand publishing., 2015. ,
2. Eastop T. D. and A. McConkay, Applied Thermodynamics , Pearson Education, 5th Ed
3. Thermal Engineering, Ballaney P. L., Khanna publishers, 1994. ,
4. Arora C. P., Refrigeration and Air conditioning, Tata McGraw Hill, 2000
5. Sachdeva R. C., Fundamentals of Engineering Heat and Mass Transfer, New Age Science Ltd., 2009.
6. 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 . 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 4	20%
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 Vapour Absorption refrigeration – Layout Ammonia –water system and Electrolux system. Air conditioning – Psychrometry - basic definitions, psychometric chart, psychometric processes - human comfort - comfort chart and limitations (brief discussion only) Summer and Winter Air conditioning Window type Air conditioning system	5 4	20%
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 – Risering – 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.Kalpakjian and Steven R Schimid, Manufacturing Engineering and Technology, Pearson,2001

Reference books:-

1. RAO, Manufacturing Technology-Vol 2 3e, McGraw Hill Education India, 2013
2. RAO, Manutacturing Technology-Vol 1 4e, McGraw Hill Education India, 2013
3. Cyril Donaldson and George H LeCain, Tool Design,TMH
4. Handbook of Fixture Design – ASTME
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,20111
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 – Risering	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.

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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 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 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:

i. Analyze flow problems associated with statics, kinematics and dynamics of fluids.
ii. Design and analyze fluid devices such as water turbines and pumps.
iii. Understand and rectify problems faced in practical cases of engineering applications.

Text Book:

1. Modi P. N. and S. M. Seth, *Hydraulics & Fluid Mechanics*, S.B.H Publishers, New Delhi, 2002.
2. Kumar D. S., *Fluid Mechanics and Fluid Power Engineering,* S. K. Kataria & Sons, New Delhi, 1998.

References:

1. J. F. Douglas, "Fluid Mechanics", Pearson education.
2. Cengel Y. A. and J. M. Cimbala, Fluid Mechanics, Tata McGraw Hill, 2013
3. Robert W. Fox and Mc Donald, "Introduction to fluid dynamics", John Wiley and sons
4. K. Subrahmanya, "Theory and applications of fluid mechanics", (TMH)
5. Shames. I. H, "Mechanics of fluids".
6. Jagadish Lal, "Fluid mechanics and Hydraulic machines".
7. 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.

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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

i. Integrate the concepts, laws and methodologies of thermodynamics in the analysis of cyclic processes

ii. Apply the thermodynamic concepts in applications like Steam Turbines, Compressors, Gas turbines.

Text Books:

1. Rudramoorthy , Thermal Engineering, McGraw Hill Education India,2003
2. R.K Rajput, Thermal Engineering, Laxmi publications,2013
3. Rathore**,** Thermal Engineering 1e, McGraw Hill Education India, 2010
4. Ballaney P.L, Thermal Engg, Khanna Publishers, 2007

Data Book (Approved for use in the examination): Steam Tables

References:

1. Kearton WJ, Steam turbines theory and practice- A text book for engineering students, Aristophanes press, 2011
2. Cohen, Rogers and Saravanamuttoo, Gas turbine Theory, Longman, 1996.
3. 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

i. understand crystal structure and various imperfections in materials.
ii. acquire a knowledge about alloying and phase diagrams
iii. know the relationship between structure, properties, processing and performance of metals.
iv. study about various fracture and failure mechanisms in structural components.
v. be able to select materials for specific applications.

Text Books:

- Raghavan V, Material Science and Engineering, Prentice Hall,2004

References:

1. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009
2. Callister William. D., Material Science and Engineering, John Wiley,2014
3. Dieter George E, Mechanical Metallurgy, Tata McGraw Hill,1976
4. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998
5. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008
6. Van Vlack -Elements of Material Science - Addison Wesley,1989
7. Askland and Phule- The Science and Engineering of Materials, Thompson publishers, 2007
8. Anderson J.C. *et.al*., Material Science for Engineers, Chapman and Hall,1990
9. Clark and Varney,Physical metallurgy for Engineers, Van Nostrand,1964
10. Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning,2009
11. http://nptel.ac.in/courses/113106032/1
12. http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2
13. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/syllabus/
14. 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			

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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
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

i. understand the principles in the formation of mechanisms and their kinematics.
ii. understand the effect of friction in different machine elements.
iii. analyse the forces and toques acting on simple mechanical systems
iv. 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 Dukkipatti 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

i. Become conversant with the concepts of flow measurements and flow through pipes
ii. Be able to apply the momentum and energy equations to fluid flow problems.
iii. Be able to evaluate head loss in pipes and conduits.
iv. Be able to 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:

1. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005
2. Cengel, Fluid Mechanics, McGraw Hill Education India 2014
3. Fox R. W. and A. T. McDonald, Introduction to Fluid dynamics, 5/e, John Wiley and Sons, 2009.
4. Joseph Karz, Introductory Fluid Mechanics, Cambridge University press,2010
5. 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.
6. Shames I. H, Mechanics of Fluids, McGraw Hill, 1992.
7. 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:

1. P L Ballaney, Theory of Machines and Mechanisms, Khanna Publishers
2. S S. Rattan-Theory of machines, McGraw Hill

References:

1. Bevan, Theory of Machines, Pearson Education, 1986
2. Rao J S and Dukkipati R V, Mechanism and Machine Theory, Wiley EasternLtd.
3. Malhotra, D.R and Gupta, H C, Theory of Machines, Satya Prakasam Tech. India Publications Ltd.
4. Gosh A and Mallick A K, Theory of Machines and Mechanisms, Affiliated East West Press .
5. 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

1. P L Ballaney, Theory of Machines and Mechanisms, Khanna Publishers
2. S S. Rattan-Theory of machines, McGraw Hill

References:

1. J. E. Shigley and J.J Uicker, Theory of Machines and Mechanisms, McGraw–Hill.
2. T. Bevan T., Theory of Machines- A Text Book for Engineering Students, Pearson.
3. Wilson C. E. and J. P. Sadler, Kinematics and Dynamics of Machinery, Pearson.
4. Ambekar A. G., Mechanism and Machine Theory, PHI Learning.
5. Gosh A. and A. K. Mallick, Theory of Machines and Mechanisms, Affiliated East West Press.
6. 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):

1. P.S.G., Tech., Machine Design Data Handbook
2. K. Mahadevan , Design data Book -– C.B.S Pub.

References:

1. Shigley J.E., Mechanical Engineering Design, McGraw Hill Book Company
2. Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company
3. Phelan R.M., Fundamentals of Mechanical Design, TMH, Ltd.
4. Doughtie V.L & Vallance A.V., Design of Machine Elements, McGraw Hill Book Company
5. Juvinall R.C. &Marshek K.M., Fundamentals of Machine Component Design, John Wiley
6. Machine Design Robert L Norton , Prentice Hall India
7. Design of machine elements M.F.Spotts, Prentice Hall India
8. Machine Design – Wentzell, Thomson Learning
9. 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

i. Integrate the concepts, laws and methodologies from the course in thermodynamics into analysis of cyclic processes

ii. To apply the thermodynamic concepts into various thermal application like IC engines, Refrigeration and air conditioning, Heat exchangers.

Text Books:

1. Rudramoorthy , Thermal Engineering, Tata McGraw Hill Education India, 2003
2. R.K Rajput, Thermal Engineering, Laxmi publications,2010
3. Rathore, Thermal Engineering 1e, Tata McGraw Hill Education India, 2010

References Books:

1. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill,2002
2. T.D. Eastop and A McConkay, 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

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Fuels and combustion- Stochiometry, 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
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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
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

1. Determination of coefficient of discharge and calibration of rectangular notch
2. Determination of coefficient of discharge and calibration of triangular notch.
3. Determination of coefficient of discharge and calibration of venturI meter
4. Determination of coefficient of discharge and calibration of orifice meter.
5. Determination of hydraulics coefficient using orifice apparatus.
6. Determination of meta-centric height and radius of gyration of floating body.
7. Pipe friction apparatus to find Darcy's frictional coefficient and Chezy's constant.
8. Performance test on positive displacement pump
9. Performance test on centrifugal pump
10. Performance test on impulse turbine.
11. Performance test on reaction turbine.
12. Performance test on hydraulic ram
13. Performance test on two stroke diesel engine.
14. Performance test on four stroke diesel engine.
15. Performance test on four stroke petrol engines
16. Performance test on two stroke petrol engines
17. 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
ME235	MACHINE DYNAMICS AND MATERIAL TESTING LAB	0-0-3-1	2016

Prerequisite: ME209 & ME213

Course Objectives:

- To make the students understand the theory of machines through practical exercises.
- To acquire knowledge on material testing principles and use of destructive testing equipment.

Syllabus

List of experiments:

1. Tensile Test on Mild Steel, High carbon Steel and Cast Iron specimens
2. Shear test on MS Rod
3. Torsion test on MS, Aluminium and Brass wire
4. Izod and Charpy Impact tests
5. Hardness test (Rockwell and Brinnell)
6. Compression test on helical springs
7. Microscopic Examination of Steels, Cast Iron, Al, Cu, Zn
8. Thermal Expansion Coefficient using Dial Gauge Dilatometer.
9. Strain Measurement using Rosette strain gauge
10. Test to study the effect of hardening- Improvement in hardness and impact resistance of steels.
11. Tempering - Improvement Mechanical properties Comparison (i) Unhardened specimen (ii) Quenched Specimen and (iii) Quenched and tempered specimen.
12. To study magnetic hysteresis of ferromagnetic material.
13. Universal Governor Apparatus
    a) Determination of speed and sensitivity of Watt governor
    b) Determination of speed and sensitivity of Proel governor
    c) Determination of speed and sensitivity of Porter governor
14. Determination of whirling speed of shaft
15. Cam Study Analysis (Circular cam with roller, knife edge and flat follower)
16. Pendulum Experiment
    a) Simple pendulum Experiment
    b) Bifilar suspension Pendulum Experiment
    c) Compound pendulum Experiment
17. Torsional vibration
    a) Single rotor Torsional vibration experiment
    b) Single rotor Torsional vibration experiment
18. Journal bearing experiment

Expected outcome:

- After completion of this programme, students are expected to have knowledge on material testing principles, destructive testing and practical background of machines theory.

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

1. Demonstration of construction and operations of general purpose machines :– lathe, drilling machine, milling machine, shaper, planning machine, slotting machine, cylindrical grinder, surface grinder, and tool and cutter grinder.
2. Plane turning and Step turning on lathe.
3. Groove turning (cup and ball) and taper turning on lathe.
4. Thread cutting and knurling operations on lathe.
5. Exercise on machining flat surfaces, grooving keyways using shaping machines.
6. Machining of V –block using shaper machines.
7. Machining grooves and key slots using slotting machine.
8. Experiment on drilling machines –drilling and boring operations.
9. Reaming, counter sinking and tapping operations using drilling machines.
10. Experiment on milling machine – Plane milling, keyway cutting, and cutting of splines.
11. Experiment on vertical milling.
12. Cutting of spur gear on milling machine.
13. Grinding of plane surface using surface grinding machine.
14. Cylindrical grinding using cylindrical grinding machine.

Expected outcome.

The students will be able to

i. operate different machine tools using proper work holders
ii. produce different part features to the desired quality.

Text Books:

1. R.K. Jain, Production Technology, Khanna Publishers.
2. HMT, Production Technology, Tata McGraw Hill.
3. Chapman, Workshop Technology Vol II, ELBS.
4. 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.
   Equipment: 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.
   Equipment: HSS Single point cutting tool.

3. Study of Centre Lathe.
   Equipment: Centre Lathe.

To perform following lathe operations on a work piece for given dimensions :

4. Plane Turning.
   Equipment: HSS Single point cutting tool (V-tool), Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, and Vernier calliper.

5. Step Turning.
   Equipment: HSS Single point cutting tool (V-tool), Parting tool, Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, and Vernier calliper.

6. Grooving.
   Equipment: 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.
   Equipment: 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.
   Equipment: 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, CO_2 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,

CO_2 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, CO_2 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
   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.

2. Study of Drilling Machines.
   Equipment: Radial Drilling Machine.

3. Study of Nomenclature of Drill Bit.
   Equipment: Drill Bit.

4. To Drill the Given Work Piece as Required.
   Equipment: Mild Steel Work Piece, Drill Bit, Lot Drill Bit, Drill Chuck.

5. Study of Shaping Machines.
   Equipment: Shaper Machine.

6. To Perform V- Machining on the Given Work Piece.
   Equipment: Shaper Machine, Punching Machine, Steel Rule, Hammer, Shaper Tool, Try Square.

7. To Perform U-Cut on the Given Work Piece.
   Equipment: Shaper machine, Steel rule, Hammer, Shaper tool, Try Square.

8. Study of Slotting Machines
   Equipment: Slotter.

9. To make a Slot on the Given Work Piece.
   Equipment: Slotting Machine, Steel rule, Hammer, Shaper tool, Try Square.

10. To Cut External Key Way Using Slotter.
    Equipment: Slotting Machine, Steel Rule, Hammer, Shaper Tool, Try Square.

11. Study of Milling Machines.
    Equipment: Milling Machine.

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 - interchangability	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 EXAMINATIONEXAM			
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' 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			

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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.

KTU Estd. 2014

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, Merchants 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 us 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

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	
V1	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

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

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

1. Develop the design and practical problem solving skills in the area of mechanisms
2. Understand the basics of vibration and apply the concepts in design problems of mechanisms.

Text Books:

1. Ballaney P.L. Theory of Machines, Khanna Publishers,1994
2. S. S. Rattan, Theory of Machines, Tata McGraw Hill, 2009
3. V. P. Singh, Theory of Machines, Dhanpat Rai,2013

References :

1. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education, 2003
2. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press, 2003
3. H. Myskza, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education, 4e, 2012
4. Holowenko, Dynamics of Machinery, John Wiley, 1995
5. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,1995
6. 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

1. Balagurusamy, Computer Programming 1e McGraw Hill Education , 2013
2. Balagurusamy, Numerical Methods 1e McGraw Hill Education, 1999
3. Jose S., Computer Programming and Numerical Methods, Pentagon, 2015.
4. Ravichandran D., Programming with C++, Tata McGraw Hill, 2007.

Reference Books

1. Balaguruswamy E., Object Oriented Programming with C++, Tata McGraw Hill, 1992.
2. Barkakati N., Object Oriented Programming in C++, SAMS, 1991.
3. Gerald C. F. and P. O. Wheatley, Applied Numerical Analysis, Pearson,2004.
4. Kamthane A. M., Object Oriented Programming with ANSI & Turbo C++,
5. 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, electrolysıs, 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:

1. R L Norton, Kinematics and Dynamics of Machinery, 1st ed., Tata McGraw Hill Education Private Limited, Delhi, 2004
2. S .S Rattan Theory of Machines, 3rd ed., Tata McGraw Hill Education Private Limited, Delhi, 2009

References:

1. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, Oxford University Press, 2016
2. A. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press, 3e, 2006
3. C. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, 3rd edition, Pearson Education, 2003
4. 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 – Involutes 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, Addision 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 makee 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

i. Identify the crystal structures of metallic materials.
ii. Analyze the binary phase diagrams of alloys Fe-Fe3C, etc.
iii. Correlate the microstructure with properties, processing and performance of metals.
iv. Recognize the failure of metals with structural change.
v. Select materials for design and construction.
vi. Apply core concepts in materials science to solve engineering problems.

Text Books

1. Jose S and Mathew E V, Metallurgy and Materials Science, Pentagon, 2011
2. Raghavan V, Material Science and Engineering, Prentice Hall,2004

References

1. Anderson J.C. *et.al*., Material Science for Engineers,Chapman and Hall,1990
2. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill, 2009
3. Callister William. D., Material Science and Engineering, John Wiley, 2014
4. Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964
5. Dieter George E, Mechanical Metallurgy, Tata McGraw Hill,1976
6. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998
7. Myers Marc and Krishna Kumar Chawla, Mechanical behaviour of materials, Cambridge University press,2008
8. Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning, 2009
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-tosolid- State-chemistry-fall-2010/syllabus/
13. 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. *(brief review only, no Universityquestions and internal assessment from these portions.)*	**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:- austermpering, 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	
	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:

1. Helmi A Youssef, Hassan A El-Hofy and Mahmoud H Ahmed, Manufacturing Technology (materials, processes and equipments) , CRC Press, 2017
2. Kalapakjian and Schmid , Manufacturing Engineering and Technology, Pearson, 7e, 2013

References:

1. Hine and Rosenthal, Principles of Metal Casting , Tata McGraw Hill India, 1995
2. 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

i. Understand the working of linear and angular measuring instruments.
ii. 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.
iii. Get an exposure to advanced measuring devices and machine tool metrology.
iv. Acquire an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
v. Get basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Text books

1. Anand K Bewoor, Vinay A Kulkarni, Metrology & Measurement, McGraw-Hill, 2009
2. Ernest O. Doebelin, Dhanesh N. Manik, Measurement Systems Application and Design, McGraw-Hill, 2004
3. Galyer J.F.W., Schotbolt C.R., Metrology for Engineers, ELBS,1990
4. 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, Rt, Rz 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**	
V1	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:

1. C.S,Sarma, KamleshPurohit, Design of Machine Elements Prentice Hall of India Ltd NewDelhi
2. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 8e, 2003
3. T. Krishna Rao, Design of machine Elements volume 2 I K International Publishing House Pvt. Ltd New Delhi, 2011
4. V.B.Bhandari, Design of Machine Elements McGraw Hill Book Company, 4e, 2016

Data book (permitted for reference in the University examination)

1. K. Lingaiah , Machine Design Data hand book, Suma Publishers, Bangalore/ Tata McGraw Hill

References:

1. Doughtie V.L., &Vallance A.V., Design of Machine Elements, McGraw Hill Book Company, 1964
2. J. E. Shigley, Mechanical Engineering Design, McGraw Hill Book Company, 5e, 1986
3. Juvinall R.C &Marshek K.M., Fundamentals of Machine Component Design, John Wiley, 5e, 2011
4. 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

i. Design simple components, joints and fasteners
ii. Select bearings for supporting rotating parts
iii. 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:

1. Robert L Norton Machine Design-An integrated Approach, Pearson, 2002
2. C S Sharma, Kamalesh Purohit, Design of Machine Elements, PHI Learning Pvt. Ltd, 2009
3. Shigly J.E., Mechanical Engineering Design, McGraw Hill, 2003
4. M.F Spotts, Design of Machine Elements, Prentice Hall India Pvt. Limited, 6e, 1991
5. Doughter & Valance, Design of Machine Elements, McGraw Hill publishers
6. 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:

1. S.C. Sachdeva, "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi,1981.
2. 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:

1. C.Y.Chow, "Introduction to Computational Fluid Dynamics", John Wiley, 1979.
2. J.P. Holman, "Heat Transfer", McGraw-Hill Book Co., Inc., New York, 6e, 1991.
3. John D. Anderson, JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New York, 1995.
4. John H. Lienhard, "A Heat Transfer Text Book", Prentice Hall Inc., 1981.
5. P. S. Ghoshdasidar , "Computer simulation of low and Heat transfer" McGraw-Hill Book Co, Inc, NewDelhi, 1998.
6. 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. Heat Exchange Analysis –E-NTU Method.	3	
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**

  Class exercises 60 marks
  Regular class viva 10 marks
  Final internal exam using software 30 marks
  All the above three evaluations are mandatory.

References Books:

1. Daryl Logan, A First course in Finite Element Method, Thomson Learning, 2007
2. David V Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill,2003
3. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill, 2007
4. Mikell P. Groover and Emory W. Zimmer, CAD/ CAM – Computer aided design and manufacturing, Pearson Education,1987
5. 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 tesing different properties of fuels & lubricants
- To perform characteristic tests on petrol and diesel engines.

List of Exercises/Experiments :

1. Determination of viscosity using Saybolt Viscometer.
2. Determination of viscosity using Redwood Viscometer.
3. Determination of Flash point and Fire point using Pensky Marten's Apparatus.
4. Fuel Injection Pump Testing and Calibration of Fuel Injection pump.
4. Performance Test on Multi cylinder Four Stroke Diesel Engine.
5. Performance Test on Multi cylinder Four Stroke Petrol Engine.
6. Retardation Test on Twin cylinder Four Stroke Diesel Engine.
7. Morse Test on Multi cylinder Four Stroke Petrol engine.
8. Heat Balance Test on Multi cylinder Four Stroke Diesel Engine.
9. Volumetric Efficiency Test on Multi cylinder Four Stroke Diesel Engine.
10. Volumetric Efficiency Test on Multi cylinder Four Stroke Petrol Engine.
11. Cooling curve Test on Twin cylinder Four stroke Diesel Engine.
12. Valve Timing on Four stroke Diesel/ Petrol Engine
13. Determination of calorific value of liquid fuel using bomb calorimeter
14. 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

i. Test different Properties of fuels and lubricants.
ii. 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 sprit 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: -

1. butt welding and
2. lap welding

Experiment on lathe:-

3. Facing,
4. plain turning,
5. step turning,
6. parting – groove cutting,
7. knurling and chamfering
8. form turning and taper turning –
9. Eccentric turning.
10. Measurement of flank wear in turning process using tool makers microscope.

Experiment on thread cutting: -

11. single and multi start external
12. single and multi start internal threads,
13. Square and V-threads.

Experiment on drilling machine: -

14. Drilling,
15. boring,
16. reaming
17. counter sinking and taping

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.

List of Exercises/ Experiments (Minimum 12 are mandatory)

1. Study of Lathes.
   Equipment: Centre lathe (Accessories & Attachments)
2. 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.
3. 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.
4. 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.
5. Study of Shaping Machine.
   Equipment: Shaping Machine
6. To perform V-Block on the given work piece
   Equipment: Shaping Machine, Cutting Tools, Try square, Parallel Block, Spanners, Marking and Measuring tools.
7. Study of Slotting Machine
   Equipment: Slotter
8. To perform a Slot on the given work piece
   Equipment: Slotting Machine, Steel rule, hammer, slotting tool, Try square.
9. To Perform Keyway using Slotter
   Equipment: Slotting Machine, Steel rule, hammer, slotting tool, Try square.
10. Study of Milling Machine(Horizontal & Vertical)
    Equipment: Horizontal Milling Machine & Vertical Milling Machine.
11. 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
12. 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.
13. To Perform Plane Milling Operation in given specimen.
    Equipment: Horizontal Milling Machine, Vernier caliper, Plane Milling Cutter, Spanners, Try Square, Parallel blocks, Marking Tools
14. To Perform Step Milling Operation in given specimens.
    Equipment: Vertical Milling Machine, Vernier caliper, End Milling Cutter, Spanners, Try Square, Parallel Blocks, Marking Tools
15. Study of Drilling Machine & Nomenclature of drill Bits

	Equipment; Radial Drilling Machine, Drill bits
16	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 Technolgy: 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

i. Recognize the particular flow regime present in typical engineering system.
ii. Demonstrate the concept of stream function, potential function and boundary layer.
iii. Calculate the vorticity of a given velocity field and analyze the vorticity in idealized vortices: forced vortex and free vortex.
iv. Choose the appropriate fluid mechanics principles needed to analyze the fluid-flow situations.
v. Recognize how fluid flow theory can be employed in a modern mechanical engineering design environment.

Text books

1. Bansal R. K., A Text Book of Fluid Mechanics and Machines, Laxmi Publications, 2010.
2. Douglas J. F., Fluid Mechanics, Pearson Education, 2005.
3. Kumar D. S., Fluid Mechanics and Fluid Power Engineering, S. K. Kataria & Sons, 1987.
4. Muralidhar K., G. Biswas, Advanced Engineering Fluid Mechanics, Alpha Science International limited, 2005.
5. Rama D. D., Fluid Mechanics and Machines, New Age International, 2009.

Reference books

1. Schlichting H., K. Gersten , Boundary Layer Theory, 8/e, Springer 2000.
2. Shames I. H., Mechanics of Fluids, 4/e, McGraw-Hill, 2002.
3. 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%**
V1	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
ME363	COMPOSITE MATERIALS AND MECHANICS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

1. To understand various matrices and reinforcements used in composites
2. To know about polymer matrix composites, metal matrix composites, ceramic matrix composites and its manufacturing and applications
3. To introduce post processing operations and micromechanics of composites

Syllabus

Composites – Reinforcements – Matrices – Polymer matrix composite – Metal matrix composite – Ceramic matrix composite – Post processing operations – Micromechanics of composites

Expected outcome:

- The students will be able to gain knowledge about composites, reinforcements, matrices, post

Text Books:

1. K. K. Chawla, Composite Materials : Science and Engineering, Springer, 3e, 2013.
2. Reddy J N (Ed.), Mechanics of Composite Materials; Selected Works of Nicholas J. Pagano, Springer, 1994
3. Robert M. Jones, Mechanics of Composite Materials, CRC Press, 1998

References Books:

1. F.L.Matthews & R.D.Rawlings, Composite Materials, Engineering and Sciences, Chapman & hall, London, 1994
2. Hand Book of Composites, George Lubin. Van Nostrand, Reinhold Co. 1982
3. Micael hyer, Stress Analysis of Fiber - Reinforced Composite Materials , Tata McGraw Hill, 1998.
4. P.K.Mallicak, Fiber-reinforced composites , Monal Deklar Inc., New York, 1988.
5. Ronald Gibson, Principles of Composite Material Mechanics , TMH, 1994.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Composite : Introduction, definition, characteristics, functions	1	15%
	classification of composites based on structure and matrix	1	
	smart composites, advantages and limitations	1	
	history, industrial scene and applications	1	
	Interfaces: wettability and bonding interface in composites	1	

	types of bonding at interface.	**1**	
II	Fibers : Introduction, types of fibers, natural fibers	**1**	**15%**
	glass fiber fabrication, structure, properties and applications	**2**	
	boron fiber fabrication, structure, properties and applications	**1**	
	carbon fiber, Ex-Pan carbon fiber	**1**	
	Ex cellulose carbon fiber, Ex-Pitch carbon	**1**	
	carbon fiber structure, properties and applications	**1**	
	aramid fiber fabrication, structure, properties and applications	**1**	
	whiskers: characteristics, properties and applications.	**1**	
	FIRST INTERNAL EXAMINATION		
III	Polymer matrix composites (PMC) : thermoset, thermoplastic and elastomeric polymers	**1**	**15%**
	properties, characteristics and applications as matrix materials	**1**	
	processing of polymer matrix composites: hand methods, Lay up method, spray up method	**2**	
	moulding methods, pressure bagging and bag moulding methods,	**1**	
	pultrusion and filament winding process.	**1**	
IV	Metal matrix composites (MMC) : classification of metals, intermetallics, alloys and their potential role as matrices in composites	**1**	**15%**
	properties, characteristics and applications of metals as matrix materials	**1**	
	production techniques: powder metallurgy, diffusion bonding, melt stirring	**2**	
	squeeze casting, liquid infiltration under pressure, spray code position, insitu process.	**2**	
	SECOND INTERNAL EXAMINATION		
V	Ceramic matrix composites (CMC) : classification of ceramics and their potential role as matrices,	**1**	**20%**
	properties, characteristics and applications of ceramics as matrix materials	**1**	
	conventional techniques : cold pressing and sintering, hot pressing, reaction bonding,	**1**	
	hot pressing and reaction bonding new techniques : liquid infiltration, pultrusion,	**1**	
	lanxide process, insitu chemical technique, sol-gel technique	**2**	

V1	Post processing operations : machining, cutting, polishing,	1	20%
	welding, rivetting and painting	1	
	Advanced post processing methods : ultrasonic welding, plasma coating,	1	
	Water jet cutting and laser machining	1	
	Micromechanics of composites: maximum stress and strain criterion (derivations)	2	
	Tsai-Hill and Tsai-Wu failure criterion (derivations)	2	
	mechanics of load transfer from matrix to fiber (description)	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
ME364	Turbomachinery	3-0-0-3	2016

Prerequisite : ME205 Thermodynamics

Course Objectives: :

1. To know the principle of operation of turbomachines
2. To provide students thorough understanding of velocity triangles, turbomachinery
3. To introduce students to fans, turbines, pumps etc..

Syllabus:

Definition of turbomachine, Application of first and second laws of thermodynamics to turbomachines, Efficiencies, Centrifugal fans and blowers, Centrifugal Compressors, Axial flow compressors, Axial and radial flow turbines

Expected Outcomes:

The students will be able to

1. Understand the operation of turbomachines
2. Gain ideas on performance characteristics, governing and selection of turbomachinery.

Text books

1. Bruneck, Fans, Pergamom Press, 1973.
2. Dixon, S.I, Fluid Mechanics and Thermodynamics of Turbomachinery , Pergamom, Press, 1990.
3. Ganesan .V, Gas Turbines , Tata McGraw Hill Pub. Co., New Delhi, 1999.
4. Stepanff, A.J, Blowers and Pumps , John Wiley and Sons Inc., 1965.
5. Yahya, S.H, Turbines, Compressor and Fans , Tata Mc Graw Hill, 1996.

Reference books

1. Earl Logan, Jr, Hand book of Turbomachinery, Marcel Dekker Inc, 1992.
2. Shepherd, D.G, Principles of Turbomachinery , Macmillan, 1969.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Definition of turbomachine, parts of turbomachines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies.	7	15%
II	Application of first and second laws of thermodynamics to turbomachines, Efficiencies of turbomachines. Stage velocity triangles, work and efficiency for compressors and turbines	7	15%
FIRST INTERNAL EXAMINATION			

III	Centrifugal fans and blowers : Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristics curves and selection, fan drives and fan noise.	**7**	**15%**
IV	Centrifugal Compressors: Construction details, types, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Axial flow compressors : Stage velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage design problems and performance characteristics.	**7**	**20%**
V1	Axial and radial flow turbines : Stage velocity diagrams, reaction stages, losses and coefficients blade design principles, testing and performance characteristics.	**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
ME365	Advanced Metal Casting	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To gain theoretical and practical knowledge in material casting processes
- To develops an understanding of the dependent and independent variables which control materials casting in a production processes.
- To impart knowledge on design of gating system for castings
- To know foundry practice of ferrous and non ferrous alloys

Syllabus

Functional requirements of molding materials, gating - type of gating- gating design- factor involved in gating design, risers – primary function of a riser-theoretical consideration-riser design and placement, solidification, heat transfer during solidification, heat flow in solidification, ferrous and non-ferrous foundry practice, steel casting, aluminum and its alloys, magnesium and its alloys, casting design, defects and testing.

Expected outcome:

- The students will have exposed to the different areas of foundry practices, gained idea about metal casting, scope and its applications.

Text Books/References

1. A.K.Chakrabarti, Casting Technology and Cast Alloys, Prentice –Hall Of India Ltd, 2005
2. Beely, Foundry Technology, Newnes-Butterworths, 1979
3. Gruzleski, The Treatment of Liquid Aluminum-Silicon Alloys, the American Foundrymen's Society Inc, USA, 1992
4. Heine, Loper and Rosenthal, Principle of Metal Casting, 2nd Edition, Tata Mc-Graw-Hill Publishing Company Limited, New Delhi, 1978
5. John Cambell, Casting, Butterworth-Heineman Ltd, Jordon Hill, Oxford, 1991
6. T.V.Rama Rao, Metal casting Principles and Practice, New Age International,2010
7. Gruzleski, The Treatment of Liquid Aluminum-Silicon Alloys, the American Foundrymen's Society Inc, USA, 1992.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	**Design of molds** Functional requirements of molding materials, type of sands Properties of molding sand, sand testing techniques Effect of molding on sand properties,	2	15%

	Bonding material	**1**	
	Mould surface coating	**1**	
	Sand design and control	**1**	
	Thermal aspect of molding sand, mould wall movement	**1**	
II	**Pouring and feeding** **Gating -** type of gating- gating design	**1**	**15%**
	Factor involved in gating design-illustrative problems in determination of filling time and discharge rate	**1**	
	Aspiration effect- effects of friction and velocity distribution	**1**	
	Risers – primary function of a riser Theoretical consideration Riser design and placement Determination of dimensions of rise- blind risers	**2**	
	Internal risers-use of chills Use of insulators and exothermic compounds	**1**	
FIRST INTERNAL EXAMINATION			
III	**Solidification**		**15%**
	Freezing of pure metal Skin effects- nucleation and growth	**1**	
	Shrinkage- freezing of alloys	**1**	
	Effect of mould materials and alloy composition on casting	**1**	
	Fluidity- factor affecting fluidity- fluidity measurement and application of fluidity	**1**	
	Gases in metals- degassing	**1**	
	Grain refinement	**1**	
	Illustrative problems related to determination of solidification time	**1**	
IV	**Heat transfer during solidification**		**15%**
	Methods of manipulating heat transfer	**1**	
	Experimental methods for the study of heat transfer during solidification		
	Crystal growth methods	**1**	
	Heat flow in solidification	**1**	
	Heat transfer with in the solid/liquid metal system	**1**	
	Heat transfer at the metal-mould interface	**1**	
	Heat flow in one dimensional solidification geometries	**1**	
	Freezing at mould wall	**1**	
	Rapid freezing in contact with a cold substrate with initial melt super cooling	**1**	
SECOND INTERNAL EXAMINATION			
V	**Ferrous and non ferrous castings** **Steel Casting** – The family of cast iron	**1**	**20%**
	Melting of steels and cast irons–Grey iron Foundry practice – ductile iron – Malleable Iron casting	**1**	

	design		
	Aluminum and its alloys: Different Aluminum alloy systems Advantage and limitation of Aluminum alloy castings	**1**	
	Molding for aluminum castings - melting of Aluminum- degassing- grain refinement	**1**	
	Modification- effect of various melt treatment on the mechanical properties of Aluminum castings.	**1**	
	Magnesium and its alloys: different alloy systems- advantage and limitation of Magnesium alloy castings Molding for magnesium casting- melting of Magnesium- flux and flux less melting	**1**	
	Type and functions of fluxes used- degassing and grain refinement- pouring technique	**1**	
	Copper alloys: advantage of Copper alloys- melting- drossing-oxygen and hydrogen in Copper melting- control of gases- de oxidation	**1**	
V1	**Casting defects and testing**		**20%**
	Functional design- metallurgical design	**1**	
	simplification of foundry practice- economic considerations	**1**	
	design of junction- specification of castings	**1**	
	inspection of castings- analysis of casting defects	**1**	
	nondestructive testing of casting- dye penetrant testing	**1**	
	magnetic flaw detection, radiography, ultrasonic testing, etc.	**1**	
	quality control and quality assurance	**1**	
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.

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Course code	Course Name	L-T-P-Credits	Year of Introduction
ME366	ADVANCED METAL JOINING TECHNOLOGY	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To expose the students to the fundamental concepts of advanced welding technologies and their relevance

Syllabus

Radiant energy welding, Electron beam and Laser beam welding, Plasma arc welding, Micro plasma welding, Magnetically impelled arc butt welding, Underwater welding, Explosive welding, Adhesive bonding, Friction welding, Friction stir welding, Friction stir processing, Diffusion welding, Cold Pressure welding, Ultrasonic welding, Vacuum brazing.

Expected outcome

- The students will be able to understand the advancements in welding technologies and processes, their significance, application areas etc. leading to the development of products and processes.

References Books:

1. ASM Metals Hand Book "Welding and Brazing", Vol. 6, ASM, Ohio, 1988.
2. Parmar R.S., "Welding Processes and Technology", Khanna Publishers, Delhi, 1998.
3. Parmer R. S., Welding Engineering and Technology", Khanna Publishers, 1997
4. Rossi, Welding Engineering, McGraw Hill, 1954.
5. Schwartz M.M., "Metals Joining Manual", McGraw-Hill Inc., 1979.
6. Udin et al., Welding for Engineers, John Wiley & Sons, New York, 1967.
7. Welding Engineers Hand Book- ASHE Vol . I, II, III and IV.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Radiant energy welding: Electron Beam Welding- Background of the Process, Guns, Weld Environment, Welding in Different Degrees of Vacuum, Equipment and Safety, Joint Design, Applications, Laser Beam Welding, Physics of Lasers, Types of Lasers, Process Parameters, Applications and Limitations.	7	15%

II	Diffusion Welding- theory and Principle of Process, Key Variables, Intermediate Materials, Deformation Welding, Equipment and Tooling, Joint Design, Economics, Advantages and Limitations, Materials and Applications, Cold Pressure Welding- Process, Equipment and Setup, Applications	6	15%
FIRST INTERNAL EXAM			
III	Explosive Welding- theory and Key Variables, Parameters, Weld Quality, Equipment and Tooling, Advantages and Limitations, Joint Design, Materials and Applications, Adhesive Bonding- theory and Key Parameters, Physical Characteristics, Metal Adhesive, Equipment, Design, Economics of Process, Materials and Applications.	7	15%
IV	Ultrasonic welding-Principles of operation, Process Characteristics and Applications, Vacuum brazing-Theory, Mechanisms and Key Variables, Equipment and Tooling, Stop-Off and Parting Agents, Advantages, Limitations, Economics Materials and Applications.	6	15%
SECOND INTERNAL EXAM			
V	Plasma arc welding: Plasma Arc Welding- theory and Principles, Transferred arc and Non-Transferred arc Techniques, Equipment and Tooling, Joint Design Advantages, Disadvantages, Economics, Materials and Applications, Needle Arc Micro Plasma Welding - Characteristics of Process, Operating Characteristics, Fixturing and Joint Design, Shielding, Weld Penetration and Shape, Applications, Magnetically impelled arc butt (MIAB) welding, Under Water Welding- Wet and Dry Under Water Welding	8	20%
VI	Friction Welding- Basic Principles, Process Variants, Different Stages of Friction Welding, Mechanism of Bonding, Influence of Process Parameters, Weld Quality and Process Control, Joining of Dissimilar Materials, Advantages, Limitations and Applications, Friction Stir Welding-Metal flow phenomena, tools, process variables and applications, Friction Stir Processing- Process, Application	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.

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Course code	Course Name	L-T-P-Credits	Year of Introduction
ME367	Non-Destructive Testing	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To introduce the basic principles, techniques, equipment, applications and limitations of NDT methods such as Visual, Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Eddy Current.
- To enable selection of appropriate NDT methods.
- To identify advantages and limitations of nondestructive testing methods
- To make aware the developments and future trends in NDT.

Syllabus

Introduction to NDT- Visual Inspection- Liquid Penetrant Inspection- Magnetic Particle Inspection- Ultrasonic Testing- Radiography Testing- Eddy Current Testing.

Expected outcome

- The students will be able to differentiate various defect types and select the appropriate NDT methods for the specimen.

Text book

- Baldev Raj, Practical Non – Destructive Testing, Narosa Publishing House ,1997

Reference books

1. Hull B. and V.John, Non-Destructive Testing, Macmillan,1988
2. Krautkramer, Josef and Hebert Krautkramer, Ultrasonic Testing of Materials, Springer-Verlag, 1990

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to NDT, Comparison between destructive and NDT, Importance of NDT, Scope of NDT, difficulties of NDT, future progress in NDT, economics aspects of NDT.	1 1	15%
	Visual Inspection - tools, applications and limitations - Fundamentals of visual testing: vision, lighting, material attributes, environmental factors.	1 1	
	visual perception, direct and indirect methods mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources	1 1	
	special lighting, a systems, computer enhanced system	1	
II	**Liquid Penetrant Inspection**: principles, properties required for a good penetrants and developers - Types of penetrants and developers	1 1	15%
	and advantages and limitations of various methods of LPI - LPI technique/ test procedure	1 1	
	interpretation and evaluation of penetrant test indications, false indication	1 1	

	and safety precaution required in LPI, applications, advantages and limitations	**1**	
FIRST INTERNAL EXAMINATION			
III	**Magnetic Particle Inspection (MPI)-** Principles of MPI, basic physics of magnetism, permeability, flux density, cohesive force, magnetizing force, rentivity, residual magnetism	**1** **1**	**15%**
	Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique, central conductor testing, magnetization using products using yokes	**1** **1**	
	direct and indirect method of magnetization, continuous testing of MPI, residual technique of MPI, system sensitivity, checking devices in MPI	**1** **1**	
	Interpretation of MPI, indications, advantage and limitation of MPI.	**1**	
IV	**Ultrasonic Testing (UT):** principle, types of waves, frequency, velocity, wavelength, reflection, divergence, attenuation, mode conversion in ultrasonic UT testing methods	**1** **1**	**15%**
	contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques	**1** **1**	
	resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used	**1** **1**	
	Reference blocks with artificially created defects, calibration of equipment, Applications, advantages, limitations, A, B and C scan - Time of Flight Diffraction (TOFD).	**1**	
SECOND INTERNAL EXAMINATION			
V	**Radiography Testing (RT):** Principle, electromagnetic radiation sources: X-ray source, production of X-rays, high energy X-ray source, gamma ray source - Properties of X-rays and gamma rays	**1** **1**	**20%**
	Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real time radiography, films used in industrial radiography, types of film, speed of films, qualities of film	**1** **1**	
	screens used in radiography, quality of a good radiograph, film processing, interpretation, evaluation of test results, safety aspects required in radiography	**1** **1**	
	applications, advantages and limitations of RT	**1**	
V1	**Eddy Current Testing (ECT)** - Principle, physics aspects of ECT like conductivity, permeability, resistivity, inductance, inductive reactance, impedance	**1** **1**	**20%**
	Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT	**1** **1**	
	equipments and accessories, various application of ECT such as	**1**	

	conductivity measurement, hardness measurement, defect detection	**1**	
	coating thickness measurement, advantages and limitations of eddy current testing	**1**	
END SEMESTER UNIVERSITY 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
ME368	Marketing Management	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To introduce the concept of market and marketing
- To give idea about launching a new product
- To introduce the various marketing strategies

Syllabus:

Introduction to marketing, Social and Marketing planning, Consumer behavior, Marketing communication, Designing the message, New trends in marketing

Expected Outcomes:

The students will be able to

i. state the role and functions of marketing within a range of organizations.
ii. describe key marketing concepts, theories and techniques for analyzing a variety of marketing situations.
iii. identify and demonstrate the dynamic nature of the environment in which marketing decisions are taken
iv. synthesize ideas into a marketing plan

Text books:

1. Majumdar R., Marketing Research, Text, Applications and Case Studies, New Age International (P), 1991
2. Ramaswamy V.S. & Namkumari S, Marketing Management: Planning, Implementation and Control, Macmillan India Limited, 2002
3. Robert, Marketing Research, Prentice Hall of India,1999
4. T N Chabra and S K Grover : Marketing management, Dhanpat Rai, 2007

Reference books:

1. Kotler P, Marketing Management: Analysis, Planning, Implementation and Control, Prentice Hall of India,1993
2. Stanton W.J., Etzel M.J. & Walker B.J, Fundamentals of Marketing, McGraw Hill International Edition, 1994

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to marketing - concept of market and marketing – marketing environment - controllable factors - factors directed by top management - factors directed by marketing - uncontrollable factors - demography, economic conditions, competition.	7	15%
II	Social and Marketing planning - marketing planning process - Boston consultancy group model - marketing mix - marketing mix variables. Developing, testing and launching of new products .	7	15%

	FIRST INTERNAL EXAMINATION		
III	Market segmentation and market targeting - introduction to segmentation - targeting and product positioning. Marketing research - need and scope - marketing research process – research objectives, developing research plan, collecting information, analysis, and findings.	**7**	**15%**
IV	Consumer behaviour - factors influencing consumer behaviour - perceived risks Product life cycle - marketing strategies for different stages of product life cycle	**6**	**15%**
	SECOND INTERNAL EXAMINATION		
V	Marketing communication - marketing mix variables - steps in developing effective communication - identification of target audience - determination of communication objectives	**7**	**20%**
V1	Designing the message - selecting the communication channels - promotion mix evaluation - advertising and sales promotion - factors in advertising - sales promotion tools. New trends in marketing- Brand management - significance of branding to consumers and firms	**8**	**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
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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
ME369	Tribology	3-0-0-3	2016
Prerequisite : Nil			

Course Objectives

- To provide broad based understanding of the subject 'Tribology' and its technological significance
- To understand the genesis of friction, the theories/laws of sliding and rolling friction and the effect of viscosity
- To learn about consequences of wear, wear mechanisms, wear theories and analysis of wear problems
- To learn about the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques and the application of lubrications in metal working.
- To understand the importance of adhesion property in different applications and to get knowledge about different bearing materials.
- To understand the nature of engineering surfaces, their topography and learn about surface characterization techniques

Syllabus

Introduction to Tribology- Tribology in Design, Tribology in Industry, Tribological Parameters Like Friction, Wear and Lubrication, different types of lubrication techniques and applications, measurement of friction and wear -The Topography of Engineering Surface, Contact Between Surfaces, surface modification techniques- Adhesion properties, Adhesion in Magnetic Recording Systems, Types of Bearings, Comparison of Sliding and Rolling Contact Bearings.

Expected Outcome

The students will be able to

i. Understand the subject 'tribology' and its technological significance.
ii. Understanding the theories/laws of sliding and rolling friction and the effect of viscosity.
iii. Get basic idea on consequences of wear, wear mechanisms, wear theories and analysis of wear problems
iv. Get an exposure to theories of hydrodynamic and the advanced lubrication techniques and the application of lubrications in metal working.
v. Gain overview of adhesion property in different applications and to get knowledge about different bearing materials
vi. Get basic idea about the nature of engineering surfaces, their topography and learn about surface characterization techniques.

Text books

1. Ernest Rabinowicz, Friction and Wear of Materials, John Wiley & sons,1995
2. I.M. Hutchings, Tribology: Friction and Wear of Engineering Materials, Butterworth-Heinemann,1992
3. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Ltd, New Delhi, 2011.

Reference books

1. B. Bhushan, Introduction to Tribology, John Wiley & Sons, Inc, New York, 2002
2. B.Bhushan, B.K. Gupta, Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill,1997
3. Halling J ,"Principles of Tribology", McMillan Press Ltd.,1978

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Tribology- Tribology in Design, Tribology in Industry, Economic Aspects of Tribology	1	15%
	Tribological Parameters Like Friction, Wear and Lubrication	1	
	The Topography of Engineering Surface, Contact Between Surfaces.	2	
	Types of Bearings, Comparison of Sliding and Rolling Contact Bearings.	2	
II	Introduction, Empirical Laws of Friction, Kinds of Friction	1	15%
	Causes of Friction, Theories of Friction	1	
	Measurement of Friction	1	
	Friction of Metals, Ceramic Materials, Polymers.	2	
	Rolling Friction- Laws of Rolling Friction, Relation Between Temperature and Friction	1	
	Stick-Slip, Prevention of Stick-Slip, Consequences of Friction.	1	
FIRST INTERNAL EXAMINATION			
III	Types of Wear, Various Factors Affecting Wear	1	15%
	Theories of Wear, Wear Mechanisms	2	
	Measurement of Wear.	1	
	Wear Regime Maps, Alternative Form of Wear Equations	1	
	Lubricated and Unlubricated Wear of Metals, Materials Used in Different Wear Situations.	2	
IV	Fundamentals of Viscosity And Viscous Flow	1	15%
	Principle and Application of; Hydrodynamic Lubrication, Elastrodynamic Lubrication, Boundary and Solid Lubrication	2	
	Types of Lubricants, Properties of Lubricants	1	
	Effect of Speed and Load on Lubrication, Frictional Polymers.	1	
	Lubrication in Metal Working: Rolling, Forging, Drawing and Extrusion.	2	
SECOND INTERNAL EXAMINATION			
V	**Adhesion:** Introduction, Adhesion Effect by Surface Tension, Purely Normal Contact and Compression Plus Shear	2	20%

	Adhesion in Magnetic Recording Systems	**1**	
	Dependence of Adhesion on Material and Geometric Properties.	**1**	
	Bearing Materials: Introduction, Rolling Bearing, Fluid Film Lubricated Bearing, Dry Bearing, Bearing Constructions.	**3**	
V1	Introduction To Surface Engineering, Concept and Scope of Surface Engineering.	**1**	**20%**
	Surface Modification – Transformation Hardening, Surface Melting, Thermo chemical Processes	**3**	
	Surface Coating – Plating and Anoding Processes, Fusion Processes, Vapor Phase Processes.	**3**	
	Selection of Coating For Wear And Corrosion Resistance, Potential Properties and Parameters of Coating.	**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
ME371	Nuclear Engineering	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To explore the engineering design of nuclear power plants using the basic principles of reactor physics, thermodynamics, fluid flow and heat transfer.
- To provide an overview on reactor principles, nuclear safety, and reactor dynamic behaviour.
- To understand the standards of radiation protection and need for nuclear waste disposal

Syllabus

Review of Elementary nuclear physics, Nuclear fission, Boiling water reactor, Structural materials, Nuclear fuels, Reactor heat removal, Safety and disposal

Expected Outcome:

The students will be able to

1. understand the theories and principles of nuclear power generation
2. understand the heat removal techniques applied to reactor heat transfer systems.
3. acquire knowledge about safe disposal of nuclear wastes

Text books/ Reference books

1. S. Glasstone and A. Sesonske, *Nuclear Reactor Engineering*, D. Van Nostrand Company, INC. 1967.
2. S Glasstone, Source book on atomic energy, Krieger Pub Co., 1979

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Review of Elementary nuclear physics: Atomic structure – nuclear energy and nuclear forces – Nuclear fission. Nuclear reactions and radiations – Principles of radioactive decay interactions of an ray with matter – Neutron cross sections and reactions –The fission process – Chain reactions	7	15%
II	Basic principles of controlled fusion .Nuclear reactor principles – Reactor classification – Critical size. Basic diffusion theory - Slowing down of neutrons – Neutrons – Neutron flux and power – Four factor formula – Criticality condition – Basic features of reactor control .	7	15%
	FIRST INTERNAL EXAMINATION		

III	Boiling water reactor . Description of reactor system – Main components –Control and safety features .Materials of reactor construction – Fuel , moderator , coolant	**7**	**15%**
IV	Structural materials – Cladding –Radiation damage, Nuclear fuels : Metallurgy of Uranium – General principles of solvent extraction – Reprocessing of irradiated fuel – Separation process fuel enrichment .	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Reactor heat removal / equations of heat transfer as applied to reactor cooling– Reactor heat transfer systems – Heat removed in fast reactors. Radiation safety : Reactor shielding – Radiation dozes – Standards of radiation protection	**7**	**20%**
V1	Safety and disposal: Nuclear plant safety-safety systems-changes and consequences of accident-criteria for safety-nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

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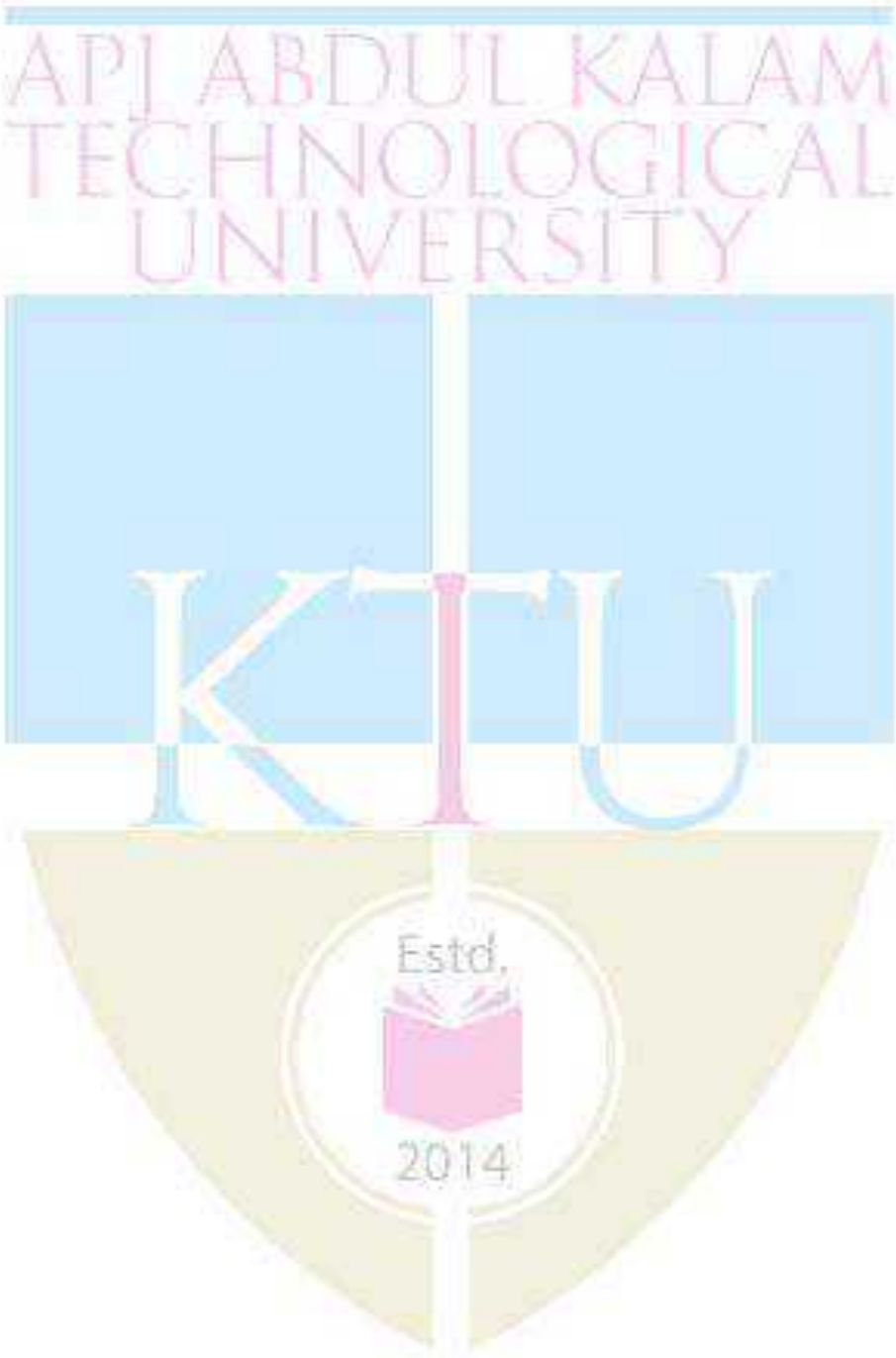
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Course code	Course Name	L-T-P-Credits	Year of Introduction
ME372	Operations Research	3-0-0-3	2016

Prerequisite -Nil

Course Objectives:

- To understand the role of operation research in decision making
- To impart the various operation research techniques for effective problem solving.

Syllabus:

Operations research models, linear programming, transportation problem, assignment problem, sequencing problem, network analysis, queuing theory, inventory control, decision theory, game theory – simulation.

Expected Outcome:

- The students will be able to understand operations research techniques and apply them in solving practical problems in industry.

Text Books:

1. Miller, D. M. and Schmidt, J. W., Industrial Engineering and Operations Research, John Wiley & Sons, Signapore, 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. Srinivasan, G. "Operations Research-Principles and Applications", Latest edition, PHI Pvt. Ltd., 2010.
5. 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.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Basics of operations research–OR models–applications.	1	15%
	Linear programming – problem formulation	1	
	Graphical method	1	
	Simplex method	1	

	Big-M method	**1**	
	Two–phase method	**1**	
	Duality in linear programming	**1**	
II	Transportation problem – formulation – balanced & unbalanced transportation problems	**1**	**15%**
	North west corner rule – least cost method	**1**	
	Vogel's method –stepping stone method	**1**	
	MODI method	**1**	
	Assignment problem – formulation – optimal solution, Hungarian algorithm	**1**	
	Variants of assignment problems	**1**	
	Traveling salesman problem.	**1**	
FIRST INTERNAL EXAMINATION			
III	Sequencing problem– terminology and notations – assumptions – problems with *n* jobs through two machines	**1**	**15%**
	Problems with *n* jobs through three machines	**1**	
	Problems with *n* jobs through *m* machines.	**1**	
	Network analysis – basic terms – network construction – time analysis	**1**	
	Critical path method (CPM)	**1**	
	Programme evaluation and review technique (PERT)	**1**	
	Cost considerations in network analysis – crashing	**1**	
IV	Introduction to queuing theory–terminologies– classification of queuing models	**1**	**15%**
	Single server problems	**1**	
	Multi server problems	**1**	
	Inventory control – variables – deterministic inventory models – purchasing model without shortages	**1**	
	Manufacturing model without shortages	**1**	
	Purchasing model with shortages	**1**	
	Manufacturing model with shortages	**1**	
SECOND INTERNAL EXAMINATION			
V	Decision theory – steps in decision theory approach – decision making conditions	**1**	**20%**
	Decisions under conditions of risk	**1**	
	Decisions under uncertainty conditions	**1**	
	Decision tree analysis	**1**	
	Game theory – games with saddle points	**1**	
	Games without saddle points – 2 x 2 games	**1**	

	Graphical method for m x 2 & 2 x n games	**1**	
VI	Simulation – types of simulation – phases of simulation – applications– advantages and disadvantages	**1**	**20%**
	Design of simulation, models & experiments, model validation	**1**	
	Generation of random numbers	**1**	
	Monte Carlo simulation	**1**	
	Queuing simulation model	**1**	
	Inventory simulation model	**1**	
	Simulation languages	**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
ME373	Human Relations Management	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To impart basic idea about human behavior as an individual and relations in group levels.
- To give idea on management of human relations in organizations and collective bargaining.
- To create knowledge on management of employer-employee relations and human conflicts.

Syllabus

Human behaviour as individual, Human behaviour in group, Management of human relations in organisations, Management of human relations and collective bargaining, Managing employer-employee relations, Managing human conflicts, Managing global human relations. Employee safety and health.

Expected outcome

The students will

i. get basic idea about human behavior in individual and group levels.
ii. understand the human relations in organizations and collective bargaining.
iii. be able to manage employer-employee relations and conflicts.

Text Books:

1. Gary Dessler, Human Resource Management., Pearson Education, 2017
2. Seema Sanghi , Stephen P. Robbins, , Timoti A Judge : Organizational Behaviour, Pearson Education, 2009

References:

1. Aubrey. C. Sanford, Human Relations: Theory and Practice, Merrill, 1973
2. C S Venkata Ratnam and B K Srivastava, Personnel Management and Human Resources, TMH, 1996.
3. William Scott, R C Clothier and W Spiegel : Personnel Management Principles: Practices and Points of Views, Tata Mc Graw Hill, 1977.
4. Uma Sekharan, Organizational Behaviour-Text and Cases ,Tata Mc Graw Hill, 1989.
5. V. Kumar, Customer Relationship Management, Wiley India Edition, 2013.

Course Plan

Module		Hours	End Sem. Exam Marks
I	**Human Behaviour**: Biological characteristics, age, gender, tenure. Ability, intellectual and physical abilities. Learning, theories of learning. Values, importance of values, types. Attitudes, types, attitudes and consistency, workforce diversity. Personality and emotions, personality determinants and traits, emotion dimensions. Perception, factors influencing perception, making judgement about others, link between perception and individual decision making.	6	15%
II	**Human Behaviour and Relations in Groups**: Defining and classifying different groups. Stages of group development, Five stage model. Group structure, roles, norms, status and size. Group decision making, group versus the individual. Types of teams, self-managed work teams, problem solving teams. Creating effective teams, composition, work design, process and team players.	6	15%
FIRST INTERNAL EXAMINATION			

III	**Management of Human Relations in Organisations**: Ethics and fair treatment at work, ethics and the law, ethics fair treatment and justice. Ethical behaviour at work, individual factors, organizational factors, the boss's influence, ethics policies and codes, the organization's culture, role of HR in fostering ethics and fair treatment. Disciplining an employee, formal disciplinary appeals process, discipline without punishment, employee privacy.	7	15%
IV	**Management of Human Laws and Collective Bargaining**: Employment law, gross misconduct, personal supervisory liability, layoffs and the plant closing law. Collective bargaining, good faith, negotiating team, bargaining items, bargaining stages, bargaining hints, impasses, mediation, and strikes, the contract agreement. Grievances, sources of grievances, the grievance procedure, guidelines for handling grievances.	7	15%
SECOND INTERNAL EXAMINATION			
V	**Management of Training and Employer-Employee Relations**: Training and development, objectives, strategies, methods and techniques. Design and organisation of training and evaluation of training. Employee relations, management-employee relations, managing discipline, grievance and stress, counselling, are handling problem employees. Industrial relations implications of personnel policies, nature of employment relationship.	8	20%
VI	**Management of Human Conflicts, Customer Relations, Unions and Global Relations:** Industrial and organisational conflict, managing for good industrial relations and managing the moment of conflict. Customer relationship management, what if customer is the problem. Place of unions in organizations. The future scenario, the changing personnel management scenario. Managing global human relations. HRD the development role of personnel to the force. Employee safety and health.	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
ME374	THEORY OF VIBRATIONS	3-0-0-3	2016

Prerequisite: ME304 Dynamics of machinery

Course Objectives

- To understand the principles of vibration theory.
- To introduce techniques for solving vibration problems.
- To enable development of mathematical model for engineering problems in vibrations.

Syllabus

Introduction to mechanical vibrations; Analysis of free, forced single degree of freedom systems; Damping; Vibration measuring instruments; Multi degree of freedom systems; Eigen value problems; Lagrange's equation; Vibration of continuous systems; Transient vibrations; Introduction to non linear and random vibrations.

Expected outcome

The students will be able to

i. formulate differential equations of motion of mechanical systems
ii. determine the natural frequencies of multi degree of freedom systems
iii. understand non linear and random vibrations.

Text Books:

1. Graham Kelly S, Schaum's outline of Mechanical Vibrations, Schaum's Outlines,1996
2. Singiresu S Rao, Mechanical Vibrations, Pearson, 2016
3. Thomson, W T , Theory of Vibration with Applications., Prentice Hall India,1981

References Books:

1. Den Hartog, J P, Mechanical Vibrations, McGrawHill, 1956.
2. Leonard Meirovitch, Elements of Vibration Analysis,McGraw Hill,1975.

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to mechanical vibrations- Simple harmonic motion- Natural frequency -Equation of motion-- Energy method-Rayleigh method	2	20%
	Free vibration of single degree of freedom (DOF) systems with damping- Viscous damping- Logarithmic decrement. Coulomb damping-Energy dissipated by damping- Structural damping -Equivalent viscous damping.	4	
II	Forced harmonic vibration- Magnification factor-Transmissibility-Vibration isolation-Base excitation-Rotating unbalance- whirling of shafts- Resonance Vibration measuring instruments. Seismometer-Accelerometer	5	15%
FIRST INTERNAL EXAM			
III	Two degree of freedom systems-Normal mode vibration-Principal co-ordinates-Coordinate coupling.	3	15%
	Beat phenomenon-Undamped vibration absorbers- Vibration dampers.	2	
IV	Multi degree of freedom systems- Matrix formulation- Influence coefficients-Flexibility matrix-Stiffness matrix	5	20%
	Eigen Value problem:Eigen value and Eigen vectors-Frequency mode shape -Modal analysis.	4	
SECOND INTERNAL EXAM			
V	Lagrange's equation- Solution to problems using Lagrange's equation.	4	15%
	Vibration of continous systems-Vibrating strings- Longitudinal vibration of rods—Torsional vibration of rods	6	
VI	Transient vibrations- Impulse excitation- Convolution integral.	4	15%
	Introduction to non linear vibrations and random vibrations	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.

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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:

i. 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
ii. Define various failure modes, their endurance limit and their association with stress concentration.
iii. Design of Springs and Bearings with appropriate materials selection.
iv. 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,.
v. Define the Non-traditional machining technology and design of various machines in this category.
vi. Define the non-traditional unconventional machining technology and design of various machines in this category.

References/Textbooks

1. Krishna Rao T., Design of machine Elements, I.K International publishing House Pvt. Ltd.
2. Bhandari V.B., Design of Machine Elements, McGraw Hill Book Company
3. Edward Trent and Paul Right, Metal Cutting, Butterworth- Heinemann
4. Jain R.K, Production Technology, Khanna publishers
5. Jain R.K., Industrial safety, Health and Environment, Khanna publishers
6. Budynas and Nisbett, Shigley's Mechanical Engineering Design, , 8th Ed., McGraw-Hill
7. Charles E.Wilson., Computer integrated machine design, Prentice-Hall.
8. Robert L.Norton., Machine design- an integrated approach, Prentice-Hall.
9. S.Md.Jalaludeen, Machine Design Volume – 1, Anuradha Publications
10. Collett. C.V and Hope A.D., Engineering measurements, Pitman publishing.
11. 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. 6x5=30 Marks
PART B: 8 Questions from Module 3&4 (4+4). 6 questions to be answered. 6x5= 30 Marks
PART C: 6 Questions from Module 5&6 (3+3). 4 questions to be answered. 4x10=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

i. Understand the relationship of key concepts in reliability engineering and application to maintenance strategies in a manufacturing environment.
ii. Establish maintenance strategies according to system characteristics and design transition programs to implement these strategies.
iii. 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

i. Find out various stresses induced in a machine element under different type of loading conditions.
ii. Devise machine components for its conceptual design.

Text Books:

1. Jalaludeen , Machine Design, Anuradha Publications, Chennai,2014
2. R. L. Norton, Machine Design – An Integrated Approach, Pearson Education, 2001
3. V.B.Bhandari, Design of Machine elements, McGraw Hill, 2010

Data books permitted for reference in the final examination:

1. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013
2. NarayanaIyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill/Suma Publications, 1984
3. PSG Design Data, DPV Printers, Coimbatore, 2012

References Books:

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill,2003
2. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley,2003
3. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006
4. 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 wed 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 road, 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

1. Apply design procedures for industrial requirements.
2. Design machine components to ease the manufacturing limitations.

Text Books:

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill,2003
2. Jalaludeen , Machine Dsign, Anuradha Publications, 2016
3. V.B.Bhandari, Design of Machine elements, McGraw Hill, 2016

References Books:

1. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley, 2011
2. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006
3. Rajendra Karwa, Machine Design , Laxmi Publications (P) LTD, New Delhi, 2006
4. Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company, 1983

Data books permitted for reference in the examination:

1. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013
2. Narayana Iyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill, 1984
3. 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

i. Know various tools and techniques in industrial Engineering.
ii. Develop work procedure applying the principles of work study.
iii. Apply inventory control techniques in materials management.
iv. Formulate replacement and purchase decisions and arrive at conclusions

Text Books:

1. B. Kumar, Industrial Engineering Khanna Publishers,2013
2. M Mahajan, Industrial Engineering & Production Management, Dhanpat Rai, 2005
3. Martand Telsang, Industrial Engineering & Production Management, S. Chand, 2006
4. O. P. Khanna, Industrial Engineering and Management, Dhanpat Rai, 2010

References:

1. E. S. Buffa, Modern Production management, John Wiley, 1983
2. Grant and Ieven Worth, Statistical Quality Control, McGraw Hill, 2000
3. Introduction to work study – ILO, Oxford And IBH Publishing,2008
4. 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. Psychometric 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, psychometric chart- Psychometric 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.

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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

i. Know the mechanical systems used in mechatronics
ii. Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems

Text Books:

1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007
2. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education, Inc., New Delhi, 2006.

References Books:

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003.
2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.
3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. 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

i. 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 (Rayliegh flow).
ii. Derive the conditions for the change in pressure, density and temperature for flow through a normal shock.
iii. Determine the strength of oblique shock waves on wedge shaped bodies and concave corners
iv. Know the various measuring instruments used in compressible flow

Data book/Gas tables:

1. Yahya S. M., Gas Tables**,** New Age International, 2011
2. Balachandran P., Gas Tables, Prentice-Hall of India Pvt. Limited, 2011

Text Books:

1. Balachandran P., Fundamentals of Compressible Fluid Dynamics, PHI Learning. 2006
2. Rathakrishnan E., Gas Dynamics, PHI Learning, 2014
3. Yahya S. M., Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, New Age International Publishers, 2003

References Books:

1. Anderson**,** Modern compressible flow, 3e McGraw Hill Education, 2012
2. 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-chocking 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- Chocking 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 chocking- 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.

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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:

Hear transfer

1. Determination of LMTD and effectiveness of parallel flow, Counter flow and cross flow heat exchangers(double pipe heat exchanger)
2. Determination of heat transfer coefficients in free convection(free convection apparatus)
3. Determination of heat transfer coefficients in forced convection (forced convection apparatus)
4. Determination of thermal conductivity of solids(composite wall)
5. Determination of thermal conductivity of powder
6. Determination of Thermal conductivity of liquids
7. Determination of emissivity of a specimen (emissivity apparatus)
8. Determination of Stefan Boltzman constant (Stefan Boltzmann apparatus)
9. Study and performance test on refrigeration (Refrigeration Test rig)
10. Study and performance test air conditioning equipment(air conditioning test rig)
11. Performance study on heat pipe(Heat pipe)
12. Calibration of Thermocouples
13. Calibration of Pressure gauge

Dynamics

14. Whirling of shaft
15. Gyroscope
16. Universal governor apparatus
17. Free vibration analysis
18. 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

1. Conduct experiments to determine thermal conductivity of materials
2. Determine heat transfer coefficient, LMTD etc..
3. Do calibration of thermometers and pressure gauges
4. Demonstrate the effect of unbalances resulting from rotary motions
5. Visualise the effect of dynamics on vibrations in single and multi degree of freedom system
6. 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:

1. A.C. Kermode, Mechanics of flight, Prentice Hall, 2007
2. Anderson, Fundamentals of Aerodynamics, McGraw-Hill, 2010
3. EHJ Pallett, Aircraft Instruments and Integrated systems, Longman,1992

Reference books:

1. 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 horse shoe vertex 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%**
V1	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

i. Perform thermodynamic analysis of aircraft engines
ii. Carry out performance analysis of aircraft systems and components
iii. Formulate and solve rocket engine problems

Text books:

1. K Ramamurthi, Rocket Propulsion, Laxmi Publications, 2016
2. Saeed Farokhi, Aircraft Propulsion, Wiley, 2e, 2014

Reference books:

1. G. P. Sutton and Oscar Biblarz, Rocket Propulsion elements- John Wiley & Sons, 2013
2. J Mattingly, H von Ohain, Elements of Propulsion: Gas Turbines and Rockets, AIAA, 2006
3. Philip Hill, Carl Peterson: Mechanics and Thermodynamics of Propulsion, Pearson, 2014
4. 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-Airscrew, Turbojet, Turboprop, turbofan, Turboshaft, 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**

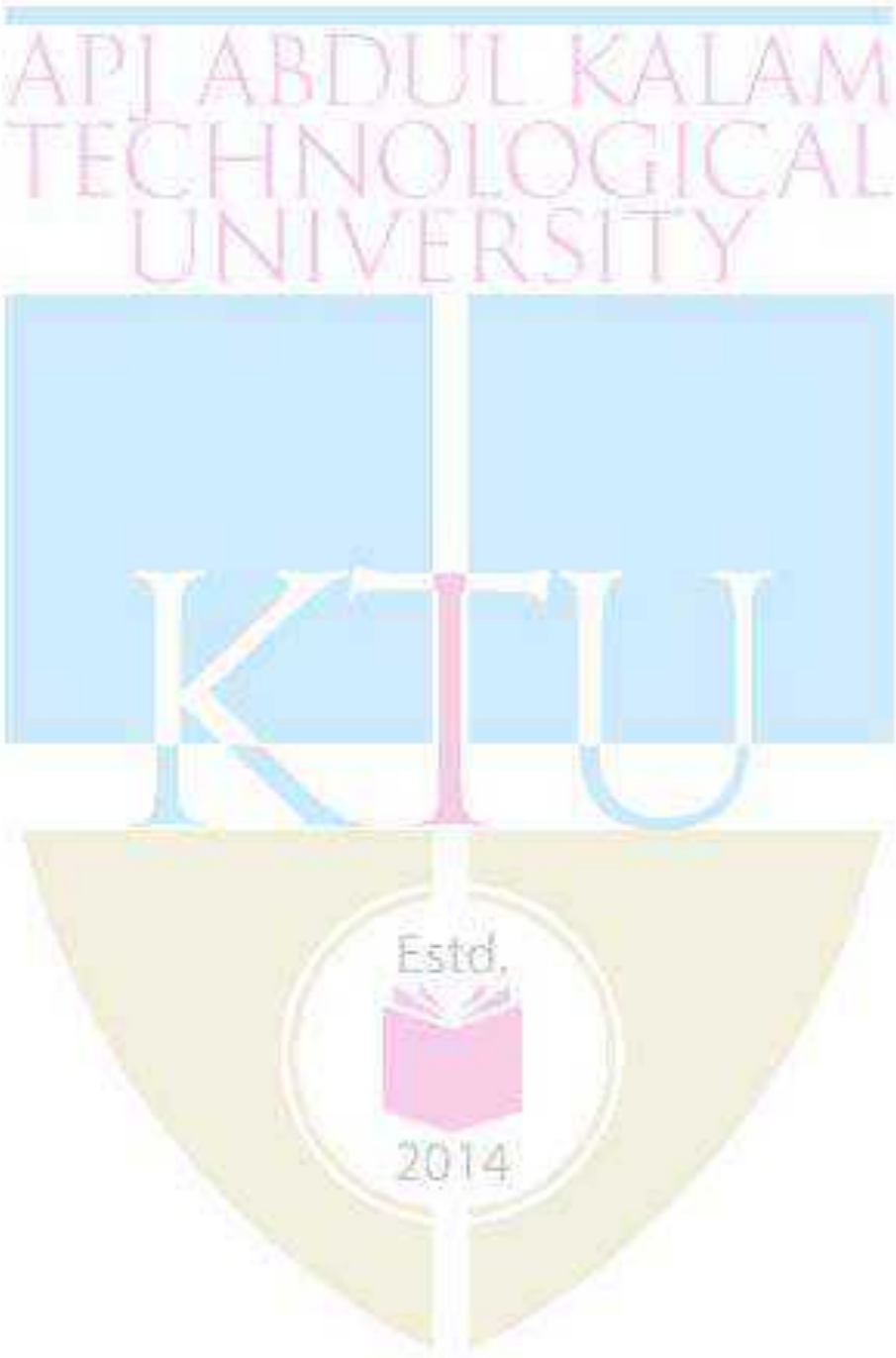
The question paper should consist of three parts

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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TECHNOLOGICAL
UNIVERSITY
KTU
Estd.
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:

i. Practically identify different automotive systems and subsystems.

ii. Understand the principles of transmission, suspension, steering and braking systems of an automobile

iii. Develop a strong base for understanding future developments in the automobile industry

Text Books

1. Gupta R.B. Auto design , Satya Prakash, New Delhi, 2015
2. Heinz Heisler, Advanced engine technology, Butterworth-Heinemann,1995
3. Heinz Heisler, Advanced vehicle technology, Society of Automotive Engineers Inc, 2002
4. Hillier and Peter Coobes, Fundamentals of motor vehicle technology, Nelson Thornes, 2004
5. 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 1	**15%**
	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 1	**15%**
	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	
	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	**15%**
	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

i. Become familiar with the history, concept, development and key components of robotics technologies
ii. Classify and characterize the robots based on the configuration and work volume
iii. Solve the problems related to robot design and control

Text books:

1. Industrial Robots, Yu.Kozyrev, Mir Publishers
2. Janakiraman.P.A., Robotics and Image Processing, Tata McGraw-Hill, 1995
3. M.P.Groover, Industrial Robotics – Technology, Programming and Applications, McGraw-Hill, 2001
4. Yoram Koren, Robotics for Engineers, McGraw-Hill Book Co., 1992

References:

1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., Robotics Control, Sensing, Vision and Intelligence, McGraw-Hill Book Co., 1987
2. K.S.Fu., R.C.Gonalez, C.S.G.Lee, Robotics Control sensing, Vision andIntelligence, McGraw Hill International Edition, 1987
3. 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 effecter 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: :

1. To introduce various fluid power systems
2. 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

1. To understand the various components used in fluid power systems
2. To select the suitable system for a particular application
3. To know the various fluid circuits used in hydraulic systems

Text books:

1. B. Lall, Oil Hydraulics, International Literature Association
2. D. A. Pease, Basic Fluid Power, Prentice Hall,1986
3. J. J. Pipenger, Tyler Gregory Hicks, Industrial Hydraulics, McGraw Hill,1979
4. Pinches, Industrial Fluid Power, Prentice Hall,1989
5. R.K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd.,2017

Reference:

1. ISO - 1219, Fluid Systems and components, Graphic Symbols
2. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier ,1999
3. Michael J. Prinches and Ashby J. G, Power Hydraulics, Prentice Hall,1988
4. 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

i. Grasp numerical modelling and its role in the field of fluid flow and heat transfer
ii. Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems
iii. Know established engineering methods to solve complex engineering problem

Text books:

1. Patankar Suhas V., Numerical Heat Transfer and Fluid Flow, Taylor &Francis,1980
2. Versteeg H.K. &Malalasekera W., An introduction to Computational Fluid Dynamics, Longman,2008

Reference books:

1. Anderson Dale A., Tannehill John C. &Pletcher Richard H., Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 2016
2. 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

i. Understand properties of material at cryogenic temperatures.
ii. Know about various liquefaction systems
iii. Get ideas on cryogenic refrigeration systems, cryogenic instrumentation and cryogenic heat exchangers

Text books

1. J. H. Boll Jr, Cryogenic Engineering
2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959
3. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986

Reference books:

1. 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

i. Understand properties of materials at nanoscale
ii. Know the fabrication and characterization methods used in nanotechnology
iii. Acquaint with the various applications of nanotechnology

Text books:

1. A.K. Bandyopdhyay, Nanomaterials, , New age international publishers,2008
2. Bharat Bhushan, Springer Handbook of Nanotechnology, 2010
   Charles P Poole, Frank J Owens, Introduction to Nanotechnology, John Wiley and Sons, 2003
3. Jeremy Ramsden,Nanotechnology, William Andrew, Elsevier, 2011
4. T Pradeep, Nano: The essentials, McGraw – Hill education,2 007
5. V.S.Muralidharan, A Subramnya,Nano science and Technology, Ane books Pvt Ltd

Reference books:

1. Gregory Timp, Nanotechnology, Springer-Verlag, 2009
2. John Mongillo, Nano Technology, Greenwood Press, 2007
3. 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

1. To learn the mathematical background of finite element methods.
2. To understand the basics of finite element formulation.
3. 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

i. understand the mathematical background of FEM .
ii. solve real life problems using finite element analysis

Text Books:

1. Chandrupatla T R., Finite Element Analysis for Engineering and Technology, University Press, 2004
2. Hutton D V., Fundamentals of Finite Element Analysis, Tata McGraw-Hill, 2005
3. Logan D L., A first course in the Finite Element Method, Thomson-Engineering, 2012
4. Seshu P., Text Book of Finite Element Analysis, PHI Learning Pvt. Ltd., 2003

References Books:

1. Cook R D., Malkus D S., Plesha M E.,Witt R J., Concepts and Analysis of Finite Element Applications, John Wiley & Sons,1981
2. 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.

A.P.J. ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd. 2014

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
5. 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**	
		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	
	Simplex method for solving goal programming	**1**	
		1	
	Dynamic programming – terminologies – forward and backward recursion –applications	**1**	
	Shortest path problems	**1**	
		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	
	Kuhn-Tucker conditions	**1**	
		1	
VI	Nontraditional optimization – computational complexity- Introduction to metaheuristics – areas of application	**1**	**20%**
		1	
	Genetic algorithm (GA) – terminologies – steps and examples	**1**	
	Tabu search (TS) – steps and examples	**1**	
	Simulated annealing (SA) – steps and examples	**1**	
	Ant colony optimization (ACO) – steps and examples - Particle Swarm Optimization (PSO)-Steps and examples	**1**	
		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

1. To understand the failure modes and theories of failure.
2. To include the effect of cyclic loading, fatigue and endurance limit in design.
3. 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

i. analyze real life failure modes and use of theories for failure prediction
ii. design for fatigue and cyclic loading
iii. make comprehensive life cycle prediction of designed products

Text Books:

1. Collins. J. A., Failure of Materials in Mechanical Design, John Wiley & Sons, 1993
2. Suresh S, Fatigue of Materials, Cambridge University Press, 1998

References Books:

1. Prashant Kumar, Elements of Fracture Mechanics, Wheeler Publishing, 1999
2. 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

i. Assess the value of facility planning on the strategy of a firm
ii. Develop a systematic plant layout
iii. Know the environmental and economical aspects in facilities planning
iv. Understand various material handling systems

Text books/Reference books:

1. A W Peymberton, Plant layout and Material Handling, John Wiley
2. James A Apple, Plant layout and Material Handlin, Krieger Pub Co,1998
3. John A Sehbin, Plant layout and Material Handling-
4. K C Arora & Shinde, Aspects of Material handling, Lakshmi Publications.
5. 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.energymanager training.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%**
V1	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%**
V1	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
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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.