B.E. (MECHANICAL ENGINEERING)
(Part Time)

FIRST TO SEVENTH SEMESTER SYLLABUS

(For the students admitted from 2009-2010 and subsequently)

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution affiliated to Anna University and Accredited by NBA)

COIMBATORE - 641 014

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B.E (Part Time)

SPECIALIZATION : MECHANICAL ENGINEERING

Semester I

Subject Code	Subject Name	L	T	P	C
	THEORY				
09 FY 11	Mathematics I	3	1	0	4
09 ME 32	Mechanics of Solids	3	1	0	4
09 ME 33	Mechanics of Fluids and Machinery	3	1	0	4
09 ME 43	Engineering Materials and Metallurgy	3	0	0	3
09 ME 45	Applied Electronics and Micro Controllers	3	0	0	3
	Total Credits				**18**

Semester II

Subject Code	Subject Name	L	T	P	C
	THEORY				
09 FY 21	Mathematics II	3	1	0	4
09 ME 35	Instrumentation and Control Systems	3	0	0	3
09 ME 36	Machine Drawing	2	0	4	4
09 ME 42	Foundry and Welding Technology	3	0	0	3
09 ME 44	Applied Thermodynamics	3	1	0	4
	Total Credits				**18**

Semester III

Subject Code	Subject Name	L	T	P	C
	THEORY				
09 CE 31	Mathematics III	3	1	0	4
09 ME 53	Manufacturing Technology	3	0	0	3
09 ME 54	Design of Machine Elements	3	1	0	4
09 ME 55	Theory of Machines	3	1	0	4
09 ME 56	Metal Forming and Material Testing	3	0	0	3
	Total Credits				**18**

Semester IV

Subject Code	Subject Name	L	T	P	C
	THEORY				
09 CE 41	Mathematics IV	3	1	0	4
09 ME 51	Metrology and Quality Control	3	1	0	4
09 ME 52	Thermal Engineering	3	1	0	4
09 ME 63	Dynamics of Machinery	3	1	0	4
09 ME 64	Design of Mechanical Transmission Systems	3	1	0	4
	Total Credits				**20**

Semester V

Subject Code	Subject Name	L	T	P	C
	THEORY				
09 ME 62	Operations Research	3	1	0	4
09 ME 66	Gas Dynamics and Space Propulsion	3	1	0	4
09 ME 73	Engineering System Design and Analysis	3	1	0	4
09 ME 82	Power Plant Engineering	3	0	0	3
09 ME 83	Engineering Economics and Industrial Management	3	0	0	3
	Total Credits				**18**

Semester VI

Subject Code	Subject Name	L	T	P	C
	THEORY				
09 ME 61	Heat and Mass Transfer	3	1	0	4
09 ME 65	Tool Engineering and Design	3	0	0	3
09 ME 72	Fluid Power Engineering	3	0	0	3
	Elective I	3	0	0	3
	Elective II	3	0	0	3
	Total Credits				**16**

Semester VII

Subject Code	Subject Name	L	T	P	C
	THEORY				
09 ME 71	CAD/CAM/CIM	3	0	0	3
09 ME 81	Manufacturing Planning and Cost Estimation	3	1	0	4
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
09 ME 88	Project work	0	0	4	4
	Total Credits				**17**

LIST OF ELECTIVES

Subject Code	Subject Name	L	T	P	C
	DESIGN ENGINEERING				
09E01	Design of Material Handling Equipments	3	0	0	3
09E02	Finite Element Method	3	0	0	3
09E03	Computational Fluid Dynamics	3	0	0	3
09E04	Vibration Engineering	3	0	0	3
	INDUSTRIAL ENGINEERING				
09E05	Manufacturing Systems Management	3	0	0	3
09E06	Marketing Management	3	0	0	3
09E07	Plant Layout and Material Handling	3	0	0	3
09E08	Agile and Lean Manufacturing Systems	3	0	0	3
09E09	Computational Methods in Mechanical Engineering	3	0	0	3
09E10	Design and Analysis of Experiments	3	0	0	3
	PRODUCTION ENGINEERING				
09E11	Micro Systems and Nano Engineering	3	0	0	3
09E12	Rapid Prototyping	3	0	0	3
09E13	Advanced Welding Technology	3	0	0	3
09E14	Artificial Intelligence and Expert Systems	3	0	0	3
09E15	Design for Manufacture and Assembly	3	0	0	3
09E16	Non - Traditional Machining Techniques	3	0	0	3
09E17	Advances in CNC systems	3	0	0	3
09E18	Robotics	3	0	0	3
09E19	Mechatronics Engineering	3	0	0	3
09E20	Total Quality Management	3	0	0	3
09E21	Automobile Engineering	3	0	0	3
09E22	Automotive Electronics - Embedded Software Developer	3	0	0	3
	THERMAL ENGINEERING				
09E23	Refrigeration and Air Conditioning	3	1	0	4
09E24	Alternative Energy Resources Engineering	3	0	0	3
09E25	IC Engines - Combustion and Pollution	3	0	0	3
09E26	Turbo Machinery	3	0	0	3

L - Lecture, T - Tutorial, P - Practical, C - Credit

09FY11 MATHEMATICS - I

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To develop the basic mathematical problem solving skills of Engineering students that are imperative for effective understanding of Engineering subjects. The topics introduced will serve as basic tools for specialized studies in many Engineering fields.

MATRIX AND HYPERBOLIC FUNCTIONS

Eigenvalues and eigenvectors - Cayley Hamilton theorem (without proof) - Application to find the inverse and higher powers of a matrix - Diagonalization - Quadratic forms - Orthogonal reduction to canonical form. Hyperbolic and inverse hyperbolic functions. **(9)**

DIFFERENTIAL CALCULUS

Curvature - Evolutes - Envelopes - Expansions and extreme values functions of two variables - Lagrange's multiplier method for constrained extrema. **(9)**

INTEGRAL CALCULUS

Beta, Gamma integrals - properties and problems - Double and triple integrals - changing the order of integration - Jacobian of transformation - Application to areas and volumes. **(9)**

ORDINARY DIFFERENTIAL EQUATIONS

Second and higher order linear differential equations with constant coefficients - Euler Cauchy equation - Linear Simultaneous equations - Method of variation of parameters - Method of reduction of order - Transformation of equation by changing the dependent and independent variables. **(9)**

SOLID GEOMETRY

Planes, straight lines - coplanar lines - skew lines. Spheres - tangent plane to the sphere - orthogonal spheres. **(9)**

Theory : 45

Tutorials : 15

Total : 60

TEXT BOOKS

1. *Kandasamy. P.et al., "Engineering Mathematics for first year B.E. / B.Tech", (Volume I & II) (8th fully Revised Edition) S. Chand & Co., New Delhi, (2008).*
2. *Veerarajan. T, "Engineering Mathematics" (For first year), (First Revised Edition) Tata McGraw Hill Publishing Company Ltd., New Delhi, (2008).*
3. *Venkataraman. M.K., "Engineering Mathematics", (First year), The National Publishing Company - (2008).*

REFERENCE BOOKS

1. *Erwin Kreyszig, "Advanced Engineering Mathematcis", (8th Edition) John Wiley & Sons (Asia) Pvt. Ltd., - (2008)*
2. *Grewal, B.S., "Higher Engineering Mathematics", (40th Edition) Khanna Publishers, New Delhi, (2007).*

09ME32 MECHANICS OF SOLIDS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To give basic knowledge about the different types of loads considering various factors which are essential for mechanical engineering students.

OUTCOME

Upon completion of the course, the student will be able to solve the problems involving different types of loads in industries.

INTRODUCTION

Properties of sections, centroid and moment of inertia. **(3)**

CONCEPT OF STRESS AND STRAIN

Simple stresses and strains at a point - Normal and shear stresses - Hooke's law - Young's modulus - bars subjected to axial forces - Simple problems. Thermal stresses - simple statically indeterminate problems like compound bars - Poisson's ratio - Modulus of rigidity - Surface and volume strain - Bulk modulus - Relation between Elastic constants - concept of factor of safety and permissible stresses - Strain energy - Resilience - stresses due to suddenly applied loads and impact loads. **(8)**

BEAMS

Types of beams - types of loads and load diagram - shear force and bending moment - relationship between loading intensity, shear force and bending moment - shear force diagram and bending moment diagram for statically determinate beams - overhanging beams. **(9)**

STRESSES IN BEAMS

Theory of simple bending - stress distribution due to force and bending moment for different cross sections - simple problems- Design of beams - Beams of uniform strength - Leaf spring - Flitched beams. **(8)**

BIAXIAL STRESSES

Membrane theory of shells- stresses in thin walled cylindrical, spherical and conical vessels - wire wound cylindrical vessels - stresses at a point - principal plane and principal stress - Mohr's circle for biaxial stresses - pure shear case - principal axes - principal moment of inertia. **(9)**

TORSION

Torsion of solid and hollow circular shafts- power transmitted through shafts, combined bending and torsion. Springs - open coiled and close coiled helical springs. **(8)**

Theory : 45

Tutorial: 15

Total : 60

TEXT BOOKS

1. *Rajput .R.K., "Strength of Materials", S.Chand & Company Ltd., New Delhi, 2006.*
2. *Sadhu Singh, "Strength of Materials", Khanna Publishers, New Delhi, 2005.*

REFERENCE BOOKS

1. *Prakash Rao D.S, "Introduction to Strength of Materials - Volume I", Universities Press (India) Ltd., Hyderabad, 2002.*
2. *Lehri R.S, Lehri A.S, "Strength of Materials", S.K. Kataria & Press, New Delhi, 2009.*
3. *W.A. Nash, "Strength of Materials", 4th Edition, Schaum's Outlines, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2007.*

09ME33 MECHANICS OF FLUIDS AND MACHINERY

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

This course imparts fundamental knowledge on fluid, kinematics and its applications to the fluid machineries, basic metrics, measuring methodology, analysis and applications of fluid mechanics, basic design parameters and selection of fluid machineries.

OUTCOME

On successful completion of the course, the student can apply current knowledge, techniques in measuring fluid parameters, conduct analysis and interpret experimental result as well as apply experimental results to improve process, develop creativity design and conduct selection of equipment in the area of fluidics.

INTRODUCTION - PROPERTIES OF FLUIDS

Basic properties - mass density, weight density, viscosity, capillarity, surface tension, compressibility - Ideal and Real fluids - Pressure measurement using manometer, U - tube manometer, differential 'U' tube manometer - total pressure and center of pressure on plane submerged surface - simple problems. **(9)**

DYNAMICS OF FLUID FLOW

Classification of fluid flow - velocity and acceleration - velocity potential and stream function - continuity equation.

Euler's equation of motion - Bernoulli's equation, limitation of Bernoulli's theorem - simple problems using Bernoulli's theorem. **(9)**

FLOW THROUGH PIPES AND MEASUREMENTS

Laminar flow - Hagen Poisueills's equation, Turbulent flow - Darcy Weisbach equation, minor losses - simple problems. Flow measurement - Venturi meter, Orifice meter, flow nozzle meter, bend meter and Pitot tube. **(9)**

HYDRAULIC TURBINES

Introduction to impulse - momentum principle, moment of momentum equation, Hydraulic turbines - classification - Pelton, Francis and Kaplan turbines - Velocity triangles - simple problems - determining geometric dimensions - specific speed - unit quantities. **(9)**

HYDRAULIC PUMPS

Centrifugal pumps- velocity triangle- performance calculations. Reciprocating pump - working principle- air vessel. **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOK

1. *Bansal R.K., "A Text Book of Fluid Mechanics & Hydraulic Machines", Lakshmi Publication (P) Ltd., New Delhi, Ninth Edition, 2005.*

REFERENCE BOOKS

1. *Modi,P.N and Seth, S.M, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Publication, New Delhi, 2009.*
2. *Ramamurtham.S, "Hydraulics and Fluid Mechanics", Dhanpat Rai Publishing Company, New Delhi, 2007.*

09ME43 ENGINEERING MATERIALS AND METALLURGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To acquire knowledge about the structure, behaviour of materials and learn about the alloy formation, classification, properties and its applications.

OUTCOME

Students gain knowledge about the properties of materials, types of alloys and heat treatments to be given to the ferrous and non ferrous alloys. Selection of materials can be made based on the properties and applications of materials.

INTRODUCTION

Description of terms - Materials and Metallurgy - Classification of engineering materials - Scope of the study. **(1)**

STRUCTURE OF MATERIALS

Structure of metals and alloys - crystals structure in metals - unit cell BCC, FCC and HCP Unit cells - Crystallographic planes and directions- Miller indices. Crystal defects - Point, line and surface defects. **(9)**

DEFORMATION OF METALS

Elastic deformation, anelastic deformation, thermo elastic effect, elastic after effect. Plastic deformation - Mechanism of slip, slip planes and twinning. Solidification- Solidification of pure metals and alloys. Grains, grain boundary and grain size measurement. Metallography - Optical microscope - Electron microscope - Scanning Electron Microscope- Preparation of specimen, etching, micro and macro examination of metals - Sulphur and Phosphorous prints. **(8)**

CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS

Constitution of alloys, compounds and solid solutions, Gibbs phase rule, Lever rule, isomorphous, eutectic, eutectoid, and peritectic systems. Iron-Carbon equilibrium diagram, development of microstructure - simple problems. **(10)**

HEAT TREATMENT

Objectives, types, annealing - full, stress-relief, process, spherodising. Normalizing, hardening, TTT diagrams, hardenability, Jominy end quench test, tempering, martempering, austempering. Surface hardening - carburising, cyaniding, nitriding, carbonitriding, flame hardening, induction hardening. Age Hardening. **(10)**

ALLOYS AND COMPOSITES

Classification, standards, general properties and uses of plain carbon steels and alloy steels - effect of alloying elements on the properties of steel- important types of alloy steel and cast irons - free cutting steels - structural steels - spring steels -HSLA steels -tool steels, heat resisting steels, stainless steels - grey cast iron, white cast iron, malleable cast iron, nodular cast iron and alloy cast iron.

Important non ferrous alloys - copper, nickel, aluminum, magnesium - typical composition, properties and applications - antifriction alloys - lead base and tin base system.

Composites - Properties and applications, types, fibre reinforced composites, particulate reinforced composites, dispersion strengthened composites and laminated composites. **(7)**

Total : 45

TEXT BOOKS

1. *Agarwal B.K., "Introduction to Engineering Materials", Tata McGraw Hill Publishing Company, New Delhi, 21st Reprint, 2008.*
2. *Avner S.H., "Introduction to Physical Metallurgy", Tata McGraw Hill Publishing Company, New Delhi, 6th Edition, 2001.*

3. *Shanta Kumar, S.R.J. "Material and Metallurgical Science", Anuradha Agencies, Kumbakonam, 2nd Edition, 2001.*

REFERENCE BOOKS

1. *Guy. A.G., "Elements of Physical Metallurgy", Oxford - IBH Publishing Co., 1993.*
2. *Raghavan, V., "Physical Metallurgy", Prentice Hall of India Pvt. Ltd., New Delhi, 2007.*
3. *William D.Callister, "Material Sciences and Engineering", John Wiley and Sons, 2007.*

09ME45 APPLIED ELECTRONICS AND MICROCONTROLLERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To understand the basic concepts of amplifiers and oscillators and provide in-depth study of microcontrollers.

OUTCOME

The student will be able to apply the acquired knowledge on different amplifiers, oscillators, microcontrollers, interrupts, timers and peripherals for practical applications.

AMPLIFIERS AND OSCILLATORS

Junction Field Effect Transistor (JFET) - pinch-off voltage - volt-ampere characteristics - FET small signal model - insulated-gate FET (MOSFET) - common source amplifier - common drain amplifier - Unijunction transistor - construction - characteristics - application as relaxation oscillator - SCR - principle of operation - characteristics - Operational amplifiers - characteristics - applications: voltage follower - adder - subtractor - inverter - scale changer - integrator - differentiator. **(9)**

PIC MICROCONTROLLER (PIC 16C6X/7X family)

CPU architecture and instruction set: program memory - register pile structure - addressing mode - CPU registers - instruction set - simple programs. **(9)**

INTERRUPTS AND TIMERS

Loop time subroutines, Timer2 and interrupts: interrupt logic - interrupt service routine -RB0/INT external interrupt input - Timer0 - compare mode - capture mode - timer1/CCP programmable period scaler - timer1 external event counter - timer1 and sleep mode - pulse width modulated outputs - PORT B change interrupts. **(9)**

PERIPHERALS

I^2C bus operation - I^2C bus subroutines - DAC output - temperature sensor - serial EEPROM - UART - waveforms and baud-rate accuracy - baud-rate selection - UART data handling circuitry - UART initialization. **(9)**

APPLICATIONS

Front panel I/O: softkeys - state machines and key switches - display plus RPG use - display of variable strings - code conversions for input and display - display of constant strings - ADC characteristics - ADC use - special features: configuration word - oscillator configurations - reset alternatives - low-power operation - serial programming - parallel slave port. **(9)**

Total : 45

TEXT BOOKS

1. *Jacob Millman and Christos C.Halkias, "Electronic Devices and Circuits", Tata McGraw Hill Publishing Company Limited, 2007.*
2. *John B.Peatman, "Design with PIC Microcontrollers", Pearson Education, 2006.*

REFERENCE BOOKS

1. *J.Millman and C.C.Halkias, "Integrated Electronics: Analog and Digital Circuits and Systems", McGraw Hill, New Delhi, 2001.*
2. *Roy Choudhury D and Sheil Jain, "Linear Integrated Circuits", 2nd Edition, New Age International Publishing Co. Ltd., 2003.*
3. *Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers: Principles and Applications", Newness Publisher, 2007.*

09FY21 MATHEMATICS - II

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To develop the basic Mathematical problem solving skills of Engineering students that are imperative for effective understanding of Engineering subjects. The topics introduced will serve as basic tools for specialized studies in many Engineering fields.

THEORY OF EQUATIONS

Relation between the roots and the coefficients - Symmetric functions of the roots - Transformation of equations - Reciprocal equations - Solution of algebraic and transcendental equations by Newton - Raphson method - polynomial equations by Graeffe's root squaring method. **(9)**

DIFFERENCE CALCULUS

Finite differences - operators and their interrelations - Interpolations - Newton's and Lagrange's method - Numerical differentiation based on Newton's formula - Numerical integration - Trapezoidal and Simpson's 1/3 rule. Solutions of finite difference equations with constant coefficients. **(9)**

VECTOR CALCULUS

Vector differentiation - gradient - divergence - curl - physical interpretation and identities. Vector integration - line - surface and volume integrals. Gauss, Stoke's and Green's theorems (without proof). **(9)**

LAPLACE TRANSFORMS

Transform of standard functions - Transform of unit step, dirac delta, error and periodic functions - Initial and final value theorems - Inverse transforms and their properties - Convolution theorem - Applications to ordinary differential equations and integral equations. **(9)**

FOURIER SERIES

Dirichlet's conditions - Full range series - Half range series - Complex form of series - Parseval's identity - Harmonic analysis. **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Kandasamy P. et al., "Engineering Mathematics for first year B.E./ B.Tech", (Volume 1 & II) (8^{th} fully Revised Edition) S. Chand & Co., New Delhi, (2008)*
2. *Kandasamy. P., et al., "Numerical Methods", S. Chand & Co - (2008)*
3. *Veerarajan. T., "Engineering Mathematics" (III Semester) (Third Edition) Tata. McGraw Hill Publishing Company Ltd., New Delhi, (2008)*

REFERENCE BOOKS

1. *Erwin Kreyszig, "Advanced Engineering Mathematics" (8^{th} Edition) John Wiley & Sons (Asia) Pvt. Ltd., - (2007)*
2. *Grewal B.S., "Higher Engineering Mathematics", (40^{th} Edition) Khanna Publishers, New Delhi, (2007).*

09ME35 INSTRUMENTATION AND CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To familiarize students with the concepts of Instrumentation systems for different parameters measurement and to provide basic knowledge about different types of sensors and transducers used for measurement and fundamental ideas about control systems and systems stability.

OUTCOME

On completion of the course, the student will be able to identify, analyze and select a suitable, reliable instrument to measure physical, fluid and its kinematic parameters for selected system and design and evaluate a suitable control system for a selected measurement system.

INTRODUCTION

Generalised Measurement System - Characteristics - Classification of sensors and transducers - Selection of sensors - Calibration. Transducers for measuring stress, strain, displacement and speed. **(9)**

FLUID PARAMETERS

Temperature, Pressure, flow, level, viscosity and humidity measurements. **(9)**

KINEMATIC PARAMETERS AND MODERN SYSTEMS

Acceleration and vibration, force and torque measurements.

Introduction to software based instrumentation - Virtual Instrumentation - Telemetry- Micro sensors- Fiber optic sensor - Sensors for manufacturing systems - Sensors for Automobiles. **(9)**

CONTROL SYSTEMS - PHYSICAL SYSTEMS

Open loop and closed loop systems - Transfer function - Physical System, Modelling - Translational and Rotational Systems - Block diagrams - Analogous Systems - Signal flow graphs. **(9)**

SYSTEMS ENGINEERING

Zeroth, First and Second Order systems - Static and dynamic error coefficients- Second order system - overshoot, damping ratio and undamped natural frequency.

Stability Analysis - Routh's Criteria, Bode Plot, Nyquist criterion. **(9)**

Total : 45

TEXT BOOKS

1. *Thomas G. Beckwith, Roy .D and Marangoni, "Mechanical Measurements", Prentice Hall of India, 6th Edition, 2007.*
2. *Nagrath I.J. & Gopal.M., "Control System Engineering", Wiley Eastern Ltd., New Delhi, 2008.*

REFERENCE BOOKS

1. *Doeblin E.O., "Measurement System Application and Design", McGraw Hill Ltd. , New Delhi, 15th Edition, 2004.*
2. *Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Ltd., New Delhi, 4th Edition, 2008.*
3. *Benjamin C Kuo and Farid Golnaraghi, "Automatic Control Systems", John Wiley & Sons, 2009.*
4. *Sawhney A.K., "A Course in Mechanical Measurements and Instrumentation",12th Edition, Dhanpat Rai & Sons, New Delhi, 2005.*

09ME36 MACHINE DRAWING

L	T	P	C
2	0	4	4

ASSESSMENT : THEORY

OBJECTIVE

To provide to the students hands-on training on the drafting skills, to generate drawings of machine components and to impart knowledge on assembly concepts, fits and tolerances.

OUTCOME

At the end of this course, the student will be able to apply the knowledge in the real time shop floor for modeling and analysis of simple machine parts.

CONVENTIONS

Code of practice for engineering drawing- conventional representation of details- drilled and tapped holes, countersunk and counter bored holes, internal and external threads, undercuts, grooves, chamfers, fillet radii and keyways. Conventions to represent standard components- bolts, nuts, washers, screws, cotters, pins, circlips, bearings, gears, springs and flanges. **(12)**

ASSEMBLY CONCEPTS

Methods and concepts of assemblies- assembly requirements, Bill of materials. Methods of assembly with bolts, nuts, studs, screws and pins. Axial and Radial retention of parts. Assembly and dismantling exercise of a typical assembly with emphasis on assembly sequence and appropriate fits. **(12)**

FITS AND TOLERANCES

Limits, fits and tolerances- need, types, representation of tolerances on drawing, calculation of minimum and maximum clearances and allowances. Geometric tolerance- uses, types of form and position tolerances, symbols, method of indicating geometric tolerances on part

drawings. Surface finish symbols- methods of indicating the surface roughness. Blue print reading exercises. **(12)**

ASSEMBLY DRAWING PRACTICE

Making free hand sketches of typical subassemblies- flange coupling, stuffing box, journal bearings, rolling element bearings, keyed joints, cotter joints and C clamp. **(12)**

ASSEMBLY USING SOLID MODELING

Introduction to Computer Aided modeling and assembly using software. Drawing of assemblies- plummer block, machine vice, stop valve, screw jack, tail stock, cylindrical gear box, simple drill jig. Creation of bill of materials, calculation of mass and section properties, interference check between solids. **(12)**

Theory : 20

Practical : 40

Total : 60

TEXT BOOKS

1. *Gopalakrishna K R, "Machine Drawing", Seventeenth Edition, Subhas Stores, Bangalore, 2003.*
2. *CAD/CAM Manual, PSG College of Technology, Coimbatore, 2002.*

REFERENCE BOOKS

1. *Varghese P I and John K C, "Machine Drawing", Jovast Publishers, Thrissur, 2007.*
2. *BIS, SP: 46-2003, "Engineering Drawing Practice for Schools and Colleges", New Delhi, 2003.*
3. *Faculty of Mechanical Engineering, PSG College of Technology, "Design Data Book", M/s. DPV Printers, Coimbatore, 2000.*
4. *ASME Y 14.5 -2009, "Dimensioning and Tolerancing", ASME, New York, 2009.*

09ME42 FOUNDRY AND WELDING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To impart fundamental knowledge on design of patterns and moulds, melting techniques and defects in casting, various types of welding principles, welding processes and design for welding, brazing and soldering.

OUTCOME

On successful completion of this course, the students can demonstrate their mastery of the knowledge, techniques and will be able to design components for casting and welding processes and identify, analyze and solve technical problems and successfully complete a comprehensive design project related to manufacture of casting and welded components.

METAL CASTING PROCESS

Patterns - types, pattern materials, pattern allowances - pattern design, Moulding - Green sand moulding - mould preparations - sand ingredients and additives. Cores and core making - preparation and testing. Various moulding methods, shell moulding, investment casting, centrifugal casting, die casting and full mould processes, CO_2 process. **(7)**

METAL MELTING PROCESS

Melting furnaces - cupola, crucible, arc and induction furnaces, limitations and applications, melting of ferrous and non-ferrous alloys (Aluminum and Copper): production of cast iron castings, steel castings, fettling and cleaning of castings. **(6)**

DESIGN FOR CASTING PROCESS

Design of simple pattern for given allowances. Gating types - design - aspiration effects - effect of friction and velocity distribution. Cooling

and Solidification - mechanism of solidification - rate of solidification. Riser - design of riser - placement. Problems in gating and riser design. Economics of casting - defects in castings. **(7)**

FUSION WELDING PROCESSES

Welding Classification - Oxy-fuel gas welding - properties, production and storage of gases, pressure regulators, welding torches and techniques, Oxy-Acetylene flames and applications, shielded metal arc welding, covered electrodes, arc blow. Arc welding power sources: transformer, rectifier, inverter, shielding gases, TIG, MIG and SAW processes and applications. **(9)**

FUSION AND PRESSURE WELDING PROCESSES

Carbon arc, atomic hydrogen arc, thermit, plasma arc, stud and friction welding processes, Electrical resistance welding processes: spot, seam, projection, percussion, flash butt, induction welding - principles and applications, Brazing, Soldering. **(8)**

METALLURGY OF WELDING

Welded joint - solidification of weld metal - heat affected zone. Weld quality- porosity - slag inclusions - incomplete fusion and penetration - weld profile - cracks - lamellar tears - Weldability. **(8)**

Total : 45

TEXT BOOKS

1. *Rao, P.N. "Manufacturing Technology - Foundry, Forging and Welding", Tata McGraw Hill Publishing Co., New Delhi, 2008.*
2. *Amitabha Gosh and Ashok Kumar Malik, "Manufacturing Sciences", East West Press Pvt. Ltd., 2005.*
3. *Kalpakjian.S and S.R.Schmid," Manufacturing Engineering and Technology", Pearson Education, India, 2006.*
4. *Parmar, R.S. "Welding Processes and Technology", Khanna Publishers, New Delhi, 2005.*

REFERENCE BOOKS

1. *Parmar, R.S., "Welding Engineering and Technology", Khanna Publishers, New Delhi, 1992.*
2. *George.E. Dieter, "Mechanical Metallurgy", McGraw Hill International Book Company Ltd., 1997.*
3. *Raghavan, V., "Material Science and Engineering", Prentice Hall of India Limited, 9th Edition, 2007.*
4. *Heire R. W., Loper C.R and Rosenthal P.C., "Principles of Metallurgy Casting", McGraw Hill Publishing Company Ltd., 1981.*
5. *Little R.L., "Welding Technology", Tata McGraw Hill, 2001.*

09ME44 APPLIED THERMODYNAMICS

(Use of steam tables and Mollier chart permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To help the students understand the basic laws governing energy transformations involving heat and work and various thermodynamic properties and processes.

OUTCOME

Students will have a deeper understanding on the basics of heat and work transfers, acquire knowledge related to analysis of power cycles and combustion of fuels.

BASIC CONCEPT AND FIRST LAW OF THERMODYNAMICS

Macroscopic and microscopic concepts- Thermodynamic system and control volume, properties, processes and cycles- Thermodynamic equilibrium- Quasi-static process- concept of continuum. Zeroth law of thermodynamics- Energy and forms of energy. Thermodynamic work- forms of work, heat. Comparison of heat and work. Concept of ideal and real gases. Equation of state. Vander Waal's equation and its limitations- compressibility factor and compressibility chart. Mixture of ideal gases. First law of thermodynamics- applications of first law to closed system - processes - work done, heat transfer, internal energy and enthalpy calculations. Flow work- steady flow energy equation and its application to various equipments. **(12)**

SECOND LAW, ENTROPY AND AVAILABILITY

Second law of thermodynamics- heat engine, refrigerator and heat pump- Kelvin Planck and Clausius statement of second law. Reversible and irreversible processes- Carnot cycle- Carnot theorem- Reversed Carnot cycle. Thermodynamic temperature scale- Clausius inequality- concept of entropy- principle of increase of entropy- entropy and

irreversibility. Available and unavailable energy- Availability of closed system and steady flow systems. **(12)**

PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE

Pure substance- phase transformation of water P-V, P-T, T-S and H-S diagrams- PVT surfaces. Properties of steam- use of tables and charts- processes- work, heat, internal energy change, enthalpy change, and entropy change calculations- measurement of steam quality. Rankine steam power cycle- efficiency and specific steam consumption. Rankine cycle with super heat. Reheat cycle and Regenerative cycle. **(7)**

AIR STANDARD POWER CYCLES

Otto, Diesel, Dual cycles- air standard efficiency- Mean Effective Pressure- comparison. Brayton cycle- efficiency. Stirling cycle and Ericsson cycle. **(7)**

FUELS AND COMBUSTION

HCV and LCV of fuels. Determination of calorific value- simple problems. Bomb calorimeter- Junker's gas calorimeter- theoretical and actual A/F calculation- volumetric and gravimetric analysis. Mass of dry products of flue gas- flue gas analysis- Orsat apparatus. **(7)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Nag. P.K., "Engineering Thermodynamics", Tata McGraw Hill, New Delhi, 2008.*
2. *Rajput R.K., "Engineering Thermodynamics", Laxmi Publications, New Delhi, 2009.*

REFERENCE BOOKS

1. *Van Wylen, "Fundamentals of Thermodynamics", John Wiley and Sons, 6th Edition, 2007.*
2. *Jones and Dugan, "Engineering Thermodynamics", Prentice Hall of India, 2009.*
3. *Kothandaraman C.P. and Domkundwar, "A course in Thermodynamics (Thermal Engineering)", Dhanpat Rai and Co. Ltd., New Delhi, 2007.*

09CE31 MATHEMATICS III

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To incorporate the ideas of complex variables, partial differential equations and its applications and Fourier transforms that are imperative for effective understanding of Engineering subjects. The topics introduced will serve as basic tools for specialized studies in many engineering fields.

OUTCOME

At the end of the course, the student will be able to solve the engineering problems involving complex integration, complex differentiation, partial differentiation and Fourier transforms.

COMPLEX DIFFERENTIATION

Analytic functions- Definitions and properties- Cauchy Riemann equations in Cartesian and Polar coordinates- construction of analytic functions- Conformal mappings- Bilinear Transformation - the mappings of the form $w = z+a$, az, $1/z$, z^2, e^z, sinz, cosz, - simple problems. **(9)**

COMPLEX INTEGRATION

Cauchy's integral theorem- Integral formula- Taylor's and Laurent's series (without proof)-Types of singularities, Poles and residues- Cauchy's residue theorem- Applications- Contour integration using circular and semicircular contours. **(9)**

PARTIAL DIFFERENTIAL EQUATIONS

Formation by elimination of arbitrary constants and functions- solution by direct method-solution of first order non-linear PDE- standard types - Lagrange's linear equation- Linear higher order homogeneous PDE with constant coefficients. **(9)**

FOURIER TRANSFORMS

Fourier integral theorem (without proof)- Infinite Fourier transform- infinite Fourier sine and cosine transforms- properties and problems- Convolution theorem- Parseval's identity- Finite Fourier sine and cosine Transforms- properties and problems. **(9)**

BOUNDARY VALUE PROBLEMS

Vibration of strings- one dimensional wave equations, one dimensional heat flow- unsteady state and steady state -Two dimensional heat flow steady state in Cartesian coordinates-Separation of variables- Fourier series solution. **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Kandasamy, P., "Engineering Mathematics - Volume II & III", S.Chand & Co., New Delhi, 2004.*
2. *Veerarajan .T, "Engineering Mathematics", 3rd Edition, Fifth Reprint, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 2008.*
3. *Venkataraman.M.K., "Engineering Mathematics III", Revised and Enlarged Fourteenth Edition, The National Publishing Company, 2008.*
4. *Venkataraman.M.K., "Engineering Mathematics III-A", Eleventh Edition, The National Publishing Company, 2008.*

REFERENCE BOOKS

1. *Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley and Sons (Asia) Private Limited, 2008.*
2. *Grewal, B.S., "Higher Engineering Mathematics", 40th Edition, Khanna Publishers, 2007.*

09ME53 MANUFACTURING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This course imparts fundamental knowledge on principles of machining process and various technologies used for machining processes.

OUTCOME

At the end of the course, the student can demonstrate his/her mastery of the knowledge, techniques, skills and modern tools of manufacturing and mechanical systems and processes, apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology, identify, analyze and solve technical problems.

MACHINING PROCESS OF ROUND SHAPES

Lathe - lathe operations - turning parameters - cutting screw threads - attachments - problems in machining time calculation, Material removal rate.

Boring and Boring machines, Drilling machines - drills - description of drill bits, reamers, tapping tool. Design consideration and machining time calculation for drilling, reaming and tapping operations. **(6)**

MACHINING PROCESS TO PRODUCE NON-ROUND SHAPES

Milling - types, operations, material removal rate and machining time calculations for milling process, planing, shaping, broaching - description, operations and types, problem in Material removal rate. **(9)**

PRODUCTION OF GEARS AND THREADS

Generation of forms, difference between forming generation, thread chasing, die-heads, thread rolling, thread milling, thread grinding, gear planing, gear hobbing, gear shaping, worm milling, gear shaving, gear grinding, straight bevel gear manufacture, spiral bevel gear manufacture. **(9)**

PRODUCTION OF FINE MACHINED SURFACES

Abrasives machining - grinding process - grinding wheel - specification and selection, wear, operations and machines. Design consideration for grinding. Finishing operations - lapping, honing, super finishing. Economics of grinding and finishing operations. **(6)**

PRODUCTION OF PLASTIC AND RUBBER

Polymers - structures, thermoplastics, moulding and machining of thermoplastics, extrusion process, sheet forming process, thermo setting plastics, moulding and machining thermo setting plastics, other processing methods for plastics, plastic component design - mould design, processing of rubber. **(6)**

SURFACE TECHNOLOGY

Friction in metal - wear - wear measurements - lubrications - types - lubricant selection. Mechanical surface treatment and coating - case hardening and hard facing - thermal spraying - vapour deposition - diffusion coating - electroplating - electroless plating - anodizing - non metallic coating - plastic coating - chemical coatings - various enamel coating and ceramic coatings. **(9)**

Total : 45

TEXT BOOK

1. *Serope Kalpakjian. S.R. Schmid, "Manufacturing Engineering and Technology", 4th Edition, Pearson Education, 2000.*

REFERENCE BOOKS

1. *Haslehurst, M., "Manufacturing Technology", English Language Book Society, 1998.*
2. *Chapman, W. A., "Workshop Technology - Vol 1, 2, 3", Oxford and IBH Publishers Co. Pvt. Ltd., 2006.*

09ME54 DESIGN OF MACHINE ELEMENTS
(Use of Design Data Book is permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To provide a detailed knowledge on simple stresses, combined stresses, simple and variable loads and their effects on various mechanical components.

OUTCOME

Candidates will be able to apply the knowledge gained to design shafts, couplings, springs and different types of joints subjected to different types of loads.

STRESS ANALYSIS

Types of stresses, stress-strain diagram in tension, mechanical properties of materials, static stress equation in axial, bending and torsional loading, criteria for failure, factor of safety. **(2)**

COMBINED STRESSES

Combination of normal stresses, eccentric loading of members, combination of normal and shear stresses, principal stresses, theories of failure. **(6)**

VARIABLE LOADS

Mechanism of fatigue failure -fatigue limit and fatigue strength, S-N curves, types of stress variations, terminology, Soderberg, Goodman and Gerber equations, stress concentration factor, notch sensitivity factor, factors affecting fatigue limit, equivalent stress, combined variable stress. **(6)**

SHAFTS AND COUPLINGS

Forces on shafts due to gears, belts and chains, estimation of shaft

size based on strength and critical speed. Couplings - types and applications, design of square key - use of standards, rigid coupling, flexible flange couplings - selection. **(8)**

SPRINGS

Helical springs and leaf springs - stresses and deflection in round wire helical springs - accounting for variable stresses - concentric springs. Design of leaf springs - stress and deflection equation. **(5)**

RIVETED AND WELDED JOINTS

Strength equations, efficiency, design of riveted joints - joints of uniform strength, eccentrically loaded riveted joints. Types of welded joints - weld symbols, strength of welds, centrally loaded, unsymmetrical sections, axially loaded, eccentrically loaded joints. **(7)**

SLIDING CONTACT BEARINGS

Theory of lubrication, hydrodynamic bearing, Sommerfield number, design of hydrodynamic and hydrostatic bearings. **(6)**

ROLLING CONTACT BEARINGS

Static and dynamic load capacity, cubic mean load, variable load, probability of survival, selection of deep groove and angular contact ball bearings. Design of roller bearings. **(5)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Robert L Moltt., "Mechanical Elements in Mechanical Design", Macmillan Publishing Co., London, 2005.*
2. *Robert L Norton, "Machine Design - An Integrated Approach", Prentice Hall, New Delhi, 2005.*

REFERENCE BOOKS

1. *Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill Publishing Ltd., New Delhi, 2007.*
2. *Faculty of Mechanical Engineering, PSG College of Technology, "Design Data Book", M/s. DPV Printers, Coimbatore, 2005.*
3. *Shigley and Mischkee, "Mechanical Engineering Design," McGraw Hill, Inc., New Delhi, 2004.*
4. *John M Barson and Stanely T Rolfe, "Fracture and Fatigue Control in Structures", Prentice Hall Inc., New Jersey, 2002.*
5. *Jacobson B O, Bernard J Hamrock and Steven R Schmid, "Fundamentals of Machine Elements", McGraw Hill Inc., 2nd Edition, 2006.*

09 ME 55 THEORY OF MACHINES

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

This course imparts knowledge on theories involved in the design of various mechanisms and their applications in manufacturing processes.

OUTCOME

Upon completion of the course, the student will be able to demonstrate his / her knowledge on various mechanisms commonly used in industries in order to construct reliable machineries.

KINEMATICS

kinematics pairs, link, Degree of freedom, mobility - kutzbach criterion - Grashoff's law , Inversions of four bar chain and Slider crank chains - transmission angle - Double slider crank chain - Velocity and acceleration mechanism - Relative Velocity and Acceleration diagrams of simple mechanism by relative velocity and acceleration method - Analytical and special graphical (Klein's and Ritterhaus) methods for slider crank mechanism, Coriollis component of acceleration. Computer application in the kinematic analysis of simple mechanisms. **(10)**

FRICTION

Friction loss in bearings - flat, conical, multiple collar. Clutches - single plate, multiple plate, cone and centrifugal. Brakes - band, band and block, Internal expanding brake, condition of self locking. Dynamometer - prony brake and Epicyclic gear train dynamometer and Flash light dynamometer. **(8)**

KINEMATICS OF CAM

Classification - Displacement, velocity and acceleration diagrams for various motions. Construction of cam profile for roller, mushroom, oscillating, flat followers with and without offset for SHM, uniform

acceleration and retardation and cycloidal motion. Tangent cam and polynomial cam with translational flat faced follower, swinging flat faced follower. **(9)**

GEAR AND GEAR TRAINS

Gear terminology - Law of gearing - Length of path of contact and arc of contact and contact ratio, - Involute tooth profile, interference and undercutting in involute tooth gear and minimum number of teeth. Determination of backlash - Rack and Pinion, Epicyclic gear train - Velocity and Torque calculation and Applications - Simple problems. **(9)**

BELT AND CHAIN

Belt - Ratio of driving tension for flat belt and V-belt , creep, Slip, determination of angle of contact, centrifugal tension, maximum tension in the belt, condition for maximum power transmission, initial tension in the belt. Power transmission using V belt - friction in Vee belt

Chain - Classification and length of chains. **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Shigley J.E. and Uicker.J.J., "Theory of Machines and Mechanisms", 3rd Edition, Oxford Press, 2003.*
2. *Ghosh A and Malik AK, "Theory of Mechanism and Machine", East West Press (Pvt) Ltd., New Delhi, 2007.*
3. *Rao.J.S. and Dukkipatti.R.V., "Mechanisms and Machine Theory", Wiley-Eastern Ltd. Publishers, 2006.*
4. *Waldron and Kinzel , "Kinematics, Dynamics and Design of Machinery", 2nd Edition, J. Wiley & Sons, 2003.*

REFERENCE BOOKS

1. *Ballaney,P.L., "Theory of Machines", Khanna Publishers, New Delhi, 2008.*
2. *Singh,V.P., "Theory of Machines", Dhanpat Rai and Co., New Delhi, 2008.*
3. *Sadhu Singh, "Theory of Machines", Pearson Education Pvt. Ltd., New Delhi, 2009.*
4. *Bansal,R.K., "Theory of Machines" , Laxmi Publications (P) Ltd., New Delhi, 2008.*

09ME56 METAL FORMING AND MATERIAL TESTING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This course aims to educate the student on fundamental mechanism on metal forming sciences, different metal forming processes and their process controls, and mechanical properties of materials and their testing procedures.

OUTCOME

On successful completion of this course, the student can demonstrate his/her knowledge on materials, design of various metal forming processes, selection of material based on process requirement, apply the current knowledge and adapt to emerging applications of engineering and technology and identify, analyze and solve technical problems.

MECHANICAL BEHAVIOUR OF MATERIALS

Elastic and plastic flow of materials - improvement of mechanical properties - strain hardening, strain ageing, solid solution hardening, grain size hardening, dispersion hardening. Fatigue concepts - fatigue mechanism - fatigue fracture - factors affecting - fatigue life. Creep - creep concepts, creep test - creep curve, mechanism of Creep, Creep properties of metal - Fracture, concepts, types - ductile fracture, brittle fracture, mechanism of brittle transition, fracture toughness. Metal forming processes - classification of metal forming processes - Hot, cold and warm Working. **(6)**

ROLLING AND FORGING

Rolling - design parameters in rolling process - neutral point-roll pressure - power requirements - effect of friction - problems. Rolling mills - types, design consideration in rolling mill selection - problems in rolling design - shape rolling operations - production of seamless tubing and pipes.

Forging - design for forging - forging of a rectangular and circular cross section - force requirements - effect of friction in forging - problems, open and closed die forging - related forging operations - Rotary swaging - forgeability - economics of forging. **(10)**

EXTRUSION, DRAWING AND SHEET METAL FORMING

Extrusion - Forward extrusion - backward extrusion - side extrusion - hydrostatic extrusion - tube extrusion - production of seamless pipe and tube - drawing of rods, wires and tubes. Problems in designing extrusion process - extrusion ratio, extrusion force - effect of friction in extrusion.

Sheet metal forming - shearing - sheet metal characteristics - test method for formability of sheet metals -types of presses, types of dies - sheet metal cutting operation. Sheet metal bending. Deep drawing - other forming methods.

Sheet metal forming methods - High energy rate forming (HERF) - High velocity forming (HVF) -Explosive forming - Electro hydraulic forming, Magnetic forming - high speed forming machines - petro - forge forming - Dyna pak - applications, merits and demerits. **(12)**

OTHER FORMING METHODS

Rapid prototyping - additive processes - fused deposition model - stereolithography - selective laser sintering - solid base curing - laminated object manufacturing - rapid tooling.

Powder metallurgy - introduction - production of metal powders - metal powder characteristics - powder compaction - sintering - post sintering process - advantages and limitations - applications. **(9)**

TESTING OF MATERIALS

Mechanical properties - Tension test - compression - impact test - torsion - bending - hardness - Brinell, Rockwell and Vickers hardness test - Microhardness test.

Non destructive testing - visual inspection, magnetic particle, liquid penetration, eddy current, radiographic and ultra sonic - inspection methods. **(8)**

Total : 45

TEXT BOOKS

1. *Serope Kalpakjian. S.R. Schmid, "Manufacturing Engineering and Technology", 4th Edition, Pearson Education, 2000.*
2. *Rao.P.N., "Manufacturing Technology", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2009.*

REFERENCE BOOKS

1. *George E.Dietor, "Mechanical Metallurgy", McGraw Hill International Book Co., 1989.*
2. *Amitabha Gosh and Ashok kumar Malik. "Manufacturing Sciences" East West Press Pvt. Ltd., 2005.*

09ME41 MATHEMATICS - IV

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To provide knowledge on the basic numerical methods required for solving engineering problems and statistical ideas and the knowledge of special functions that are imperative for effective understanding of engineering subjects.

OUTCOME

At the end of the course, the student will be able to solve the engineering problems involving ordinary differential equations, finite difference approximations, sampling theory and special functions.

NUMERICAL METHODS - I

Linear simultaneous equations : Gauss elimination method - Gauss Jordan method - Crout's method - Gauss Seidal method - Relaxation method.

Ordinary differential equations : Taylor's series - Modified Euler's - Runge- Kutta fourth order methods - Milne's predictor - Corrector method. **(9)**

NUMERICAL METHODS - II

Finite difference approximations - solution of PDE - Laplace equation - Liebmann's iteration process - Poisson equation - Parabolic equation - Bender Schmidt and Crank - Nicholson methods - Hyperbolic equation. **(9)**

TWO DIMENSIONAL RANDOM VARIABLES

Probability mass function - Probability distribution function - Cumulative distribution function - Marginal probability functions - Conditional distribution - Expectation of two dimensional random variables - Covariance - Correlation - regression - curve fitting - least

square technique - only curve of the form or reducible to the form $y = ax+b$, $y = ax^2 + bx + c$ **(9)**

SAMPLING THEORY

Elements of sampling theory - large sample tests - test for mean, variance and proportions - small sample tests-t, F, chi-square tests - contingency table - test for independence. **(9)**

SPECIAL FUNCTIONS

Bessel functions- Differential equations- Generating function - Orthogonality- Recurrence relations - Legender Polynomials - Differential equations - Rodrigue's formula - Generating function - Orthogonality - Recurrence relations . **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Kandasamy. P., "Numerical Methods", S.Chand & Co., New Delhi, 2009 .*
2. *Veerarajan .T., "Engineering Mathematics", Tata McGraw Hill Publishing Company Ltd., 3rd Edition, New Delhi, 2008.*
3. *Veerarajan T, "Probability, Statistics and Random Process", 3rd Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.*
4. *Venkataraman M .K , "Higher Mathematics for Engineering and Science", 4th Edition, National Publishing Company , 2006.*

REFERENCE BOOKS

1. *Kapoor.J.N and Saxena.H.C., "Mathematical Statistics", S.Chand and Co., New Delhi, 12th Edition, 2009.*
2. *Grewal. B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 40th Edition, 2007.*

09 ME 51 METROLOGY AND QUALITY CONTROL

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To impart knowledge on the different types of measuring instruments and measuring methods commonly used in industries and also to provide knowledge on different types of quality control measures and techniques.

OUTCOME

To provide good exposure on various measuring instruments their usage and understand the methods of testing and inspecting various power transmitting elements used in the manufacturing industries.

They would also know the construction procedure of control charts and their importance along with the knowledge of quality of product manufacture and ISO standards.

Student will be able to control quality of manufactured product and establish quality systems.

INTRODUCTION

Precision and accuracy, standards of measurement, errors in measurement, Length measuring instruments - vernier calipers, micrometers, height gauge, dial indicators. Angle measuring instruments - sine bar, angle gauges and autocollimator. Interchangeability, limit gauges and Taylor's principle of gauge design.

(9)

THREAD AND GEAR METROLOGY

Elements of screw thread, measurement of effective diameter by two wire and three wire methods, pitch measurement, errors in threads. Measurement of pitch, profile errors and total composite errors of gears.

(9)

SURFACE FINISH MEASUREMENTS AND ACCEPTANCE TESTS

Measurement of surface finish, roughness and waviness, stylus probe instruments - Talysurf profilometer and Tomlinson surface meter. Interferometry - principle, optical flat. Instruments to measure geometric shape. Optical projectors and microscopes. Acceptance test for machine tools. Laser Interferometer, CMM. **(9)**

INSPECTION AND QUALITY CONTROL

Definition and need for SQC, quality assurance, probability distributions. Acceptance sampling - principles, operation characteristic curves. Types of sampling plans, Design of sampling plans, standard sampling plans. Reliability - definition, relationship to quality control, achieving reliability, Mean Time Between Failure (MTBF). **(9)**

CONTROL CHARTS AND ISO SYSTEMS

Axiom of manufacture, need for control charts, control charts for attributes and control charts for variables (problems), evaluation of process capability. Total Quality Management (TQM), ISO 9000 systems - concepts and practices. Quality circles. **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Gupta. I. C., "Text Book of Engineering Metrology", Dhanpat Rai and Sons, New Delhi, 2000.*
2. *Jain. R.K., "Engineering Metrology", Khanna Publishers, New Delhi, 2007.*
3. *Mahajan.M. , "A Text Book of Metrology", Dhanpat Rai and Sons, New Delhi, 2002.*

REFERENCE BOOKS

1. *ASTME, "Hand Book of Industrial Metrology", Prentice Hall of India Pvt. Ltd., New Delhi, 1992.*
2. *Seigmund and Halpen, "The Assurance Science", Prentice Hall of India (P) Ltd., New Delhi, 1982.*
3. *Mahajan. M., "Statistical Quality Control", Dhanpat Rai and Sons, New Delhi, 2002.*

09ME52 THERMAL ENGINEERING

(Use of steam and refrigerant tables and charts permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

This course is intended to provide knowledge about the principles of thermal systems like heat engines, cooling systems, and compressors by applying the laws of thermodynamics.

OUTCOME

Students would acquire sufficient theoretical knowledge about IC engines, Steam turbines, refrigerators and air conditioning systems and compressors.

I.C.ENGINES

Classification- working principle of four stroke and two stroke engines using petrol and diesel as fuel - indicator diagrams, valve timing and port timing diagrams. Comparison of petrol and diesel engines - four stroke and two stroke engines- testing and performance of internal combustion engines- supercharging principle. **(8)**

STEAM BOILERS

Classification of boilers - low pressure and high pressure boilers. Boiler mountings and accessories. **(3)**

STEAM NOZZLES

Flow of steam through nozzles- effect of friction, critical pressure ratio, super saturated flow of steam. **(4)**

STEAM TURBINES

Impulse and reaction principles- compounding- velocity diagrams for impulse and reaction stages-50% reaction turbine. **(6)**

REFRIGERATION

Methods of refrigeration - air refrigeration, Bell Coleman cycle, vapour compression refrigeration cycle, use of T-s and P-h diagrams - under cooling and superheating. Performance calculations. Study of absorption refrigeration system. Refrigerants - selection and properties. **(8)**

PSYCHROMETRY AND AIR CONDITIONING

Psychrometric chart- properties. Requirements for comfort and industrial air conditioning, air washer, by-pass factor, summer and winter air conditioning systems. **(5)**

SINGLE STAGE RECIPROCATING COMPRESSORS

Working principle - equations for shaft work and efficiencies- effect of clearance on volumetric efficiency. **(5)**

MULTI STAGE RECIPROCATING AND ROTARY COMPRESSORS

Working principle, inter-cooler, optimum intermediate pressure in a two stage compressor and performance of multi stage compressor. Rotary positive displacement compressor - types and performance calculations. **(6)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Rudramurthy, R., "Thermal Engineering", Tata McGraw Hill, New Delhi, 2006.*
2. *Kothandaraman C.P. and Domkundwar, "Thermodynamics and Thermal Engineering", Dhanpat Rai and Sons, New Delhi, 2006.*

REFERENCE BOOKS

1. *Rajput. R.K., "Thermal Engineering", Laxmi Publications, New Delhi, 2007.*
2. *Ganesan.V., "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2005.*
3. *Mathur M L and Sharma R P, "Internal Combustion Engines", Dhanpat Rai and Sons, New Delhi, 2004.*

09ME63 DYNAMICS OF MACHINERY

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To impart the knowledge of theory of machines with the study of forces due to combined effect of mass and motion acting on various machine elements.

OUTCOME

Upon completion of the course, the students will be able to design various mechanical controlling equipments and balancing equipments and they will be able to analyse and control the vibrations in mechanical elements.

INERTIA FORCE, TURNING MOMENT DIAGRAMS AND FLYWHEEL

Inertia force and inertia torque in crank mechanism, D-Alembert's principle - turning moment diagrams of engines. Fluctuation of energy - Determination of maximum fluctuation of energy, coefficient of fluctuation of energy and speed, energy stored in flywheel, dimensions of flywheel rim. Flywheel in punching press and forging. **(9)**

MECHANISM FOR CONTROL

Gyroscope - forces and torques - Gyroscopic couple and its effects on aeroplane, naval ships and automobiles. Effect of gyroscopic couple on a disc fixed rigidly at certain angle to a rotating shaft.

Governor - function, types - Porter, Proell. Effect of friction, definition of sensitiveness, stability, isochronism, hunting - controlling force - coefficient of insensitiveness - governor effort and power, calculation of equilibrium speeds and ranges of speed of governors. **(10)**

BALANCING

Static and dynamic balancing of rotating masses in same and different planes, partial balancing of reciprocating masses - Balancing of in-

line, V and radial engines, direct and reverse crank methods - Hammer blow and swaying couple in locomotives. **(10)**

LONGITUDINAL AND TRANSVERSE VIBRATION

Free and forced vibration - natural frequency of longitudinal and transverse vibrations. Critical speed - Dunkerley's method, energy method effect of inertia of constraints, damping factor, Damping ratio, logarithmic decrement, magnification factor, vibration isolation and transmissibility. **(9)**

TORSIONAL VIBRATION

Torsional Vibration of single and multiple rotor systems, Torsionally equivalent shaft, geared system, whirling speed of shaft - Holzer method.

Application of computers in dynamics. **(7)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Shigley J.E. and Uicker.J.J., "Theory of Machines and Mechanisms", 3rd Edition, Oxford Press, 2003.*
2. *A Ghosh and AK Malik, "Theory of Mechanism and Machine", East West press Pvt. Ltd., New Delhi, 4th Edition, 2010.*
3. *Rao.J.S. and Dukkipatti.R.V., "Mechanisms and Machine Theory", Wiley - Eastern Ltd. Publishers, 2007.*
4. *Waldron and Kinzel., "Kinematics, Dynamics and Design of Machinery", 2nd Edition, J. Wiley and Sons, 2007.*

REFERENCE BOOKS

1. *Ballaney,P.L., "Theory of Machines", Khanna Publishers, New Delhi, 2008.*

2. *Singh,V.P., "Theory of Machines" , Dhanpat Rai and Co., New Delhi, 2008.*
3. *Sadhu Singh, "Theory of Machines", Pearson Education Pvt. Ltd., New Delhi, 2009.*
4. *Bansal,R.K., "Theory of Machines" , Laxmi Publications Pvt. Ltd., New Delhi, 2008.*

09ME64 DESIGN OF MECHANICAL TRANSMISSION SYSTEMS

(Use of Design Date Book is permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To impart a detailed knowledge on design procedures of various power transmission systems.

OUTCOME

Student will be able to select a suitable power transmission system for the required application and design efficiently various elements of the selected system.

SELECTION OF V BELTS AND CHAINS

V belts for given power and velocity ratio, selection of micro V-belts, timing belts, selection of roller chain and power speed ratio, silent chain. **(7)**

SELECTION OF BELTS FOR SPINDLE DRIVE AND FEED DRIVE IN APPLICATION FOR CNC MACHINE TOOLS

Poly Vee belts, HTD belts, V-belts of 3V, 5V and 8V types. Taper lock bushes and timing belts-SPZ, SPA, SPB, SPC types. **(7)**

POWER SCREWS

Forms of threads, force analysis, square and trapezoidal threads, collar friction, design of power screws (for screw jack, lathe, etc.,), selection of ball screws. **(7)**

DESIGN OF GEARS

Review of gear fundamentals, interference, gear forces, determining dimensions of a spur gear pair. Design of helical gears- parallel axis helical gear, normal and transverse planes, helix angles, equivalent

number of teeth, determining dimension of helical gear pair. Nomenclature of straight and spiral bevel gears. **(10)**

WORM GEARS

Nomenclature, thermal capacity, efficiency, gear forces, design of a pair of worm gears. **(5)**

MULTI SPEED GEAR BOX

Ray diagram, Kinematic diagram, gear tooth profile correction, finalization of the gear train, gear tooth loads and bearing reactions. **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Robert L Norton, "Machine Design - An Integrated Approach", Pearson Education, New Delhi, 2006.*
2. *Shigley and Mischke, "Mechanical Engineering Design", McGraw Hill, Inc., New Delhi, 2004.*

REFERENCE BOOKS

1. *Robert L Mortt, "Mechanical Elements in Mechanical Design", Macmillan Publishing Co., London, 2005.*
2. *Maitra GM, "Hand Book of Gear Design", Tata McGraw Hill, New Delhi, 2008.*
3. *Faculty of Mechanical Engineering, PSG College of Technology, "Design Data Book", M/s DPV Printers, Coimbatore, 2000.*
4. *Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2007.*

5. *Prabhu T J, "Design of Transmission Elements", Mani offset, Chennai, 2003.*
6. *Darle W Dudley, "Hand Book of Practical Gear Design", CRC Press, Florida, 2002.*
7. *Allen S Hall and Alfred R Holowenko, "Schaum's Outlines of Theory and Problems of Machine Design", Tata McGraw Hill, 2006.*

09ME62 OPERATIONS RESEARCH

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

The course provides an insight to decision making process involved in engineering applications. This course imparts knowledge on obtaining optimal solution for linear system.

OUTCOME

On successful completion of the course, the student can identify linear and non linear systems, differentiate between ideal, best and optimal solutions, formulate analytical models for a given system, optimise linear systems of different kinds and ability to identify, analyse and solve technical problems.

LINEAR PROGRAMMING

Linear programming formulation, graphical solutions, simplex methods - two phase method - Big M method - degeneracy - alternative optima - unbounded solutions, infeasible solutions.

Dual problem - primal - dual relationships - optimal dual solution - simplex tableau computations, additional simplex algorithms - dual simplex method, generalised simplex algorithm. **(9)**

TRANSPORTATION AND ASSIGNMENT MODELS

Transportation models - transportation algorithms - determination of the starting solution, iterative computation of the transportation algorithms - simplex method - explanation of the method of multipliers. **(5)**

NETWORK MODELS

Definition of network models - minimal spanning tree algorithm, shortest route algorithm, maximal flow algorithms, PERT, CPM - LP formulation of minimal spanning, maximum flow and PERT, CPM calculations.**(5)**

INVENTORY MODELS

General inventory models - role of demand in inventory models - EOQ models - with price breaks, with shortage limitations - dynamic order quantity - (setup / no setup) model, ABC analysis, Probabilistic EOQ models. **(5)**

DECISION MAKING AND GAME THEORY

Decision making under certainity - Analytical Hierarchy Process (AHP), Decision making under risk - decision trees, decision making under uncertainity.

Game Theory - two persons zero sum games - pure strategies and saddle points, mixed strategies - solution of games by dominance - graphical solution- linear programming model in game theory. **(6)**

QUEUING AND SIMULATION

Elements of queuing theory - Poisson's queuing model - single serve models, multi server models - machine servicing models.

System concepts - Types of systems and models - system simulation procedure - Monte- Carlo simulation method (simple problems) - Introduction to simulation languages. **(6)**

OTHER OPTIMISATION ALGORITHMS

Integer Programming algorithms - branch and bound techniques, cutting plane algorithm, computational consideration in Integer Linear Programming.

Goal Programming - weights method - pre-emptive method.

Dynamic Programming - introduction - recursive nature of computations in DP, forward and backward recursions. **(6)**

NON TRADITIONAL OPTIMISATION

Non Traditional Optimization - Multi objective optimization, genetic algorithms and simulated annealing techniques, Meta heuristics search techniques - Tabu search, ant colony optimization. **(3)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Hamdy Taha,"Operations Research- An Introduction", Prentice Hall of India (P) Ltd., 8th Edition, 2006.*
2. *Frederik S.Hiller, Gerald. J.Libermann, "Introduction to Operations Research", Tata McGraw Hill, 2006.*
3. *Richard Bronson, and Govindasami Naadimuthu, "Operations Research, Schaum's Outline Series", Tata McGraw Hill, 2nd Edition, 2004.*

REFERENCE BOOKS

1. *Rao S.S., "Optimisation Theory and Applications", Wiley Eastern Ltd, New Delhi, 2004.*
2. *Phillips, Ravindran and Solesberg, "Operations Research Principles and Practices", Prentice Hall, 2nd Edition, 2007.*

09ME66 GAS DYNAMICS AND SPACE PROPULSION

(Use of approved gas tables permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To develop an understanding of low speed aerodynamics and an introduction to compressible flows. This course covers topics in elementary gas dynamics, including shock waves.

OUTCOME

On completion of the course, the students will be able to apply principles of gas dynamics to solve compressible flow problems. They will also have an exposure to recent developments in aerodynamics, with application to aerospace systems.

FUNDAMENTALS OF COMPRESSIBLE FLOW

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility. **(7)**

FLOW THROUGH VARIABLE AREA DUCTS

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles. **(7)**

FLOW THROUGH CONSTANT AREA DUCT WITH FRICTION (FANNO FLOW)

Fanno flow - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length. Isothermal flow with friction in constant area ducts. **(5)**

FLOW THROUGH CONSTANT AREA DUCT WITH HEAT TRANSFER (RAYLEIGH FLOW)

Rayleigh flow - Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer. **(5)**

NORMAL SHOCK

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl - Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock, normal shock in Fanno and Rayleigh flows, flow with oblique shock (elementary treatment only). **(6)**

GAS TURBINES

Open and closed cycle gas turbines - practical cycle - methods for improvement of performance of open cycle system - regeneration, intercooling and reheating. Effect of operating variables on thermal efficiency. Advantages of gas turbines over IC engines. **(6)**

PROPULSION

Aircraft propulsion - Jet engines - energy flow, study of turbojet engine components - diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines - thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet engine.

Rocket propulsion - rocket engines thrust equation - effective jet velocity specific impulse - rocket engine performance, solid and liquid propellants, comparison of different propulsion systems. **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Yahya. S.M., "Fundamental of compressible flow", New Age International (P) Ltd., New Delhi, 2007.*
2. *Ganesan.V., "Gas Turbines", Tata McGraw-Hill, New Delhi, 2005.*

REFERENCE BOOKS

1. *Cohen. H., Rogers R.E.C and Sravanamutoo, "Gas Turbine Theory", Addison Wesley Ltd., 1998.*
2. *Radhakrishnan.E, "Gas Dynamics", Prentice Hall of India, New Delhi, 2006.*

09ME73 ENGINEERING SYSTEM DESIGN AND ANALYSIS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To understand the system design, design for manufacturing, industrial design and ergonomic design and to learn the aesthetic and ergonomic design concepts for various products.

OUTCOME

On completion of the course, the student will be able to demonstrate his / her knowledge to design a high quality engineering system.

INTRODUCTION

Introduction to System Design, Asimov's Model - Product Design Practice- Industry strength considerations for system design- Design for Manufacturing - Identifying customer needs. **(9)**

SYSTEM DESIGN

Concept scoring - Concept Generation and Evaluation- Understanding the problem and development of Engineering specification - Screening Matrix - System Architecture- Development Economics. **(9)**

INDUSTRIAL DESIGN

Elements of Industrial Design - Structure of Industrial Design- General approach to man machine relationship - Work station Design - Shapes and sizes of various controls and display - The mechanics of Vision. **(9)**

ERGONOMIC DESIGN

Expert system for Ergonomic Design - Anthropomorphic data and its applications in Ergonomic design - Colour- Colour to Colour - Colour terms - Colour on Engineering Equipments - Aesthetic Expression - House style. **(9)**

DESIGN APPLICATIONS

Gear box for automobiles and machine tools, Suspension for 2 wheeler and 4 wheeler, Piston and cylinder assembly, Kinematic diagrams for lathe, special purpose machines and CNC machines, Four bar Mechanisms. **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOK

1. *Chitale A.K. and R.C. Gupta, "Product Design and Manufacturing", Prentice Hall of India, New Delhi, 2007.*

REFERENCE BOOKS

1. *David G Ullman , "The Mechanical Design Process", Tata McGraw Hill, New Delhi, 2009.*
2. *Karl T Ulrich, Steven D Eppinger, " Product Design and Development", Tata McGraw Hill, New Delhi, 4th Edition, 2008.*
3. *Mayall,W.H., " Industrial Design for Engineers", London Iliffe Book Ltd., 1967.*
4. *MCCormick, E.J (ED), "Human Factors Engineering", McGraw Hill Company Ltd., USA, 1992.*

09ME82 POWER PLANT ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To gain knowledge on power plants, layouts, plant accessories, plant controls and maintenance.

OUTCOME

On completion of the course, the student can demonstrate his / her mastery of the knowledge on various sources for power generation and different power generation methods.

ESSENTIALS OF POWER PLANT

Introduction to combined cycle, cogeneration, types of power plants - conventional and non- conventional. Hydrological data- capacity and type. General layout and types of hydroelectric power plant. Selection and governing of turbines. General layout of diesel power plant and their components. Types of layout - comparison of diesel plant with thermal plant. **(9)**

STEAM POWER PLANT

Steam power plant layout and components- modern steam generators- fire tube and water tube types. Function of super heater, economizer and air heater. Fuels and combustion - fuel preparation and burning, grates, burners draft, combustion calculation, boiler trials. **(9)**

GAS TURBINE AND NUCLEAR POWER PLANTS

Comparison and types of gas turbine power plants and their components. combined gas and steam power plants - Advantages of gas turbine plants over diesel and thermal plants. General components of nuclear reactors - Types of reactors - Location safety and economics of nuclear plants. comparison with thermal plants. **(9)**

ACCESSORIES AND CONTROLS

Fuel handling systems - types, ash - handling methods, gas cleaning methods and dust collection. Types of condensers - cooling towers - water treatment method. Economics of power plant operation - instrumentation and control - variable load operation and economics.

(9)

NON CONVENTIONAL ENERGY SOURCES

Non- conventional power generating systems- MHD power plants- solar power plants ,wind power generation , tidal power generation, geo thermal power plant, OETC plants- selection and installation of power plants.

(9)

Total : 45

TEXT BOOKS

1. *Domkundwar. S., "Power Plant Engineering", Dhanpat Rai and Sons, 1995.*
2. *Sharma .P.C., "Power Plant Engineering", S.K Kataria and Sons, 2009.*

REFERENCE BOOKS

1. *Nagpal .G.R., " Power Plant Engineering", Khanna Publishers, 2002.*
2. *Morse .F.P, "Power Plant Engineering", Affiliated East West Press Ltd., 1995.*

09ME83 ENGINEERING ECONOMICS AND INDUSTRIAL MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide basic economic and industrial management concepts which will help implement these concepts practically in industries.

OUTCOME

On completion of the course, the students gain ability to apply the fundamental concepts of engineering economics and to know about the different costs involved and its analysis, develop ability to function effectively in teams, they acquire knowledge on different types of organizations and its importance with the required knowledge on production planning and control.

INTRODUCTION

Economics - Flow in an economy - Law of supply and demand. Concept of Engineering economics - Types of efficiency - Definition and scope - Elements of costs - Other costs / revenues - Break even analysis - profit / volume ratio. **(9)**

ELEMENTARY ECONOMIC ANALYSIS

Concepts - Examples of simple economic analysis. Interest formulas and their applications - Time value of money - Interest formulas - Basis for comparison of alternatives. **(9)**

MANAGEMENT CONCEPTS

Scientific management- Contributions of F.W. Taylor and Henri Fayol- Principles of management- Functions of management- Industrial Management, Project management- MIS - MBO. **(9)**

ORGANIZATION

Process, principles, Organization structure, Organization chart, Types of Organization- Industrial Psychology- Morale- Motivation- Industrial

Fatigue- Accidents - Personnel Management- Recruitment and selection of Employees- Education, Training and Skills- Qualities of Leadership- Safety Engineering- social responsibilities of business. **(9)**

PRODUCTION PLANNING AND CONTROL

Plant location- plant layout- production planning and control- plant maintenance- material handling - CAPP. **(9)**

Total : 45

TEXT BOOKS

1. *James L Riggs., "Engineering Economics", Tata Mc Graw Hill Ltd., New Delhi, 2004.*
2. *Koontz, Weihrich and Aryasri, "Principles of Management", Tata McGraw Hill Publishing Co. Ltd., 2006.*

REFERENCE BOOKS

1. *Pannerselvam , "Engineering Economics" , Prentice Hall of India, New Delhi, 2007.*
2. *Ricky W. Griffin, "Management", Haughton Mifflin Publication, 2007.*
3. *Hillier and Frederick S., "Introduction to Management Science", Tata McGraw Hill Publishing Co. Ltd., 2008.*

09ME61 HEAT AND MASS TRANSFER

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To provide an understanding of the basics of heat and mass transfer theory, the laws governing transfer of heat by conduction, convection and radiation, and the transfer of mass by diffusion.

OUTCOME

Students would be able to apply the principles learned for the analysis of problems involving conduction, convection and radiation.

CONDUCTION I

Modes of heat transfer - mechanism of conduction, convection and radiation - steady state conduction- one dimension only - overall heat transfer coefficient - heat flow through composite slabs, cylinders, spheres with and without heat generation - variable thermal conductivity - insulation - critical thickness. **(9)**

CONDUCTION II

Fins - types - purpose - applications - one dimensional heat transfer - temperature variation - fin efficiency - fin effectiveness. Unsteady state heat transfer - lumped parameter analysis - heat transfer with internal resistance - problems using Heisler charts. **(9)**

CONVECTION

Application of dimensional analysis for forced convection: flow over flat plate - hydrodynamic boundary layer and thermal boundary layer - Vonkarman integral momentum equation - velocity distribution - flow through pipes - heat transfer coefficient - heat transfer rate calculations using empirical correlations.

Application of dimensional analysis for free convection - vertical surfaces - horizontal surfaces - heat transfer coefficient - heat transfer rate calculations using empirical correlations **(9)**

RADIATION

Mechanism - different surfaces - Stefan Boltzman's Law, Kirchoff's Law - emissivity - absorptivity - reflectivity - transmissivity - intensity of radiation - emissive power - shape factor for simple geometries - heat transfer between surfaces separated by non absorbing medium - radiation shields - gas radiation. **(9)**

HEAT EXCHANGERS AND MASS TRANSFER

Heat exchangers - Classification- parallel, counter and cross flow - multiple pass flow - LMTD- Fouling factor. Effectivness - NTU method of analysis of heat exchangers.

Mass transfer - diffusion through a plane membrane - equimolar counter diffusion - diffusion of water vapour through air - mass transfer coefficient - convective mass transfer coefficient - simple problems **(9)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Holman, J.P., "Heat Transfer", McGraw Hill Book Co., SI Version, 10th Edition, 2009.*
2. *Rajput, R.K., "Heat and Mass Transfer", S.Chand Publishers, 2007.*

REFERENCE BOOKS

1. *Domkundwar, "Heat and Mass Transfer", Dhanpat Rai Sons, 2006.*
2. *Ozisik M.N.,"Heat Transfer", Prentice Hall of India Ltd., 1985.*
3. *Frank P. Incropera, David P. DeWitt, "Heat and Mass Transfer", John Wiley and Sons (ASIA) Pvt. Ltd., 2008.*
4. *Nag P.K., "Heat and Mass Transfer", Second Edition, Tata McGraw Hill Co., 2008.*

5. *Christopher A Long, "Essential Heat Transfer", Pearson Education (ASIA), 2008.*
6. *Kothandaraman C.P. and Subramanyan S., " Heat and Mass Transfer Data Book", New Age International Publishers, 2008.*
7. *Domkundwar and Domkundwar, "Heat and Mass Transfer Data Book", Dhanpat Rai and Co., 2008.*

09ME65 TOOL ENGINEERING AND DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To impart knowledge on design aspects of different types of tooling, cutting conditions, clamping methods and jigs and fixtures.

OUTCOME

The students will have the ability to design / select appropriate single point and multi point cutting tools, clamping devices and jigs and fixtures for various components to be machined.

MECHANISM OF CHIP FORMATION AND TYPES OF CHIPS

Mechanism of chip formation, Types of chip, techniques for the study of chip formation, chip tool interface, built-up edge, chip breakers. **(4)**

FORCES IN METAL CUTTING

Stress on the shear plane, Shear angle relationship in thin plane analysis - Merchant diagram. Minimum energy theory - stresses on the tool - problems in tool geometry. Problems in measurement of tool forces - virtual tool dynamometers. **(4)**

THERMAL ASPECTS OF METAL CUTTING

Heat in metal cutting - primary and secondary temperature zone due to cutting - problems - heat flow - Methods of tool temperature measurement, significance of cutting tool temperature. Cutting fluids- Types and selection. **(5)**

CUTTING TOOL MATERIAL AND TOOL WEAR

Cutting tool materials - classification, application, treatment. Mechanisms of tool wear, Tool failure, Methods of tool wear measurement. Tool life, Machinability index, Tool life equations, Universal machinability index - problems. **(5)**

DESIGN OF SINGLE AND MULTI POINT CUTTING TOOLS

Design of single point tools - Tools for turning, boring, shaping and planing. Design of milling cutters, drills, reamers, broaches, gear shaper cutters, gear hobs and form tools. ISO designation of turning tool holders and inserts. Tool holders for CNC applications. **(9)**

JIGS AND FIXTURES

Location principles -3-2-1. locators , clamping - clamping forces - devices. Design of jigs - Drill bushes -different types of jigs-plate, channel, box, swing latch, indexing jig, turnover jigs - Automatic drill jigs - Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for given components. Design of fixtures - principles of boring, turning, milling and broaching fixtures- Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- Modular fixtures. Design and development of fixtures for given component. **(9)**

PRESS TOOLS AND ECONOMIC ASPECTS OF TOOLING

Dies, punches, types of presses, clearances, types of dies, strip layout, calculation of press capacity, center of pressure. Design consideration for die elements. Economics of tooling - Tool selection and tool replacement with respect to small tools. **(9)**

Total : 45

TEXT BOOKS

1. *Ranganath.B.J., "Tool Engineering Design", Vikas Publishing House Pvt. Ltd., New Delhi, 2005.*
2. *ASTME "Fundamentals of Tool Design", Prentice Hall of India Pvt. Ltd., New Delhi, 5th Edition, 1985.*
3. *Amitabh Ghosh, and Ashok Kumar Mallik," Manufacturing Sciences", East -West Press Pvt. Ltd., 2005.*

4. *Rodin .P., "Design and Production of Cutting Tools", MIR publishers, 1998.*
5. *Donaldson, "Tool Design Hand Book", McGraw Hill, New York, 2004.*

REFERENCE BOOKS

1. *Amerego.E.J and Brown.R.H., "The Machining of Metals", Prentice Hall, 1969.*
2. *ELBS, "Principles of Jig and Tool Design", Tata McGraw Hill, 1969.*
3. *PSG College of Technology, "P.S.G. Design Data Book", DPV Printers, Coimbatore, 2005.*

09ME72 FLUID POWER ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide a first-level introduction to hydraulic and pneumatic components and systems for low cost automation and also to provide the basic knowledge on various hydraulic and pneumatic circuits used for different applications.

OUTCOME

On completion of the course, students will be able to apply the knowledge on hydraulics and pneumatics systems in the design of machines and process layouts.

INTRODUCTION

Fluid Power - Hydraulic fluids - properties and selection. Pneumatic fluid - properties and selection. Advantages and applications of Fluid Power. **(2)**

HYDRAULIC PUMPS AND MOTORS

Symbolic representation of fluid power elements. Hydraulic pumps and motors- principle of working, calculation of discharge, power and efficiency - simple problems. **(8)**

HYDRAULIC VALVES

Pressure, flow and direction control valves, Electro hydraulic elements, accumulators, intensifiers, power calculations, size of accumulators - fluid seals - types and constructional details. **(8)**

BASIC HYDRAULIC CIRCUITS

Unloading, speed control, regenerative and sequencing circuits. Servo systems, typical hydraulic circuits for machine tools and other industrial applications. Circuit design for given functional requirements. **(9)**

PNEUMATICS

Air preparation units - Filter, Regulator and Lubricator. Valve configuration and controls. Pneumatic actuators, diaphragm actuators, back pressure sensors. Pneumatic circuits design - Cascade method. **(9)**

HYDRO PNEUMATICS AND ELECTRO PNEUMATICS

Hydro-pneumatics and electro-pneumatic elements and circuits. **(3)**

FLUIDICS

Fluidics - Coanda effect, wall attachment devices, digital and proportional devices. Fluidic amplifiers, typical application of fluidics for control in fluid power circuits. **(6)**

Total : 45

TEXT BOOKS

1. *Anthony Esposito, "Fluid Power with Application", Prentice Hall, 2008.*
2. *Stewart, "Practical Guide to Fluid Power", Taraporevala Sons & Co., Bombay, 2002.*

REFERENCE BOOKS

1. *Subir Kar, "An Introduction to Fluidics", Oxford and IBH Publishing Co., New Delhi, 1984.*
2. *Fitch, E.C. Jr., "Fluid Power and Control Systems", McGraw Hill Book Co., 1966.*
3. *Pippenger, J.J. and Hicks, T.G., "Industrial Hydraulics", McGraw Hill Book Co., 1979.*
4. *Andrew Parr, "Hydraulics and Pneumatics", Jaico Publishing House, 2008.*

09ME71 CAD/CAM/CIM

(Computer Aided Design / Computer Aided Manufacturing / Computer Integrated Manufacturing)

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To introduce to the students the concepts of CAD/CAM technology, various methods of product design, modeling techniques, the hardware and software modules and transformation principles.

To make the students learn how products are manufactured on CNC machine tools using programs along with the product testing and inspection methods.

OUTCOME

The students will have the ability to apply the concepts of geometrical modeling, know various steps involved in the design process and ultimately understand the procedure for analyzing various engineering components.

In addition, they gain knowledge on the various design workstations, their operating features and functions.

Besides, they get adequate practice on CAD and CAM software along with different activities associated with manufacturing operations.

INTRODUCTION

CAD/CAM - Definition- Computer Technology - Basic Hardware Configuration, Input / Output Devices - Mini and Micro Computer - Design Workstation / Graphics Terminals, Types, study of hardware requirements. **(9)**

COMPUTER AIDED DESIGN (CAD)

Fundamentals of CAD, Design Process, Application of Computers for Design, Benefits of CAD -Hardware configuration in CAD - Operator

Input Devices - Output devices and plotters. Computer Graphics - software and database. Software Configuration of a Graphic System. Functions of Graphic Package, Construction of Solid Geometry, Wire Frame Models, Surface and Solid Models. **(9)**

COMPUTER AIDED MANUFACTURING (CAM)

Introduction to Computer Numerical Control (CNC) - Direct Numerical Control (DNC), Combined CNC and DNC systems - Introduction to FMS- Computer Aided Process Planning (CAPP) and its types - Benefits of CAPP. **(9)**

COMPUTER INTEGRATED PRODUCTION MANAGEMENT SYSTEM (CIPMS)

Problems with Traditional Production Planning System - Inventory Management, Materials Requirement Planning (MRP) concepts, Benefits of MRP, Manufacturing Resources Planning (MRP -II) - Functions of Shop Floor Control, Operation Scheduling - Supervisory Computer Control - Computer Aided Quality Control (CAQC). **(9)**

COMPUTER INTEGRATED MANUFACTURING (CIM)

Types of Manufacturing Systems, Computer Control Systems, CIM Benefits, Automation - Automated Guided Vehicles. **(9)**

Total : 45

TEXT BOOKS

1. *Mikell.P.Groover and Emory.W.Zimmers,Jr, "CAD/CAM", Prentice Hall of India (P)Ltd., 2007.*
2. *Surendrakumar and A.K.Jha, "Technology of CAD/CAM", Dhanpat Rai and Co. (P) Ltd., 2008.*

REFERENCE BOOKS

1. Radhakrishnan.P and Kothandraman.C.P., "Computer Graphics and Design", Dhanpat Rai and Sons Co. (P) Ltd., 2008.

2. Banarjee.K., "Computer Management and Planning", Tata McGraw Hill, 2007.
3. Rao P.N., "CAD/CAM Principles & Application" Tata McGraw Hills Education Ltd., New Delhi, 2006.

09ME81 MANUFACTURING PLANNING AND COST ESTIMATION

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To impart knowledge on manufacturing planning and cost estimation for products and processes.

OUTCOME

The student will be able to execute manufacturing planning cost estimation for product and processes and to reduce the cost of manufacturing.

INTRODUCTION

Estimation - importance, aims and functions. Costing - importance, aims and difference between estimation and costing, importance of preparing realistic estimates, estimating procedure and its division. **(8)**

MANUFACTURING PLANNING

Introduction, production, types of production, production control and its necessity, production control enforcement procedure. **(4)**

ELEMENTS OF COST

Material cost - determination. Labour cost, determination of direct cost, expenses, cost of product (Ladder of cost). **(7)**

ANALYSIS OF OVERHEADS

Factory expenses, depreciation, causes of depreciation, methods of depreciation, administration expenses, selling and distribution expenses (over heads), allocation of overhead expenses. **(8)**

COSTING - MACHINES AND TOOLS

Distinction between fixed and variable expenses. Fixed overheads and Variable overheads. **(7)**

COST ESTIMATION FOR PRODUCTION PROCESS

Machining time calculation for turning, drilling, boring, threading, shaping and grinding operations. Forging operations - estimation of losses and operation time. Problems. **(11)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Banga. T.R and Sharma. S.C., "Mechanical Estimating and Costing", Khanna Publishers, New Delhi, 2004.*
2. *Narang. G.B.S. and Kumar. V., "Production and Costing", Tata McGraw Hill, New Delhi, 2005.*

REFERENCE BOOKS

1. *Gopalakrishnan. K.R. "Machine Drawing", Jubhas Publications, 1998.*
2. *Gupta C.B., "Fundamentals of Business Accounting", Sultan Chand and Co., New Delhi, 2003.*

09E01 DESIGN OF MATERIAL HANDLING EQUIPMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide the details about the material handling system playing a vital role in modern manufacturing and process industries to improve the productivity, reduce the lead time and increase safety level. To make the students understand the importance of basic principles, cost analysis and effective utilization of man, machine, and material.

OUTCOME

After having studied this subject, the students will be able to design and rectify problems related to material handling equipments.

They will also be able to select the right material handling systems and equipments based on the applications, besides cost reduction techniques.

INTRODUCTION

Material handling equipment - Principal groups - Hoisting equipment - Steel wire ropes - Welded chains, Hemp ropes, calculation of steel wire rope dimensions, fastening methods of chains and ropes. Material handling in Flexible Manufacturing System. **(6)**

LOAD SUSPENSION APPLIANCES

Pulley Systems - Rope sheaves- Rope drums - Load handling attachments - Hooks, Grabbing attachments. Unit and piece loads, loose materials. Ratchet and Pawl arrangement, Shoe brakes. **(7)**

MATERIAL HANDLING

Basic principles of material handling, analysis of material handling problem, organization for material handling, analysis of cost of material handling, basic types of material handling equipments - characteristic,

uses and limitations. Stability of forklift trucks, selection of material handling equipment, unit load handling, palletizing & packaging. **(9)**

HOISTING MECHANISM

Hoisting mechanisms - Layouts, Steady state motion - starting and stopping of hoisting mechanism - Safety Aspect Gear travelling mechanism - Slewing mechanisms. **(9)**

ELEVATORS

Design of Cage, Freight and bucket elevators. **(7)**

CONVEYORS

Design of pneumatic conveyors, belt conveyors and screw conveyors. **(7)**

Total : 45

TEXT BOOKS

1. *Rudenko.N, "Material Handling Equipment", MIR Publishers, Moscow, 1985.*
2. *Alexander.A.P., "Materials Handling Equipment", MIR Publishers, 1980.*

REFERENCE BOOKS

1. *PSG College of Technology, "PSG Design Data Book", DPV Printers, Coimbatore, 2005.*
2. *Robert M.East man., "Materials Handling", Marcel Decker Inc., New York, 1987.*

09E02 FINITE ELEMENT METHOD

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide basic procedure of finite element formulation and solution method to engineering problems and to acquire knowledge about various types of elements and their corresponding applications.

OUTCOME

Upon completion of the course, students will be able to model and solve simple solid mechanics, heat transfer and fluid flow problems.

INTRODUCTION TO FINITE ELEMENT METHOD

Modeling - Basic concepts - element, nodes and degree of freedom, engineering application of finite element method - comparison of finite element method with other methods of analysis-solution of equations-Ritz method, Variational method, Method of Weighted Residuals. **(9)**

GENERAL PROCEDURE OF FINITE ELEMENT METHOD

Discretization of the domain- interpolation polynomials - formulation of element characteristic matrices - linear bar, triangular, rectangular elements, assembly of element matrices and vectors and derivation of system equation - solution of finite element equation - computation of element resultants - nodal loads and elemental stresses. **(9)**

HIGHER ORDER AND ISOPARAMETRIC ELEMENT FORMULATIONS

Higher order one - dimensional, triangular, quadrilateral, hexahedral elements, determination of shape functions- continuity equation - comparative study of elements - isoparametric elements and formulations, numerical integration, nodal loads - stress calculations, simple 1D & 2D problems. **(9)**

SOLID AND STRUCTURAL MECHANICS

Introduction - linear elastic stress analysis, formulation of equilibrium equations - Dynamic analysis, Mass matrices, free vibration analysis - simple problems - analysis of solids of revolutions. **(9)**

HEAT TRANSFER AND FLUID MECHANICS

Basic equations of heat transfer - derivation of finite element equations - one and two dimensional heat transfer - basic equations of fluid mechanics - inviscid incompressible flows - Potential function and stream function formulations - simple problems. **(9)**

Total : 45

TEXT BOOK

1. *Rao.S.S., "The Finite Element Method in Engineering", 4th Edition, Pergamon Press, 2006.*

REFERENCE BOOKS

1. *Krishnamoorthy.C.S., "Finite Element Analysis", Tata McGraw Hill Publishing Co. Ltd., 2nd Edition, 1994.*
2. *Kenneth H.Huebner, Dewhirst,D.L.Smith,D.E. and Byrom,T.G. "The Finite Element Method for Engineers", John Wiley and Sons, 2nd Edition, 2004.*
3. *Vince Adams and Abraham Askenazi, "Finite Element Analysis", Onword Press, 1st Edition, 1999.*
4. *Tirupathi.R.Chandrupatla and Ashok.D.Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd., 3rd Edition, 2005.*
5. *Reddy J.N., "An Introduction to Finite Element Method", Tata McGraw Hill, 3rd Edition, 2006.*

09E03 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide a first-level introduction to computational fluid dynamics analysis to under-graduate students of mechanical engineering.

OUTCOME

Upon completion of the course the student is expected to have the necessary skills required to model and solve simple multi-dimensional fluid flow and heat transfer problems.

The background material will also be useful to the student when he/she tries to do CFD analysis using commercial software packages.

CONSERVATION LAWS OF FLUID MOTION AND HEAT TRANSFER

Introduction - Governing equations of fluid flow and heat transfer - Navier-Stokes (N-S) equations for a Newtonian fluid - Differential and Integral forms- Classification of fluid flows and flow equations. **(9)**

IRROTATIONAL FLOWS AND LAMINAR BOUNDARY LAYERS

Introduction- Potential functions and stream functions - Numerical treatment of steady irrotational flows in two dimensions - Laminar flows and boundary layers- Blasius solution - Numerical treatment of ordinary differential equations related to Blasius solution. **(9)**

NUMERICAL HEAT TRANSFER - FINITE VOLUME METHOD

Introduction- Discretization of governing partial differential equations of heat transfer - Applications to steady and unsteady heat conduction in one and two dimensions - Treatment of heat sources - Solution schemes for steady and unsteady heat conduction. **(9)**

NUMERICAL TREATMENT OF FLUID FLOW - FINITE VOLUME METHOD

Discretization of governing partial differential equations of fluid flow - Differencing schemes for convective - diffusive flows - Treatment of flow boundary conditions Introduction to the SIMPLE Algorithm **(9)**

TURBULENT FLOWS

Introduction- Reynolds Averaged N-S equations for turbulent flows - Eddy viscosity - Mixing length models - Turbulence kinetic energy and dissipation (k-epsilon) models - Advanced turbulent flow modeling and limitations. **(9)**

Total : 45

TEXT BOOKS

1. *Ghoshdastidar.P.S, "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill, New Delhi, 1999.*
2. *Versteeg. H.K. and Malalasekara. W, "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2004.*

REFERENCE BOOKS

1. *Muralidhar. K., Sundararajan. T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.*
2. *Niyogi P., Chakrabarthy. S.K., Laha. M.K., "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.*
3. *Chung T.J., "Computational Fluid Dynamics", Cambridge Univ. Press, New York, 2002.*

09E04 VIBRATION ENGINEERING

(Use of Beam Equation Sheet Permitted)

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide a first-level introduction to the mathematical basis of analyzing vibration related problems in mechanical engineering.

OUTCOME

Upon completion of the course the student will possess the necessary skills required to model and solve simple vibration-related problems.

The background material will also be useful to the student when he/she tries to pursue research into areas related to mechanical vibrations.

SINGLE DEGREE OF FREEDOM SYSTEMS

Introduction and Terminology - Single vs Multiple degrees of freedom - Equations of motion for conservative system by Rayleigh method - Free vs forced oscillation - Damped vs Undamped oscillations - solution by Laplace Transform Method - logarithmic decrement - Coulomb Damping - Harmonic excitation - Transmissibility - Support motion - Rotating unbalance - Vibration Measurement - Critical speed of rotating shafts. **(12)**

TRANSIENT VIBRATION

Impulse function - Arbitrary Excitation - Duhamel's Theorem - Finite difference digital computation of damped and undamped oscillations. **(8)**

TWO DEGREE OF FREEDOM SYSTEMS

Free and Forced Vibration of undamped systems - natural Frequencies - Mode shapes - Lagrange's Equation - Undamped Vibration Absorber - Eigen value Formulation - Dynamic matrix - Orthogonality of eigen vectors - Matrix methods - Direct and Iterative methods. **(12)**

MULTIPLE DEGREES OF FREEDOM

Matrix Iteration - Holzer's method, Dunkerley's Formula, Rayleigh's Method - Gear Systems - Approximation of string vibration by a multiple DOF system. **(6)**

VIBRATION IN CONTINUOUS MEDIA

Longitudinal Vibration and Torsional vibration of shafts - wave equation and solution - Bending vibrations of Beams - Determination of fundamentals frequencies for various end conditions. **(7)**

Total : 45

TEXT BOOKS

1. *Benson H. Tongue, "Principles of Vibration", Oxford University Press, New Delhi, 2002.*
2. *Thomson. W.T., "Theory of Vibrations with Applications", 4th Edition, Prentice Hall, Inc., New Jersey, 1993.*
3. *Seto.W, "Theory and Problems of Mechanical Vibrations", Schaum's Outline Series, Tata McGraw Hill Book Company, 2005.*

REFERENCE BOOKS

1. *Meirovitch. L., "Elements of Vibrations Analysis", McGraw Hill Book Company, New York, 1986.*
2. *James. M.L., Smith. G.M., Wolford. J.C., and Whaley. P.W, "Vibration of Mechanical and Structural Systems", Harper and Row, Singapore, 1989.*
3. *Tse. F.S., Morse. I.E., and Hinkle. R.T., "Mechanical Vibrations - Theory and Applications", Allyn and Bacon, Boston, 1978.*

09E05 MANUFACTURING SYSTEMS MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This course imparts basic knowledge on various activities involved in managing a manufacturing system and different manufacturing management principles involved.

OUTCOME

On successful completion of this course, the students can demonstrate their mastery of the knowledge and techniques and will be able to identify the tools required to manage a given system, identify, analyze and solve technical problem.

ESSENTIALS OF A MANUFACTURING SYSTEM

Production and Manufacturing - input and output of production system. System definition - system design. Modes of production - types of production - mass, batch and job shop - characteristics. Integrated Manufacturing System (IMS). **(9)**

PROCESS SYSTEM FOR MANUFACTURING

Flows in manufacturing system - Material and technology information flow-Logistics. Product Planning and Design - Product Structure Explosion. Process Planning-Process Design, Operation Design and Optimal Routing Design, Line Balancing. Layout Design - Systematic Layout Planning (SLP) - mathematical layout design - Production Flow Analysis. Logistic Planning- Distribution Problems, Manufacturing Optimization-Evaluation of Criteria for Manufacturing Optimization. **(12)**

MANAGEMENT SYSTEMS FOR MANUFACTURING

Managerial Information Flow - Decision Problems in Managerial Information Flow, Aggregate Production Planning - Production Planning - Short Term and Multiple Objective Production Planning, Product Mix

and Lot Size Analysis, Materials Requirement Planning (MRP), Production Scheduling - Operation Scheduling, Project Scheduling-Inventory System-Multiple Product Inventory Managements - Just In Time (JIT) Production. **(12)**

VALUE AND SOCIAL SYSTEMS FOR MANUFACTURING

Value/Cost flow in manufacturing systems-classification of costs, product cost structure, manufacturing cost, selling price, profit planning and break-even analysis, evaluation of capital investment, social manufacturing systems-strategy and tactics, corporate strategy, manufacturing strategy, global manufacturing-movements towards globalization, international manufacturing. **(12)**

Total : 45

TEXT BOOK

1. *Katsundo Hintomi, "Manufacturing Systems Engineering", Viva, Low Priced Student Edition, 2nd Edition, 2004.*

REFERENCE BOOKS

1. *Donald Bowersox and David Closs, "Logistics Management - The Integrated Supply Chain Processes", Tata McGraw Hill, 2005.*
2. *Tarek Khalil, "Management of Technology", Tata McGraw Hill Pvt. Ltd., 2005.*

09E06 MARKETING MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide a detailed knowledge on the methods adopted by industries in meeting consumer needs through marketing, to enhance knowledge on the steps undergone by major industries in marketing research and provide vision about the need, and future of marketing management.

OUTCOME

The students will have understanding about the importance and necessity of marketing and the ways of achieving customer satisfaction.

INTRODUCTION

Nature, scope and importance of marketing - modern marketing concept - marketing environment - marketing information system - physical distribution of goods - distinction between marketing and selling - marketing mix - marketing environment. **(6)**

CONSUMER BEHAVIOUR, FORECASTING AND NEW PRODUCT DEVELOPMENT

Consumer behavior - consumer buying motives - types of buying motives - marketing mix - marketing information system- components of Marketing Information System (MIS) - marketing research - distinction between marketing research and marketing information system - scope of marketing research - importance and steps in marketing research - new product development - product life cycle - sales forecasting product life cycle - sales forecasting. **(10)**

PLANNING, ORGANIZATION AND TRAINING

Consumer and industrial products- marketing planning-steps in planning process - sales promotion and advertising - need and importance of sales promotion programs - organization chart for marketing - personal

selling versus advertising - advertising and publicity - advertising and sales promotion - advertising objective and functions- sales promotion-functions of sales promotion -types of sales programs - sales promotion programs. **(10)**

PRICING, BRANDING AND PACKING

Significance of price marketing - pricing policies and decisions - new product development - stages in new product development - total quality management - elements of Total Quality Management - whole selling and retailing- transportation functions and model - branding- packing - labeling - consumer sales promotion schemes - sales force management - Product Life Cycle - stages in product life cycle. **(9)**

MARKETING RESEARCH, SELLING AND ADVERTISEMENT

Marketing research - distinction between marketing research and marketing information system - objectives and nature of marketing research - areas of marketing research - advantages and limitations of marketing research - marketing research process - kinds of sales man-advertising objectives and functions - significance of advertising - kinds of advertising- advertising copy - advertising agency- advertisement - comparative effectiveness of different advertising method. **(10)**

Total : 45

TEXT BOOKS

1. *Ramaswamy V.S and Namakumari.S, "Marketing Management", McMillan India Ltd., 2002.*
2. *Gupta.C.B and Rajan Nair, "Marketing Management", Sultan Chand and Sons, 2000.*
3. *Phillip Kotler and Gary Armstrong, "Principle of Marketing", Prentice Hall of India Ltd., 2009.*

09E07 PLANT LAYOUT AND MATERIAL HANDLING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To study different types of layouts and their application manufacturing plants and their parameters, and to introduce various material handling systems.

OUTCOME

On successful completion of this course the students can demonstrate their mastery of the knowledge, techniques and will be able to design an efficient plant layout and material handling systems for a given system, identify, analyze and solve technical problems and successfully complete a comprehensive design project related to mechanical or manufacturing fields.

INTRODUCTION

Objectives and criteria for facilities planning and industrial plant design. **(2)**

PLANT LAYOUT

Plant location - Factors affecting location, selection, application of transportation problems, assignment problems in layout design. **(9)**

TYPES OF PLANT LAYOUT AND LAYOUT PLANNING

Types of manufacturing system - types of plant layout and practical application - preliminary enterprise design activity - design process - factors influencing plant layout - design considerations - steps in planning- safety measures. **(9)**

QUANTITATIVE EVALUATION OF PLANT LAYOUT

Material flow - flow planning criteria, flow possibilities - design of material flow pattern conventional and quantitative techniques for analyzing material flow. Application of computer aided layout design. **(8)**

MATERIAL HANDLING AND ANALYSIS

Organization for material handling - relationship with plant layout - objectives, scope, principle and importance of material handling, selection and replacement of material handling equipments and analysis of handling problems. **(8)**

MATERIAL HANDLING SYSTEMS

Basic material handling systems - types of material handling equipments used for different applications - their selections and characteristics, auxiliary equipments, safety in operation. **(9)**

Total : 45

TEXT BOOKS

1. *James Apple,"Plant Layout and Material Handling", John Wiley and Sons, New York, 1997.*
2. *Richard L Francis, Leon F McGinnis, Jr., and John A. White,"Facility Layout and Location - An Analytical Approach", Prentice Hall of India (P) Ltd., New Delhi , 2005.*
3. *Choudary.R.B. and Tagore.G.R.N., "Plant Layout and Material Handling", Khanna Publishers, New Delhi, 2005.*

REFERENCE BOOKS

1. *Muthur,"Practical Plant Layout", McGraw Hill, New York, 1976.*
2. *Moor, "Plant Layout and Design", McMillan India Ltd., 1978.*

09E08 AGILE AND LEAN MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide the value added functions essentially required for a value chain, i.e. the lean supply and agile responsiveness, and to provide an understanding to students about push and pull management in the value chain.

OUTCOME

Students will be able to identify bottlenecks in the value chain and improve the efficiency of the value chain, irrespective of the product type, perform "as-if analysis" on the value chain and provide optimised solution.

INTRODUCTION TO AGILE MANUFACTURING

Concepts of agility - agile manufacturing system - agile relationship models - products, services and enrichment of each customer - enrichment chain - moving from one time product to providing customer enrichment. **(9)**

AGILE BUSINESS STRATEGIES

Generally accepted accounting principles - activity based costing - time based costing - budgeting procedures - dysfunctional organization and information systems - betrayal of trust - not sharing information - empowerment - enterprise integration - concurrent operations - external barriers. **(9)**

INTRODUCTION TO LEAN MANUFACTURING SYSTEM

Basic concepts of lean - elements of lean - functional areas of lean - Lean techniques - procedure to implement lean in manufacturing industries - prerequisites of becoming lean in manufacturing system - education and training. **(9)**

LEAN MANUFACTURING PRACTICES

System model for lean manufacturing - interaction between production workmen influences and production strategies - performance impacts of the lean manufacturing system - relationship between lean manufacturing practices and performance measures. **(9)**

IMPLEMENTATION OF LEAN MANUFACTURING SYSTEM

Lean manufacturing program - lean flow - paths of implementing lean manufacturing system - preparing and motivating people - roles in the change process - methodologies for change - environment for change - model of success factors in becoming lean. **(9)**

Total : 45

TEXT BOOKS

1. *Goldman, S.L. Nagal, R.N. and Press, K., "Agile Competitors and Virtual Organizations", Van Nostrand Reinhold, New York, 1995.*
2. *Liker, J.K., "Becoming lean", Productivity Press, Oregan, 1997.*
3. *Nick and Rick, "Lean Evolution: Lessons From The Workplace", Cambridge University Press, 2006.*

REFERENCE BOOKS

1. *Montgomery, J.C. and Levine, L.O., "The Transition to Agile Manufacturing", ASQC Quality Press, Wisconsin. 1995.*
2. *William M., Feld, "Lean Manufacturing Tools, Techniques and How to Use Them", The St. Lucie Press, Boca Raton, 2001.*
3. *Ronal G Askin, "Design and analysis of Lean Production System", John Wiley & Sons, 2002.*
4. *Bicheno, John Holweq, and Matthias., "The Lean Toolbox: The Essential Guide to Lean Transformation", 4th Edition, Picsie Books, 2009.*

09E09 COMPUTATIONAL METHODS IN MECHANICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To give first level introduction about the computational methods that can be used in mechanical systems.

OUTCOME

Upon completion of the course, the students will have the necessary skills required to model and solve simple problems using systems approach.

The background material will also be useful to the student when he/she tries to do simulations using commercial software packages such as ProModel / Preactor.

INTRODUCTION : SYSTEM MODELS AND SIMULATION

System concepts- system environments- stochastic activities. Continuous and discrete systems- system modeling - types of models - static and dynamic physical models - static and dynamic mathematical models - principles used in modeling. The techniques of simulation- Monte Carlo method- comparison of simulation- computation of continuous and discrete models - distributed lag models - Cobweb models. **(9)**

CONTINUOUS AND DISCRETE SYSTEM SIMULATION

Continuous system models - differentials - differential equations- analog computers. Simulators - continuous system simulation languages - Continuous System Modeling Program (CSMP) - feed back systems- real time simulation. Discrete events- representation of time - simulation of discrete systems - examples - simulation algorithms - discrete simulation languages (ProModel/Preactor). **(9)**

PROBABILITY CONCEPTS IN SIMULATION

Stochastic variables - discrete and continuous probability function- measures of probability functions - numerical simulation of probability functions - continuous uniformly distributed random numbers. A uniform random number generator- generating discrete distributions - non-uniform continuously distributed random number - the rejection method. **(9)**

GENERAL PURPOSE SYSTEM SIMULATION (GPSS)

General description- action times - succession of events - choice of path - facilities and storage- gathering statistics - conditional transfer - program control statements - examples - transfer modes - Set operations. **(9)**

INTRODUCTION TO SIMSCRIPTS

Simscripts programs- system concepts - organization of simscripts program - name and labels -statements referencing variables- main routine- arrival events- timing routine- disconnect event - closing event - definition of sets in simscript - set organization - set controls - gathering statistics in simscript - searching arrays- searching sets. **(9)**

Total : 45

TEXT BOOK

1. *Gordan. G, "System Simulation", Prentice Hall of India, New Delhi, 2nd Edition, 2005.*

REFERENCE BOOKS

1. *Zeigler and Bernard P, "Theory of Modeling and Simulation", John Wiley and Sons Inc., New York, 2nd Edition, 1976.*
2. *Chu and Yoahan, "Digital Simulation of Continuous Systems", McGraw Hill Book Company, New York, 1969.*

3. *Lewis.P.A.W., Goodman.A.S and Miller. J.M, "A Pseudo Random Number Generator for the System 1360, IBM system V11, No.2. PP.136-146", 1969.*
4. *Gordon,Geoffrey, "The Application of GPSS to Discrete System Simulation", Prentice Hall of India, 2004.*
5. *Dimsdale, B and Markowitz. H.M., "A Description of the SIM SCRIPT Language, IBM Systems" J III NO 1 57-67, 1964.*
6. *Wyman, Forest Paul, "Simulation Modeling: A Guide to Using SIM SCRIPTS", John Wiley and Sons Inc., New York, 1970.*

09E10 DESIGN AND ANALYSIS OF EXPERIMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide a first-level introduction to design and analysis of experiments to mechanical engineering students.

OUTCOME

Students can select a suitable design of experiment for conducting practical experiment to understand the behavior of any process or to develop a new product.

INTRODUCTION

Basic principles, guidelines for designing experiments, Basic statistical concepts, inferences about the differences in mean, randomized, paired comparison designs, Analysis of variances. **(9)**

RANDOMIZED BLOCKS, LATIN SQUARES AND RELATED DESIGNS

Completely randomized, Latin square, Graceo-Latin square and crossover designs. **(9)**

FACTORIAL DESIGN

Advantages of factorial design, description, calculation of direct and interaction effects. 2k factorial designs. Blocking and confounding - principle and use of confounded designs. **(9)**

FRACTIONAL FACTORIAL DESIGN

Two, three and mixed level fractional factorial designs - applications. **(9)**

RESPONSE SURFACE DESIGN

Fitting regression model. Response surfaces- first and second order designs. **(9)**

Total : 45

TEXT BOOKS

1. *Douglas C.Montgomery ,"Design and Analysis of Experiments", John Wiley and Sons, Inc., 5th Edition, 2003.*
2. *Cochran. W.G. and Cox .G.M., "Experimental Designs" Second Edition, John Wiley and Sons, 1958.*

REFERENCE BOOKS

1. *John Lawson and John Erjavee, "Modern Statistics For Engineering and Quality Improvement", Duxbury, 2001.*
2. *Stephen R.Schmidt and Robert G. Launs, "Understanding Industrial Designed Experiments", Air Academy Press, 4th Edition, 2005.*
3. *Andre I Khuri and John A Cornel, "Response Surfaces - Design and Analysis", 2nd Edition, Marcel Deckker, Inc. New York, 1996.*

09E11 MICRO SYSTEMS AND NANO ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide knowledge required for the design, fabrication and characterization of micro and nano systems and their applications in the present and future trends.

OUTCOME

Students will be able to design micro and nano systems for advanced manufacturing technology.

INTRODUCTION

Definition, historical development, application. **(2)**

VLSI TECHNOLOGY

Refreshing basics of electronics, logic and memory chips, silicon water, epitaxy, lithography, diffusion, thin film deposition, assembly bulk micro machining. **(3)**

MEMS

Background and fundamentals - properties, micro fluidics, design and fabrication - modeling, fabrication techniques, application in various fields. **(4)**

MICRO SENSORS

Classification of sensors, signal conversion, ideal characteristics of sensor, scaling, mechanical sensors, displacement and accelerometers, pressure and flow sensors. **(9)**

NANO MEASURING SYSTEMS

In process or in situ measurement of position of processing point, post process and on line measurement of dimensional features and surface,

mechanical measuring systems, optical measuring systems, electron beam measuring systems, pattern recognition and inspection systems. **(9)**

APPLICATION OF NANO ENGINEERING

Nano-grating system, nano- lithography, machining of soft metal mirrors with diamond turning, mirror grinding of ceramics, ultra-precision block gauges, balls for rolling bearings, fabrication of CCDs, VCR head assemblies, optical fibres. **(9)**

FUTURE TRENDS IN NANO ENGINEERING

Development of intelligent products, nano processing of materials for super high density IC's, nano mechanical parts, micro machines. **(9)**

Total : 45

TEXT BOOKS

1. *May G.S. and Size S.M., "Fundamentals of Semiconductor Fabrication", John Wiley and Sons Inc., 2004.*
2. *Bharat Bhushan,"HandBook of Nano Technology," Springer, Germany, 2004.*

REFERENCE BOOKS

1. *Tai Ran Hsu, "Mems and Micro Systems Design and Manufacture," Tata McGraw Hill, 2003.*
2. *Norio Taniguchi, "Nanotechnology", Oxford University Press, New York, 2003.*
3. *Chang C.V. and Size S.M., "VLSI Technology," Tata McGraw Hill, New Delhi, 2007.*
4. *Mark J Madou, "Fundamentals of Micro Fabrication," CRC Press, 2002.*
5. *Julian.W.Gardner, "Micro Sensors, Principles and Applications", CRC Press, 2003.*

09E12 RAPID PROTOTYPING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This course is intended to provide a detailed knowledge on advanced manufacturing technique, the Rapid Prototyping Process. This course is to help students to understand the need, types, method of operation and the future of Rapid Prototyping system in industrial applications.

OUTCOME

The students will have the ability to apply the knowledge gained in Rapid Prototyping techniques, process parameters and their optimization in addition to the applications.

INTRODUCTION

Product definition - Engineering Design Process - Product Prototyping and its impact - Prototype design and Innovation - Impact on Cost, Quality and Time - Process requirements for Rapid Prototyping - Product Prototyping and Product Development - Prototyping - Virtual and Rapid Prototyping in Product Development. **(8)**

PRODUCT PROTOTYPING

Need for Prototyping - Issues in Prototyping - Conducting Prototyping - Design Procedure - Prototype Planning and Management - Product and Prototype Cost Estimation - Fundamentals of Cost Concepts - Prototype Cost Estimation - Cost Complexities - Prototype Design Methods - Prototype Design tools - Morphological Analysis - Functional Efficiency Technique - Paper Prototyping - Selecting a Prototype - Learning from Nature. **(9)**

VIRTUAL PROTOTYPING, MATERIAL SELECTION & RAPID PROTOTYPING

Using Commercial Software for Virtual Prototyping - Prototyping Materials - Material Selection Methods - Rapid Prototyping Overview -

Rapid Prototyping Cycle - Rapid Prototyping Procedure - STL files - Converting STL File from Various CAD Files - Controlling Part Accuracy in STL Format - Slicing the STL File - Case Studies in Design for Assembly. **(10)**

TYPES OF RAPID PROTOTYPING PROCESS

Types of RP Process - Stereolithography -- Fused Deposition Modelling - Selective Laser Sintering - 3D Printing Process -- Laminated Object Manufacturing - Electron Beam Melting Process -- History - Operation - Advantages and Disadvantages - Applications - Relation to Other RP Technologies - (applies to all the process) - Direct Laser Deposition. **(9)**

APPLICATIONS OF RAPID PROTOTYPING

Investment Casting - Sand Casting - Permanent Mould Casting - Direct RP Tooling - Silicone Rubber Tooling - Investment Cast Tooling - Powder Metallurgy Tooling - Desktop Machining - Case Studies on Current Applications of RP- Novel Application of RP Systems - Future Trends of RP Systems. **(9)**

Total : 45

TEXT BOOKS

1. *Cooper, G.K, "Rapid Prototyping Technology - Selection and Application", Marcel Dekker Inc, USA, 2001.*
2. *Liou, W.F., "Rapid Prototyping and Engineering Applications - A Toolbox for Prototype Development", CRC Press, Taylor & Francis Group LLC, USA, 2008.*
3. *Kai., C.C, Lim, C.S. and Leong, F.K., "Rapid Prototyping: Principles and Applications in Manufacturing", Wiley Publication, 2008.*

09E13 ADVANCED WELDING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide knowledge about the recent welding processes, the weldability of ferrous and non-ferrous metals and alloys, the effects of heat flow in welding, the resulting residual stresses and distortion, good welding design principles and welding automation.

OUTCOME

The students will have the ability to select suitable welding process and technique for a given material and to minimize distortion and residual stresses induced in weldments.

With the adequate knowledge on weldability of material one can able to evolve better design for both fatigue and static loading conditions and select suitable welding automation for the entire production of engineering components.

SPECIAL WELDING PROCESSES

Electron beam welding, Laser beam welding, Ultrasonic welding, Explosion welding, Electro slag and Electro gas welding, Cold pressure welding, Friction welding, Friction stir welding, Diffusion bonding and Adhesive bonding. **(8)**

HEAT EFFECTS OF WELDING

Metallurgical effects of heat flow in welding - TTT curve - continuous cooling transformation diagrams - development of residual stress, methods of relieving or controlling welding residual stresses, types and control of distortion, pre-heat and post weld heat treatment. **(9)**

WELDABILITY OF FERROUS AND NON-FERROUS ALLOYS

Weldability of carbon and alloy steels, stainless steels, cast irons, copper and its alloys, aluminum and its alloys, titanium and its alloys, Nickel and its alloys, weldability tests. **(10)**

WELDING DESIGN

Typical joints for different welding processes, principles of welding joint design and location of joint within the member, evolving good weld design, welding symbol - Blue print reading, welding design for static and fatigue loading, fracture toughness. **(9)**

AUTOMATION IN WELDING

Welding sequence and classification of processes, manual and semi-automatic, automatic, automated welding - adaptive controls - remote welding, robotic welding - selecting welding system, gravity welding and fire cracker welding, under water welding- wet and dry, and microjoining. **(9)**

Total : 45

TEXT BOOKS

1. *Parmar.R.S," Welding Processes and Technology", Khanna Publishers, 2009.*
2. *Parmar.R.S, " Welding Engineering and Technology", Khanna Publishers, 2002.*

REFERENCE BOOKS

1. *Davies .A.C, "Welding", Cambridge University Press, 10th Edition, 1996.*
2. *Larry Jeffus, "Welding - Principles and Application", Delmar Publisher, New York, 4th Edition, 2007.*
3. *"Welding Hand Book - Vol. 2 & 4", American Welding Society, 8th Edition, 1998.*

09E14 ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This course imparts fundamental knowledge in the area of Artificial Intelligence and Expert Systems, knowledge representation techniques, languages used in AI and Expert systems and development of experts systems and along with its applications.

OUTCOME

On successful completion of the course the students can demonstrate mastery of the knowledge, techniques, skills used in the area of AI and expert system. He/she can identify, analyze and solve technical problems, design expert systems and, its components and successfully complete a comprehensive design project related to mechanical engineering or manufacturing fields.

INTRODUCTION

Concept of fifth generation computing - Applications of Artificial Intelligence techniques. **(2)**

HUMAN AND MACHINE INTELLIGENCE

Programming in artificial intelligence environment, developing artificial intelligence system, definition of expert systems, natural language processing, neural networks. Tools of machine thinking, forward chaining, backward chaining, use of probability and fuzzy logic. **(9)**

ADVANCED KNOWLEDGE REPRESENTATION TECHNIQUES

Rule based system, semantic nets- structure and objects, certainty factors, automatic learning advanced programming techniques, fundamentals of object oriented programming creating structure and objects, objects operations, invoking procedures, programming applications, object oriented expert systems. **(9)**

EXPERT SYSTEM DEVELOPMENT

Choice of domain, collection of knowledge base, selection of inference mechanism, case studies of expert system development in design and manufacturing, expert system tools, general structure of expert system, shell, examples of creation of an expert system using expert system tools. **(9)**

LANGUAGES USED

Using Prolog to design an expert system, converting rules to prolog, conceptual examples, introduction to LISP, function evaluation. List predicates, rule creation. **(9)**

INDUSTRIAL APPLICATION OF AI AND EXPERT SYSTEMS

Robotic vision systems, image processing techniques, application to object recognition and inspection, automatic speech recognition. **(7)**

Total : 45

TEXT BOOKS

1. *Robert Levine, "A Comprehensive Guide to AI and Expert Systems", Tata McGraw Hill, 2005.*
2. *Henry C. Mishk off, "Understanding AI", BPB Publications, New Delhi, 2005.*

REFERENCE BOOKS

1. *Janakiraman, "Foundations of Artificial Intelligence and Expert System", McMillan India,2000.*
2. *Krishnamoorthy C.S, Rajeev, "Artificial Intelligence and Expert Systems for Engineers", CRC Press,1996.*

09E15 DESIGN FOR MANUFACTURE AND ASSEMBLY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide a first-level introduction to general rules for design and assembly to under-graduate students of mechanical engineering and to provide the basic knowledge on design and redesign methods on casting and welding.

OUTCOME

The students will be able to design mechanical parts for use in a flexible automation system for the increased effectiveness and to automate assembly of existing design.

They can design such a system with no errors and defects so that they can be used for subsequent assembly and subassembly.

They can implement newer approaches for the better form design with the help of knowledge on positional tolerances.

INTRODUCTION

Methodologies and tools, design axioms, design for assembly and evaluation. **(3)**

DFM APPROACH

Minimum part assessment - Taguchi method. Robustness assessment, manufacturing process rules, failure mode effect analysis, value analysis. Design for minimum number of parts, development of modular design, Poka Yoka principles. **(8)**

GEOMETRIC ANALYSIS

Process capability, feature tolerance, geometric tolerance, surface finish, tolerance grades. Analysis of tapers, screw threads, probability to tolerances. **(8)**

FORM DESIGN

Redesign of castings based on parting line consideration, minimizing core requirements, redesigning cast numbers using weldments, use of welding symbols. **(9)**

DESIGN FOR ASSEMBLY

Selective assembly, deciding the number of groups, control of axial play, grouped datum systems - types, geometric analysis and applications - design features to facilitate automated assembly. **(9)**

TRUE POSITION THEORY

Virtual size concept, floating and fixed fasteners, projected tolerance zone, zero true position tolerance, functional gauges. Operation sequence for typical shaft type of components. Preparation of process drawings for different operations, tolerance work sheets and centrality analysis. **(8)**

Total : 45

TEXT BOOKS

1. *Harry Peck, "Design for Manufacture", Pitman Publications, 1983.*
2. *Matousek, "Engineering Design - A Systematic Approach", Blackie & Son Ltd., London, 1999.*

REFERENCE BOOKS

1. *Trucks.H.E., "Design for Economic Production", Society of Manufacturing Engineers, Michigan, 2nd Edition, 1987.*
2. *Sports.M.F. "Dimensioning and Tolerance for Quantity Production", Prentice Hall Inc., 1983.*
3. *James.G.Bralla, "Hand Book of Design for Manufacturing", McGraw Hill Book Co., 1983.*
4. *Oliver.R.Wade, "Tolerance Control in Design and Manufacturing", Industrial Press Inc., New York Publications, 1967.*

09E16 NON TRADITIONAL MACHINING TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To impart knowledge on the selection of machining techniques based on the precision, accuracy and finishing of the component / product manufactured by different manufacturing methods including machining and to make the students understand that every machine shop engineer should have the skill to select the relevant techniques for the relevant component based on the above and to provide an overall idea about the selection and application of the non-traditional machining techniques.

OUTCOME

On completion of the course the student will be in a position to solve industrial and technical problems in the field of nonconventional machining techniques and optimize various machining parameters.

INTRODUCTION

Nontraditional machining techniques- classification based on source of energy, transfer media and mechanism. Abrasive jet machining and abrasive flow machining - description of apparatus, nozzles, metal removal rates, process capabilities and applications. **(9)**

ULTRASONIC MACHINING

Principles, equipments, power supply, transducer, tool holders, tools, abrasive, process parameters- process capabilities. Ultrasonic welding- principle equipments, power supply, transducers, coupling systems - clamping systems, process parameters, power clamping force, welding time, frequency, process capabilities and applications. **(9)**

ELECTRO CHEMICAL MACHINING

Principles, equipments, chemistry of process, electrolytes, tools, metal removal rate, accuracy and surface finish, process parameters, process

capability and applications. Electro chemical grinding and Electro chemical discharge grinding - principles, process parameters, equipments, process capabilities and applications. **(9)**

ELECTRO DISCHARGE MACHINING

Principles, equipments, power supply, dielectric system, electrodes, servo system, process capabilities and applications. Electrical discharge wire cutting - Principles, equipments, positioning system wire drive system, power supply, dielectric systems, process parameters, process capabilities and applications in die making. Electrical discharge grinding, process principles, equipments, process parameters, process capabilities and applications. **(9)**

ELECTRON BEAM MACHINING

Principles, equipments, electron beam gun, power supply, and electron beam machining systems-process parameters, process capabilities and applications. An overview of electron beam welding. Laser processing-process capabilities, equipments, solid state laser, gas laser, thermal features-applications-drilling-cutting, marking, welding, heat treating and cladding. Plasma arc machining-principles, equipments, process capabilities and applications. **(9)**

Total : 45

TEXT BOOKS

1. *Gary. F.Benedict, "Non-Traditional Machining Processes", Marcell Dekker Inc., 1990.*
2. *Bhattacharya A, "New Technology", IE Publishers, 1984.*

REFERENCE BOOKS

1. *PandeyP.C. and Shanan.S., "Modern Machining Processes", Tata McGraw Hill Co. Ltd., 2005.*
2. *HMT, "Production Technology", Tata McGraw Hill Co. Ltd., 2005.*

09E17 ADVANCES IN CNC SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This Course will enable the student to learn the elements involved in CNC Machines and Mechanism for converting program instructions to mechanical action and to generate program using various techniques and study of special type CNC machines

OUTCOME

On successful completion of the course, the student can demonstrate his mastery on the knowledge, techniques, and skills in CNC systems. He/she can adapt to emerging applications of mathematics, science, engineering and technology, conduct, analyze and interpret experiments and apply experimental results to improve processes and apply creativity in the design of systems, components or processes appropriate to program objectives and successfully complete a comprehensive design project related to mechanical or manufacturing fields.

INTRODUCTION

Classification - Construction details of CNC machines - machine structure, guideways, feed drives - spindle, measuring systems - Drivers and controls - Spindle drives, feed drives, D.C.drives - A.C.drives. **(8)**

CNC SYSTEM

Introduction - Configuration of CNC system - Interfacing - Monitoring - Diagnostics - Machine data - Compensations for machine accuracies - PLC programming - DNC - Adaptive control CNC systems. **(10)**

PROGRAMMING OF CNC MACHINES

Various programming techniques - APT - Programming for various machines in ISO and FANUC - CAM packages for CNC Machines such

as UniGraphics, IDEAS, Pro-Engineer, CATIA, ESPIRIT, MASTERCAM, etc. **(12)**

TOOLING FOR CNC MACHINES

Interchangeable tooling system - preset and qualified tools - coolant fed tooling system - Modular fixture - quick change system - Automatic head changers - tooling requirements for turning and machining centres - Tool Assemblies - Tool Magazines -ATC mechanisms - Tool Management. **(8)**

SPECIAL TYPES OF CNC MACHINES

CNC grinding machines, EDM, Wire cut EDM, Punch press - Installation, Maintenance - Testing and performance, Evaluation of CNC Machines. **(7)**

Total : 45

TEXT BOOKS

1. *Radhakrishnan,P., "Computer Numerical Control Machines", New Central Book Agency, 2000.*
2. *Sehrawat,M.S and NarangJ.S., "CNC Machines", Dhanpat Rai and Co., 1998.*

REFERENCE BOOKS

1. *HMT, "Mechatronics", Tata McGraw Hill Publishing Company Ltd., 1998.*
2. *Thyer,G.E., "Computer Numerical Control of Machine Tools", B.H.Newberg, 1993.*
3. *Krar.S., "CNC Technology and Programming", McGraw Hill, 1990.*
4. *Peter Smid, "CNC Programming Hand Book", Industries Press Inc, 2000.*

09E18 ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This module will aid students in understanding the potential of robotics application, utilisation of robotics in industry and escalates to the design of robotics system.

OUTCOME

The students can apply the knowledge gained in e-manufacturing applications with the use of robots in manufacturing automation and design optimization.

INTRODUCTION

Brief history of robots, robot definitions, today's practical importance of robot applications, challenges faced by robots in industrial situations, future scope of robotics. **(3)**

GENERAL CONSIDERATION OF ROBOTIC MANIPULATORS

Introduction - Brief history of robotics- Robot geometrical configurations - wrist and gripper subassemblies - robot drive systems - robot software. **(5)**

KINEMATICS OF ROBOT MANIPULATORS

Homogeneous representation of objects, robot manipulator joint coordinate system, Euler angles and Euler transformations, Denavit-Hartenburg (D-H) representations, direct kinematics in robotics, inverse kinematic solutions, geometrical approach in inverse Kinematics, Jacobian of transformation in robotic manipulation. **(12)**

ROBOT WORKSPACE AND MOTION TRAJECTORY DESIGN

General Structure of robotic workspaces, robotic workspace performance index, extreme reach of robotic hands, robotic task description, robotic motion, trajectory design, general design

considerations on trajectories, 4-3-4 trajectory, 3-5-3 trajectory, simulation of robotic workspaces. **(8)**

MOTION CONTROL OF ROBOTIC MANIPULATORS

General arm control system - open and closed loop control systems-error controlled robotic dynamics - control structure of amplifier- control of a single axis robotic arm, common control systems for industrial robots, force control of robotic manipulators. **(9)**

ROBOT SENSING AND ROBOT VISION SYSTEM

Desirable features of sensor- range sensors - proximity sensors - tactile sensors-force sensors, torque sensing detectors - TV cameras - illumination techniques - fundamentals of image processing visual data acquisition - image enhancement - image segmentation - image extraction and recognition- object and model matching - image extraction. Typical vision systems, robot programming languages - characteristics of robot- level languages - characteristics of task level languages, simulation languages. **(8)**

Total : 45

TEXT BOOK

1. *Fu.K S, Gonzales .R.C., and Lee.C.S.G., "Robotic Control, Sensing, Vision and Intelligence", McGraw Hill International, 2006.*

REFERENCE BOOKS

1. *Mikell.P.Groover, MitchellWeiss, Tooger.N.Nager, and Nicholas G.Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill International, 2004.*
2. *Richard.D.Klafter, Thomas.A.Chmielewski, and Michaelnegin, "Robotic Engineering - An Integral Approach", Prentice Hall of India, 2002.*

09E19 MECHATRONICS ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To understand the interdisciplinary concepts by focusing application of electronics concepts in Mechanical Engineering and also to know the design of products and processes using Mechatronics system design.

OUTCOME

On completion of the course, the student will be able to demonstrate his / her understanding on how to interface a computer with the real world, the concepts of different types of sensors and their use, different types of actuators and their use and also will able to understand the important logic devices like microprocessor, microcontroller and PLC.

INTRODUCTION

Introduction to Mechatronics - Definition - Mechatronics in Products - Classification of Mechatronics - Measurement Systems - Control Systems - Traditional design and Mechatronics Design. **(5)**

SENSORS AND TRANSDUCERS

Sensors and Transducers - Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors. **(12)**

MICROPROCESSORS IN MECHATRONICS

Microprocessors in Mechatronics - Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters - Applications - Temperature control - Stepper motor control - Traffic light controller. **(12)**

APPLICATION OF PLC

Programmable Logic Controllers - Introduction - Basic structure - Input/ Output processing - Programming - Mnemonics Timers, Internal relays and counters - Data handling - Analog input/output - Selection of PLC. **(8)**

DESIGN AND CASE STUDIES

Design of Mechatronics - Designing - Possible design solutions - Case studies of Mechatronics systems. **(8)**

Total : 45

TEXT BOOKS

1. *Bolton, "Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering", Addison Wesley Longman Ltd., 2005.*
2. *Devdas shetty, Richard A. Kolk, "Mechatronics System Design", PWS Publishing Company, 2007.*
3. *Bradley D.A., Dawson D., Burd N.C. and Loader A.J., "Mechatronics: Electronics in Products and Processes", Chapman and Hall, London, 2001.*

REFERENCE BOOKS

1. *Brian Morriss, "Automated Manufacturing Systems - Actuators, Controls, Sensors and Robotics", McGraw Hill International, 1995.*
2. *Gopel, "Sensors: A Comprehensive Survey - Vol I and Vol VIII", BCH Publisher, New York, 2002.*
3. *K.P.Ramachandran, G.K Vijayaraghavan ,and M.S. Balasundaram, "Mechatronics - Integrated Mechanical Electronic Systems", Wiley India Edition , 2008.*
4. *Michael B. Histand and David G.Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw Hill International Editions, 1999.*

5. *HMT Ltd., "Mechatronics", Tata McGraw Hill Publishing Co. Ltd., 1998.*
6. *Ramesh S. Gaonkar, "Microprocessor Architecture Programming and Applications", Wiley Eastern, 1997.*
7. *Dan Necsulescu, "Mechatronics", Pearson Education Asia, 2002.*

09 E 20 TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

This subject is intended to provide knowledge about the TQM concepts and their practical implementation by specifying the TQM principles, tools and quality systems. This course is to increase the understanding of students in product and process quality management system involved in a production environment.

OUTCOME

Students are expected to demonstrate various statistical process control methods and continuous improvement tools in industry.

INTRODUCTION

Definition and dimensions of quality - quality costs -basic concepts of TQM - principles of TQM-leadership concepts - role of senior management-quality council - quality statement - strategic planning - Deming philosophy - PDSA Cycle - TQM implementation barriers. **(9)**

TQM PRINCIPLES

Customer satisfaction - employee involvement - continuous process improvement - supplier partnership - performance measures. **(9)**

STATISTICAL PROCESS CONTROL

The seven tools of quality - statistical fundamentals - control charts for variables - control charts for attributes - process capability - concept of six sigma - new seven management tools. **(9)**

TQM TOOLS

Benchmarking - quality function deployment - Taguchi quality loss function - total productive maintenance - FMEA. **(9)**

QUALITY SYSTEM

Need- ISO 9000 quality system - quality system elements - implementation of quality system -documentation- QS 9000 - ISO 14000. **(9)**

Total : 45

TEXT BOOK

1. *Dale H.Besterfield , Carol Besterfield -Michna, Glen H.Besterfield and Mary Besterfield-Sacre, "Total Quality Management", Pearson Education Inc., 2nd Impression, 2007.*

REFERENCE BOOKS

1. *Winchell William, "TQM: Getting Started and Achieving Results with Total Quality Management", Society of Manufacturing Engineers, Dearborn ML, 1993.*
2. *Feigenbaum.A.V, "Total Quality Control", McGraw Hill Book Company, New York, 2004.*
3. *Taguchi.G, "Introduction to Quality Engineering", Asian Productivity Organisation, Tokyo, 2004.*
4. *Mahajan.M, "Statistical Quality Control", Dhanpat Rai and Co. Pvt. Ltd., New Delhi, 2002.*

09E21 AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To enlighten the basic concepts of automotive engines and automotive mechanisms, automobile fuel systems, electrical systems, recent emission norms, fuel injection systems and ignition systems.

OUTCOME

Upon completion of the course, the students can demonstrate his / her mastery of the knowledge, technique and skills in automobile engineering. He / she can identify, analyse and solve technical problems in automobile engineering.

INTRODUCTION

History of Automobiles- classifications - Scope - Past and present developments and future trends-Advanced Automotive mechanisms - alternate fuels - Driverless vehicles - auto tracking mechanisms - remote driven aspects - future trend. **(5)**

AUTOMOTIVE ENGINES

Types of engines - engine rating - multi cylinder - Power & Mechanical balance - firing order - rotary engines - stratified charged engines - Lean burn engines - Turbocharged engines - CNG engines -Emission and its control. **(8)**

STEERING AND SUSPENSION SYSTEMS

Principle of steering - Steering geometry and Wheel alignment - types of steering gear box- steering linkages - power steering, wheels and tyres - Construction - Types and Specifications - wear types and causes, Front and rear axle - Types - stub axles. Suspension systems -Need and types - Independent - Coil and leaf Spring and air suspensions, torsion bar, shock absorbers. **(8)**

TRANSMISSION SYSTEMS

Clutches - Need - types - Single and Multi plate - diaphragm clutch - over running clutch - fluid coupling.

Gear boxes - Manual and automatic - Epi cyclic and hydromatic transmission, universal joint, propeller shaft, Hotchkiss drive, torque tube drive, differential - Need and types - Construction - Four Wheel drive. **(8)**

BRAKE SYSTEMS, ALTERNATIVE FUELS AND POWER PLANTS

Brakes - Need - types - Mechanical, hydraulic and pneumatic - Details of Components, redundancy in brake system, trouble shooting in brake system, power brake- Diagonal Braking system- Antilock Braking System. Alternative fuels - Hydrogen - Compressed Natural Gas (CNG) - Liquified Petroleum Gas (LPG), alternative power plants - Electric - Hybrid Vehicle -Fuel Cells. **(8)**

ENGINE AUXILIARY SYSTEMS

Carburetors, Electronic fuel injection systems - mono point and Multi point types - CRDI, principles of modern electrical systems - Battery, dynamo, alternator, starting motor, lighting and ignition (Battery and electronic types) - Automobile air conditioning, turbo charging. **(8)**

Total : 45

TEXT BOOKS

1. *Sethi H.M, "Automobile Technology", Tata McGraw Hill, 2004.*
2. *Kirpal Singh, "Automobile Engineering - Vol 1 and 2", Standard Publishers, New Delhi, 2004.*

REFERENCE BOOKS

1. *Joseph Heitner, "Automotive Mechanics", East West Press, 3rd Edition, 2002.*

2. *Gupta R.B., "Automobile Engineering", Sathya Prakashan Publications, New Delhi, 1993.*
3. *William H.Crouse, "Automotive Mechanics", Tata McGraw Hill, 10th Edition, 2007.*
4. *Crouse and Anglin., "Automotive Mechanism", Tata McGraw Hill, 9th Edition, 2003.*
5. *Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers, 2004.*

09E22 AUTOMOTIVE ELECTRONICS - EMBEDDED SOFTWARE DEVELOPER

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide Automotive Electronics related domain exposure and to establish a learning platform for embedded system development environment with the application of engineering aspects in the development life cycle of projects for automobiles.

OUTCOME

At the end of the course, students shall acquire knowledge on basics of automotive electronics, embedded software development and embedded system communication protocols.

AUTOMOBILE ELECTRICALS AND ELECTRONICS

Basic Electrical Components in an automobile - Starting system (Battery, Ignition Switch, Solenoid, Starter, Neutral Safety Switch), Charging system (Alternator Drive Belt, Battery, Alternator, Voltage Regulator), Fuses.

Overview of Vehicle Electronic system - Driver - Vehicle - Environment system (Control and monitoring systems, Electronic systems of the vehicle and the environment) ECUs and vehicle subsystems - Electronic systems of Powertrain subsystem, Electronic systems of Chassis subsystem, Electronic systems of Body subsystems (Comfort and Passive safety), Multimedia subsystems.

Automobile sensors and actuators, Engine Management System, Vehicle safety systems, Environmental legislation (Pollution Norms - Euro / Bharat standards). **(9)**

(PASSENGER CAR) BASICS

Evolution of car, Typical Car components, Engines - IC engine, Operation of typical four Stroke Engine, Comparison of Diesel and Gasoline Engines, Other engines like Electric, Hybrid……, Drive Train.

AUTOMOTIVE EMBEDDED SOFTWARE DEVELOPMENT

INTRODUCTION TO EMBEDDED SYSTEMS

Embedded Systems - definition, Components of Embedded systems, Microprocessor, Classification of Microprocessors (based on architecture, based on performance), Microcontrollers, Memory, Peripherals. Introduction to an embedded board (TMS470 based / ARM9 based) for hands on lab sessions (RISC processor based with standard peripherals / interfaces and I/Os). **(8)**

OPERATING SYSTEM IN EMBEDDED ENVIRONMENT

Introduction to OS - General Purpose OS, RTOS - Kernel - Pre-emptive & Non pre-emptive, Scheduler, Interrupt - Interrupt latency and Context Switch Latency - Board Support package, Task - Multi-tasking, Task synchronization, Inter-task communication, Features of a typical embedded RTOS (µC/OS-II). **(6)**

INTEGRATED DEVELOPMENT ENVIRONMENT IN EMBEDDED ENVIRONMENT

Integrated Development Environment (Introduction to IDE, Getting Started, Hardware / Software Configuration (Boot Service, Host - Target Interaction), Booting (IDE-Interaction, target-Agent), Reconfiguration, Managing IDE, Target Servers, Agents, Cross - Development, debugging), Introduction to an IDE for the lab board - RTOS, PC based debugger. **(8)**

EMBEDDED SYSTEM IN AUTOMOTIVE CONTEXT

Embedded systems in typical modern automobile - Distributed systems, Embedded components a) Engine Management system - Diesel / Gasoline system, Components, System architecture (H/W, S/W) b) Vehicle safety systems, c) Body electronics systems, d) Infotainment systems - Navigation, Car radio. **(4)**

EMBEDDED SYSTEM COMMUNICATION PROTOCOLS

Introduction to Control networking, Communication protocols in embedded systems - SPI, I2C, USB, -Vehicle communication protocols

- Introduction to CAN, LIN, FLEXRAY, MOST, KWP 2000- Details of CAN. **(4)**

AUTOMOTIVE APPLICATION DEVELOPMENT: FUNCTIONAL DESIGN, AUTO-CODE GENERATION

Introduction to Modeling and Simulation - ASCET, Labcar, INCA (Setup 1 definition support by RBEI) or Matlab, Simulink, Labview (Setup 2), Autocode generation for a given automotive control application (e.g. Throttle valve control, PID simulation). **(8)**

Total : 47

REFERENCE BOOKS

1. *Robert Bosch, "Bosch Automotive Handbook", Bentley Publishers, 6th Edition, 2004.*
2. *Joerg Schaeuffele, Thomas Zurawka, "Automotive Software Engineering - Principles, Processes, Methods and Tools", SAE International, 2005.*
3. *Jean J. Labrosse, "µC/OS-II Real Time Kernel", CMP Books, 2002.*

09E23 REFRIGERATION AND AIR CONDITIONING

(Use of refrigeration, air conditioning and thermodynamic tables and charts permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

OBJECTIVE

To provide an introduction to the various thermodynamic cycles used in refrigeration and air conditioning systems, aspects related to selection of refrigerants, cooling systems and design for comfort air conditioning.

OUTCOME

On completion of the course, the student will be able to perform basic calculations related to the performance of various refrigeration cycles and air conditioning processes. The student would acquire basic knowledge of psychrometry.

AIR CYCLE REFRIGERATION

Review of thermodynamic principles of refrigeration. Bell Coleman air refrigeration- Aircraft cycle- simple, boot strap and regenerative cycle analysis - COP Calculation. **(4)**

REFRIGERANT SELECTION

Properties, Eco-friendly refrigerants. **(2)**

VAPOUR COMPRESSION REFRIGERATION SYSTEM

T-S and P-H charts - analysis - Performance of systems under varying operating conditions. Multi-Stage refrigeration working principles - Cascade refrigeration. **(8)**

BALANCING OF COMPONENTS

Condensers - Air cooled, water cooled and evaporative condensers. Evaporator - flooded, dry expansion, shell and tube and double pipe.

Compressors - reciprocating, rotary and centrifugal types. Expansion devices- capillary and TEV. **(8)**

VAPOUR ABSORPTION SYSTEMS

Ammonia - water systems, three fluid systems. Water - lithium bromide system - Comparison - Steam jet refrigeration, solar refrigeration. **(8)**

AIR CONDITIONING

Psychrometric processes - use of psychrometric chart - Bypass factor - air conditioning cycles - winter, summer and year round air conditioning systems - effective temperature - comfort conditions. **(8)**

AIR CONDITIONING SYSTEMS

Duct design - economic considerations, methods - air distributing systems - humidification - air cleaning - controls - window air conditioners. **(7)**

Theory : 45

Tutorial : 15

Total : 60

TEXT BOOKS

1. *Manohar Prasad, "Refrigeration and Air conditioning", Wiley Eastern Ltd., Third Edition, 2007.*
2. *Domkundwar and Arora, "A Course in Refrigeration and Air-Conditioning", Dhanpat Rai and Co. (P) Ltd., 2007.*

REFERENCE BOOKS

1. *Arora C.P., "Refrigeration and Air conditioning", Tata McGraw Hill Publishing Company Ltd., New Delhi. 2007.*
2. *Roy.J.Dossat., "Principles of Refrigeration", Prentice Hall of India Pvt. Ltd., 2005.*
3. *Thipse S.S., "Refrigeration and Air conditioning", Jaico Publishing House, 2006.*

09E24 ALTERNATIVE ENERGY RESOURCES ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To impart basic knowledge on various non-conventional energy resources and to explain the importance of these energies in current scenario.

OUTCOME

Upon completion of the course, the student will be able to apply current knowledge and adopt emerging applications of alternative energy resources.

ENERGY CONSUMPTION PATTERN

Commercial energy resources - study of global energy availability. Energy consumption pattern in India and growth rate, total energy concept, total energy installations. Non-commercial sources-Availability. **(9)**

SOLAR SYSTEMS

Collectors - flat plate, parabolic, storage systems- case studies- solar cooker- water heaters - photo voltaic conversion systems. **(9)**

WIND POWERED SYSTEM

Principle of wind energy conversion, power coefficient, typical design of wind turbines, horizontal and vertical axis - comparison - site selection. **(9)**

NUCLEAR PLANTS

Nuclear energy - Energy from fission and fusion, Fission reactor types, Reactor control - Heavy water reactor plants - Indian Scenario. **(9)**

NON CONVENTIONAL PLANTS

Bio gas plants- types - design principles - applications. OTEC - Tidal Power systems - MHD systems. Thermo electric, thermionic systems, fuel cells. **(9)**

Total : 45

TEXT BOOKS

1. *Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2007.*
2. *Sukhatme, S.P., "Solar Energy", Tata McGraw Hill, 2nd Edition, 2007.*

REFERENCE BOOKS

1. *Clup, "Principle of Energy Conversion", Tata McGraw Hill, 2005.*
2. *Magal, "Solar Power Engineering", Tata McGraw Hill, 2005.*
3. *Ashok V Desai, "Non-Conventional Energy", Wiley Eastern Ltd., New Delhi, 2002.*

09E25 IC ENGINES - COMBUSTION AND POLLUTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To introduce the theory behind combustion-related pollution in IC Engines, the analysis of Engine processes, and to introduce techniques for the measurement of emissions from IC Engines.

OUTCOME

Upon successful completion of the course the student will be able to model and solve simple reaction processes that occur inside an IC Engine cylinder.

The background material will also be useful to the student when he/she tries to gain meaning employment in industry specific to IC Engine instrumentation and R&D.

CYCLE ANALYSIS

Introduction- Fuel air cycle- use- variation of specific heat - dissociation and chemical equilibrium loss- Comparison of P-V Diagrams- Thermal efficiency and fuel consumption and its effects and variations- Use of combustion charts- gas tables. Simple problems. Actual cycle- introduction -difference between real and fuel air cycle in C.I. and S.I. engines. **(12)**

COMBUSTION IN SI ENGINE

Combustion in SI engine- ignition limits- stages of combustion- concept of combustion quality- effect of engine variables on ignition lag, flame propagation. Rate of pressure rise- cyclic variations- abnormal combustion, detonation and its effects- theory and chemistry of detonation- effect of engine variables- control- S.I. engine combustion chamber designs, Lean burn engines- stratified charge engines. **(10)**

COMBUSTION IN CI ENGINE

Combustion in C.I engines- delay period- variables affecting delay period- diesel knock- methods of controlling diesel knock- C.I engine combustion chamber- cold starting of C.I. engines- cold starting aids- super charging and turbo charging. **(9)**

I.C ENGINE EMISSION AND ITS CONTROL

Pollution from I.C. engines, Formation of pollution from C.I. and S.I. engines- control methods- NOx, CO and UBHC emission formation- particulate emission- EGR- particulate traps- catalytic converters- continuous regeneration traps- simultaneous reduction of smoke and NOx. **(7)**

EMISSION MEASURING TECHNIQUES

Emission instrumentation- Measurements of pollution- FID, NDIR and chemiluniscent techniques- smoke measurement for diesel engines- Driving cycles, USA, FTP, ECE, Japan test procedures and Indian driving cycles- SHED Test- Chassis dynamometer- Emission standards. **(7)**

Total : 45

TEXT BOOKS

1. *Mathur.M.L. and Sharma. R.P., "I.C. Engines", Dhanpat Rai Publishers, 2004.*
2. *John Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill Inc., 2007.*

REFERENCE BOOKS

1. *Edward.F.Obert, "Internal Combustion Engines and Air Pollutions", Horapar and Row Publishers, 2001.*

2. *Colin R Ferguson, "Internal Combustion Engines and Applied Thermodynamics", John Wisely and Sons, 2005*
3. *Watson, H. C. and Milkins, E. E., "Fundamentals of Exhaust Emissions", The University of Melbourne, 1971.*
4. *Sher, and Eran, "HandBook of Air Pollution from Internal Combustion Engines - Pollution Formation and Control", Academic Press, 1998.*

09E26 TURBO MACHINERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To review/acquire thermo-fluids concepts applicable to turbo machinery to study Reynolds transport theorem, first and second laws, isentropic efficiencies, potential flow, boundary layer flow, turbulent flow and losses and to develop an understanding of working principles applicable to centrifugal and axial machinery.

OUTCOME

Upon successful completion of the course the student is expected to model and perform thermodynamic analysis of problems related to turbo-machines.

The background material will also be useful to the student when he/she tries to do analysis of turbo-machinery using commercial software packages.

INTRODUCTION

Definition of Turbo machines, parts of a turbo machine, comparison with positive displacement machine, classification, dimensionless parameters and their physical significance, Euler turbine equation; components of energy transfer. **(6)**

AXIAL AND CENTRIFUGAL COMPRESSOR

Axial flow compressor - classifications, expression for pressure ratio developed per stage - workdone factor. Centrifugal Compressor - classification, expression for overall pressure ratio developed, blade angles, slip factor, diffuser, surging. **(6)**

AXIAL AND CENTRIFUGAL PUMPS

Axial flow pumps: Expression for degree of reaction; velocity triangles for different values of degree of reaction. Centrifugal Pumps: Definition

of terms used in the centrifugal pumps like manometric head, suction head, delivery head, pressure rise and efficiency, slip, priming, cavitations, NPSH **(6)**

THERMODYNAMIC FLUID FLOW, THERMODYNAMIC ANALYSIS OF COMPRESSION AND EXPANSION PROCESSES

Stagnation and static properties and their relations, sonic velocity and Mach number, classification of fluid flow based on Mach number, compression and expansion processes- overall isentropic efficiency, stage efficiency, comparison and relation between overall efficiency and stage efficiency, polytropic efficiency, preheat factor, Reheat factor. **(9)**

STEAM TURBINES

Classification, single stage impulse turbine, condition for maximum blade efficiency, stage efficiency. Compounding - Need for compounding, method of compounding. Impulse Staging - maximum utilization factor for multistage turbine with equiangular blades, effect of blades and nozzle losses. Reaction turbine- maximum blade efficiency. **(9)**

HYDRAULIC TURBINES

Classification - Pelton, Francis and Kaplan turbines - velocity triangles, design parameters - efficiency - different blade speeds.

(9)

Total: 45

TEXT BOOKS

1. *Dixon D.L., "Turbomachinery", Pergamaon Press, 2007.*
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