DAYANANDA SAGAR UNIVERSITY

Shavige Malleshwara Hills, Kumaraswamy Layout,

Bengaluru - 560078, Karnataka.

SCHOOL OF ENGINEERING

SCHEME & SYLLABUS
FOR
BACHELOR OF TECHNOLOGY (B.Tech) – 2016

MECHANICAL ENGINEERING

(3rd to 8th Sem)

(With Effect from 2016-17)

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S/P	C	CIA	END EXAM
1	16MA201	ENGINEERING MATHEMATICS	CR	03	01	--	--	04	40	60
2	16ME202	MECHANICS OF MATERIALS	CR	03	01	--	--	04	40	60
3	16ME203	THERMODYNAMICS	CR	03	01	--	--	04	40	60
4	16ME204	ENGINEERING DESIGN	CR	03	--	--	02	04	40	60
5	16ME205	MACHINE DRAWING	CR	01	--	04	--	03	40	60
6	16HU201	ECONOMICS FOR ENGINEERS	CR	03	--	--	--	03	40	60
7	16ME271	MATERIALS LABORATORY	CR	--	--	04	--	02	40	60
8	16ME272	MANUFACTURING PROCESS LABORATORY	CR	--	--	04	--	02	40	60
GRAND TOTAL = 800				**16**	**03**	**12**	**02**	**26**	**320**	**480**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S/P	C	CIA	END EXAM
1	16MA202	ENGINEERING MATHEMATICS	CR	03	01	--	--	04	40	60
2	16ME206	ENGINEERING MATERIALS	CR	03	--	--	--	03	40	60
3	16ME207	FLUID MECHANICS AND MACHINES	CR	03	01	--	--	04	40	60
4	16ME208	KINEMATICS OF MACHINES	CR	03	01	--	--	04	40	60
5	16ME209	MANUFACTURING TECHNOLOGY – I	CR	03	--	--	--	03	40	60
6	16ME210	MECHANICAL MEASUREMENTS	CR	03	--	--	--	03	40	60
7	16ME273	FLUID MECHANICS AND MACHINES LABORATORY	CR	--	--	04	--	02	40	60
8	16ME274	MEASUREMENT LABORATORY	CR	--	--	04	--	02	40	60
GRAND TOTAL = 800				**18**	**03**	**08**	**--**	**25**	**320**	**480**

L : Lecture , T : Tutorial , P : Practical , S : Seminar , C : Credits , CIA : - Continuous Internal Evaluation : 40 Marks, 1. Two IA Tests (20 Marks), 2. Assignment or Mini project (10 Marks), 3. Any two of self-study presentation, survey reports, quiz, laboratory exercises, presentation in seminar & workshops (10 marks)., SEE : Semester End examinations

SEMESTER V

SL. NO.	COURSE CODE	COURSE CODE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S	C	CIA	SEE
1	16ME301	HEAT TRANSFER	CR	03	--	--	--	03	40	60
2	16ME302	DESIGN OF MACHINE ELEMENTS-1	CR	03	--	--	--	03	40	60
3	16ME303	COMPOSITES	CR	03	--	--	--	03	40	60
4	16ME304	DYNAMICS OF MACHINERY	CR	03	--	--	--	03	40	60
5	16ME305	MANUFACTURING TECHNOLOGY-II	CR	03	--	--	--	03	40	60
6	16ME3XX	DEPARTMENT ELECTIVE-I	CR	03	--	--	--	03	40	60
7	16ME3XX	DEPARTMENT ELECTIVE-II	CR	03	--	--	--	03	40	60
8	16ME371	HEAT TRANSFER LABORATORY	CR	--	--	04	--	02	40	60
9	16ME372	FOUNDRY AND FORGING LAB	CR	--	--	04	--	02	40	60
GRAND TOTAL 900				**21**	**--**	**08**		**25**	**360**	**540**

COURSE CODE	DEPARTMENT ELECTIVE-I		COURSE CODE	DEPARTMENT ELECTIVE-II
16ME321	REFRIGERATION AND AIR CONDITIONING		16ME325	PRODUCT DESIGN AND MANUFACTURING
16ME322	QUALITY AND RELIABILITY ENGINEERING		16ME326	SURFACE ENGINEERING
16ME323	NON-DESTRUCTIVE EVALUATION AND TESTING		16ME327	RENEWABLE ENERGY SOURCES
16ME324	TOOL DESIGN		16ME328	ROBOTICS
16ME339	FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE & MACHINE LEARNING			

L : Lecture , T : Tutorial , P : Practical , S : Seminar , C : Credits , CIA : - Continuous Internal Evaluation : 40 Marks, 1. Two IA Tests (20 Marks), 2. Assignment or Mini project (10 Marks), 3. Any two of self-study presentation, survey reports, quiz, laboratory exercises, presentation in seminar & workshops (10 marks)., SEE : Semester End examinations

SEMESTER VI

SL. NO.	COURSE CODE	COURSE CODE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S	C	CIA	SEE
1	16ME306	FINITE ELEMENT METHOD	CR	03	--	--	--	03	40	60
2	16ME307	DESIGN OF MACHINE ELEMENTS-II	CR	03	--	--	--	03	40	60
3	16ME308	MECHANICAL VIBRATIONS	CR	03	--	--	--	03	40	60
4	16ME309	MECHATRONICS	CR	03	--		--	03	40	60
5	16ME3XX	DEPARTMENT ELECTIVE-III	CR	03	--	--	--	03	40	60
6	16ME3XX	DEPARTMENT ELECTIVE-IV	CR	03	--	--	--	03	40	60
7	16ME373	DESIGN ENGINEERING LABORATORY	CR	--	--	04	--	02	40	60
8	16ME374	MODELING, ANALYSIS AND SIMULATION LABORATORY	CR	--	--	04	--	02	40	60
9	16ME375	ENERGY CONVERSION LABORATORY	CR	--	--	04	--	02	40	60
GRAND TOTAL 900				**18**	**--**	**12**		**24**	**360**	**540**

COURSE CODE	DEPARTMENT ELECTIVE-III		COURSE CODE	DEPARTMENT ELECTIVE-IV
16ME329	PRINCIPLES OF FRACTURE MECHANICS		16ME333	ADVANCED MACHINING PROCESSES
16ME330	INTERNAL COMBUSTION ENGINES		16ME334	GAS DYNAMICS AND JET PROPULSION
16ME331	MODELLING AND SIMULATION OF MANUFACTURING SYSTEMS		16ME335	MEMS (MICRO ELECTRO MECHANICAL SYSTEMS)
16ME332	ADVANCED MATERIAL TECHNOLOGY		16ME336	DESIGN OF COMPOSITE MATERIALS

L : Lecture , T : Tutorial , P : Practical , S : Seminar , C : Credits , CIA : - Continuous Internal Evaluation : 40 Marks, 1. Two IA Tests (20 Marks), 2. Assignment or Mini project (10 Marks), 3. Any two of self-study presentation, survey reports, quiz, laboratory exercises, presentation in seminar & workshops (10 marks)., SEE : Semester End examinations

SEMESTER - VII

SL. NO.	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S/P	C	CIA	END EXAM
1	16ME401	CONTROL ENGINEERING	CR	03	--	--	--	03	40	60
2	16ME402	OPERATION RESEARCH	CR	03	--	--	--	03	40	60
3	16ME403	HYDRAULICS AND PNEUMATICS	CR	02	--	--	02	03	40	60
4	16ME4XX	DEPARTMENT ELECTIVE –V	CR	03	--	--	--	03	40	60
5	16ME4XX	DEPARTMENT ELECTIVE -VI	CR	03	--	--	--	03	40	60
6	16ME404	LAW FOR MECHANICAL ENGINEERS	CR	03	--	--	--	03	40	60
7	16IE4XX	INSTITUTIONAL ELECTIVE-I	CR	03	--	--	--	03	40	60
8	16ME471	CONTROL ENGINEERING LABORATORY	CR	--	--	04	--	02	40	60
9	16ME481	PROJECT WORK STAGE - I	CR	--	--	04	--	02	40	60
GRAND TOTAL = 900				**20**		**08**	02	**08**	**360**	**540**

DEPARTMENT ELECTIVE-V			DEPARTMENT ELECTIVE-VI	
COURSE CODE	COURSE TITLE		COURSE CODE	COURSE TITLE
16ME421	RAPID MANUFACTURING TECHNOLOGIES		16ME425	TRIBOLOGY AND BEARING DESIGN
16ME422	DESIGN FOR MANUFACTURING		16ME426	PLASTIC PROCESSING TECHNOLOGY
16ME423	COMPUTATIONAL FLUID DYNAMICS		16ME427	AUTOMOBILE ENGINEERING
16ME424	OPERATIONS MANAGEMENT		16ME428	FUELS AND COMBUSTION

CIA :30 Marks, 1. Two IA Tests (20 Marks), 2. Assignment or Mini project (05 Marks), 3. Any two of self-study presentation, survey reports, quiz, laboratory exercises, presentation in seminar & workshops (05 marks).

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S/P	C	CIA	END EXAM
1	16ME4XX	DEPARTMENT ELECTIVE-VII	CR	03	--	--	--	03	40	60
2	16IEXXX	INSTITUTIONAL ELECTIVE-II	CR	03	--	--	--	03	40	60
3	16ME482	SEMINAR	CR	--	--	--	02	01	50	--
4	16ME483	PROJECT WORK STAGE - II	CR	--	--	--	20	10	100	100
GRAND TOTAL = 450				**06**	**--**	**--**	**22**	**17**	**230**	**220**

CIA : 40 Marks; 1. Two IA Tests (20 Marks), 2. Assignment or Mini project (10 Marks), 3. Any two of self-study presentation, survey reports, quiz, laboratory exercises, presentation in seminar & workshops (10 Marks).

DEPARTMENT ELECTIVE-VII	
COURSE CODE	**COURSE TITLE**
16ME429	FEM- STRUCTURAL MECHANICS APPLICATIONS
16ME430	DESIGN OF EXPERIMENTS
16ME431	AUTOMATION IN MANUFACTURING
16ME432	ORGANIZATIONAL BEHAVIOUR AND PROFESSIONAL COMMUNICATION

INSTITUTIONAL ELECTIVES LIST - B.TECH PROGRAMME

GENERAL COURSE CODE: 16IE4XX

SL.No	COURSE CODE	COURSE TITLE	OFFERING DEPARTMENT
1	16IE401	ARTIFICIAL INTELLIGENCE	CSE
2	16IE402	DATA STRUCTURES& ALGORITHMS	CSE
3	16IE403	WEB TECHNOLOGIES	CSE
4	16IE404	MANAGEMENT INFORMATION SYSTEM	CSE
5	16IE405	SOCIAL NETWORKS AND ANALYTICS (15CS338)	CSE
6	16IE421	SENSORS, NETWORKS AND PROTOCOLS	ECE
7	16IE422	IMAGE PROCESSING AND COMPUTER VISION	ECE
8	16IE423	AUTOMOTIVE EMBEDDED SYSTEMS	ECE
9	16IE424	EVOLUTION OF TELECOMMUNICATIONS	ECE
10	16IE441	ENTREPRENEURSHIP MANAGEMENT	CT
11	16IE442	INNOVATION AND ENTREPRENEURSHIP	CT
12	16IE443	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	CT
13	16IE444	DIGITAL MARKETING	CT
14	16IE445	ADVANCED ORGANIZATIONAL BEHAVIOR(15CT449)	CT
15	16IE461	INDUSTRIAL ROBOTICS & AUTOMATION	ME
16	16IE462	TOTAL QUALITY MANAGEMENT	ME
17	**16IE463**	**FUNDAMENTALS OF AUTOMOBILE ENGINEERING**	**ME**
18	16IE464	RENEWABLE ENERGY SOURCES	ME
19	16IE465	PRODUCT & INDUSTRIAL DESIGN	ME
20	**16IE466**	**PRODUCT ENGINEERING & ENTREPRENEURSHIP**	**CT**
21	**16IE467**	**FUNDAMENTALS OF CLOUD COMPUTING**	**CSE**
22	**16IE468**	**MACHINE LEARNING WITH PYTHON**	**CSE**
23	**16IE469**	**FUNDAMENTALS OF AEROSPACE ENGINEERING**	**ASE**

UPDATED ON 11.11.2020

SEM/YEAR : III SEM
COURSE CODE : 16MA201
TITLE OF THE COURSE : ENGINEERING MATHEMATICS
L: T/A:P: C : 3 :1 : 0 : 4
TOTAL HOURS : 52

Course Learning Objectives

The course will enable the students to:
1. Understand linear system of equations
2. Understand the structure of Matrices and Determinants
3. Infer different co-ordinate systems and applications of vectors.
4. Know the higher integrations applications in polar coordinates.
5. Learn the concepts of Surface areas and apply to solve numerical problems in engineering domain.

Course Outcomes

At the end of the course, the students will be able to:
1. Apply Linear Algebra to solve linear equations for a given linear system.
2. Evaluate numerical problems on matrices and determinants.
3. Analyze vectors in space and solve problems in engineering domain.
4. Apply double and triple integrations to solve engineering problems.
5. Apply Line integration concepts to vectors in space for problems.
6. Calculate surface areas of given distribution functions.

Module I: 12 Hrs
Row reduction and echelon forms, Vector equations, Solution sets of linear equations, Linear transformations, Matrix of Linear Transformations, Matrix Operations, Inverse of a matrix, Characteristics of invertible matrices

Module II: 10 Hrs
Determinants, Eigenvalues and Eigenvectors, Characteristic equation, Diagonalization, Diagonalization of symmetric matrices, Quadratic forms and Singular Value Decomposition

Module III: 10 Hrs
3-D Coordinate systems, Vectors, Dot and Cross products, Lines, planes and curves in space, Tangents to curves, Normal vectors of curve, Taylor's formula for two variables

Module IV: 10 Hrs
Double integration in polar form, Triple integration in cylindrical and spherical coordinates, Line integrals, Vector Fields and Line integrals.

Module V: **10 Hrs**

Path independence, Green's theorem, Surfaces and area, Surface Integrals, Stoke's Theorem, Divergence Theorem

Text books

1. Linear Algebra and its applications, David Lay, Steven Lay, Judi Mc Donald, Pearson, 5th Edition
2. Thomas's Calculus, G.B.Thomas, M.Weir, J. Hass, Pearson , 12th Edition

References

1. Advanced Engineering Mathematics, E. Kreyzsig, Wiley, 10th Edition
2. Introduction to Linear Algebra, G. Strang, Wellesely- Cambridge Press, 4th Edition.

SEM/YEAR : III SEM
COURSE CODE : 16ME202
TITLE OF THE COURSE : MECHANICS OF MATERIALS
L: T/A:P: C : 3 :1 : 0 : 4
TOTAL HOURS : 52

Course Learning Objectives

1. To understand the basic concepts and terms on materials
2. To provide knowledge on bending stress and torsion on materials
3. To understand the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.
4. To study the general state of stresses and strains in a given loaded member and the magnitude and direction of the principal stresses

Course Outcomes

1. Apply concepts of strength of materials to obtain solutions to real time Engineering problems
2. Able to analyze the different types of loading and the consequent Deflection
3. Students will analyze the terms involved and apply knowledge for deformation
4. Understanding the mechanical terms and deformation behavior for different loads

Module I: Stress, Strain and Deformation of Solids 8 (L) + 2 (T) Hrs

Introduction, stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation, Rigid bodies and deformable solids, Tension, Compression and Shear Stresses, Deformation of simple and compound bars, Thermal stresses, Elastic constants, volumetric strains, Stresses on Inclined planes, principal stresses and principal planes, Mohr's circle of stress.

Stress in Composite Section: Expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses.

Module II: Beams and Bending Stress 9 (L) + 3 (T) Hrs

Beams: Concept of beams, Types of beams, Types of loading, Concept of end supports, Roller, hinged and fixed, Concept of bending moment and shearing force, Bending moment and shearing force diagram for cantilever and simply supported beams with and without overhang subjected to concentrated and UDL. Point of contra-flexure. Numerical problems.

Bending Stress: Concept of bending stresses, Theory of simple bending, assumptions made in bending theory, Use of equation $\sigma/y=M/I=E/R$, Concept of moment of resistance, Bending stress diagram, Calculation of maximum bending stress in beams of rectangular, I and T sections, Permissible bending stress, section modulus for rectangular, circular and symmetrical I sections.

Module III: Torsion 8 (L) + 2 (T) Hrs

Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, Torsional moment diagrams, Torsion formula for circular cross-sections, Maximum normal and shear stresses, Angle of twist, Torsion formulation stresses and deformation in circular and hollows shafts, stepped

shafts, Deflection in shafts fixed at the both ends, Stresses in helical springs, Deflection of helical springs, carriage springs.

Module IV: Thin Cylinders, Spheres and Thick Cylinders 8 (L) + 2 (T) Hrs

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders, spherical shells subjected to internal pressure, Deformation in spherical shells, Lame's theorem.

Energy Methods: Work and strain energy, Strain energy in bar/beams, Castiglinios theorem, Energy methods

Module V: Columns 8 (L) + 2 (T) Hrs

Concept of column, modes of failure, Types of columns, buckling load, crushing load, Slenderness ratio, Factors effecting strength of a column, End restraints, Effective length, Strength of column by Euler Formula, Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations of Euler's theory, Rankine Gourdan formula

Text books

1. S. S. Bhavikatti, "Strength of Materials", Vikas publications House-Pvt. Ltd., 2nd Edition, 2006
2. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, 2007.

Reference books

1.Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2007
2.W.A. Nash, "Strength of Materials", Schaum's Outline Series, 2007.
3.Ferdinand P. Been, Russell Johnson, Jr. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.
4.S.S Rattan, "Strength of Materials", Tata McGraw Hill,2009

SEM/YEAR : III SEM
COURSE CODE : 16ME203
TITLE OF THE COURSE : THERMODYNAMICS
L: T/A:P: C : 3 :1 : 0 : 4
TOTAL HOURS : 52

Course Learning Objectives

1. To teach students the basic principles of classical thermodynamics and prepare them to apply basic conversion principles of mass and energy to closed and open systems.
2. To enable the students to understand the laws of thermodynamics and apply it to various systems, note the significance of the results and to know about availability, entropy and second law aspects of daily life.
3. To help the students understand various gas laws and equations of state and apply them to solve problems of gas mixtures in estimating enthalpy, entropy, specific heat and internal energy
4. To teach students about properties of pure substances

Course Outcomes

1. Demonstrate an understanding of the concepts such as conservation of mass, conservation of energy, work interaction, heat transfer and first law of thermodynamics
2. Identify closed and open systems and analyze related problems
3. Apply gas laws to mixtures and their properties
4. Identify closed and open systems and analyze related problems.

Module I: Basic Concepts of Thermodynamics 9L + 3T Hrs

Introduction- Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, Thermodynamic properties: definition and units. Intensive and extensive properties. Thermodynamic state, state point, path and process, quasi-static process, cyclic and non-cyclic processes, Energy and its forms, Work and heat (sign convention), irreversible process, causes of irreversibility

Module II: Gas Laws and Zeroth Law of Thermodynamics 8L + 2T Hrs

Gas Laws: Gas laws, Ideal gas, Real gas, Law of Corresponding states, internal energy and enthalpy as functions of temperature only, universal and particular gas constants, specific heats, perfect and semi-perfect gases.

Zeroth Law of Thermodynamics: Zeroth law of thermodynamics statement, Concept of Temperature and its' measurement, Temperature scales.

Module III: First Law of Thermodynamics **8L + 2T Hrs**

First law of thermodynamics-application to closed and open system, Joules experiments, equivalence of heat and work, Internal energy and enthalpy, energy as a property, steady state, steady flow energy equation, extension of first law to control volume, Limitations of first law of thermodynamics,

Module IV: Second Law of Thermodynamics **8L + 2T Hrs**

Thermal reservoirs, Energy conversion, Efficiency, devices converting work to heat in a thermodynamic cycle, direct heat engine, reversed heat engine, Coefficient of Performance, Kelvin-Planck and Clausius statement of second law of thermodynamics, Equivalence of the two statements, reversible and irreversible processes, factors that make a process irreversible, Carnot cycle and Carnot engine, Carnot theorem and its corollaries.

Module V: Entropy **8L + 2T Hrs**

Classius Inequality: Statement, proof, application to a reversible cycle, Entropy: Definition, a property, principle of increase of entropy, entropy as a quantitative test for irreversibility, Tds equation, calculation of entropy using TdS relations, entropy as a coordinate, Available and unavailable energy, Availability and Irreversibility, Second law efficiency, Helmholtz & Gibb's function.

Text books

1.P K Nag, Engineering Thermodynamics, Tata McGraw-Hill Publishing Company Ltd., 2009.
2.Yunus A. Cengel Michael A. Boles, Thermodynamics: An Engineering Approach, McGraw-Hill Science, 2005.

Reference books

1. R K Rajput, Engineering Thermodynamics Laxmi Publications, 2013.
2. C. P. Arora, Thermodynamics, Tata McGraw-Hill Publishing Company Ltd.,2005.
3. Y.V.C. Rao, An Introduction to Thermodynamics, Universities Press, 2004.
4. B. K Venkanna, Swati.B. Wadavadagi, Basic Thermodynamics, PHI New Delhi, 2010.

SEM/YEAR : III SEM
COURSE CODE : 16ME204
TITLE OF THE COURSE : ENGINEERING DESIGN
L: T/A:P: C : 3 :0 : 2 : 4
TOTAL HOURS : 44

Course Learning Objectives

1. The purpose of this course is to expose the beginning student of engineering to the typical methodology of problem solving used by the engineer
2. In the design of products, processes or systems for satisfying man's needs

Course Outcomes

Major learning by the student will be through a

1. Design case studies
2. Number of tutorial exercises
3. Design problem solving assignments
4. Group design seminar
5. Group design project.

Module I: Introduction to Design 08 Hrs

Definition of engineering design with illustrations, place of design in engineering activity, life cycle of product, design morphology, design process methodologies, basic methodology for problem solving.

Recognition of design problems needs analysis, design requirements, formulation of design problems.

Module II: Analysis of Design 10 Hrs

Analysis of design problem, description of inputs and outputs, weightages & trade-offs among requirements, criteria for comparison & evaluation of solution, identification of constraints, pair wise comparison chart, objective trees, work breakdown structures

Synthesis of alternative solutions, creativity & techniques for creative idea generation & evaluation of solutions.

Module III: Design Communication & Design for X 10 Hrs

Design communication & presentation, design and the environment, professional ethics in engineering, design for manufacture, design for assembly, design for reliability & design for affordability

Module IV: Engineering Materials for Design 08 Hrs

Introduction to engineering materials – metals, non- metals, plastics, ceramics, composites.

Module V: Manufacturing considerations in design 08 Hrs

Manufacturing considerations in design – A brief overview of conventional manufacturing processes like casting, forging, welding, machining, powder metallurgy

Note: The following course topics will be covered by the instructors through 44 lectures and design case studies, major learning by the student will be through a number of tutorial exercises

Text books

1. C. L. Dym and Patrick Little, Engineering Design- A Project Based Introduction, John Wiley, 1995.
2. N. Cross, Engineering Design Methods: Strategies for Product Design, John Wiley, 1995.

Reference books

1. Ian C. Wright, Design Methods in Engineering & Product Design, McGraw-Hill, 1998.
2. M. A. Parameswaran, An Introduction to Design Engineering, Narosa, 2004.
3. Atila Ertas and Jesse C. Jones, The Engineering Design Process, John Wiley & Sons, 1993.

SEM/YEAR : III SEM
COURSE CODE : 16ME205
TITLE OF THE COURSE : MACHINE DRAWING
L: T/A:P: C : 1 :0 : 4 : 3
TOTAL HOURS : 47

Course Learning Objectives

1. The objective of this course is to make students understand the principles and requirements of machine & production drawings.
2. To make the students understand and interpret drawings of machine components so as to prepare assembly drawings using standard CAD packages.
3. To develop the technical skills necessary to generate an engineering drawing and an engineering assembly using a modern CAD system.
4. This course will provide a way to learn how to assemble and disassemble important parts used in major mechanical engineering applications.

Course Outcomes

1. After going through this course, students shall be able to draw & understand the drawings of mechanical components and their assemblies.
2. Students can create 3D models of engineering objects, engineering drawings with different views, and an assembly of the objects that make up engineered systems, using a CAD system (e.g. AutoCAD)

Module I: Sections of Solids 08 Hrs

Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids) True shape of sections.

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.

Module II: Permanent Fastenings 08 Hrs

Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets) Common types of joints, terminology, proportions and representation; Welds: Types of welds and welded joints, edge preparation, specifications, and representation of welds on drawings

Module III: Detachable Fasteners 08 Hrs

Thread forms: Types, forms, standard, and specifications; Drawing of temporary connections; Thread terminology, sectional views of threads. Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

Module IV: Keys, Joints and Couplings **08 Hrs**

Keys: Parallel key, Taper key, Feather key, Gib head key and Woodruff key, cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. Couplings: Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)

Module V: Assembly drawing **15 Hrs**

Assembly drawing with sectioning and bill of materials from given detailed drawings of assemblies.

1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Tool Head of a shaper

Text books

1. N.D. Bhat & V.M. Panchal 'Machine Drawing'
2. French, T. E., Vierch, C. J., and Foster, R. J., Engineering Drawing and Graphic Technology,14th Ed., McGraw-Hill, 1993

Reference books

1. S. Trymbaka Murthy, 'A Text Book of Computer Aided Machine Drawing', CBS Publishers, New Delhi, 2007
2. K.R. Gopala Krishna 'Machine Drawing', Subhash Publication.
3. Narayana K.L., Kannaiah, P., and Venkata Reddy K, Machine Drawing, 3rd Ed., New Age International Publishers, 2006.
4. Johan K. C., Text Book of Machine Drawing, PHI Learning Pvt., 2009

SEM/YEAR : III SEM
COURSE CODE : 16HU201
TITLE OF THE COURSE : ECONOMICS FOR ENGINEERS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

Course Learning Objectives

Study of this subject provides an understanding of
1. The scope of an entrepreneurship development, key areas of business development, sources of finance, project preparation, methods of taxation and tax benefits
2. Significance of economic growth, application of engineering skills in entrepreneurial activities.

Course Outcomes
The course is intended to provide basic understanding of Economics and Management to engineering students with following aspects:

1. To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.
2. To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.

Module I: Introduction 08 Hrs
Micro and Macro Economics, Relationship in Science, Engineering, Technology and Economic Development. Production Possibility Curve, Nature of Economic Laws.

Module II: Time Value of Money: 08 Hrs
Concepts and application. Capital budgeting; Traditional and modern methods, Payback period method, Return on Investment Internal Rate of Return, Equity value analysis, Net Present Value (with the help of case studies)

Module III: Costing 10 Hrs
Meaning of Production and factors of production, Law of variable proportions and returns to scale. Internal and external economies and diseconomies of scale. Concepts of cost of production, different types of costs; accounting cost, sunk cost, marginal cost, and Opportunity cost. Break even analysis, Make or Buy decision (case study). Relevance of Depreciation towards industry.

Module IV: Market and supply 08 Hrs
Meaning of market, types of market, perfect competition, Monopoly, Monopolistic, Oligopoly. (Main features). Supply and law of supply, Role of demand and supply in price determination.

Module V: Indian Economy **10 Hrs**

Indian Economy, nature and characteristics. Basic concepts; fiscal and monetary policy, Liberalization Privatization Globalization, Inflation, Sensex, General Agreement on Tariffs and Trade, World trade organization and International Money Fund. Difference between Central bank and Commercial banks

Text books

1.Jain T.R., Economics for Engineers, VK Publication
2.Singh Seema, Economics for Engineers, IK International

Reference books

1.Chopra P. N., Principle of Economics, Kalyani Publishers
2.Dewett K. K., Modern economic theory, S. Chand
3.H. L. Ahuja., Modern economic theory, S. Chand
4.Dutt Rudar & Sundhram K. P. M., Indian Economy
5.Mishra S. K., Modern Micro Economics, Pragati Publications
6.Pandey I.M., Financial Management; Vikas Publishing House

SEM/YEAR : IV SEM
COURSE CODE : 16MA202
TITLE OF THE COURSE : ENGINEERING MATHEMATICS
L: T/A:P: C : 3 :1 : 0 : 4
TOTAL HOURS : 52

Course Learning Objectives

The course will enable the students to:
1. Perform an error analysis for various numerical methods
2. Derive appropriate numerical methods to solve non-linear algebraic and transcendental equations and linear system of equations
3. Develop appropriate numerical methods to approximate a function
4. Provide appropriate numerical methods to calculate a definite integral and to evaluate a derivative at a value
5. Develop appropriate numerical methods to solve an ordinary differential equation
6. Understand the various techniques to solve Partial differential equations

Course Outcomes

At the end of the course, the students will be able to:
1. Perform an error analysis for a given numerical method
2. Solve a linear system of equations and non-linear algebraic or transcendental equation using an appropriate numerical method
3. Approximate a function using an appropriate numerical method
4. Calculate a definite integral and evaluate a derivative at a value using an appropriate numerical method
5. Solve an Ordinary differential equation using an appropriate numerical method
6. Solve partial differential equations using an appropriate numerical method

Module I: Linear Algebraic Equations 12 Hrs

Linear Algebraic Equations: Gauss Elimination, LU Decomposition and Matrix Inversion, Special Matrices and Gauss Seidel.

Module II: Optimization 10 Hrs

Optimization: One dimensional unconstrained optimization, Multidimensional unconstrained optimization, Constrained Optimization.

Module III: Curve Fitting 10 Hrs

Curve Fitting: Least Squares Regression, Interpolation, Fourier Approximation.

Module IV: Numerical Integration and Differentiation 10 Hrs

Numerical Integration and Differentiation: Newton Coates Integration Formulas, Integration of equations, Numerical Differentiation schemes.

Module V: ODEs **10 Hrs**

ODEs: Runge Kutta Methods, Stiffness and Multistep methods, Boundary Value and Eigen value problems.

Text books

1.Numerical Methods for Engineers, S. Canale and R. Chapra, Mc Graw Hill Education(India), 6th edition.

References

1.Applied Numerical Methods with MATLAB for Engineers and Scientists, Mc Graw Hill Education (India), 3rd edition.

SEM/YEAR : IV SEM
COURSE CODE : 16ME206
TITLE OF THE COURSE : ENGINEERING MATERIALS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

Course Learning Objectives

1. To understand the mechanical behavior of engineering materials
2. To understand the atomic and molecular structures of engineering materials
3. To learn properties of engineering materials
4. To know the knowledge on the structure, properties, testing of metals

Course Outcomes

1. Understanding basic structure and terms associated with engineering materials
2. Perform calculations to qualify materials properties and characteristics.
3. Ability to construct phase diagrams.
4. Selecting the right materials for engineering process and application.

Module I: Introduction and Structure of Solids **09 Hrs**

Historical perspective of Materials Science. Classification of materials, Advanced Materials, Future materials and modern materials.

Structure of Solids: Overview of Crystal Structure, Solid Solutions, Hume Rothery Rules, Crystal Imperfections, Point Defects, Line Defects, Surface Defects, Bulk Defects, Critical nucleus size and Critical Free energy, Mechanism of Crystallization, Nucleation, Homogeneous and Heterogeneous, Nucleation- Growth, Single crystal, Polycrystalline Materials, Basic principles of solidification of metals and alloys. Growth of crystals, Planar growth, dendritic growth, Solidification time, Cooling curves, Non-crystalline solids, Glass Transition Temperature.

Module II: Phase Diagrams **09 Hrs**

Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Phase Rule, Unary System, Binary Phase diagrams, iron-carbon system. Phase transformations. Transformation rate effects and Isothermal transformations (TTT Curves), Microstructure and property changes in iron-carbon system, Typical Phase diagrams, Magnesia-Alumina, Copper-Zinc, Al-Cu and AlSi phase diagrams, Ag-Pt system, Iron – Carbon systems, Ternary phase diagrams, Iron – Carbon Equilibrium Diagram.

Module III: Ferrous and Non-Ferrous Materials **09 Hrs**

Classification of steels and cast iron, Microstructure, Effect of alloying elements on steel, Ferrous alloys and their applications, Factors affecting conductivity of a metal, Electrical Resistivity in alloys, Thermal conductivity of metals and alloys, High Resistivity alloys, Titanium alloys, Nickel alloys, Copper alloys, Magnesium alloys and Aluminum alloys, High temperature alloys

Module IV: Structural Materials: **08 Hrs**

Metals, Ceramics, Glass Ceramics, Advanced ceramics, Functional properties and applications of ceramic materials and Glasses, Polymers Mechanisms of polymerization, Liquid crystal polymers, Defects in Polymers, Composites

Module V: Failure and Tests **09 Hrs**

Fracture, Types, Fracture mechanics. Crack initiation and propagation. Crack propagation rate. Characteristics of creep curve & steady state creep. Mechanisms & creep mechanism maps, creep under complex stress-states, prediction of long time properties, Generalized creep behavior. Fracture toughness & fatigue, Stress and temperature effects, Non-Destructive Testing, Testing of materials under tension, compression and shear loads, Hardness tests, fatigue and creep test. Impact testing, Fatigue testing,

Text books

1. William D. Callister, Jr., "Materials Science and Engineering an Introduction", 2nd Edition, John Wiley & Sons, Inc., 2007.
2. V. Raghavan, "Materials Science and Engineering", Prentice – Hall of India Pvt. Ltd., 2007

Reference books

1. J.M. Shackelford, Introduction to Materials Science for Engineers, 5th Edition, Prentice-Hall, Inc. 2000.
2. Suryanarayana, A. V. K., "Testing of Metallic Materials", Prentice Hall India, New Delhi, 1979.
3. W. Bolton, "Engineering materials technology", 3rd Edition, Butterworth & Heinemann, 2001.
4. William F. Smith, "Structure and Properties of Engineering Alloys", Mc-Graw-Hill Inc., U.S.A, 2nd edition, 1993.
5. Kingery, W. D., Bowen H. K. and Uhlmann, D. R., "Introduction to Ceramics", 2nd Edition, John Wiley & Sons, New York, 1976.

SEM/YEAR : IV SEM
COURSE CODE : 16ME207
TITLE OF THE COURSE : FLUID MECHANICS AND MACHINERY
L: T/A:P: C : 3 :1 : 0 : 4
TOTAL HOURS : 52

Course Learning Objectives

1. The aim of this course is to introduce and explain basic fundamentals of Fluid Mechanics.
2. To understand the importance of flow measurement and its applications in Industries and to obtain the loss of flow in a flow system.
3. The development of boundary layers and advancement of practical hydraulics and understanding the concept of advanced fluid mechanics
4. To understand working principles and performance of hydraulic machines

Course Outcomes

1. Student will be able to terminologies used in fluid mechanics, principles of fluid statics, kinematics and dynamics.
2. Student will be able to find the dependent and independent parameters for a model of fluid flow.
3. Analyze and evaluate the implications of the concepts studied in real-life applications.
4. Student will be able to implement fundamental principles of fluid mechanics to hydraulic machines.

Module I: Fluid Properties and Fluid Statics 17 Hrs

Introduction, properties of fluids, viscosity, thermodynamics properties, surface tension and capillarity, vapor pressure. Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Hydrostatic forces on plane – inclined and curved surfaces, Fluid Statics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid. Total pressure and center of pressure on submerged plane surfaces, horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. Buoyancy – center of buoyancy – metacenter and metacentric height, conditions of equilibrium of floating and submerged bodies

Module II: Fluid Kinematics and Fluid Dynamics 14 Hrs

Fluid Kinematics - Types of flows; Steady flow, Unsteady flow, Uniform and Non-Uniform flow, Rotational flow, Irrational flow, 1-D, 2-D, 3-D flows–Streamline
Fluid Dynamics **-** Introduction, Equation of motion, Euler's equation of motion, and Bernoulli's equation derived from fundamental &Euler's equation, Bernoulli's equation for real fluids. Fluid Flow measurements-Venturimeter, orifice meter and Pitot tube. Flow through Pipes-Major & Minor losses in pipe flow.

Module III: Dimensional Analysis and Boundary Layers **08 Hrs**

Introduction, Dimensional homogeneity – Raleigh and Buckingham theorems – Non-dimensional numbers – Model laws and distorted Models-Unit Quantities-Specific quantities, Boundary layers – Laminar flow and Turbulent flow – Boundary layer thickness

Module IV: Hydraulic Turbines **08 Hrs**

Classification of turbines, Impulse and reaction turbines, Pelton wheel, Francis and Kaplan turbine –work done and efficiencies. Draft tube theory, Performance of hydraulic machines, unit and specific quantities, turbine governing.

Module V: Pumps **05 Hrs**

Classification, working, work done – manometric head- losses and efficiencies- specific speed- pumps in series and parallel-performance characteristic curves, NPSH. Reciprocating pumps: Working, Discharge, slip, indicator diagrams

Text books

1. Dr. R.K. Bansal, (2000), Fluid Mechanics and Hydraulic Machines, Laxmi Publication(P) Ltd., New Delhi.
2. P.N. Modi and S.M. Seth (1999), Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House, Naisarak, Delhi

Reference books

1. Yunus A Cengel, John M Cimbala, "Fluid Mechanics: Fundamentals and Applications" (in SI units) – McGraw Hill company, 2nd reprint, 2008

SEM/YEAR : IV SEM
COURSE CODE : 16ME208
TITLE OF THE COURSE : KINEMATICS OF MACHINES
L: T/A:P: C : 3 :0 : 2 : 4
TOTAL HOURS : 52

Course Learning Objectives

1. The study of kinematics is concerned with understanding of relationships between the geometry and the motions of the parts of a machine.
2. The overall objective of this course is to learn how to analyze the motions of mechanisms, design mechanisms to give desired motions.
3. This course includes relative motion analysis, design of gears, gear trains, cams and linkages, graphical and analytical analysis of position, velocity and acceleration, clutches, brakes & dynamometers.

Course Outcomes

1. Students will be able to understand the concepts of displacement, velocity and acceleration of simple mechanism, drawing the profile of cams and its analysis, gear kinematics with gear train calculations, brakes & dynamometers.

Module I: Basics of Mechanisms **10 Hrs.**

Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. Kinematic Chains and Inversions: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.
Quick return motion Mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.

Module II: Mechanisms with Lower Pairs **10 Hrs.**

Pantograph, Straight Line Mechanisms, Approximate Straight Line Motion Mechanism: Watt's Straight mechanism, Application of Straight Line Mechanisms. Steering gears: Davis Steering gear, Ackermann Steering gear, Universal Hook's Joint. Brakes and Dynamometers: Types of brakes: Simple shoe brake, Band Brake, Band and Block brake, Internal expanding shoe brake, Dynamometer, Absorption Dynamometer: Prony brake dynamometer, Transmission Dynamometer: Epi-cyclic train dynamometer, Belt transmission dynamometer, Torsion dynamometer.

Module III: Kinematic Analysis **10 Hrs.**

Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons: Relative velocity and acceleration of particles in a common link, relative velocity and accelerations of coincident Particles on separate links- Coriolis component of acceleration. Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's Theorem, Determination of linear and angular velocity

using instantaneous center method Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.

Module IV: Gears and Gear Trains **10 Hrs.**

Spur Gears: Gear terminology, law of gearing, Characteristics of involute action, Path of contact. Arc of contact, Contact ratio of spur, helical, bevel and worm gears, Interference in involute gears. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth. Profile Modification.

Gear Trains: Simple gear trains, Compound gear trains for large speed. Reduction, Epicyclical gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclical gear trains. Tooth load and torque calculations in epicyclical gear trains.

Module V: Cams **12 Hrs.**

Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion

Text books

1.Theory of Machines, Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009.

2. Theory of Machines, Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi.

Reference books

1. "Theory of Machines & Mechanisms", J.J. Uicker, G.R. Pennock, J.E. Shigley. Oxford 3rd Edition, 2009.
2. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Second Edition, MGH, New York.
3. Theory of Mechanisms and Machines: Amitabha Ghosh and Ashok kumar Mallik, Third Edition Affiliated East-West Press.
4. Mechanism and Machine theory, Ambekar, PHI, 2007

SEM/YEAR : IV SEM
COURSE CODE : 16ME209
TITLE OF THE COURSE : MANUFACTURING TECHNOLOGY – I
L: T/A:P: C : 3 :0 : 0: 3
TOTAL HOURS : 44

Course Learning Objectives

1. Understanding importance of cutting tool materials
2. Define the various terms related to metal cutting and recognize the types of chip formation.
3. Identify the applications of various cutting tool material, mechanism and operation of a machine tools.
4. Practical experience on various machine tools and their operations
5. Identify different arc welding processes for joining the materials and recognize the metallurgical aspects of welding.

Course Outcomes

1.Summarize basic machine tools for various machining operations
2.Analyze machining parameters on surface finish, type of operations, production and tool life
3.Interpret type of tools for suitable machining operations based on machining parameters
4.Identify machine tools, operation and other condition for industrial machining components
5.Choose correct manufacturing process for a particular engineering application.

Module I: Fundamentals of Manufacturing 08 Hrs

Manufacturing: selecting manufacturing process, global competitiveness of manufacturing costs, Classification of manufacturing, Fundamentals of materials- their behavior and manufacturing properties – Ferrous metals and alloys – Non-ferrous metals and alloys

Module II: Cutting Tool Materials 08 Hrs

Desired properties, types of cutting tool materials-HSS carbides, ceramics cutting fluids, desired properties, types and selection, machinability, factors affecting machinability.

Module III: Theory of Metal Cutting 10 Hrs

Single point cutting tool nomenclature, geometry, orthogonal and oblique cutting, mechanism of chip formation, types of chip, merchant analysis, Ernst-merchant's solution, shear angle relationship, problem of merchant's analysis, tool wear and tool failure effects of cutting parameters, tool life criteria, Taylor's tool life equation, problem on tool evaluation, heat generation in metal cutting, tool tip measurements

Module IV: Joining Processes **10 Hrs**

Metal fusion welding processes: Oxy-fuel gas welding – Arc welding processes, Consumable electrode: Shielded Metal Arc Welding (SMAW), Submerged Arc Welding (SAW), Gas Metal Arc Welding (GMAW), Electro gas welding, Electro slag welding. Non-consumable Electrode: Gas Tungsten Arc Welding (GTAW), Electron Beam Welding (EBW), and LASER Beam Welding (LBW), Solid state welding processes: Ultrasonic welding, Friction welding, Resistance welding: Spot welding, seam welding, Weld quality, welding defects.

Module V: Processing of Power metals, Ceramics and Glass **08 Hrs**

Production of metal powders: Compaction – Sintering and Finishing – Design, Considerations for powder metallurgy and Process capability – Shaping of ceramics – Forming and shaping of glass – Design considerations for ceramics and glass – Processing of superconductors.

Text books

1. Serope Kalpak Jian; Steven R. Schmid (2010), Manufacturing Engineering and Technology, 6th Edition, Publisher: Prentice Hall, ISBN-10 0-13-608158-1, ISBN- 13 978-0-13-608158-5.
2. P.N. Rao. (2009), Manufacturing Technology – Foundry, Forging and Welding, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference books

1. M P Groover (2007), Fundamentals of Modern manufacturing (materials, processes and systems) third edition, Wiley publications, ISBN-978-0-471-74485-6, USA

SEM/YEAR : IV SEM
COURSE CODE : 16ME210
TITLE OF THE COURSE : MECHANICAL MEASUREMENTS
L: T/A:P: C : 3 :0 : 0: 3
TOTAL HOURS : 44

Course Learning Objectives

1. To understand the basic concepts on measurements and their terms
2. To provide knowledge on various measurement equipment sand components.
3. To learn the procedure adopted to measure the dimension of the components

Course Outcomes

1. Students will have thorough knowledge on different measurement components
2. Understanding the terms and knowing the various parameters in measurements

Module I: Introduction 10Hrs

Introduction to measurement and measuring instruments, Generalized measuring system and functional elements, units of measurement, static performance characteristics and elementary idea of dynamic performance characteristics of measurement devices, calibration, concept of error (systematic and random), sources of error, statistical analysis of errors

Module II: Linear and angular measurements 08Hrs

Linear Measurement Instruments, Vernier caliper, Micrometer, Interval measurements: Slip gauges,Checking of slip gauges for surface quality, Optical flat, Limit gauges, Problems on measurements with gauge.

Module III: Measurement of Force, Torque, Strain and Vibration 10Hrs

Force measurement: load cells, cantilever beams, proving rings, differential transformers. Measurement of torque: Torsion bar dynamometer, servo controlled dynamometer, absorption dynamometers. Power Measurements.

Measurement of strain: Mechanical strain gauges, electrical strain gauges, strain gauge: materials, gauge factors, theory of strain gauges and method of measurement, bridge arrangement, temperature compensation. Vibration measurement: Vibration pickups and decibel meters, Vibrometers

Module IV: Measurement of Time, Pressure and Temperature 08Hrs

Time Related Measurements: Stroboscope, frequency measurement by direct comparison. Measurement of displacement

Measurement of Pressure: Gravitational, directing acting, elastic and indirect type pressure transducers. Measurement of very low pressures (high vacuum).

Temperature Measurement: Thermometers, bimetallic thermocouples, thermistors and pyrometers

Module V: Metrology and Inspection **08Hrs**

Standards of linear measurement, line and end standards. Limit fits and tolerances. Interchangeability and standardization. Linear and angular measurements devices and systems Comparators: Sigma, Johansson's Microkrator. Limit gauges' classification, Taylor's Principle of Gauge Design. Measurement of geometric forms like straightness, flatness, roundness. Tool maker's microscope, profile project autocollimator. Interferometry: principle and use of interferometry, optical flat. Measurement of screw threads and gears. Surface texture: quantitative evaluation of surface roughness and its measurement

Text books

1. Beckwith Marangoni and Lienhard, "Mechanical Measurements", Pearson Education, 6th Edition, 2006.
2. A. K Sawhney, "A course in Mechanical Measurements and Instrumentation", Dhanpat Rai Publications.

Reference books

1. Alan S. Morris, "The Essence of Measurement", Prentice Hall of India, 1997
2. Beckwith T.G, and N. Lewis Buck, "Mechanical Measurements", Addison Wesley, 1991
3. Ernest O. Doebelin, "Measurement Systems Applications and Design",5th Ed., McGraw Hill Book Co.
4. N. V. Raghavendra and Krishnamurthy, "Engineering Metrology and Measurement", Oxford University Press

SEM/YEAR : III SEM
COURSE CODE : 16ME271
TITLE OF THE COURSE : MATERIALS LABORATORY
L: T/A:P: C : 0 :0 : 4: 2

Course Learning Objectives

1. Introduction to basic characterization techniques for materials, such as Hardness testing, Tensile testing, Shear testing, Compression, Bending, Fracture testing, Fatigue testing & Impact testing.
2. To study the different methods to enhance the properties of materials from few mechanical & metallurgical process like heat treatment.

Course Outcomes

1. Students will be able to demonstrate the knowledge, skills to conduct & analyzing the results with different mechanical testing.
2. Identification of Metals & Microstructure examination.

LIST OF EXPERIMENTS

1. **Tension Test**- To determine mechanical properties such as ultimate tensile strength, elastic modulus, proportionality limit, yield point, fracture stress, percentage elongation & reduction in area of metals & alloys and also study the behaviour of material & characterize types of fracture under tensile load.
2. **Compression Test** -To conduct compression test on the given material and to determine properties such as compressive strength, modulus of elasticity, percentage constriction & percentage increase in area.
3. **Shear Test** - To determine ultimate shear stress of the given specimens in single and double shear.
4. **Bending Test** -To study the characteristics of materials under the gradually increasing flexural loading and to determine Modulus of rupture, Modulus of elasticity, Maximum shear stress.
5. **Impact Test** - (Charpy and Izod) - To find out the impact strength of the given notched specimens.
6. **Brinell hardness Test** -To determine the Brinell Hardness Number (BHN) of the given specimens.
7. **Vicker's Hardness Test** - To determine Vickers Hardness Number for a given specimen.
8. **Wear Test** - To determine the wear rate of different materials by using pin and disc apparatus.

SEM/YEAR : III SEM
COURSE CODE : 16ME272
TITLE OF THE COURSE : MANUFACTURING PROCESS LABORATORY
L: T/A:P: C : 0 :0 : 4: 2

Course Learning Objectives

The objective of this course is to make the student aware of

1. The basic fundamentals and mechanics of metal cutting, tool geometry, tool life and tool wear etc.
2. It will give knowledge of tool materials, tool life, tool wear, effect of lubrications and coolant used in machining operation.
3. The basic knowledge of various machine tools, classification, specification, operations of each machining processes like turning, milling, shaping, final finishing operations.

Course Outcomes

The students able learn and understand

1.The fundamental concepts and mechanics of metal cutting operations, various tool materials, various parameters affecting machining operations like feed, speed, coolant, tool life, tool wear, temperature etc.

2.The students experience the practical and theory of various machining processes. The various operations, equipment's, specifications and applications of individual machining processes etc.

LIST OF EXPERIMENTS

1. Introduction of General Purpose Machines
2. Study of Single Point Cutting Tool and Multi Point Cutting Tool
3. To Study of Mechanism in Lathe and Perform Various Operations on a Lathe Machine
4. To Study Construction, Working and Performing Operations on a Drilling Machine
5. To Study Construction and Working of Milling Machine
6. To Study Construction, Working and Perform Grinding Operation on a Grinding Machine
7. To Study Construction, Working and Perform of Shaping Operation on a Shaper Machine
8. Introduction of Computer Numerical Control Machines and Demonstration of Few Work Pieces Jobs.

SEM/YEAR : IV SEM
COURSE CODE : 16ME273
TITLE OF THE COURSE : FLUID MECHANICS AND MACHINES LABORATORY
L: T/A:P: C : 0 :0 : 4: 2

Course Learning Objectives

Upon completion of this Laboratory, students can be able to

1. Have hands on experience in flow measurements using different flow measurement device like Notch, Venturi Meter, orifice meter and also perform calculations related to losses in pipes.
2. Performance characteristics.
3. Study of Various pumps and turbines.

Course Outcomes

1. Ability to use various flow measurement equipment's
2. Ability to do performance characteristics study on different fluid machineries

LIST OF EXPERIMENTS

1. **Performance Test on Pelton Wheel Turbine** -To evaluate the constant speed and constant head characteristics and also to plot unit quantities.
2. **Characteristics Curves of Francis Turbine** -To evaluate the constant speed and constant head characteristics on Francis turbine and also to plot unit quantities.
3. **Determination of the Co-Efficient of Discharge of the Given Orifice Meter** -To determines the co-efficient of discharge for orifice meter at different flow rates.
4. **Determination of the Co- Efficient of Discharge of the Given Venturimeter** -To determine the coefficient of discharge for venturimeter at different flow rates.
5. **Co- Efficient of Discharge of the Given Notch Apparatus** -To calibrate and determine the co-efficient of discharge of notches of different shapes for different flow rates.
6. **Calculation of the Rate of Flow Using Rotameter-**To calibrate rotameter at different flow rates with actual discharge.
7. **Pipe Friction Apparatus**- i) To draw the Moody's friction factor diagrams for different diameter and material of the pipe. ii) To find and compare friction factor for different types of pipe.
8. **Loss of Head on Pipe Fittings Apparatus** -To determine and compare pressure drop across various pipe settings.
9. **Performance Test on Centrifugal Pump** -To evaluate the characteristics of centrifugal pump at various speeds, heads and flow rates, using digital power meter for measurement of input power.
10. **Performance Test on Reciprocating Pump** - To determine the flow, head, power performance characteristics of a reciprocating pump at various speeds and to determine the characteristics with volumetric efficiency (slip).
11. **Performance Test on Gear Pump Test Rig**- To evaluate the flow, head, power performance characteristics of a gear pump at various speeds using oil as the medium of flow.

SEM/YEAR : IV SEM
COURSE CODE : 16ME274
TITLE OF THE COURSE : MEASUREMENTS LABORATORY
L: T/A:P: C : 0 :0 : 4:

Course Learning Objectives

1. The objectives of this course are to:
2. Introduce the students to the need, standards and principles of measurement.
3. Introduce the students to the principles of various mechanical elements – such as screws, threads and gears.
4. Provide the students the basics of measurements systems.
5. Focus on principles of transducers.

Course Outcomes

The purpose of this course is to provide the student with a basic understanding of the theory and practice of measurement and instrumentation. Upon completion of this course, the student should:

1. Recognize the basic elements of common measurement systems.
2. Be able to estimate the accuracy of a measurement, identify possible sources of Measurement errors.
3. Be able to operate various measurement devices / systems such as transducers, LVDT, Pressure cell, thermocouple, strain gages, etc.

LIST OF EXPERIMENTS

1. **Calibration of Micrometer** - To calibrate the given micrometer using slip gauge, draw the calibration curve and to evaluate the errors occurred.
2. **Calibration of Vernier caliper and measurement of the given component** - To calibrate and measure the given component by using Vernier caliper.
3. **Calibration of Thermocouple** - To calibrate the given T-Type Thermocouple at different temperatures.
4. **Calibration of Linear Variable Differential Transformer (LVDT)** - To calibrate the given LVDT (for the performance using Vernier height gauge.
5. **Calibration of Load Cell** - To calibrate the given Cantilever Beam type load cell.
6. **Measurements using Optical Profile Projector** – To measure the screw thread parameters of a given specimen using Optical Profile projector.
7. **Measurements using Toolmaker's Microscope** - To measure the screw thread parameters of a given specimen using Tool Maker's Microscope.
8. **Measurements of angle using Sine bar** - To determine the unknown angle of the given specimen using sine bar with the help of slip gauge.
9. **Measurements of angle using universal bevel protractor** - To determine the unknown angle of the given specimen using universal bevel protractor.

10. **Measurements of Screw thread parameters using two wire or three-wire methods** - To find the effective diameter of a given screw thread by two or three wire method.
11. **Measurements of surface roughness parameters using mechanical comparator** - To measure the various surface roughness parameters of the components using mechanical comparator (dial gauge indicator)
12. **Measurements of gear tooth profile using gear tooth Vernier caliper** - To Measure the tooth thickness of the given gear using Gear Tooth Vernier Caliper.
13. **Measurements of Vibrations -**To study the vibrations measurement, frequency, displacement, velocity & acceleration.

SEM/YEAR : V SEM
COURSE CODE : 16ME301
TITLE OF THE COURSE : HEAT TRANSFER
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To understand basic phenomenon of heat transfer and its importance in engineering applications.
2. To enable the students to understand the different modes of heat transfer like conduction, convection and radiation.
3. To illustrate the development of the governing differential, algebraic equations related to different modes of heat transfer.

COURSE OUTCOMES

1. Ability to define and solve steady-state and transient problems in 1-D and 2-D.
2. Apply heat transfer principles to design and evaluate performance of thermal systems.
3. Predict and evaluate the impact of boundary conditions on the solutions of heat transfer problems.

MODULE I

Introduction and basic concepts **08L Hrs**

Modes of heat transfer: Basic laws governing conduction, Thermal conductivity.
Conduction: Derivation of general three dimensional conduction equation in Cartesian coordinate, discussion on 3-D conduction in cylindrical and spherical coordinate system. One dimensional conduction equations for plane, cylinder and spheres. Overall heat transfer coefficient, Thermal conductive resistance and numerical problems. Derivation for heat flow and temperature distribution in a plane for variable thermal conductivity case, critical thickness of insulation and numerical problems.

MODULE II **08L Hrs**

Heat Transfer in Extended Surfaces

Introduction, Heat transfer through rectangular fin, infinitely long fin, short fin with insulated tip and without insulated tips. Fin efficiency and effectiveness. Numerical problems.
Transient Conduction: Lumped parameter analysis, use of transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere, numerical problems

MODULE III **10L Hrs**

Natural Convection and Forced Convection

Natural Convection**:** Introduction, laminar flow, momentum and energy equations for vertical flat plate, physical significance of Grashoff number, use of correlations for free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, numerical problems.
Forced Convection: Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various

correlations for hydro dynamically and thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems.

MODULE IV **08L Hrs**

Thermal Radiation

Fundamental concepts of radiation, different laws governing radiation heat transfer, Stefan-Boltzman law, Kirchoff's law, Planck's law, Wein's displacement law, Intensity of radiation and Lambert's cosine law, Radiation shape factor, Heat exchange by radiation between two black and diffuse gray surfaces, radiation shields, numerical problems.

MODULE V **10L Hrs**

Heat Exchangers and Boiling & Condensation

Heat exchangers: Classification and applications, overall heat transfer coefficient, heat exchanger analysis–Logarithmic mean temperature difference for parallel and counter flow heat exchanger, effectiveness–number of transfer units, method for parallel and counter flow heat exchanger, introduction to cross flow heat exchanger, Logarithmic mean temperature difference correction factor. Numerical problems.

Condensation and Boiling: Boiling heat transfer, types of boiling, pool boiling curve and forced boiling phenomenon, condensation heat transfer, film wise and drop wise condensation. (no numerical problems).

Text Books

1. Ozisik, Heat Transfer-A Basic Approach, Tata Mc Graw Hill, 2002.
2. Incropera, F.P. and DeWitt, D.P. “Fundamentals of Heat and Mass Transfer”, John Willy & Sons, New York, NY, 2002.

Reference Books

1. R.K. Rajput, Heat & Mass Transfer, S Chand publishers, 2008.
2. C.P. Kothandraman, S. Subramanyan, Heat and Mass Transfer Data Book, New Age International Publishers, 2014.

SEM/YEAR : V SEM
COURSE CODE : 16ME302
TITLE OF THE COURSE : DESIGN OF MACHINE ELEMENTS- I
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To analyse the stress and strain on mechanical components.
2. To identify and quantify failure modes for mechanical parts.
3. To develop an ability to design a system, component by using principles of design engineering to meet desired needs within realistic constraints.

COURSE OUTCOMES

The students will demonstrate the

1. Ability to understand different kinds of loading in mechanical engineering components.
2. Ability to apply the fundamentals of mechanics of solids, stress analysis, theories of failure and material science in the design of machine components.
3. Ability to take technical, safety and other issues such as environmental into account when selecting and/or designing mechanical systems and components.

MODULE I

Introduction 08L Hrs

Normal, shear, biaxial and tri axial stresses, stress tensor, principal stresses. Engineering materials and their mechanical properties, stress-strain diagrams, stress analysis. Design considerations: Codes and standards.

General Considerations: Selection of materials, design stress, factor of safety, stress concentration factor in tension, bending and torsion, theories of failures.

MODULE II

Design for Static & Impact Strength 08L Hrs

Static Strength: Static loads and factor of safety, theories of failure: maximum normal stress theory, maximum shear stress theory, maximum strain theory, strain energy theory, distortion energy theory. Failure of brittle and ductile materials, stress concentration, determination of stress concentration factor.

Impact Strength: Introduction, impact stresses due to axial, bending and torsional loads, effect of inertia.

MODULE III

Design for Fatigue Strength 08L Hrs

Introduction, S-N Diagram, low cycle fatigue, high cycle fatigue, endurance limit, modifying factors: size effect, surface effect, stress concentration effects, fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

MODULE IV

Design of Threaded Fasteners, Riveted and Welded Joints **10L Hrs**

Threaded fasteners: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static, dynamic and impact loads, design of eccentrically loaded bolted joints.

Riveted and Welded Joints: Types, rivet materials, failures of riveted joints, joint efficiency, boiler joints, riveted brackets.

Welded Joints: Types, strength of butt and fillet welds, eccentrically loaded welded joints

MODULE V

Design of Joints, Couplings and Shafts **10L Hrs**

Joints: Types of keys, design of socket-spigot cotter joint, design of knuckle joint.

Couplings: Types of couplings, design of flange and flexible couplings andmuff coupling.

Shafts: Torsion of shafts, design for strength and rigidity with steady loading, ASME codesfor power transmission shafting, shafts under fluctuating loads and combined loads.

Design Data Handbook

1. K. Lingaiah, Design Data Hand Book, McGraw Hill, 2nd Ed, 2003.
2. K. Mahadevan and K. Balaveera Reddy, Data Hand Book, CBS Publication, 2013.

Text Books:

1. Joseph E Shigley and Charles R. Mischke, Mechanical Engineering Design, McGraw Hill International edition, 6th Edition 2009.
2. V.B. Bhandari, Design of Machine Elements,Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

Reference Books:

1. Robert L. Norton, Machine Design, Pearson Education Asia, 2001.
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Design of Machine Elements Pearson Education, 2006.
3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.

SEM/YEAR : V SEM
COURSE CODE : 16ME303
TITLE OF THE COURSE : COMPOSITES
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To develop the fundamentals of composite materials for high performance structures
2. To learn how composite materials achieve properties of strength, weight ratios and durability in engineering components design.
3. To interpret the mechanical properties of the composite in specific applications.

COURSE OUTCOMES

1. Understand the fundamental properties, applications of composite materials
2. Understanding the function of fiber and matrix materials used in composites.
3. Understanding the role of lamina and their arrangement in a laminate.

MODULE I

Introduction to Composites **08L Hrs**

Fundamentals of composites - need for composites, classification, types of matrices and fibers polymer matrix composites, metal matrix composites, ceramic matrix composites, applications of composites.

MODULE II

Macro Mechanics of a Lamina **09L Hrs**

Hooke's law for different types of materials, elastic constants, independent constants for orthotropic material, two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - stress-strain relations for lamina of arbitrary orientation.

MODULE III

Micromechanics of Composites **08L Hrs**

Introduction, rule of mixture, volume and weight fraction of fiber and matrix, density and void fraction in composites, longitudinal modulus and stiffness, transverse modulus, in-plane shear modulus.

MODULE IV

Stresses and Fracture Modes of a Composite **09L Hrs**

Inter-laminar stresses and edge effects. Bending stress of laminated beams. Tensile and compressive strength of unidirectional fiber composites, fracture modes in composites: Single and multiple fracture, de-bonding, fiber pullout and de-lamination failure, fatigue of laminate composite.

MODULE V

Fabrication and Testing of Composites **10L Hrs**

Open and closed mould processing, hand lay-up techniques, bag moulding and filament winding. pultrusion, resin transfer moulding (RTM), thermoforming, injection moulding, measurement of basic composite properties: tensile test, compressive test, shear test, interlaminar shear test, flexure test. Nondestructive testing method - ultrasonic inspection, radiography, acoustic emission and acoustic ultrasonic method.

Text Books

1. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K.K., Composite Materials, Springer-Verlag, 1987

Reference Books

1. Jones, R.M., Mechanics of Composite Materials, McGraw Hill Co., 1967.
2. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRC Press, 2nd Ed, 2004.
3. P.C. Mallik, Fibre Reinforced Composites, Marcel Decker, 1993.

SEM/YEAR : V SEM
COURSE CODE : 16ME304
TITLE OF THE COURSE : DYNAMICS OF MACHINERY
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To enable students to do static & dynamic force analysis of mechanical machines and mechanisms.
2. To enable students to analyse gyroscopes, flywheels and governors to solve important engineering problems.
3. To enable students to understand how balancing is carried out theoretically in single and multi-cylinder engines (for rotating and reciprocating masses).

COURSE OUTCOMES

At the end of the course, the student will be able to

1. Understand static and dynamic forces acting on different mechanisms.
2. Understand the principle of power transmission in belt drives.
3. Calculate the effect of gyroscopic couples on ships, aeroplanes, two wheelers and balance different types of engines.
4. Apply the concepts of sensitiveness and isochronism's in the analysis of governors.

MODULE I
Static & Dynamic Force Analysis 10L Hrs
Introduction, Static equilibrium. Equilibrium of two and three force members, members with two forces and torque, free body diagrams. Principle of virtual work, static force analysis of four bar mechanism and slider-crank mechanism with and without friction
Dynamic Force Analysis: D'Alembert's principle, inertia force, inertia torque. Dynamic force analysis of four-bar mechanism and slider crank mechanism.

MODULE II
Power Transmission 07L Hrs
Friction and Belt Drives: Definitions, types of friction, laws of friction, friction in pivot and collar bearings.
Belt drives: Flat belt drives. Ratio of belt tensions, centrifugal tension, power transmitted.

MODULE III
Balancing of Rotating Masses 08L Hrs
Static and dynamic balancing. Balancing of single rotating mass by balancing masses in same plane and in different planes, balancing of several rotating masses by balancing masses in same plane and in different planes

MODULE IV
Balancing of Reciprocating Masses 09L Hrs
Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; radial engine – direct and reverse crank method.

MODULE V

Governors & Gyroscope **10L Hrs**

Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, Stability, sensitiveness, Isochronism, effort and power.

Gyroscope: Vectorial representation of angular motion. Gyroscopic couple, effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers.

Text Books:

1. Sadhu Singh, Theory of Machines, Pearson Education. 2nd edition, 2007.
2. Rattan S.S. Theory of Machines, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.

Reference Books:

1. J.J. Uicker, G.R. Pennock, J.E. Shigley, Theory of Machines & Mechanisms, Oxford 3rd Ed. 2009
2. A.G.Ambekar, Mechanism and Machine Theory, PHI, 2007

SEM/YEAR : V SEM
COURSE CODE : 16ME305
TITLE OF THE COURSE : MANUFACTURING TECHNOLOGY-II
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. Understand and appreciate the importance of basic principles of traditional manufacturing and material removal processes.
2. To enable students understand processes like casting, forging, rolling etc.
3. Understand the application of those principles in practice.
4. To have a basic knowledge on non-conventional machining processes.

COURSE OUTCOMES

After successful completion of the course, the students should be able to

1. Understand the various machining processes such as turning, drilling, milling and grinding.
2. Understand the principle of non-traditional machining processes.
3. Identify and suggest correct manufacturing process for particular application and fundamentals of CNC machining.

MODULE 1

Metal Casting Processes 08L Hrs

Fundamentals of metal casting, Fluidity of molten metal, solidification time, sand casting, shell mold casting, investment casting, plaster mold casting, ceramic mold casting, die casting, centrifugal casting, melting practice and furnaces, defects in castings, testing and inspection of castings.

MODULE II

Metal Forming Processes 08L Hrs

Cold and hot working, Rolling – Forging – Extrusion – Drawing – Sheet metal forming processes – High Energy Rate Forming processes: Explosive forming, Electro hydraulic forming – Electromagnetic forming.

MODULE III

Conventional Machining Processes 10L Hrs

Turning: Classification, tool layout, driving mechanisms of lathe and different operations on lathe.

Drilling machines: Classification, constructional features, drilling & related operations.
Milling: Classification, constructional features, milling operations, up milling and down milling concepts, various milling operations indexing: simple, compound, differential and angular indexing calculations.

Grinding: Types of abrasives, grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines.

MODULE IV

Non-Conventional Machining Processes and Introduction to Computer Numerical Control Machines **09L Hrs**

Classification, Principle of abrasive jet machining, water jet machining, ultrasonic machining, electric discharge machining, electro chemical machining, laser beam machining - process characteristics – applications, advantages and disadvantages.
Introduction to computer numerical control machines- principle of operation, coordinate systems. Basics of manual part programming methods.

MODULE V

Additive Manufacturing **09L Hrs**

Development of additive manufacturing systems, virtual prototyping, rapid tooling. Classification of additive manufacturing processes-benefits- applications, introduction on liquid and solid based additive manufacturing systems, powder based additive manufacturing systems, three-dimensional printing.

Text Books

1. Kalpak Jain, Manufacturing Engineering & Technology, Addison Wesley,1997
2. Poul De Garmo, J.T.Black, R.A.Kosher, Materials and Processes in Manufacturing, Prentice Hall of India, 1997.
3. Gibson, I., Rosen, D.W. and Stucker, B., Additive Manufacturing Methodologies: RapidPrototyping to Direct Digital Manufacturing, Springer, 2010.

Reference Books

1. R.K.Jain, Production Technology, Khanna Publishers, 2001.
2. R.K.Gupta,Production Technology, Sathya Prakashan, 2010.

SEM/YEAR : V SEM
COURSE CODE : 16ME371
TITLE OF THE COURSE : HEAT TRANSFER LABORATORY
L: T/A:P: C : 0 :0 : 4 : 2

COURSE LEARNING OBJECTIVES

Upon completion of this Laboratory, students can be able to

1. To understand the modes of heat transfer.
2. To apply the basic laws of heat transfer.
3. To gain insights into operational ranges, behavioural trends and shortcomings across different heat transfer equipment's.

COURSE OUTCOMES

1. Ability to understand industrial application of heat transfer.
2. Ability to understand the use of different heat exchangers and their applications.

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	=	10 marks
Conduction of experiments	=	10 marks
Internal Assessment	=	20 marks
Total	=	40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

LIST OF EXPERIMENTS

1. Determination of thermal conductivity of metal rod.
2. Determination of thermal conductivity of insulating powder.
3. Determination of thermal conductivity of composite wall.
4. Determination of heat transfer coefficient in natural convection.
5. Determination of heat transfer coefficient in forced convection.
6. Determination of temperature distribution, fin efficiency in natural / forced Convection.
7. Determination of emissivity of a test surface.
8. Determination of emissive power of black body using Stefan's Boltzmann's constant.
9. Determination of effectiveness and logarithmic mean temperature difference in parallel flow and counter flow heat exchanger.
10. Study of pool boiling phenomenon and determination of critical heat flux.
11. Determination of equivalent thermal conductivity of heat pipe.
12. Experiment on transient conduction heat transfer.

SEM/YEAR : V SEM
COURSE CODE : 16ME372
TITLE OF THE COURSE : FOUNDRY AND FORGING LABORATORY
L: T/A:P: C : 0 :0 : 4 : 2

COURSE LEARNING OBJECTIVES

Upon completion of this laboratory, students can be able to

1. Understand the different components of foundry and forging tools used in industry.
2. Understand the different proportions of mould ingredients, preparation of sand systems, selection of parting line, placement of pattern, ramming of sand around pattern, preparation of mould, visual inspection of mould, hardness of mould at different locations, closing of mould.

COURSE OUTCOMES

1. This course is intended to serve as a bridge between the study of the basic principles of metal foundry and their application in the producing parts.
2. To understand metal forming process that involves mechanical forces.

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	=	10 marks
Conduction of experiments	=	10 marks
Internal Assessment	=	20 marks
Total	=	40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

LIST OF EXPERIMENTS

1. Use of foundry tools and other equipment, preparation of moulds using two moulding boxes with or without patterns. (Split pattern, Match plate pattern and Core boxes).
2. Preparation of one casting (Aluminium or cast iron-demonstration only).
3. Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
4. Permeability test
5. Core hardness & Mould hardness tests.
6. Sieve Analysis to find grain fineness number of base sand
7. Clay content determination in base sand
8. Calculation of length of the raw material required to do the model, preparing minimum three forged models involving upsetting, drawing and bending operations manually using hammers.
9. Out of these three models, at least one model is to be prepared by using power hammer

SEM/YEAR : V SEM
COURSE CODE : 16ME321
TITLE OF THE COURSE : REFRIGERATION AND AIR CONDITIONING
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To introduce various concepts of Refrigeration and Air conditioning.
2. To give basic knowledge of various thermodynamic cycles and methodologies of Refrigeration and Air Conditioning.
3. Understand working of vapour compression and vapour absorption refrigeration systems

COURSE OUTCOMES

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning systems.
2. To understand coefficient of performance on refrigeration systems.
3. To carry out heating and cooling load in Refrigeration and Air conditioning systems.

MODULE I

Introduction to Refrigeration **08L Hrs**

Methods of refrigeration, ice refrigeration, evaporative refrigeration, air refrigeration, vapour refrigeration, dry ice refrigeration, pulse tube refrigeration, thermo-acoustic refrigeration, reverse Carnot cycle, block diagram of refrigerator & modified reverse Carnot cycle (Bell Coleman cycle). Unit of refrigeration and coefficient of performance.

MODULE II

Refrigerants **08L Hrs**

Refrigerants: Classification of refrigerants, desirable properties of refrigerants, environmental issues, Ozone depletion potential and global warming potential & life cycle climate performance. Selection of environment friendly refrigerants, secondary refrigerants, anti-freeze solutions, Zeotropes and Azeotropes.

MODULE III

Refrigeration Systems **08L Hrs**

Vapour Compression Systems: Vapor compression cycle: p-h and T-s diagrams – deviations from theoretical cycle – sub cooling and super heating-effects of condenser and evaporator pressure on COP- multi pressure system – low temperature refrigeration – cascade systems – problems.

Vapour Absorption Systems: Introduction, working of simple vapour absorption system, desirable properties of binary mixture (aqua-ammonia), Lithium-Bromide (Li-Br) absorption system, performance evaluation, applications and comparison between vapour compression system and vapour absorption system.

MODULE IV

Psychometric Properties and Processes **10L Hrs**

Properties of moist air-Gibbs Dalton law, specific humidity, dew point temperature, degree of saturation, relative humidity, enthalpy, humid specific heat, wet bulb temperature thermodynamic wet bulb temperature, psychrometric chart; psychrometric of air-conditioning processes, mixing of air streams.

MODULE V

Air Conditioning Systems **10L Hrs**

Air conditioning loads**:** Outside and inside design conditions; heat transfer through structure, solar radiation, electrical appliances, infiltration and ventilation, internal heat load; apparatus selection; fresh air load, human comfort, effective temperature & chart, calculation of summer & winter air conditioning load; classifications, layout of plants; air distribution system; filters; air conditioning systems with controls: temperature, pressure and humidity sensors, actuators & safety controls.

Text Books

1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill, 2008.
2. Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd, 1983.

Reference Books

1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000.
2. R. S. Khurmi, Refrigeration and Air Conditioning, S Chand, 2006.

SEM/YEAR : V SEM
COURSE CODE : 16ME322
TITLE OF THE COURSE : QUALITY & RELIABILITY ENGINEERING
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To understand importance of concepts of quality control and management in product development
2. To understand concepts of total quality management for different sectors like product development, maintenance.
3. To enable students to understand the different quality management systems like ISO 9000 and 14000 series.
4. To understand the concepts of reliability engineering.

COURSE OUTCOMES

1. Ability to demonstrate different aspects of quality control and management in product development, maintenance engineering.
2. Ability to implement different quality management series for engineering application
3. To implement the concepts of reliability for engineering application.

MODULE I

Quality Control 09 Hrs

Management of product quality, evolution of quality control, changing quality concepts, modern concept of total quality management, contribution of quality masters (Deming, Juran, Crosby, Ishikawa, Taguchi),process control charts; statistical quality control tools; statistical process control and process capability.

MODULE II

Total Quality Management 09 Hrs

Total quality management, concept of total quality, total quality maintenance, total quality in service sector; role of customer and people in total quality management; steps for quality improvement, Kaizen; organizing for effective quality management; creating quality by design assessment of customer's needs; formulation of design specifications; standardization; costs of quality; quality circles; 5-S concept;, zero defect programme; Six – Sigma approach.

MODULE III

Quality Management Systems 09 Hrs

Quality Management Systems: ISO 9000 series of standard; ISO 14000 series of standards, Strategic tools and techniques for TQM, need for tools and techniques in TQM; commonly used tools for TQM; approaches and deployment of tools for quality planning – quality function deployment (QFD), concurrent engineering; tools for continuous improvement

– Deming's Plan – Do – Check – Act (PDCA) cycle, Poka – Yoke (Mistake – Proofing), Taguchi's quality loss function.

MODULE IV

Reliability **09 Hrs**

Reliability,concept and definition, reliability parameters: Reliability as a function of time, failure rate as a function of time, constant failure rate, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failure (MTBF), mean down time (MDT), maintainability & availability, increasing failure rate, bath-tub curve; Weilbull distribution, System reliability models: series system, parallel system, series-parallel system, six sigma approach in reliability.

MODULE V

Risk Assessment & Reliability in Design **08 Hrs**

Risk assessment & reliability design, causes of failures, failure modes & effects analysis (FMEA), faulty tree analysis (FTA); Tribological failure and monitoring techniques; Design based on reliability, redundancy in design.

Text Books

1. H. Lal, Total Quality Management – A Practical Approach, New Age International (P) Ltd. Publishers, 2015.
2. S. K. Mondal, Total Quality Management Principles and Practice, Vikas Publishing House Pvt. Ltd, 2009.

Reference Books

1. A. V. Feigenbum, Total Quality Control, McGraw-Hill Book Company, 1991.
2. Juran's, Quality Control Handbook, McGraw Hill Book Company, 1988.
3. Amitava Mitra, Fundamentals of quality Control and Improvement, PHI, 2016.

SEM/YEAR : V SEM
COURSE CODE : 16ME323
TITLE OF THE COURSE : NON-DESTRUCTIVE EVALUATION AND TESTING
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To appreciate the use of Non Destructive Testing (NDT) in evaluating the defects in mechanical components
2. To know the applications of NDT and recent trends

COURSE OUTCOMES

Students will demonstrate the ability to,

1. Describe the basic theory and practice of visual inspection, liquid penetrant testing, magnetic particle testing, radiographic testing, ultrasonic testing, and eddy current testing
2. Describe which NDT methods are appropriate for various applications.

MODULE I

Introduction and Eddy current Testing 09L Hrs

Introduction to NDT, scope and advantages, Classification of NDT, Selection of ND methods, Visual inspection, Equipment used for visual inspection.

Eddy current Testing: Principles, advantages, disadvantages, eddy current response, material conductivity permeability, frequency, geometry, proximity, types of probes, typical applications and limitations.

MODULE II

Liquid Penetrant Evaluation and Testing 08L Hrs

Introduction, principle, equipment, procedures, characteristics of penetrants, Liquid penetration inspection, evaluation, hazards, precautions, applications, advantages and limitation.

MODULE III

Magnetic particle Testing 09L Hrs

Magnetic particle: Principle of magnetic particle testing, Methods to generate magnetic fields, magnetic particle testing equipment, types of magnetic particles, testing procedures, method of demagnetization, magnetic particle medium, evaluation of indications and acceptance standards, magnetic particle test, application, advantages and limitations,

MODULE IV

Ultrasonic inspection 09L Hrs

Basic equipment characteristics of ultrasonic waves, variables inspection, inspection methods pulse echo A,B,C scans transmission, resonance techniques, transducer elements couplets, search units, contact types and immersion types inspection standards-standard reference blocks.

MODULE V

Radiographic Testing and Inspection **09L Hrs**

X-ray radiography principle, equipment and methodology, Radiography image quality indicators, radiographic techniques, radiographic testing procedures, radiation source X-rays and gamma rays, X-ray-tube, radio graphic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications.

Text Books

1. J Prasad, C.G.K. Nair, Non Destructive Testing and Evaluation of Materials, Tata MC Graw Hill,
2. Mc Gonnagle J.J , Non Destructive Testing, New York, 1986

Reference Books

1. Bray, Don E, and Stanley Roderick K, Non destructive evualtion -A tool in design manufacturing and service, revised, CRC Press, New York, 1997
2. Davis H.E Troxel G.E Wiskovil C.T,The Testing instruction of Engineering materials, McGraw hill, 1998.

SEM/YEAR : V SEM
COURSE CODE : 16ME324
TITLE OF THE COURSE : TOOL DESIGN
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To understand the various aspects of cutting tool design.
2. To understand the various work holding and tool holding devices.

COURSE OUTCOMES

1. Ability to design various types of dies for different processes.
2. Ability to design Sheet metal blanking and piercing dies.
3. Ability to design jigs and fixtures for simple components.

MODULE I

Introduction 08 Hrs

Different tool materials: cemented carbides, coated carbides, cermet's, ceramics and polycrystalline tool materials, selection, compositions, properties of tool materials, plastics as tool materials, chip breakers, twist drill and reamers. Tooling materials - properties of materials, ferrous, nonferrous, nonmetallic materials, heat treating, coated tools. Tool life and tool wear- theories of tool wear, wear mechanisms, tool life criteria and machinability index.

MODULE II

Design of Cutting Tools 10 Hrs

Design of single point cutting tools - various systems of specifications, geometry and their interrelation, theories of formation of chip and their effect, materials, threading tools.
Design of multipoint cutting tools - drill geometry, design of drills, rake &relief angles of twist drill, speed, feed and depth of cut, machining time, forces, milling cutters, cutting speeds and feed machining times-design-form cutters, combination tools, reamers.

MODULE III

Design of jigs and fixtures 10 Hrs

Introduction to locating and clamping devices, difference between jigs and fixture, advantages of jigs and fixture, materials used in jigs and fixture.
Design principles of jigs- principles of jigs, locating elements, drill bushes, different types of jigs, plate, latch, channel, post, angle plate, turn over, and pot jigs, automatic drill jigs, economics of drill jigs, case studies on jigs design.
Design principles of fixtures - Types of fixtures &application, vice fixtures, milling fixtures, boring fixtures, broaching fixtures, lathe fixtures, grinding fixtures, welding fixture, indexing fixture, economics of fixtures, case studies on fixture design.

MODULE IV

Press Tool Design 08 Hrs

Press working terminology, presses and press accessories, computation of capacities and tonnage requirements, types of dies, design and development of various types of cutting, forming and bending dies, drawing operation and dies, progressive dies, combination and compound dies, blank development for cylindrical and non-cylindrical shells.

MODULE V

Design of Sheet Metal Blanking and Piercing Die **08 Hrs**

Fundamentals of die making, cutting operating, power press types, introduction to sheet metal forming operation, material handling equipment, cutting action in punch and die operation. Die clearance, types of die construction. Die design fundamentals-blanking and piercing die construction, pilots, stripper and pressure pads, presswork material, strip layout, short run tooling for piercing dies.

Text Books

1. Donaldson.C, Lecain.G.H and Goold.V.C, Tool Design, Tata McGraw Hill publishing company limited, New Delhi, 2002.
2. Sadasivan.T.A, and Sarathy.D, Cutting tools for Productive machining, First edition, Widia (India) Ltd, Bangalore, 1999.
3. Prakash H. Joshi, Cutting tools, First edition, Wheeler Publishing, New Delhi,1997

Reference Books

1. Surendra Kenav and Umesh Chandra, Production Engineering Design (Tool Design), New Delhi, 1994.
2. Mehtha.N.K, Machine Tool Design and Numerical Control, Tata Mc-Graw Hill, Third Edition, 2012
3. Kempster.M.H.A, An Introduction to Jig and tool design, 3rd edition, ELBS, 1987.

SEM/YEAR : V SEM
COURSE CODE : 16ME325
TITLE OF THE COURSE : PRODUCT DESIGN AND MANUFACTURING
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To expose the students the basics of product design and manufacturing.
2. To introduce students to the basic principles and evaluation methods of various aspects of designing components
3. To teach students about the manufacturability requirements

COURSE OUTCOMES

Student will be able to

1. Possess customer-oriented, manufacturing and life cycle sensitive approach to product design and development, with product design principles and structured design methodologies
2. Possess methods and approaches for developing, implementing and nurturing an effective DFM process within the firm

MODULE I

Introduction to Product design 08L Hrs

Introduction, Characteristics of successful product development, Design and development of products, duration and cost of product development, challenges of product development. Asimow's Model - Product design practice in Industry -Strength consideration in product design.

MODULE II

Product Planning and Specification 09L Hrs

Product Planning: product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre-project planning, reflect all the results and the process.

Product Specifications: specifications, specifications established, establishing target specifications, setting the final specifications.

MODULE III

Product Architecture and Industrial Design 09L Hrs

Product Architecture: Product architecture, implications of architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Assessing the need for industrial design, impact of industrial design, industrial design process, managing industrial design process and assessing quality of industrial design.

MODULE IV

Design for Manufacturing and Production **09L Hrs**

Design for Manufacturing**:** Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

Design for Production: Forging Design, Pressed Components Design, Casting Design, Design for Machining Ease, Design for PM Parts, Approach to Design with Plastics, Rubber, Ceramics.

MODULE V

Prototyping **09L Hrs**

Prototyping basics, principles of prototyping, technologies, planning for prototypes, advantages and applications.

Rapid Prototyping: Two-Dimensional Layer, Techniques- Steriolithography (SL), Solid Foil Polymerization (SFP), Selective Laser Sintering (SLS), Selective Powder Building (SPB), Ballistic Particle Manufacturing (PM), Fused Deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Solid Ground curing (SGC).

Text Books

1. A C Chitale and R C Gupta, Product Design and Manufacturing **-**, PH1, - 3rd Edition, 2003
2. Amitabha Ghosh, - Rapid Prototyping-A Brief Introduction, Affiliated East West Press Pvt. Ltd., 1997.

Reference Books

1. Karl. T. Ulrich, Steven D Eppinger, Product Design and Development **-** McGraw Hill -2000.
2. Timjones. Butterworth Heinmann, New Product Development **-** Oxford. UCI -1997
3. Geoffery Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacture and Assembly -2002

SEM/YEAR : V SEM
COURSE CODE : 16ME326
TITLE OF THE COURSE : SURFACE ENGINEERING
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To familiarize the students with the concepts of surface engineering.
2. To learn overview of techniques for surface modification or deposition of protective coatings and performance assessment of engineered surfaces.

COURSE OUTCOMES

Students will be able to understand

1. Basic technologies of surface engineering and fundamental properties of modified surface.
2. Apply surface engineering knowledge in mechanical systems.

MODULE I

Introduction to Friction, Wear and Corrosion 09L Hrs

Introduction - tribology, surface degradation, wear and corrosion, types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication- overview of different forms of corrosion

MODULE II

Electrochemical Polishing 09L Hrs

Chemical and electrochemical polishing, significance, specific examples, chemical conversion coatings, phosphating, chromating, chemical colouring, anodizing of aluminium alloys, thermochemical processes -industrial practices.

MODULE III

Electroplating 09L Hrs

Surface pre-treatment, deposition of copper, zinc, nickel and chromium - principles and practices, alloy plating, electro composite plating, properties of electro deposits, electro-less composite plating; application areas, properties.

MODULE IV

Vapour Deposition Techniques 08L Hrs

Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities, chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD.

MODULE V

Thermal Spray and Laser Surface Modification **09L Hrs**

Thermal spraying, techniques, advanced spraying techniques - plasma surfacing, detonation gun and high velocity oxy-fuel processes, laser surface alloying, laser cladding, specific industrial applications, tests for assessment of wear and corrosion

Text Books

1. Sudarshan T S, Surface modification technologies - An Engineers Guide, Marcel Dekker, Newyork, 1989
2. Varghese C.D, Electroplating and other Surface Treatments - A Practical Guide", TMH, 1993.

Reference Books

1. D.S.Rickerby and A.Matthews, Advanced Surface Coatings: a Handbook of Surface Engineering, Chapman and Hall, New York, 1991.
2. Tadeusz Burakowski, Tadeusz Wierzchon, Surface Engineering of Metals: Principles, Equipment, Technologies, CRC, 1998.
3. N.B.Dahorte, Lasers in Surface Engineering, ASM International, 1998.
4. P.K. Datta and J.S. Burnell-Gray, Advances in Surface Engineering,, Royal Society of Chemistry, 1997.

SEM/YEAR : V SEM
COURSE CODE : 16ME327
TITLE OF THE COURSE : RENEWABLE ENERGY SOURCES
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To educate the students scientifically the new developments in renewable energy studies
2. To make understand the new developments in non-conventional and renewable energy studies.
3. To emphasize the significance of Green Energy Technologies

COURSE OUTCOMES

1. To understand importance of solar energy applications
2. To know the principles of power generation by wind energy
3. To know ocean energy technologies to harness power
4. To appreciate the use of hydrogen as renewable energy source

MODULE I

Solar Energy 08 Hrs

Solar Energy- Solar radiation its measurements and prediction - solar thermal collectors - flat plate collectors, concentrating collectors – applications - heating, cooling, desalination, drying, cooking, etc. Principle of photovoltaic conversion of solar energy - types of solar cells and fabrication -photovoltaic applications - battery charging, domestic lighting, street lighting.

MODULE II

Wind Energy 09 Hrs

Wind Energy- Wind energy - energy chains - application - historical background, merits and limitations - nature of wind - planetary and local day / night winds - wind energy quantum - power in wind- turbine efficiency - torque thrust calculations - velocity at different heights - site selection - components of wind energy conversion system (WECS).

MODULE III

Energy from Biomass 9Hrs

Energy from biomass - biomass as renewable energy source - types of bio mass fuels - solid, liquid and gas - biomass conversion techniques- wet process, dry process- photosynthesis - biogas generation - factors affecting bio- digestion - classification of bio gas plant - continuous, batch and fixed dome types - advantages and disadvantages.

MODULE IV

Tidal, Ocean Thermal Energy, Hydel and Geothermal Energy Conversion 09 Hrs

Tidal Energy: tide – spring tide, neap tide – tidal range – tidal power – types of tidal power plant – single and dual basin schemes – requirements in tidal power plant - ocean thermal energy conversion (OTEC): principle - open and closed OTEC cycles - hydel energy: micro hydro - geothermal energy: geothermal energy sources - power plant and environmental issues.

MODULE V

New Energy Sources **09 Hrs**

Hydrogen as a renewable energy source - sources of hydrogen - fuel for vehicles - hydrogen production - direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production - storage of hydrogen - gaseous, cryogenic and metal hydride - fuel cell – principle of working, construction and applications.

Text Books

1. Rai.G.D, Non- conventional resources of energy, Khanna publishers, Fourth edition, 2010.
2. Khan. B.H, Non-Conventional Energy Resources, McGraw Hill, Second edition, 2009.

Reference Books

1. Rao.S & Parulekar, Energy Technology, Khanna publishers, Fourth edition, 2005.
2. Pai.B.R and Ram Prasad.M.S, Power Generation through Renewable Sources of Energy, Tata McGraw Hill, New Delhi, 1991.
3. Godfrey Boyl, Renewable Energy: Power Sustainable Future, Oxford University Press, Second edition, 2006.

SEM/YEAR : V SEM
COURSE CODE : 16ME328
TITLE OF THE COURSE : ROBOTICS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To introduce the basic concepts, parts and types of robots.
2. To make the student familiar with the various sensors, drive systems in robots and programming.
3. To discuss about the various applications, justification and implementation of robot.

COURSE OUTCOMES

Students will be able to

1. Explain the basic principles of Robotic technology, configurations, control and programming of Robots
2. Describe the concept of Robot kinematics and dynamics, algorithms & analytical approaches
3. To choose the appropriate Sensor and Machine vision system for a given application
4. Design an industrial robot which can meet kinematic and dynamic constraints.

MODULE I

Introduction 06 Hrs

Historical back ground, definitions, robot anatomy, robot configurations, coordinate system, work envelop, specifications and classification of robots, flexible automation versus robotic technology, dynamic properties of robots- stability, control resolution, spatial resolution, accuracy, repeatability, compliance. Applications of robots- material transfer, machine loading / unloading, welding, assembly and spray painting operations.

MODULE II

Robot Kinematics and Dynamics 12 Hrs

Positions, orientations and frames, mappings, operators. Translations, rotations and transformations - homogeneous transformations, kinematics equation using homogeneous transformations, composite rotation matrix, D-H representation - forward and inverse kinematics, robot arm dynamics. Euler angle & Euler transformations, manipulator dynamics-construction of manipulators, Lagrangian formulation and N-E formulation.

MODULE III

Robot Drives and Power Transmission Systems 08 Hrs

Drive system, control system, robot drive mechanisms, hydraulic – electric – servomotor-stepper motor - pneumatic drives, mechanical transmission method - gear transmission, belt drives, cables, roller chains, link - rod systems - rotary-to-rotary motion conversion,

rotary-to-linear motion conversion, rack and pinion drives, lead screws, ball bearing screws.

MODULE IV

Robot Sensing and Vision **10 Hrs**

Various sensors and their classification, use of sensors, transducers, sensors in robotics and their classification, touch, proximity and range sensors, force and torque sensing, robotic assembly and intelligent sensors. Machine vision system, description, sensing, digitizing, image processing and analysis, application of machine vision system.

MODULE V

Path planning & Programming **08 Hrs**

Basic structure of trajectory interpolators, trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion – straight line motion, general design consideration on trajectories.

Robot languages- lead through method, VAL systems, robot program as a path in space, methods of defining positions in space, motion interpolation, branching, textual robot programming languages, off line programming systems.

Text Books

1. John J.Craig , Introduction to Robotics, Pearson, 2009.
2. Mikell P. Groover et. al., Industrial Robots - Technology, Programming and Applications, McGraw Hill, New York, 2008.
3. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning. 2009.

Reference Books

1. Fu, K. S, Gonzalez, R. C, Lee, C.S.G, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill, 1987
2. F.L. Lewis, D.M. Dawson, and C.T. Abdallah, Robot Manipulator Control: Theory and Practice, Revised and Expanded, Marcel Dekker, New York, 2004.
3. Koren, Yoram, Robotics for Engineers, McGraw Hill, 1985.
4. Richard D.Klafter,Robotic Engineering, Prentice Hall of India Pvt., Ltd., 2001.

SEM/YEAR : VI SEM
COURSE CODE : 16ME306
TITLE OF THE COURSE : FINITE ELEMENT METHOD
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To enable the students to appreciate the use of finite element methods to analyze structural and dynamic problems.
2. To enable the students to understand and perform finite element analysis of 1D and 2D structures.
3. To teach the procedure to perform finite element based steady-state and transient response analysis**.**

COURSE OUTCOMES

At the end of the course, the student will be able to

1. Calculate element energy functions for 1-D and 2D finite elements.
2. Understand and apply Raleigh Ritz method and develop mathematical expressions for bars and beams.
3. Understand and appreciate the finite element method in solving simple problems of engineering significance.
4. Understand and appreciate the finite element method in solving steady state heat transfer problems.

MODULE I

Introduction 07L Hrs

Introduction: Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of finite element method, application and limitations, types of elements based on geometry. Node numbering, half band width.

MODULE II

Basic Methods in FEM 07L Hrs

Euler - Lagrange equation for bar, beam (cantilever / simply supported fixed). Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element and Galerkin's method.

MODULE III

Interpolation Models 10L Hrs

Interpolation Models: Interpolation polynomials- linear, quadratic and cubic. Simplex complex and multiplex elements, 2D PASCAL's triangle, CST elements-shape functions and nodal load vector, strain displacement matrix and Jacobian for triangular and rectangular element.

Higher Order Elements: Langrange's interpolation, one dimensional elements-quadratic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Isoparametric, sub parametric and super parametric elements.

MODULE IV

1-D Bars &Trusses **10L Hrs**

Solution of 1-D Bars: Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique.

Trusses: Stiffness matrix of truss element. Numerical problems

MODULE V

Beams & Heat Transfer **10L Hrs**

Beams: Hermite shape functions for beam element, derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads. Heat Transfer: Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction, Galerkin's approach for heat conduction, 1D heat transfer in thin fins.

Text Books:

1. T.R. Chandrupatla and A.D Belegunde , Finite Elements in Engineering, 3rd Ed PHI.
2. S.S. Rao, Finite Element Method in Engineering,4th Edition, Elsevier, 2006.

Reference Books:

1. R.D. Cook D.S Maltus, M.E Plesha and R.J.Witt, Concepts and applications of Finite Element Analysis, Wiley 4th Ed, 2009
2. J.N.Reddy, Finite Element Method, McGraw -Hill International Edition, 2009.

SEM/YEAR : VI SEM
COURSE CODE : 16ME307
TITLE OF THE COURSE : DESIGN OF MACHINE ELEMENTS-II
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To understand the procedure for design of power transmission elements, springs, gears, clutches and brakes.
2. To develop an ability to design a system, component and process to meet desired needs within realistic constraints.
3. To develop an ability to analyze and design different types of gear.

COURSE OUTCOMES

The students will demonstrate the

1. Ability to design power transmission elements, springs, gears, clutches and breaks.
2. Ability to take technical, safety and other issues such as environmental into account when selecting and/or designing mechanical systems and components.
3. Apply the knowledge of velocity ratio to analyze and design different types of gear trains

MODULE I

Curved Beams & Elements of Power Transmission 09L Hrs

Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps.

Belts, Ropes and Chains: Flat belts: Length & cross section, selection of V-belts, ropes and chains for different applications

MODULE II

Design of Springs 08L Hrs

Springs: Types, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, springs under fluctuating loads. Leaf springs: Stresses in leaf springs. Equalized stresses, energy stored in springs, torsion, belleville and rubber springs.

MODULE III

Design of Spur & Helical Gears 08L Hrs

Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear load.

Helical Gears: Definitions, formative number of teeth, design based on strength, dynamic and wear loads.

MODULE IV

Design of Bevel and Worm Gears 08L Hrs

Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic and wear loads.

Worm Gears: Definitions, design based on strength, dynamic, wear loads and efficiency of worm gear drives.

MODULE V

Design of Bearings, Clutches & Brakes **11L Hrs**

Bearings: Lubricants and their properties, mechanisms of lubrication bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, heat dissipated, bearing materials, examples of journal bearing and thrust bearing design. Clutches & Brakes: Design of clutches: Single plate, multi plate and cone clutches. Design of Brakes: Block and band brakes: Self-locking of brakes: Heat generation in brakes.

Design Data Handbook:

1. K. Lingaiah, Design Data Hand Book, McGraw Hill, 2nd Ed. 2010.
2. K. Mahadevan and Balaveera Reddy,Data Hand Book, CBS Publication,2009.

Text Books:

1. Joseph E Shigley and Charles R. Mischke, Mechanical Engineering Design, McGraw Hill International edition, 6th Edition 2009.
2. V.B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

Reference Books:

1. Robert L. Norton, Machine Design, Pearson Education Asia, 2001.
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Design of Machine Elements, Pearson Education, 2006.

SEM/YEAR : VI SEM
COURSE CODE : 16ME308
TITLE OF THE COURSE : MECHANICAL VIBRATIONS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To learn analytical, experimental, and numerical analysis of vibrational phenomena.
2. To acquaint with the principles of vibration measuring instruments
3. To study balancing of mechanical systems

COURSE OUTCOMES

1. Develop mathematical model to represent dynamic system
2. Determine the natural frequency of mechanical element system
3. Analyze vibratory response of mechanical element system

MODULE I

Basic Concepts of Vibration 08 Hrs

Introduction, classification of vibration systems, harmonic motion, natural frequency & response, effects of vibration, superposition of simple harmonic motions, beats, Fourier Series.

Single degree freedom system- equation of motion, Newton's method, D'Alembert's principle, energy method. Free vibration, equivalent systems, displacement, velocity and acceleration, response to an initial disturbance, torsional vibrations, damped vibrations, vibrations of systems with viscous damping, Logarithmic decrement, energy dissipation in viscous damping.

MODULE II

Single Degree Freedom Systems-Forced Vibration 08 Hrs

Forced vibration, harmonic excitation with viscous damping, steady state vibrations, forced vibrations with rotating and reciprocating unbalance, support excitation, vibration isolation, transmissibility, displacement, velocity and acceleration measuring instruments.

MODULE III

Two Degree Freedom Systems 08 Hrs

Introduction, principal modes, torsional system with damping, coupled system, principle of vibration absorber, undamped dynamic vibration absorbers, torsional vibration absorber, centrifugal pendulum absorbers, vibration isolators and dampers.

MODULE IV

Multi-Degree Freedom Systems 10 Hrs

Exact Analysis- undamped free and forced vibrations of multi-degree freedom systems, influence coefficients, reciprocal theorem, torsional vibration of multi-degree rotor system, vibration of gear system, continuous systems- longitudinal vibrations of bars, torsional vibrations of circular shafts**.**

Numerical Analysis- Rayleigh's method, Dunkerely's, Holzer's and Stodola methods, Rayleigh-Ritz method critical speed of shafts, whirling of uniform shaft, shaft with one disc with and without damping, multi-disc shafts, secondary critical speed.

MODULE V

Vibration Measuring Instruments and Field Measurement 10 Hrs

Vibration instruments – transducer, vibrometer, accelerometer, seismometer, vibration pickup, proximity probe spectrum analyzer, principle of seismic instruments, frequency measuring instruments -single reed-multi reed – Stroboscope-vibration exciters-experimental modal analysis-condition monitoring techniques- diagnostic tools -signal analysis-time and frequency domain analysis- balancing of rotors. Introduction to conditioning monitoring and fault diagnosis.

Text Books

1. Rao.S.S, Mechanical Vibrations, 4thEdition, Pearson Education Inc. Delhi 2009.
2. Thomson.W.T, Theory of Vibration and its Applications, 5thEdition, Prentice Hall, New Delhi, 2001.

Reference Books

1. Rao.J.S and Gupta.K, Introductory Course on Theory and Practice of Mechanical Vibrations, New Age International, New Delhi, 1999.
2. Ramamurthi.V,Mechanical Vibration Practice with Basic Theory, 1st Edition, Narosa Publishing House, Chennai, 2000.
3. Keith Mobley.R, Vibration Fundamentals, Plant Engineering Maintenance Series, Elsevier, 2007.
4. S.Graham Kelly, Mechanical Vibrations - Schaum's outline series, McGraw Hill, 2007

SEM/YEAR : VI SEM
COURSE CODE : 16ME309
TITLE OF THE COURSE : MECHATRONICS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To understand principles and operation of different mechatronic components used in engineering applications.
2. To know different types of sensors, transducers and control systems
3. Students are able to acquaint themselves with the application of mechatronics systems in various engineering applications.

COURSE OUTCOMES

1. Ability to appreciate the mechatronic system design and applications.
2. Theoretical and practical aspects of computer interfacing, real time data acquisition and control.
3. Able to apply mechatronics skills and principles for designing mechanical components and systems.

MODULE I

Introduction to Mechatronics 08 Hrs

Definition of Mechatronics, key elements of a mechatronic system, measurement systems, mechatronics in manufacturing, products, and design, mechatronics design process, design parameters, traditional and mechatronics designs, advanced approaches in mechatronics, data conversion devices, electrical components, resistive circuits, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs.

MODULE II

Sensors and Transducers 08 Hrs

Sensors and Transducers**:** performance terminology, displacement, position and proximity, velocity and motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors, selection of sensors, inputting data by switches.

MODULE III

Control and Drives 10 Hrs

Control devices**:** Electro hydraulic control devices, electro pneumatic proportional controls. Drives: Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems. Rotational drives–Pneumatic motors: Continuous and limited rotation – Hydraulic motor: continuous and limited rotation –Motion convertors, fixed ratio, invariant motion profile, variators.

MODULE IV

Basic System models **10 Hrs**

Mathematical models, mechanical system building blocks, electrical system building blocks, fluid system building blocks, thermal system building blocks, engineering systems, rotational-translational systems, electro mechanical systems, hydraulic mechanical systems, hydraulic systems- flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps.

MODULE V

Data Acquisition **8 Hrs**

Introduction**:** Quantizing theory, analog-to-digital conversion, digital-to-analog conversion, virtual instrumentation, data acquisition, and control. Practical considerations-introduction to LabVIEW programming, USB 6009 data acquisition card.

Text Books

1. Bolton, W., Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, 2nd Edition, Addison Wesly Longman Ltd., 1999.
2. Gupta, Virtual Instrumentation Using Lab view, 2nd Edition, Tata McGraw-Hill Education, 2010
3. Brian Morriss, Automated Manufacturing Systems - Actuators Controls, Sensors and Robotics, McGraw Hill International Edition, 1995.

Reference Books

1. G. S. Hegde, Mechatronics Jones and Bartlett Publishers, 2010.
2. Georg pelz, Mechatronic Systems: Modeling and Simulation, with HDL's, John wiley and sons, Ltd, 2003
3. Gary Jonson, Labview Graphical Programming, Second Edition, McGraw Hill, New York, 1997

SEM/YEAR : VI SEM
COURSE CODE : 16ME373
TITLE OF THE COURSE : DESIGN ENGINEERING LABORATORY
L: T/A:P: C : 0 :0 : 4 : 2

COURSE LEARNING OBJECTIVES

1. To enable students to analyse gyroscopes, flywheels and governors to solve important engineering problems.
2. To enable students to understand how balancing is carried out practically.
3. To enable students to do the Photo-elastic stress analysis.
4. To enable students to understand how vibration test is carried out practically.

COURSE OUTCOMES

At the end of the course, the student will be able to

1. Analyze gyroscopes, flywheels and governors to solve important engineering problems.
2. Understandhow balancing is carried out practically.
3. Perform the Photo-elastic stress analysis.
4. Carry out vibration test practically.

PART - A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Balancing of rotating masses.
3. Determination of critical speed of a rotating shaft.
4. Determination of Fringe constant of Photo-elastic material using.
    a) Circular disc subjected to diametral compression.
    b) Pure bending specimen (four point bending)
5. Determination of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D crane hook.

PART – B

1. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Prowel /Hartnel Governor (only one or more).
2. Determination of pressure distribution in journal bearing.
3. Determination of principal stresses and strains in a member subjected to combined loading using strain rosettes.
4. Determination of stresses in curved beam using strain gauge.
5. Experiments on Gyroscope.

Text Books:

1. Sadhu Singh, Theory of Machines, Pearson Education. 2nd edition, 2007.
2. Rattan S.S. Theory of Machines, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.

Reference Books:

1. J.J. Uicker, G.R. Pennock, J.E. Shigley "Theory of Machines & Mechanisms", Oxford 3rd Ed. 2009
2. A.G.Ambekar, Mechanism and Machine Theory, PHI, 2007

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	=	10 marks
Conduction of experiments	=	10 marks
Internal Assessment	=	20 marks
Total	=	40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

SEM/YEAR : VI SEM
COURSE CODE : 16ME374
TITLE OF THE COURSE : MODELING, ANALYSIS AND SIMULATION LABORATORY
L: T/A:P: C : 0 :0 : 4 : 2

COURSE LEARNING OBJECTIVES

1. To equip students to use FEA package and modelling stress analysis of bars, trusses & beams.
2. To equip students to carry out thermal and dynamic analysis using FEA package.
3. To equip students to use CAM Software for solving Mechanical Engineering problems
4. To introduce them to solving application oriented problems using FEA & CAM

COURSE OUTCOMES

At the end of the course, the student will be able to

1. Apply the concepts of finite element method to solve structural, dynamic and thermal problems using FEA package.
2. Use CAM software and functions in their codes.
3. Perform matrix related operations and employ conditional and looping statements.
4. Create user-defined functions and solve linear algebraic equations of first order and second order differential equations.

PART - A

Study of a FEA package and modeling stress analysis of

a. Bars of constant cross section area, tapered cross section area and stepped bar 6 Hours
b. Trusses – (Minimum 2 exercises) 3 Hours
c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises) 09 Hours

PART - B

a) Stress analysis of a rectangular plate with a circular hole 3 Hours
b) Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises) 9 Hours
c) Dynamic analysis
    1) Fixed – fixed beam for natural frequency determination
    2) Bar subjected to forcing function
    3) Fixed – fixed beam subjected to forcing function 8 Hours

PART - C

Study of a CAM package and generating CNC Codes.

a) CNC part programming using CAM packages- Simulation of Turning, Drilling, Milling operations.
b) 3 typical simulations to be carried out using simulation packages like Master - CAM, or any equivalent software.
c) Basic knowledge of CNC Codes.

Text Books:

1. A First Course in the Finite Element Method, Daryl L Logan, Thomason, Third Edition

Reference Books:

1. Fundaments of FEM, Hutton – McGraw Hill, 2004
2. Finite Element Analysis, George R. Buchanan, Schaum Series.

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	=	10 marks
Conduction of experiments	=	10 marks
Internal Assessment	=	20 marks
Total	=	40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

SEM/YEAR : VI SEM
COURSE CODE : 16ME375
TITLE OF THE COURSE : ENERGY CONVERSION LABORATORY
L: T/A:P: C : 0 :0 : 4 : 2

COURSE LEARNING OBJECTIVES

The main objective of this Course is to help students

1. To carry out tests to investigate the performance of internal combustion engines
2. Find out fire and flash point of different combustion fuels
3. To impart how to measure important performance parameters of experimental investigation on internal combustion engines

COURSE OUTCOMES

Student will be able to

1. Understand IC engine, its components and selection of fuels
2. Analyse carburettor& ignition system to be suitable for CI and SI engines
3. Draw heat balance sheet for different types of internal combustion engines.

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	=	10 marks
Conduction of experiments	=	10 marks
Internal Assessment	=	20 marks
Total	=	40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

LIST OF EXPERIMENTS

1. Determination of Flash point and Fire point of lubricating oil using Abel, Pensky and Marten's (closed) / Cleavland's (Open Cup) Apparatus.
2. Determination of Calorific value of solid, liquid and gaseous fuels.
3. Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers.
4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke).
5. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A-F Ratio, heat balance sheet for
   (a) Four stroke Diesel Engine
   (b) Four stroke Petrol Engine
   (c) Multi Cylinder Diesel/Petrol Engine, (Morse test)
   (d) Two stroke Petrol Engine
   (e) Variable Compression Ratio I.C. Engine.

SEM/YEAR : VI SEM
COURSE CODE : 16ME329
TITLE OF THE COURSE : PRINCIPLE OF FRACTURE MECHANICS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To determine material failure by energy criteria, possibly in conjunction with strength (or yield) criteria
2. To understand various modes of failure propagating through the engineering structures.

COURSE OUTCOMES

1. The course covers the basic aspects of Engineering Fracture Mechanics. Spectacular failures that triggered the birth of fracture mechanics.
2. To know the various Modes of loading, Classification, Crack growth and fracture mechanisms, Energy release rate, Resistance, Griffith Theory of fracture.
3. To know the various methods for evaluating Stress Intensity Factors, Modelling plastic zone at the crack-tip, Irwin model, Fracture toughness testing.

MODULE I

Overview of Engineering Fracture Mechanics (EFM) 08L Hrs

Introduction to EFM, spectacular failures, LEFM and EPFM, fatigue crack growth model, crack growth and fracture mechanisms.

MODULE II

Energy Release Rate 09L Hrs

Elastic strain energy, fracture strength by Griffith, energy release rate, utility of energy release rate, pop-in phenomenon.

Module III

Crack-Tip Stress and Displacement Field Equations – I 09L Hrs

Review of Theory of Elasticity - Displacement and stress formulations,forms of stress functions.

Airy's stress function for mode-I, Westergaard solution of stress field for mode-I, displacement field for mode-I, relation between K_I and G_I.

MODULE IV

Crack-Tip Stress and Displacement Field Equations – II 09L Hrs

Stress field in mode-II, stress field in mode-II, William's Eigen function approach, multi-parameter stress field equations, validation of multi-parameter field equations.

MODULE V

Modeling of Plastic Zone and Fracture Toughness Testing 09L Hrs

Evaluation of stress intensity factor (SIF) for various geometries, SIF for embedded cracks, modeling of plastic deformation, Irwin's model, fracture toughness testing, plane strain fracture toughness testing, plane stress fracture toughness testing.

Text Books

1. D. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Dordrecht, 1986.
2. T.L. Anderson, Fracture Mechanics - Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005.

Reference Books:

1. K. R.Y. Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited, 2001
2. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009.
3. K. Ramesh, NPTEL e-Book on Engineering Fracture Mechanics, IIT Madras, 2007.

SEM/YEAR : VI SEM
COURSE CODE : 16ME330
TITLE OF THE COURSE : INTERNAL COMBUSTION ENGINES
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To get familiar with the fundamentals of I.C engines, construction and working principle of an engine, and testing of an engine for analysing its performance.
2. To study the combustion and its controlling factors in order to design efficient engine.
3. To study emissions from internal combustion engines and its controlling methods, various emission norms.

COURSE OUTCOMES

Students will be able to

1. Analyse thermodynamic cycles based on actual conditions.
2. Understand operating characteristics of different engine and combustion process for SI and CI engines.
3. Understand the different combustion chamber designs and compare for different types fuels used.

MODULE I

Basics of Internal Combustion Engines 10L Hrs

Heat engine, internal combustion engines and external combustion engines, internal combustion engine construction - components and materials, engine nomenclature, valve timing diagram, intake and exhaust system, engine classification, applications.

Fuel air cycle and actual cycle: fuel air cycle, assumptions, comparison with air standard cycle, effect of variables on performance, actual cycle and various losses.

MODULE II

Spark Ignition Engines 08L Hrs

Theory of carburetion, types of carburetors, electronic fuel injection system, combustion in spark ignition engines, stages of combustion, flame propagation, rate of pressure rise, abnormal combustion, phenomenon of detonation in spark ignition engines, effect of engine variables on detonation. Combustion chambers, rating of fuels in spark ignition engines, additives.

MODULE III

Compression Ignition Engines 08L Hrs

Fuel supply system, types of fuel pump, injector and distribution system, combustion in compression ignition engines, stages of combustion, factors affecting combustion, phenomenon of knocking in compression ignition engine. Effect of knocking, methods of knock control, types of combustion chambers, rating of fuels in compression ignition engines. Dopes &additives, comparison of knocking in spark ignition & compression ignition engines.

MODULE IV

Combustion Chambers **08L Hrs**

Requirements of combustion chambers,features of different types of combustion chambers system for S.I. engine. I-head, F-head combustion chambers. C.I. engine combustion chambers-air swirl turbulence, M-type combustion chamber. Comparison of various types of combustion chambers.

MODULE V

Internal Combustion Engine-System, Emission and Control **10L Hrs**

Internal combustion,Engine Systems**:** Cooling system, lubrication system, ignition system, governing system, starting system.

Internal combustion engine emissions and control air pollution due to internal combustion engine and its effect, emissions from petrol/gas and diesel engines, sources of emissions, euro norms, Bharat stage norms, emission control methods for spark ignition and compression ignition engines.

Text Books

1. M. L. Mathur and R. P. Sharma , A course in I.C. Engines, , Dhanpat Rai Pub, 2001.
2. Colin R. Ferguson C,Internal Combustion Engines, John Wiley & sons, 1986

Reference Books

1. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw-Hill, 2011
2. V. Ganesan, Internal Combustion Engines, Tata McGraw-Hill, 2012

SEM/YEAR : VI SEM
COURSE CODE : 16ME331
TITLE OF THE COURSE : MODELING AND SIMULATION OF MANUFACTURING SYSTEMS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. Define the basics of simulation, modelling and replicating the practical situations in manufacturing industries.
2. Develop simulation model using heuristic methods.
3. Analysis of Simulation models using input and output analyser.

COURSE OUTCOMES

Students will be able to:

1. Describe the role of important elements of discrete event simulation and modelling paradigm.
2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
3. Develop skills to apply simulation software to construct and execute goal-driven system models.

MODULE I

Principles of Computer Modelling and Simulation 08L Hrs

Monte Carlo Simulation. Nature of computer- modeling and simulation. Limitations of simulation, areas of applications.

System and environment: Components of a system -discrete and continuous systems, different modeling approaches

MODULE II

Discrete Event Simulation 09L Hrs

Discrete Event Simulation: Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.

Statistical Models in Simulation: Discrete distributions, continuous distributions.

MODULE III

Random Number Generation 09L Hrs

Techniques for generating random numbers- Mid square method -the mod product method -Constant multiplier technique -Additive congruential method -Linear congruential method -Tests for random numbers -The Kolmogorov-Smirnov test -the Chi-square test.

MODULE IV

Random Variable Generation 09L Hrs

Inversion transforms technique-exponential distribution. uniform distribution, Weibul distribution, continuous distribution, generating approximate normal variates-Erlang distribution.

Empirical Discrete Distribution: Discrete uniform -distribution poisson distribution - geometric distribution - acceptance -rejection technique for Poisson distribution gamma distribution.

MODULE V

Design and Evaluation of Simulation Experiments **09L Hrs**

Variance reduction techniques -antithetic variables, variablesverification and validation of simulation models.

Simulation Software: Selection of simulation software, simulation packages.

Text Books

1. Jerry Banks & John S Carson, Discrete Event System Simulation, Prentice Hall Inc.1984.
2. Gordan. G, Systems Simulation, Prentice Hall India Ltd -1991.

Reference Books

1. Nusing Deo, System Simulation with Digital Computer, Prentice Hall of India - 1979.
2. Francis Neelamkovil, Computer Simulation and Modeling, John Wilely & Sons - 1987.
3. Rath M.Davis & Robert M O Keefe, Simulation Modeling with Pascal, Prentice Hall Inc. -1989.

SEM/YEAR : VI SEM
COURSE CODE : 16ME332
TITLE OF THE COURSE : ADVANCED MATERIAL TECHNOLOGY
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To impart knowledge to students in the latest technological topics on material technology.
2. To provide them with opportunities in taking up advanced topics in the field of research.
3. To equip students with recent study and advancement on novel materials.

COURSE OUTCOMES

Students will be able to:

1. Use the techniques, skills, and modern engineering tools necessary for advanced material technology.
2. Acquire fundamental knowledge and understanding in the field of materials.
3. Use effectively on multipurpose materials.

MODULE I

Selection of Advanced Materials 08L Hrs

Introduction to advanced materials, Super alloys, Ferro electric and piezoelectric materials, Advanced magnetic materials, Smart materials, Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

MODULE II

Modern Metallic and Non Metallic Materials 09L Hrs

Modern Metallic materials: Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials, bio materials.

Non Metallic Materials: Plastics, rubber, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, processing and applications.

MODULE III

Mechanical Behavior & Service Performance of Materials 09L Hrs

Behaviour: Tensile testing, other tests of plastic behaviour, strain hardening of metals, strain rate and temperature dependence, slip, Hardening mechanisms in metals, dynamic strain aging; ductility and fracture, fracture mechanics theories, Creep mechanisms, Fatigue Analysis, cyclic stress-strain behaviour, Mechanical behaviour of ceramics and glasses.

Performance: Corrosion and its control, Performance of materials at High & low temperatures, Radiation damage and recovery

MODULE IV

Micro and Nano Manufacturing **09L Hrs**

Introduction to Micro and Nano manufacturing technology, advantages and applications of nanotechnology, Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, Chemical Vapour Deposition, Physical Vapour Deposition, etching, and material modification methods, processes and equipment.

MODULE V

Fracture Behavior **09L Hrs**

Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of nonmetallic materials – Failure Analysis, sources of failure, procedure of failure analysis

Text Books

1. Thomas H. Courtney, Mechanical Behavior of Materials , McGraw-Hill, 2000.
2. Flinn, R.A. and Trojan, P.K., Engineering Materials and their Applications , (4th Edition), Jaico Publishing, 1999.
3. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta and John J. Moore, Introduction to Nano science and Nanotechnology, CRC Press, Boca Raton, 2009.

Reference Books

1. Willam D. Callister, Jr., Material Science and Engineering: An introduction, John Wiley & Sons, Inc, 2003.
2. Willam F. Smith, Principles of Materials Science and Engineering, 3rd edition, McGraw Hill, 2002.
3. Charles J.A., Crane, F.A.A and Furness, J.A.G., Selection and use of Engineering Materials, 3rd Edition, Butterworth-Heinemann, 1977.

SEM/YEAR : VI SEM
COURSE CODE : 16ME333
TITLE OF THE COURSE : ADVANCED MACHINING PROCESS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

Course Learning Objectives

1. To make awareness among students on recent trends in advanced machining processes
2. To understand the knowledge of advanced machining over conventional machining
3. To learn the advantages of advanced machining and applications

Course Outcomes

Students should be able to

1. Select appropriate advanced materials processes for a given product or component recognizing material, size, precision, and surface quality requirements.
2. Discuss the working of unconventional machining processes.

MODULE I

Mechanical Machining 07L Hrs

Introduction: Need and classification of nontraditional machining processes – material removal in traditional and nontraditional machining processes - considerations in process selection

Ultrasonic Machining: Introduction, ultrasonic machining system- mechanics of cutting, parametric analysis- process capabilities, applications.

Water Jet Machining: Principle, process variables, advantages and disadvantages, applications, Abrasive water jet machining- pumping system- abrasive feed system- abrasive water jet nozzle, catcher, process variables, applications.

MODULE II

Electric Discharge Machining 09L Hrs

Electric Discharge Machining: Mechanism of material removal, dielectric fluid, electrode materials, spark erosion generators, electrode feed system, material removal rate, process parameters– characteristics of spark eroded surfaces, advantages and disadvantages, applications.

Die-sinker EDM: Principle, electrolytes, advantages and disadvantages, applications.

Wire EDM: Principle, wire feed system – advantages and disadvantages, applications.

Electro-chemical discharge machining: Working principle, process parameters, advantages and disadvantages, applications

MODULE III

Chemical Machining 09L Hrs

Chemical Machining: Fundamentals, principle, classification, selection of etchant, Chemical milling – engraving – blanking – drilling – trepanning.Advantages and disadvantages – applications.

Electro Chemical Machining: Electro chemical process, electrolytes, properties, material removal rate, tool materials, tool feed systems, design of electrolyte flow – process

variables, advantages – disadvantages, applications, Electro chemical grinding, honing, deburring, turning.

MODULE IV

Electron Beam Machining **09L Hrs**

Electron Beam Machining: Principle, generation – control of electron beam – advantages –disadvantages, applications.

Laser Beam Machining: Principle, solid – gas laser methods, applications, thermal features, advantages – disadvantages, applications.

Ion Beam Machining: Equipment, process characteristics, advantages, disadvantages, applications, plasma arc machining, principle, gas mixture, types of torches, process parameters, advantages, disadvantages, applications.

Plasma Arc Machining - Metal removal mechanism, process parameters, process characteristics, types of torches, applications.

MODULE V

Abrasive Machining **10L Hrs**

Abrasive Jet Machining (AJM): Introduction, abrasive jet machining setup, abrasive feeder, machining chamber, AJM nozzle, parametric analysis - stand-off-distance - abrasive flow rate - nozzle pressure - mixing ratio, applications,

Abrasive Flow Machining (AFM) - working principle, AFM system, process variables, process performance and applications.

Magnetic Abrasive Finishing (MAF) - working principle, MAF system, material removal and surface finish, process variables and applications.

Chemo-Mechanical Polishing: working principle, material removal and surface finish and applications.

Text Books

1. Vijay.K. Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi,
2. Pandey P.C., and Shan H.S. Modern Machining Processes, Tata McGraw-Hill, New Delhi,

Reference Books

1. Mc Geough, Advanced Methods of Machining, Chapman and Hall, London, 1998.
2. Paul De Garmo, Black, J.T.and Ronald.A.Kohser, Material and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi (8th Edition), 2001: ISBN – 81-
3. Benedict. G.F. Nontraditional Manufacturing Processes, Marcel Dekker Inc., New York,

SEM/YEAR : VI SEM
COURSE CODE : 16ME334
TITLE OF THE COURSE : GAS DYNAMICS AND JET PROPULSION
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To impart the basic concepts of dynamics and thermodynamics of gas flow.
2. To study the aircraft propulsion systems and rocket propulsion and its applications.

COURSE OUTCOMES

Student will be able to

1. Apply the concepts of gas dynamics for applications related to compressible flows and jet propulsion
2. Possess the knowledge of jet engines and aircraft propulsion theories.

MODULE I

Introduction 08L Hrs

Continuum- control volume and system approaches- continuity and momentum equations for control volume- Mach number- velocity of sound- classification of flow based on Mach number- physical difference between incompressible, subsonic and supersonic flows- Mach angle- Karman's rule of supersonic flow- effect of Mach number on compressibility- general features of one dimensional flow of compressible fluid.

MODULE II

Isentropic Flow of an Ideal Gas 09L Hrs

Isentropic flow of an ideal gas: General features and governing equations- Stagnation properties and state- Reference velocities- Dimensionless velocity- Crocco number- Bernoulli equation- Isentropic flow through variable area- Comparison of isentropic and adiabatic flow- Mach number variations- Area ratio- Impulse function- Mass flow rate, Chocking in Isentropic flow- Variation of flow parameters in isentropic flow- Performance of convergent and De lavel nozzle- Performance of real nozzles- Applications of Isentropic flow.

MODULE III

Simple Frictional Flow 09L Hrs

Governing equations- Fanno curves- limiting conditions- Fanno flow equations- Variation of flow properties- Variation of Mach number with duct length- Choking due to friction. Isothermal flow with friction: Basic equations- limiting conditions- variation of flow properties. Flow with heat transfer: Governing equations- Rayleigh curves- limiting condition- Rayleigh flow relations- Variation of flow properties- Maximum heat transfer- Thermal choking.

MODULE IV

Normal and Oblique Shocks **09L Hrs**

Development of a shock wave- Governing equations- Intersection of Fanno and Rayleigh lines- Prandtl-Meyer relation- Properties of flow across normal shock- Thickness of shock waves- Shock strength- Determination of Mach number of supersonic flow- Variation of flow parameters through normal shock. Flow with oblique Shock – Fundamental relations, Prandtl‟s equation, Variation of flow parameters.

MODULE V

Air Craft Propulsion **09L Hrs**

Air craft propulsion: Types of jet engines- Components, energy flow through jet engines, Performance of jet engines- thrust, thrust power, propulsive and overall efficiencies – turbojet, turbofan, ramjet, pulsejet and scramjet engine.

Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse –rocket engine performance, solid and liquid propellants.

Text Books

1. Yahya. S.M., Fundamental of compressible flow with Aircraft and Rocket propulson, New Age International (p) Ltd., New Delhi, 2005
2. James John & Theo Keith, Gas Dynamics, Pearson International., 2006

Reference Books

1. Shapiro. A.H., Dynamics and Thermodynamics of Compressible fluid Flow, John wiley, New York, 1953.
2. Anderson, J.D., Modern Compressible flow, 3rd Edition, McGraw Hill, 2003.
3. P Balachandran, Fundamentals of Compressible Fluid Dynamics, Prentice Hall of India.2006
4. Zucrow. N.J., Principles of Jet Propulsion and Gas Turbines, John Wiley, New York, 1970.

SEM/YEAR : VI SEM
COURSE CODE : 16ME335
TITLE OF THE COURSE : MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To provide fundamental knowledge of Micro electro mechanical systems (MEMS) and various fabrication techniques
2. Use of MEMS for industrial applications.

COURSE OUTCOMES

Students will be able to understand the

1. Fundamentals of MEMS , Materials and Fabrication process
2. Types of Microsensors, Microactuators and their applications

MODULE I

Introduction to MEMS 09L Hrs

Definition – development- fundamentals of MEMS. Micro fluidics, microelectronics, micro systems- design and fabrication, working principles and applications. Integrated circuit processes, potential of MEMS in industry

MODULE II

Substrates and Wafers 08L Hrs

Materials substrates and wafers, silicon substrate- properties of silicon, silicon compounds, silicon piezo resistors. Galium Arsenide, quartz, polymer for MEMS, conductive polymer. Shape memory alloys.

MODULE III

Fabrication Processes 09L Hrs

Photolithography, photo resist applications, light sources, X-ray lithography, electron beam lithography,ion implantation, thin film deposition, diffusion process, Chemical and physical vapour deposition, bulk and surface machining, LIGA, laser ablation process. Microsteriolithography for 3D fabrication and nanolithography.

MODULE IV

Sensors 09L Hrs

Micro sensors, classification of physical sensors, integrated, intelligent or smart sensors, sensors principle, thermal sensors, electrical sensors, mechanical sensors, chemical and biosensors.

MODULE V

Microactuators 09L Hrs

Electromagnetic and thermal microactuation, mechanical design of micro actuators, microactuator, micro valves, micro pumps, micro motors. Microactuator systems: Ink jet printers, micro-mirror TV projectors. Micro-opto- electromechanical systems, metal oxide semiconductor field effect transistor, multi-disciplinary applications.

Text Books

1. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata McGraw Hill, New Delhi, 2002.
2. Nitaigour Premchand Mahalik, Micro Electro Mechanical Systems, Tata McGraw Hill, New Delhi, 2007.
3. Mohamed Gad-El-Hak, The Micro Electro Mechanical SystemsHandbook, CRC Press, New York, 2002.

Reference Books

1. Kalpakjian, Manufacturing Engineering and Technology, 4thedition, Addison Wesley Congmen Pvt. Ltd., Singapore, 2009.
2. Mark Madou, Fundamentald of Microfabrication, CRC Press, New York, 1997.
3. Maluf.N, An Introduction to Microelectro mechanical Sytems Engineering, Artech House, Boston, 2000.
4. Rai Choudhury, Micro Electro Mechanical Systems and Micro-opto-electromechanical systems Technology and Applications, PHI Learning, 2009.

SEM/YEAR : VI SEM
COURSE CODE : 16ME336
TITLE OF THE COURSE : DESIGN OF COMPOSITE MATERIALS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS : 44

COURSE LEARNING OBJECTIVES

1. To learn basics of composite properties, mechanics, and manufacturing processes.
2. Design guidelines will be emphasized for composite components with various fiber-reinforcements such as unidirectional fibers, random short fibers, and laminate stacking sequences.
3. Failure analysis of laminated composite structures for aerospace, automobile, marine and other engineering applications.

COURSE OUTCOMES

1. Understand the fundamentals, properties and main applications of composite materials.
2. Understand and apply the composite design guidelines to suit industrial requirements.

MODULE I

Introduction to Composite Materials 08L Hrs

Introduction, concepts of isotropy vs. anisotropy, generalized Hooke's law of isotropic materials, classification of composites, fibrous, laminate, particulate, combination, polymer matrix composites, metal matrix composites, mechanical behavior of composite material, applications and use of composite materials. Maximum stress theory, maximum strain criteria, Inter-laminar Strength, maximum work (Tsai-Hill), criterion, Wu tensor theory.

MODULE II

Macro mechanical Analysis of a Lamina 09L Hrs

Lamina Constitutive Equations: Lamina assumptions – macroscopic viewpoint. Definitions of stress, strain, elastic moduli and strain energy, stress-strain relationships for different types of materials.

Engineering constants of a unidirectional/bidirectional lamina, stiffness and compliance parameters of the lamina, elastic moduli, strengths, thermal and moisture expansion coefficients. Stress-strain relationships for a unidirectional/bidirectional lamina.

MODULE III

Micromechanical Analysis of a Lamina 09L Hrs

Rule of mixture, volume and weight fraction of fiber and matrix, density and void fraction in composites, longitudinal strength and stiffness, transverse modulus, in-plane shear modulus. Mechanical and hygrothermal constants, elastic moduli, strength parameters, coefficients of thermal and moisture expansion of a lamina.

MODULE IV

Macromechanical Analysis of a Laminate **09L Hrs**

Macro mechanical analysis of laminate-classical laminate theory, stress-strain variation. Relations for a laminate, strain-displacement relationship, laminate stiffness, strength of laminates, in-plane and flexural modulus of a laminate and hygrothermal effects in a laminate. Relationships of mechanical and hygrothermal loads applied to a laminate. Elastic moduli of laminate, coefficients of thermal and moisture expansion of a laminate, stacking sequence.

MODULE V

Analysis and Design of Laminates **09L Hrs**

Significance of stiffness, hygrothermal and mechanical response of special cases of laminates. Bending, buckling and vibration analysis of laminated plates - governing equations, simply supported laminated plates – deflection under distributed transverse load, buckling under in-plane load and vibration.

Thermal Analysis - assumption of constant co-efficient of thermal expansion (C.T.E.) - modification of Hooke's law. Modification of laminate constitutive equations. Orthotropic lamina C.T.E's. C.T.E's for special laminate configurations – unidirectional, symmetric balanced laminates, Zero C.T.E laminates, thermally quasi-isotropic laminates.

Preliminary design of composite structures for aerospace and automotive applications, mechanical design issues in laminated composites.

Text Books

1. Autar K. Kaw, Mechanics of Composite Materials, CRC-LLC Press,FL, Â Second Edition, 2005
2. Isaac M. Daniel and Ori Ishai, Engineering Mechanics of Composite Materials, Oxford University Press- -2006,
3. R M Jones, Mechanics of Composite Materials, CRC Press Taylor & Francis,1999

Reference Books

1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994, Second Edition - CRC press in progress.
2. Mallick, P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, Maneel Dekker Inc, 1993.
3. Reddy, J.N., Mechanics of Laminated Composite Plates and Shells -Theory and Analysis, CRC Press, 2nd Edition, 2004.

SEMESTER : VII
COURSE CODE : 16ME401
TITLE OF THE COURSE : CONTROL ENGINEERING
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

The study would enable the student to learn

- Mathematical Modeling, of mechanical and electromechanical control systems
- Characteristics and performance of feedback systems: transient and steady state response of lower order systems
- Stability analysis of feedback systems using Routh- Hurwitz criterion, root locus method, stability in frequency domain using polar plots, bode plots, performance specifications
- Basic concepts of digital control systems.

Course Outcomes

- Demonstrate an understanding of the fundamentals of (feedback) control systems.
- Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.
- Express and solve system equations in state-variable form (state variable models).
- Apply root-locus technique to analyze and design control systems.

Module I: Introduction to Automatic Control Systems 10L Hrs

Concept of automatic controls, Examples of control systems, open and closed loop systems, concept of feedback, requirements of an ideal control system.
Mathematical Modeling Introduction, Review of Laplace transforms, Transfer functions, Transfer function Models, Mechanical systems (both translation and rotational), Problems on Transfer functions. Electrical Analog of mechanical systems: Force-voltage, Force-current analogies, Models of thermal and hydraulic systems. Block diagrams and signal flow graphs: Block representation of system elements, reduction of block diagrams. Signal flow graphs: Mason's gain formula.

Module II : System Response 09L Hrs

Introduction, Transient & Steady state response analysis ,Standard test inputs, First order and second order system response to unit step, ramp inputs, concept of time constant and its importance in speed of response. Steady State Error, Static and Dynamic Error Constants. System stability, Routh-Hurwitz Criterion.

Module III: Stability, R-H criterion, Root Locus 08L Hrs

The root locus concept, Guidelines for sketching root loci, Selected illustrative root loci.

Module IV: Frequency response –Polar, Nyquist, Bode Diagrams 09L Hrs

Frequency response –Polar, Nyquist, Bode Diagrams:Polar plots, Nyquist Stability Criterion, Stability analysis, Relative stability concepts, Phase and gain margin, M&N circles.

Frequency response analysis using Bode plots:Bode attenuation diagrams, Stability Analysis using Bode plots, Simplified Bode Diagrams.

Module V: Introduction to P-I-D controllers **08L Hrs**

Introduction to P-I-D controllers: Types of controllers-Proportional, Integral, Proportional Integral, Proportional Integral Differential controllers.

Analysis of control systems in state space: Introduction to state concepts, state-space representation of transfer-function systems, controllability and observability.

Introduction to Digital control systems: Introduction, Advantages offered by digital controls.

Text books

1. Katsuhiko Ogata, Modern Control Engineering, Second edition, Prentice Hall of India Private Ltd, NewDelhi, 1995.
2. Nagrath I J and Gopal .M, Control Systems Engineering, FirstEdition,Wiley and sons, 1985.

Reference books

1. Benjamin C Kuo, Automatic Control System, 7thEdition, Prentice Hall of India, Private Ltd, New Delhi, 1993.
2. Richard .C. Dorf and Robert.H.Bishop, Modern Control System Engineering, Addison Wesley, 1999.

SEMESTER : VII
COURSE CODE : 16ME402
TITLE OF THE COURSE : OPERATION RESEARCH
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

1. To appropriately formulate Linear Programming models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these LP problems.
2. To interpret and apply the results of an operations research model.
3. Solve specialized linear programming problems like the transportation and assignment problems
4. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems.

Course Outcomes

1. Formulate and solve Linear Programming Problems
2. Determine performance measures for basic queuing problems using appropriate closed form equations
3. Work in teams to complete projects or case studies
4. have a knowledge of logical issues

Module I: Introduction & Linear Programming Problem 09L Hrs

Origin of Operation Research, Historical Standpoint, Methodology, Different Phases, Characteristics, Scope and Application of Operations Research.

Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods, Analytical Methods: Simplex, Big M and Two Phase, Sensitivity Analysis, Primal and Dual Problems, Duality in linear programming problems, dual simplex method.

Module II : Transportation & Assignment 09L Hrs

Transportation Problems definition, Linear form, Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. Transshipment Problems.

Assignment problem - Introduction, Mathematical formulation of the problem, Hungarian assignment method only, special cases in assignment problems, Travelling sales man Problem.

Module III: Queueing theory & Inventory Control 09L Hrs

Queueing theory **-** Basic structure of queuing systems, elements of queuing theory, Kendall's Notation,Operating characteristics of a queuing system, roles of the Poisson and exponential distributions, classification of queues basic results of M/M/1: FIFO systems, extension to multi-server queues.

Inventory Control **-** classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands.

Module IV: Game Theory **09L Hrs**

Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods.
CPM & PERT- project scheduling, critical path calculations, Crashing

Module V: Replacement & Decision Theory **08L Hrs**

Replacement Theory: Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.
Decision Theory: Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, hurwicz criterion, Decision tree.

Text books

1. Hamdy. A. Taha, "Operations Research an Introduction", Pearson Education, 17th Edition, 2002.
2. Ravindran A, Philips D.T &Solbery.J.J, Operations Research: Principles and practice, John Wiley & Sons, New York, 1987.
3. S.D Sharma, "Operation Research", KedarNath and Ram Nath - Meerut, 2008.

Reference books

1. Joseph.G.Ecker& Michael KupperSchimd, Introduction to operations Research, John Wiley & Sons, 1988.
2. KantiSwarup, Gupta.P.K. & Man Mohan, Operations Research, S.Chand& Sons, 2005.
3. Gillet.B.E., Introduction to Operations Research - A Computer oriented algorithmic approach, McGraw Hill, 1987.

SEMESTER : VII
COURSE CODE : 16ME403
TITLE OF THE COURSE : HYDRAULICS AND PNEUMATICS
L: T/A:P: C : 2 : 0 : 2 : 3

Course Objectives

The course will enable the students to:

- Appreciate the fundamental principles of Fluid Mechanics
- Study of working principle of various components used in hydraulic and pneumatic systems.
- Select different components used in hydraulic and pneumatic systems.
- Design of hydraulic and pneumatic circuits.
  Understand industrial applications of hydraulic and pneumatic circuits.

Course Outcomes

At the end of the course, the students will be able to:

- Understanding operating principles and constructional features of hydraulic and pneumatic systems.
- Knowledge with selection of hydraulic / pneumatic components
- Understanding of designing and layout of Hydraulic Power package and trouble shooting.

Module I: Fluid power principles and hydraulic pumps 09L Hrs

Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids-Properties of fluids – Basics of Hydraulics – Pascal's Law- Principles of flow – Friction loss- Work, Power and Torque. Problems Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps-Problems

Module II : Hydraulic actuators and valves 09L Hrs

Hydraulic Actuators: Cylinders– Types and construction, Application, Hydraulic cushioning - Hydraulic motors Control Components: Direction control, Flow control and Pressure control valves- Types, Construction and Operation- Servo and Proportional valves - Applications – Types of actuation. Accessories: Reservoirs, Pressure Switches- Applications- Fluid Power ANSI Symbols - Problems

Module III: Hydraulic systems 09L Hrs

Accumulators, Intensifiers, Industrial hydraulic circuits- Regenerative, Pump Unloading, Double pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical Hydraulic servo systems

Module IV: Pneumatic systems 09L Hrs

Properties of air– Perfect Gas Laws- Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Design of pneumatic circuit cascade method- Electro pneumatic circuits, Introduction to Fluidics, Pneumatic logic circuits.

Module V: Trouble shooting and applications **08L Hrs**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems. Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for a Pick and Place application and tool handling in a CNC machine. - Low cost Automation – Hydraulic and Pneumatic power packs- case studies.

Text books

1. Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill,2001
2. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.

Reference books

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. Shanmugasundaram.K, "Hydraulic and Pneumatic Controls", Chand & Co, 2006.
3. Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
4. Srinivasan.R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008.
5. Joji.P, "Pneumatic Controls", John Wiley & Sons India, 2008

SEMESTER : VII
COURSE CODE : 16ME404
TITLE OF THE COURSE : LAW FOR ENGINEERS
L: T/A:P: C : 2 : 0 : 2 : 3

Course Objectives
The students will be able to

1. Apply the knowledge of the constitutional literacy to become aware of the fundamental rights and duties in their role as Engineers
2. Understanding of ethical and legal aspects of advertising, consumer problems and their redressal mechanism related to product and service standards.
3. Demonstrate an advanced and integrated understanding of the nature and extent of the corporate entity principle and to understand how this principle applies to corporate groups
4. Critically evaluate the extent and application of the Corporate Law.

Course Outcomes
After completing the course, the students will be able to

1. Understand process of ethical and moral analysis in decision making scenarios and inculcate ethical behavior as a trait for professional development.
2. Apply the knowledge to solve practical problems with regard to personal issues & business enterprises.
3. Identify the conflict management in legal perspective and judicial systems pertaining to professional environment; strengthen the ability to contribute to the resolution of human rights & Ragging issues and problems through investigative and analytical skills.

Module I: Introduction 08L Hrs

Introduction to Indian legal system, Review of Constitution of India, Sources of Law and Judicial system.

Contracts and its Elements: Employment contracts, Contract Interpretation, service contract , Contract of Indemnity, Law of Agency, Employment Agreement

Module II : Legal documentation 08L Hrs

Legal documentation: Drafting of legal documents including Non-Disclosure Agreements (NDA) , Request for proposal (RFP), Collaboration Agreement , Joint Venture Agreements, Tendering and sub-contracting

Module III: Property Rules, Trademarks & Copy Rights 10L Hrs

Intellectual Property Rules (IPR) Overview, Trademarks , Copy Rights , Patents with special emphasis in Biotechnology Inventions, Software Circuits and Design, Protection in Foreign Countries

Module IV: Introduction to Labour and Environmental Laws 08L Hrs

Labour Laws: Provident Fund, ESIC, Gratuity, Bonus, Perquisites, Contract labour, Health, Safety and welfare of construction workers,

Introduction to Environmental Law, Concept of Law & Policy , Environment and Governance ,Sustainable Development and Environment , Understanding Climate Change and its processes – CDP, CDMs and Carbon Off Setting, Overview of International Environmental Laws, Introduction to Environment and IPR

Module V: Cyber Laws & Taxation **10L Hrs**

Cyber Laws , E-Commerce and E-Governance, Taxation: Income Tax, Service Tax, VAT, Excise Duty, RTI Act.

Text books

1. V.S. Datey, Indirect Taxes: Law and Practice, Taxmann Publications (P) Ltd, Latest Edition Publications (P) Ltd, latest Edition.
2. S.C. Srivastava, Industrial Relations and Labour Laws, Vikas Publishing House Pvt. Ltd.
3. Joseph Minatiur, Indian Legal System, Indian Law Institute, New Delhi.

Reference books

1. Kamith Seth, Computer Internet and New Technology Laws, LexisNexis, First Edition 2013.
2. Prafulla C Pant, The Arbitration and Conciliations Act, 1996, ButterworthsIndia, New Delhi.
3. J. Beatson, Anson's Law of Contract, Oxford University Press.

SEMESTER : VII
COURSE CODE : 16ME421
TITLE OF THE COURSE : RAPID MANUFACTURING TECHNOLOGIES
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

1. To provide knowledge of methods for the manufacturing of prototypes from computer based models
2. To understand the entire process of direct manufacturing from the creation of computer based models to their physical realization
3. To understand the various methods of manufacturing and their merits, demerits and applications
4. To impart students to convert CAD models into real life engineering components

Course Outcomes

1. Able to understand the various rapid prototyping, rapid tooling technology pertaining to RPT
2. Able to gain knowledge to select appropriate technology for product development
3. Able to use tools to explore rapid prototyping techniques and CAD modelling software

Module I: Introduction 08L Hrs

Introduction- Need for the compression in product development, Historical development, Fundamentals of RP, Advantages and Classification of RP systems. Process chain, RP Data Formats, Information flow in an RP system.

Module II : Liquid based rapid prototyping systems 08L Hrs

Stereo lithography Apparatus (SLA): Principle, process parameters, process details, machine details, products, Advantages, Limitations and applications. Solid ground curing (SGC): Principle, process parameters, process details, machine details, products, Advantages, Limitations and applications.

Module III: Solid based rapid prototyping systems 08L Hrs

Fused Deposition Modelling (FDM): Principle, process parameters, process details, machine details, products, Advantages, Limitations and applications. Laminated Object Manufacturing (LOM):Principle, process parameters, process details, machine details, products, Advantages, Limitations and applications. Ballistic Particle Manufacturing (BPM): Principle.

Module IV: Powder based rapid prototyping systems and concept modellers 10L Hrs

Selective laser sintering (SLS): Principle, process parameters, process details, machine details, products, Advantages, Limitations and applications. Three dimensional Printing (3DP): Principle, process parameters, process details, machine details, products, Advantages, Limitations, applications. Laser Engineering Net Shaping (LENS) - Principle. Concept modellers like thermal jet printers, Sander's model maker, GenisysXs 3D printers, JP system 5, Object Quadra system.

Module V: Rapid Tooling and Applications **10L Hrs**

Introduction to rapid tooling: Direct soft tooling- casting molds, Direct AIM, composite tooling. Indirect soft tooling- spray metal molding, silicon rubber molds, Castable resin and ceramic molds. Direct hard tooling-rapid tool, Laminated metal tooling, DMLS tooling. Indirect hard tooling- 3D keltool, ED electrodes, Ecotool, copy milling. Applications: Application-Material Relationship, Applications in Design, Applications in Engineering, Analysis and Planning. Application of Rapid prototyping in biomedical, automotive, aerospace, jewellery and coin industries.

Text books

1. C. K.Chua, K. F.Leong and C. S.Lim, Rapid prototyping: Principles and applications, World Scientific Publishers, 2003.
2. Ramesh S " Rapid prototyping" ANE Publications, New Delhi.
3. D. T.Pham and S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.

Reference books

1. Andreas Gebhardt, Hanser , Rapid prototyping, Gardener Publications, 2003.
2. L.W.Liou, F.W. Liou, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007.
3. K. Kamrani, E. A. Nasr, Rapid Prototyping: Theory and practice, Springer, 2006.
4. Terry Wohlers, "Wohlers Report 2001", Wohlers Associates, 2008.
5. Kenneth G. cooper, Rapid prototyping technology: Selection and application, CRC Press, 2001.

SEMESTER : VII
COURSE CODE : 16ME422
TITLE OF THE COURSE : DESIGN FOR MANUFACTURING
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

This course contributes to the following program learning outcomes of the Bachelor of Engineering:

- Understanding of the scope, principles, norms, accountabilities and bounds of DFM.
- Application of systematic engineering synthesis and design processes.
- Differences and similarities between design for manufacturing and design for assembly.
- Describe how product design has a primary influence in manufacturing.
- Quantitative analysis of a design's efficiency.
- Method of design for ease of manufacturing of the collection of parts that will form the product after assembly.

Course Outcomes

1. Demonstrate an understanding of the concepts such as tolerances, limits & fits
2. Demonstrate an understanding of component design from casting considerations and machining consideration
3. Demonstrate an understanding of design considerations and selection of materials in design

Module I: Tolerances, Limits & Fits 10L Hrs

Tolerances, Limits &Fits:General Tolerances, Tolerance grades, Limits fundamental deviation, Fits, Tolerance Accumulation cumulative effect of tolerances in assembly. Relationship between attainable tolerance grades and different machining processes.
Geometric Tolerances:Geometrical characteristics and symbols. Definition and Measurement of circularity, cylindricity, flatness and runout. True position tolerance.

Module II : Surface Roughness and Tolerances 09L Hrs

Surface Roughness:Terminology, Terms used for surface roughness, measurement of surface roughness. Surface roughness values obtained from various machining processes. Cumulative Effect of Tolerances:sure fit law and truncated normal law. Selective assembly and interchangeable part manufacture, Control of axial play by introducing secondary machining processes and by adding laminated shims.

Module III: Casting and Machining Considerations 09L Hrs

Component Design From Casting Considerations:Pattern, Mould, Parting line, cored holes and machined holes, Design for reducting/eliminating sand cores.
Component Design from Machining Consideration:Design considerations for turning, drilling, tapping, milling and grinding operations, provisions for clamping, Reduction in machining area, simplification by separation and amalgamation, Use of productive machines.

Module IV: Design Considerations **08L Hrs**

Design Considerations: Major Design Phases. Design for Manufacturability consideration. Influence of Fabrication properties (Machinability, Castability, Weldability, Polymer processing).

Module V: Selection of Materials In Design **08L Hrs**

Selection of Materials In Design:Properties of Materials used in design. Material selection process – cost per unit property, weighted properties and limits on properties methods.

Text books

1. Design for Manufacture, Harry Peck, Pitman Publications,1983.
2. Engineering Metrology, R.K. Jain Khanna Publishers, 2000.

Reference books

1. ASM Handbook, vol.20. Material Selection & Design.
2. Design for Manufacturability Handbook, Jamesh G. Baralla, Editor, Mcgraw Hill 1998.
3. Product Design for Manufacture and Assembly, GeofferyBoothroyed et al,Mercel Dekker Inc. New York.
4. Engineering Design: A Materials and Processing Approach, Geaorge. E. Dieter, Mcgraw Hill, 1991.

SEMESTER : VII
COURSE CODE : 16ME423
TITLE OF THE COURSE : COMPUTATIONAL FLUID DYNAMICS
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

The course will enable the students to:

- Introduce Governing Equations of viscous fluid flows
- Introduce numerical modelling and its role in the field of fluid flow and heat transfer
- Enable the students to understand the various discretization methods, solution procedures and turbulence modelling.
- Create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

Course Outcomes

After completion of the course student would be able to

- Create numerical modelling and its role in the field of fluid flow and heat transfer.
- Use the various discretization methods, solution procedures and turbulence modelling to solve flow and heat transfer problems.

Module I: Governing equations and boundary conditions 08L Hrs

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

Module II : Finite difference and finite volume methods for diffusion 09L Hrs

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three –dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

Module III: Finite volume method for convection diffusion 10L Hrs

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

Module IV: Flow field analysis 09L Hrs

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

Module V: Turbulence models and mesh generation 08L Hrs

Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools

Text books

1. Versteeg, H.K., and Malalasekera, W., “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Second Edition Pearson Education Ltd. 2007.
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.

Reference books

1. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow, Hemisphere" Publishing Corporation, 2004.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.

SEMESTER : VII
COURSE CODE : 16ME424
TITLE OF THE COURSE : OPERATIONS MANAGEMENT
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

- To understand the concepts of Operation Management and its applications in industrial situations and to familiarize the students with various concepts of Operation Planning and Management.
- To enable the students to evaluate the technical feasibility, financial viability, market acceptability and social desirability of projects.
- To understand the concept of project and steps in project management.
- To enable the students to prepare business proposals.

Course Outcomes

- In solving problems regarding project management and to develop team work in industrial situations.
- Determine performance measures for project evaluation and management
- Work in teams to complete projects or case studies
- Have a knowledge of feasibility & evaluation issues

Module I: Introduction 08L Hrs

Need, History, System, Types, functions, characteristics, importance of modern project management – An Integrated Approach – Project Portfolio Management System – Choosing the appropriate Project Management structure - Organizational considerations-structure and culture, project considerations – steps in defining the project – project Rollup – Process breakdown structure – Responsibility Matrices – External causes of delay and internal constraints.

Module II : Project feasibility studies 09L Hrs

Opportunity studies, pre-feasibility studies, feasibility study, functional studies, support studies, components of project feasibility studies – Managing Project resources flow – project planning to project completion, Pre-investment phase, Investment Phase and operational phase – Project Life Cycle – Project constraints.

Module III: Project Evaluation under certainty 09L Hrs

Net Present Value (Problems - Case Study), Benefit Cost Ratio, Internal Rate of Return, Urgency, Payback Period, ARR – Project Evaluation under uncertainty – Methodology for project evaluation – Commercial vs. National Profitability – Social Cost Benefit Analysis. Computer applications-selection of software packages for applications to project management.

Module IV: Developing a project plan 09L Hrs

Developing the project network – constructing a project network (Problems) – PERT – CPM – crashing of project network (Problems - Case Study), network analysis for monitoring the project, resource leveling and resource allocation – how to avoid cost and time overruns – Steps in Project Appraisal Process – Project Control Process – control issues – project audits –process – project closure – team, project manager evaluations.

Module V: Managing a project **09L Hrs**

Managing versus leading a project - managing project stakeholders – social network building (Including management by wandering around) – qualities of an effective project manager – managing project teams – Five Stage Team Development Model – Situational factors affecting team development – project team pitfalls. Project Audit and closure.

Text books

1. Clifford F. Gray and Erik W. Larson, Project management – The Managerial Process, Fourth Edition, Tata McGraw Hill, 2011.
2. Gopalakrishnan P and Ramamoorthy, V.E., Project Management, Macmillan
3. Gary R Heerkens, Project Management, McGraw-Hill, 2002.

Reference books

1. Prasanna Chandra, Projects: Planning, Analysis, Selection, Implementation and Review, 4th Edition, Tata MC Graw Hill, 1995.
2. Harold Kerzner, Project Management: A systems approach to planning, scheduling and controlling, Wiley, 2012.
3. Gregory M. Horine, Project Management Absolute Beginner's Guide (3rd Edition), 2012.

SEMESTER : VII
COURSE CODE : 16ME425
TITLE OF THE COURSE : TRIBOLOGY AND BEARING DESIGN
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

- To provide the students with the fundamental concepts and principles of tribology and lubrication, with emphasis on the design, selection and performance of the main lubricated component such as bearings.
- To enhance students awareness of tribological issues in the design of machine components like journal bearings.
- To enhance students awareness of bearing materials and behavior of tribological components.

Course Outcomes

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

- Appreciate lubrication principles, classification of lubricants.
- Differentiate between the types of lubricants and its respective application area.
- Understand and explain different laws of friction and topology of surfaces.
- Appreciate the various modes of wear and the wear-mechanisms.
- Understand behaviour of bearing in different lubrication regimes.

Module I: Introduction to Tribology 08L Hrs

Introduction to Tribology: Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen- Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants, Nano tribology, nano coatings and nano fluids and their applications.

Module II : Hydrodynamic Lubrication 08L Hrs

Hydrodynamic Lubrication:Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, mechanism of pressure development in an oil film, Reynold's investigation and Reynold's equation in 2D, numerical problems.

Module III: Idealized Journal Bearing 10L Hrs

Idealized Journal Bearing:Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's numbers and significance of it; Partial bearings, end leakages in journal bearing, numerical problems.

Module IV: Oil Flow & Hydrostatic Lubrication 08L Hrs

Oil Flow And Thermal Equilibrium of Journal Bearing: Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings.

Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing.

Module V: Bearing Materials **10L Hrs**

Bearing Materials: Commonly used bearings materials, properties of typical bearing materials, Advantages and disadvantages of bearing materials.

Behavior of Tribological Components:Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.

Text books

1. Fundamentals of Tribology , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006.
2. Introduction to Tribology Bearings, Mujumdar B. C., S. Chand company pvt. Ltd 2008.

Reference books

1. Theory and Practice of Lubrication for Engineers, Fuller, D., New York company 1998.
2. Principles and Applications of Tribology, Moore, Pergamaon press 1998.
3. Tribology in Industries, Srivastava S., S Chand and Company limited, Delhi 2002.
4.Lubrication of bearings – Theoretical Principles and Design, Redzimovskay E I., Oxford Press Company 2000.

SEMESTER : VII
COURSE CODE : 16ME426
TITLE OF THE COURSE : PLASTIC PROCESSING TECHNOLOGY
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

1. To give a basic knowledge of plastics including their development and compounding technology.
2. To give an overview of shaping processes, with a focus on injection moulding. In-depth process-related properties of plastics, special injection moulding technologies and process chains

Course Outcomes

1. A good understanding of principles of polymer compounding and processing and their effects on morphological structure and properties of manufactured plastic products, and
2. Ability of material and process selection, Knowledge of product design for manufacture, plastics conversion techniques, especially injection moulding.

Module I: Introduction 08L Hrs

Basic Principles of Melt Processing of Thermoplastics – Effect of Polymer Properties on Processing - Thermal Behaviour of Polymer Melt, flow behaviour of polymer melts - Rheology
of Ideal Fluids and Polymers – Newtonian & Non-Newtonian fluids, Different Types of Processes and Limitations - Process Flow Charts – Selection of Process – Degradation – molecular orientation – Processing advantage of Plastics over conventional Materials and different grades of plastics.

Module II : Injection Moulding Process 09L Hrs

Basic Process Principles, Machine rating and Specifications - Types of Machines – Construction - Parts and its functions – Start up and shut down procedure – Operation procedure - projected area , Press capacity, clamping system Type of Screws and its function- Process variables - Heating System - Ejection system – Back Pressure - Suck back- Drooling - Nozzle Types - Moulding cycle - Shot weight -Purging - Material recommendation- grades, Interaction of process variables- injection moulding operation- theoretical concepts and their relationship to processing- Shrinkage –Annealing - Dimensional Control - Moulding Records - Trouble Shooting – handling of finished products

Injection Moulds: Types of Injection Moulds - Two Plate Mould - Three Plate Mould - Cavity &
Core finishing – Gate Types - Runners – Hot Runner Moulds –Insulated Runner Mould system.

Module III: Extrusion **09L Hrs**

Introduction - principles - classification of extruders –drive mechanism - single screw extruder- specification - screw nomenclature - types of screws - L/D ratio, compression ratio-backpressure - factors governing back pressure - output and factors affecting output-heating &cooling systems - breaker plate - screen pack & its functions - screw & hopper cooling-dieentry effects and die exit instabilities - shark skin, melt fracture &bambooing.

Twin screw extruder - principle - types - process - merits & demerits - Vented barrel extruder -hopper loading devices - Drying equipments - Process, machinery - downstream equipments-Tube/pipe-sizing take off equipment, extrusion coating, wire & cable covering, , cooling,takeoff equipment - dies for producing products such as - film - blow film, cast film - Sheets -Tubes and pipes, corrugated pipes - Mono filaments - Box strapping - Wire & Cable Coating.

Module IV: Compression moulding & Transfer moulding **10L Hrs**

Principle – Process - Machine Specification - Material Recommendation and flow properties – Bulkfactor - Moulding powders - Preforms & Preheating Techniques - Process Variables – Pressurerequirements, Flash Mould - Positive mould - Semi Positive mould - Flow Characteristics & Curing. Time - Mould Heating & Cooling System - Types of Processes - moulding faults, correction andTrouble Shooting - Moulding of Thermoplastic & Thermoset Material, Finishing of mouldingsPrinciples of transfer moulding-advantages over compression moulding-Equipment used-Types ofTransfer moulding, Moulds, Press capacity-Integral moulds and auxiliary ram moulds-Mouldingcycles-Tool costs-Moulding tolerances - Materials Theoretical calculation of pressures-Linepressures- Injection ram pressure-clamping-Heating requirements-Finishing of moulded parts -Moulding faults - causes and remedies.

Module V: Secondary Processing Techniques **08L Hrs**

Powder coating, casting, machining & joining of plastics-Decoration of Plastics-Metalizing-Printing & Painting etc-Post moulding operations techniques , Inmould labelling. Plastics waste management- Basic principles-mechanical recycling-chemical recycling-incineration, Pyrolysis -mixed wasterecycling-value addition, application and development for recycled materials.

Text books

1. Injection Moulding Theory & Practice – Rubin, Irvin.
2. Plastics Materials & Processing – Brent Strong.

Reference books

1. Total Quality Process Control for Injection Molding, 2nd Edition, M. Joseph Gordon, Jr.
2. Compression Moulding – Iyesaw, A.I.
3. Plastics Engineering Hand Book – Society of Plastics Industry Inc.
4. Plastics Processing Data Hand Book – D.V. Rosato.

SEMESTER : VII
COURSE CODE : 16ME427
TITLE OF THE COURSE : AUTOMOBILE ENGINEERING
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

The course will enable the students to:

- Understand basics of Automobile Engineering & various Automotives system.
- Understand vehicle layout, vehicle specifications & important of automobile.
- Make the student conversant with drive train & transmission.
- Make the student conversant with Suspension, Steering, Brakes systems & Tyre Wheel assembly.
- Make the student conversant with Vehicle Maintenance & Garage Practice.
- Understand the various Automobile Electrical System, Vehicle performance & their safety.

Course Outcomes

After completion of the course student would be able to

- Handle technical & management problems in automotive industries.
- Diagnosis the faults of automobile vehicles.
- Understand various transmission systems, Suspension, brakes, Vehicle Performance, Vehicle Safety.

Module I: Introduction to Automobile Engineering 07L Hrs

Automobile history and development, current scenario in Indian auto/ ancillary industries, Role of the automobile industry in national growth, Classification, types of chassis layout with reference to power plant locations and drive, Vehicle frames, Various types of frames. Constructional details, Unitised frame body construction, Loads acting on vehicle frame, details of chassis material.

Module II : Drive Train & Transmission 09L Hrs

Classification of clutches, Single plate & with dual flywheel effect, Multi plate, Cone, diaphragm spring, Centrifugal, Clutch materials, Clutch plate, Electromagnetic, vacuum operated, Necessity of gear box, Manual gear box-Constant mesh, Sliding mesh, Synchromesh, Epicyclic, fluid flywheel, Torque convertor, Continuous variable transmission, Electronic transmission control, overdrive, Propeller Shaft, Universal Joint, Differential and final drive, hotchkiss drive, torque tube drive.

Module III: Front & Rear Axle, Steering System,Suspension & Brakes System 10L Hrs

Axle: Purpose and requirement of front & rear axle, live and dead axles types & arrangement, types of loads acting on rear axles, full floating, three quarter floating and semi floating rear axles.

Steering System: Steering mechanism, steering geometry, cornering force, slip angle, scrub radius, steering characteristic, steering linkages & gearbox, power steering, collapsible steering, reversibility of steering, four wheel steering.

Suspension: Sprung and unsprung mass, types of suspension linkages, types of suspension springs- leaf, coil, air springs, hydro gas, rubber suspension, interconnected suspension, self levelling suspension (active suspension), damping and shock absorbers

Brakes: Types of brake systems - drum, disc, operation-mechanical, hydraulic, air brakes, servo and power braking, hand brake, ABS.

Module IV: Vehicle Performance, Safety & Modern Trends 08L Hrs

Vehicle performance parameters, road resistance, traction and tractive effort, power requirement for propulsion, road performance curves(Numerical treatment expected), Stability of vehicles, roll over safety regulations, Vehicle safety- active, passive safety, air bags, seat belt, Vehicle interior and ergonomics, comfort, NVH in automobiles, electrical car layout, hybrid vehicles, Solar operated vehicle, measuring instruments for wear, speed, acceleration, vibration, noise.

Module V: Electrical System & Vehicle maintenance 08L Hrs

Batteries: Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods.

Lighting System & Accessories: Insulated & earth return systems, positive & negative earth systems, electrical fuel pump, speedometer, fuel, oil & temperature gauges, horn, wiper system, trafficator, sensors and actuators, electronic control unit, traction control devices.

Vehicle maintenance Schedule maintenance chart of a vehicle, maintenance, overhauling & servicing of chassis, clutch, gear box, propeller shaft, differential, axles, steering system, wheels, tyres, suspension, brakes system, electrical system.

Text books

1. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House.
2. Automobile Electrical Equipment -P. S. Kohali, Tata McGraw Hill Publishing House.

Reference books

1. K. Newton and W. Seeds, T.K. Garrett, "Motor Vehicle", 13thEdition, Elsevier publications.
2. Hans Hermann Braess, Ulrich Seiffen, "Handbook of Automotive Engineering ", SAE Publications
3. Narang G. B. S , " Automobile Engineering", S. Chand and Company Ltd.
4. Dr.Kirpal Singh, "Automobile Engineering", Volume 1, Standard Publishers distributors.

SEMESTER : VII
COURSE CODE : 16ME428
TITLE OF THE COURSE : FUELS AND COMBUSTION
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives
The course will enable the students to:

- To understand the types of fuels.
- To understand the principles of combustion and combustion equipments.
- To understand the thermodynamic process behind the combustion.

Course Outcomes
After completion of the course student would be able to

- On successful Completion of this course the student will be understand combustion, Types of Fuels, Combustion Equipments

Module I: Characterization of Fuels 09L Hrs
Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels - Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value - Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation - Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures.

Module II : Solid & Liquid Fuels 09L Hrs
Solid Fuels Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking Coals – Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels - Manufactured Solid Fuels. Liquid Fuels Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number etc, - Alcohols - Tar Sand Oil - Liquefaction of Solid Fuels.

Module III: Gaseous Fuel 09L Hrs
Gaseous Fuel Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non - Thermal Route - Biogas - Digesters - Reactions - Viability - Economics.

Module IV: Combustion Stoichiometry &Kinetics 09L Hrs
Stoichiometry – Mass Basis & Volume Basis – Excess Air Calculation – Fuel & Flue Gas Compositions - Calculations – Rapid Methods – Combustion Processes – Stationary Flame – Surface or Flameless Combustion – Submerged Combustion – Pulsating & Slow Combustion Explosive Combustion. Mechanism of Combustion – Ignition & Ignition Energy – Spontaneous Combustion – Flame Propagation – Solid, Liquid & Gaseous Fuels Combustion – Flame Temperature – Theoretical, Adiabatic & Actual – Ignition Limits – Limits of Inflammability. Thermo Chemistry - Equilibrium combustion products. Low temperature combustion products – High temperature combustion products.

Module V: Combustion Equipments **08L Hrs**

Coal Burning Equipments – Types – Pulverized Coal Firing – Fluidized Bed Firing – Fixed Bed & Recycled Bed – Cyclone Firing – Spreader Stokers – Vibrating Grate Stokers – Sprinkler Stokers, Traveling Grate Stokers. Oil Burners – Vaporizing Burners, Atomizing Burners – Design of Burners. Gas Burners – Atmospheric Gas Burners – Air Aspiration Gas Burners – Burners Classification according to Flame Structures – Factors Affecting Burners & Combustion.

Text books

1. B.I. Bhatt and S.M. Vora, Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984.
2. Sharma SP., Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984

Reference books

1.Blokh A.G., Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988.
2. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966.
3. Holman J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1988.
4. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990

SEMESTER : VII
COURSE CODE : 16ME471
TITLE OF THE COURSE : CONTROL ENGINEERING LABORATORY
L: T/A:P: C : 0 : 0 : 4 : 2

Course Objectives

The study would enable the student to learn

- To understand the experimental approach for determination of step response of first and second order systems
- To understand the experimental approach to identify frequency response of second order system and evaluation of frequency domain specification using Matlab
- To plot root locus plot for given open loop transfer functions.
- To determine gain and phase margin through Bode plots.
- To examine the stability of a closed loop unity feedback system with open loop transfer function.

Course Outcomes

- Students will have the knowledge on MATLAB tools.
- Students will be able to write Matlab programming for the analysis of LTI system.
- Students able to use concepts Differential equations - using Laplace transforms to solve them, Poles and zeroes of a transfer function and impedance ands – impedances also students will be able to analyze Network functions.
- Students able to do System identification and analyze the system for time and frequency response.

LIST OF EXPERIMENTS

MAT LAB Basics

- Introduction: Staring MATLAB, elementary functions, commands and variables
- Expressions: Scalar and vector expressions and their evaluations
- Arrays: Creation and manipulations of array, built in functions for arrays.
- Scripts and functions: Creation and execution of script files and function files.
- Programming in MATLAB: Loops and conditional statements.

1. Working on different MatLab commands to understand MATLAB usage.
2. Simulation of a typical first order & second order system and determination of step response of the system using MatLab.
3. Determine the frequency response of second order system and evaluation of frequency domain specifications using MatLab.
4. Obtain the unit impulse response, ramp response & sinusoidal input response of the second order system using MatLab.
5. Obtain the root locus plot for the given open loop transfer function G(s) H (s). Determine the closed loop poles that have the damping ratio 0.5. Find the gain value K at this point.
6. Obtain the gain margin and Phase margin for a given transfer function by drawingBode plots and verify the same using MatLab.

7. Find the find the value of gain K for a specified Gain margin and Phase margin for a given transfer function by drawing Bode plots using MatLab.
8. Examine the stability of the closed loop unity-feedback system with the open loop transfer function, draw the Nyquist plot.
9. Using MatLab SIMULINK, simulate the three linear systems to compare their step responses.
10. Using MatLab SIMULINK, simulate the feedback systems.

UNIVERSITY PRACTICAL EXAMINATION
Allotment of Marks
Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]
SPLIT UP OF INTERNAL MARKS

Record Note	=	10 marks
Conduction of experiments	=	10 marks
Internal Assessment	=	20 marks
Total	=	40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

SEMESTER : VII
COURSE CODE : 16ME481

TITLE OF THE COURSE : PROJECT WORK STAGE - I
L: T/A:P: C : 0 : 0 : 4 : 2

Course Objectives

1. To develop the work practice in students to apply theoretical and practical tools/techniques
2. To improve the professional competency
3. To improve research aptitude by touching the areas which otherwise not covered by theory or laboratory classes.
4. To solve real life problems related to industry and current research.

Course outcomes

1. Solving of real time problems not necessarily new line of enquiry, but shows that student has interest in research and synthesising skills in producing a contribution to knowledge.
2. Builds competency and research aptitude.

The project work for B.Tech consists of Project Work Stage - I and Project Work Stage - II. Project Work Stage - I is to be undertaken during B.Tech VII semester and Project Work Stage - II, which is generally a continuation of Project Work Stage - I and is to be undertaken during B.Tech VIII semester.

GENERAL SUGGESTIONS AND EXPECTATIONS

The Project Work is by far the most important single piece of work in the programme. It provides the opportunity for student to demonstrate independence and originality, to plan and organize a large Project over a long period and to put into practice some of the techniques student have been taught throughout the course. The students are advised to choose a Project that involves a combination of sound background research, a solid implementation, or piece of theoretical work, and a thorough evaluation of the Project's output in both absolute and relative terms. Interdisciplinary Project proposals and innovative Projects are encouraged and more appreciable.

It is good to try to think of the Project as a deliverable at reviews rather than an effort to deliver a fully functioning 'product'. The very best Projects invariable covers some new ground, e.g. by developing a complex application which does not already exit, or by enhancing some existing application or method to improve its functionality, performance etc.

A straightforward implementation Project is acceptable, but student must appreciate that it is unlikely to gain high marks, regardless of how well it is done and its usage. Likewise, Projects which are predominantly survey reports, unless they are backed up with experimentation, implementation, on theoretical analysis, e.g. for performing an

objective comparison of surveyed methods, techniques etc. pure survey reports with no supporting implementation or theory, are not acceptable.

1. Undergraduate students are to decide on the Project Work Stage - I and Project Work Stage - II Project with their proposal and Project Supervisor during the month of July/August with a Synopsis consisting of about three chapters –
    a. Introduction,
    b. Literature Review
    c. Methodology which should highlight the deliverables.
2. In Case of re-reviews, any number of re-reviews can happen depending on the discretion of the committee and it should happen within the prescribed time.
3. If the student fails to attend, the Supervisor refuses to endorse the student's work. The committee can invite Head of the Department who is empowered to resolve among further matters.
4. If the work of the candidate is found to be insufficient and plagiarism, the committee and Head of the Department will decide the further process.
5. Head of the Department can initiate further steps to ensure the smooth implementation as deems appropriate of guidelines.

- The idea for student's Project may be a proposal from a faculty member or student's own, or perhaps a combination of the two.
- All B. Tech projects are to be done in the Institute. For industry specified projects, students will be permitted to spend 1-2 weeks in the industry on recommendation by the supervisor. The number of students per batch should be 4.
- The End Semester evaluation shall be based on the report submitted and a viva-voce exam by committee comprising of the head of the department, project supervisor and an external examiner.

The Departmental Committee (DC) consists of HOD, Supervisor and two senior experts in the department. The committee monitors the progress of Project Work. The DC is constituted by the Principal on the recommendations of the department Head
Student shall register for the Project work with the approval of Departmental Committee in the B.Tech VII semester and continue the work in the B.Tech VIII semester too. The Departmental Committee (DC) shall monitor the progress of the project work. In B.TechVII semester, Stage - I of the Project Work is to be completed. A team has to identify the topic of work, collect relevant Literature, preliminary data, implementation tools / methodologies etc., and perform a critical study and analysis of the problem identified. They shall submit status report in addition to oral presentation before the Departmental Committee for evaluation.

A candidate shall continue the Project Work in B.Tech VIII semester (Stage - II) and submit a Project report at the end of Stage - II after approval of the Departmental Committee. During Stage - II, the teams shall submit status report in addition to oral presentation before the DC. The DC shall evaluate the project for internal marks (Stage - I & II) based on the progress, presentations and quality of work.

SEMESTER : VIII
COURSE CODE : 16ME429
TITLE OF THE COURSE : FEM-STRUCTURAL MECHANICS APPLICATIONS
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

- To Understand the fundamental ideas of the FEM
- To Prepare a suitable FE model for structural mechanical analysis problems
- In understanding of the significance, calculation, interpretation and convergence criteria for structural mechanics.

Course Outcomes

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

- Have acquired knowledge of finite element analysis linear and nonlinear analysis of structural application problems.
- Evaluate and interpret FEA analysis results for structural design and evaluation purposes.

Module I: Analysis of Beams and Frames 08L Hrs

Beam Elements –Analysis of Beams and Frames, 1-D Beam Element, 2-D Beam Element, 3-D Beam Element, Shear Flexible Beam Elements, Test Problems, practical Applications and computational Problems.

Module II : Finite Elements for Plates, Plate Theories 08L Hrs

Finite Elements for Plates, Plate Theories – Classical plate theory, shear deformation theory, improved shear deformation theory. Kirchoff Plate Elements, Mindlin Plate Elements, Test Problems, Practical Applications and Computational Problems.

Module III: Finite Elements or Shells 10L Hrs

Finite Elements or Shells, Flat Shell Elements: Facet Approximation, Curved Shell Elements Isoparametric Shell Elements: Eight- node quadrilateral shell element. Axisymmetric Shell Elements, Practical Applications in Stress analysis of industrial fan impeller, Vibration analysis of a cylinder cantilever shell, Buckling analysis of a blade stiffened panel, Nonlinear behavior of a curved panel , Computational Problems.

Module IV: Finite Element Analysis Programs 08L Hrs

Finite Element Analysis Programs- FEA Program, Organization, Capabilities-Material Models Element library, procedures library, Data processing. FEA Program- A Catalogue, MSc.Nastran, NISA, MARC.LS-DYNA, ANSYS.

Module V: Advanced Applications 10L Hrs

Advanced Applications, Nonlinear Finite Element Analysis, Analysis of laminated Composite Structures. Computational Fracture Mechanics, Structural Optimization, Computational Heat Transfer, Computational Fluid Dynamics, Electromagnetic and Coupled- Field analyses, Simulation of Manufacturing Processes.

Text books

1. Lakshminarayana, H. V. Finite Element Analysis Procedures in Engineering, Universities Press private Limited, Hyderabad, 2012.

Reference books

1.Tirupathi R. Chandrupatla, Ashok D. Belegundu,Introduction to Finite Elements in Engineering, PHI Learning, 2008.

SEMESTER : VIII
COURSE CODE : 16ME430
TITLE OF THE COURSE : DESIGN OF EXPERIMENTS
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

- This course is designed for those interested in the design, conduct, and analysis of experiments in the physical, chemical, engineering, or industrial sciences.
- The course will examine how to design experiments, carry them out, and analyze the data they yield.

Course Outcomes

It is desired that at the end of the course, the student will be equipped with the basic knowledge and art of statistical data analysis combined with systematic approaches to experimental design.

Module I: Introduction & Basic Statistical Concepts 09L Hrs

Basic Principles, Guidelines for Designing Experiments, Typical applications of Experimental design, Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size.

Module II :Experimental Design 09L Hrs

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.

Module III: Analysis and Interpretation Methods 08L Hrs

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

Module IV: Quality by Experimental Design 09L Hrs

Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust Design: Steps in Robust Design: Parameter design and Tolerance Design. Reliability Improvement through experiments, Illustration through Numerical examples.

Module V: Experiment Design Using Taguchi's Orthogonal Arrays 09L Hrs
Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples.

Text books

- D.C. Montgomery "Design and Analysis of Experiments", 7th edition John Wiley and sons, NewYork.
- Das. M.M. and Giri N.C., Design and Analysis of Experiments.

Reference Books

- Fisher R.A. Design of Experiments.
- Dean Voss: Design And Analysis Of Experiment

SEMESTER : VIII
COURSE CODE : 16ME431
TITLE OF THE COURSE : AUTOMATION IN MANUFACTURING
L: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

1. To provide a comprehensive introduction to industrial automation
2. To introduce the modeling methods for the performance analysis and design of automation systems
3. To provide comprehensive introduction of various automation systems and related techniques for programming and system analysis.

Course Outcomes
Students will be able to

1. Appreciate the relevance of industrial automation.
2. Analyze the performance of automated production lines and automated assembly systems.
3. Design and draw the functional and logic circuits for the programming of the control elements for automation.
4. Understand the role of computer-numerical control and robotics in programmable automation and estimate the effectiveness of programmable automation using cycle time analysis
5. Become familiar with the tools and techniques for automated inspection.

Module I: Introduction 08L Hrs

Automation in production systems. Fixed, flexible and programmable automation. Principles, reasons and strategies for automation.
Automated systems – elements, functions, levels of automation. Continuous Vs discrete control.
Product/production relationships, Production concepts and mathematical models, Costs of manufacturing operations.

Module II : Automated Production Lines and Automated Assembly 08L Hrs

Fundamentals of automated production lines. Applications. Analysis of transfer lines with no internal storage. Analysis of storage lines with storage buffers.
Fundamentals of automated assembly systems. Design for automated assembly.

Module III: Control Elements for Automation 10L Hrs

Sensors, Sensors position and velocity feedback. Actuators. Servo control. ADC, DAC.
Control of electro-hydraulic and electro-pneumatic systems – Fluid-power symbols and fluid-power control circuits.
Programmable logic controllers – architecture - Ladder logic diagrams.

Module IV: Programmable Automation 10L Hrs

NC and CNC units – Part programming – Direct Numerical control – Adaptive control.
Robot anatomy – specifications – end effectors – applications in manufacturing.
Robot cell design and control. Robot cycle-time analysis. Flexible manufacturing systems.

Module V: Automated Material Handling and Inspection **08L Hrs**

Automated guided vehicle systems. Automated storage and retrieval systems, carousel storage, and their analysis.
Automated inspection systems: Inspection metrology and conventional methods. Coordinate measuring machine. Surface measurement. Introduction to Machine Vision and other optical methods. Non-contact and non-optical inspection techniques.

Text books

1. M. P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson, 2016.

Reference books

1. B. Benhabib, Manufacturing: Design, Production, Automation and Integration, New York: Marcel Dekker, 2003
2. Y. Altintas, Manufacturing Automation, Cambridge University Press, 2nd Edition, 2012.
3. J.A. Rehg, Introduction to Robotics in CIM Systems, 5th edition, Prentice Hall, 2003.
4. G.G. Rigatos, Intelligent Industrial Systems: Modeling, Automation and Adaptive Behavior, Information Science Reference, New York, 2010.
5. W. Bolton, Mechatronics: A Multidisciplinary Approach, 4th Edition, Pearson, 2008.
6. M.P. Groover et al., Industrial Robots: Technology, Programming and Applications, McGraw Hill, 2008.

SEMESTER : VIII
COURSE CODE : 16ME432
TITLE OF THE COURSE : ORGANIZATION BEHAVIOUR & PROFESSIONAL COMMUNICATION
L: T/A:P: C : 3 : 0 : 0 : 3

Course Learning Objectives

1. To study the behaviour of individuals and groups as part of the social and technical system in the workplace.
2. To examine individual and group behaviour, communication, conflict and various management styles, motivational techniques and coordination in the work environment and apply these concepts to the development of an organization's human resources.

Course Outcomes

Upon successful completion of this course, the student will have demonstrated the ability:

1. To discuss the development of the field of organizational behaviour and explain the micro and macro approaches.
2. To analyze and compare different models used to explain individual behaviour related to motivation and rewards.
3. To identify the processes used in developing communication and resolving conflicts.

Module I: Introduction 08L Hrs

Definition of Organization Behaviour and Historical development, Environmental context (Information Technology and Globalization, Diversity and Ethics, Design and Cultural, Reward Systems). Foundations of individual behaviour, individual differences. Ability. Attitude, Aptitude, interests. Values.

Module II : Learning and Perception 08L Hrs

Definition, Theories of Learning, Individual Decision Making, classical conditioning, operant conditioning, social learning theory, continuous and intermittent reinforcement. Definition, Factors influencing perception, attribution theory, selective perception, projection, stereotyping, Halo effect.

Module III: Motivation 10L Hrs

Maslow's Hierarchy of Needs theory, Mc-Gregor's theory X and Y, Hertzberg's motivation Hygiene theory, David Mc-Clelland's three needs theory, Victor Vroom's expectancy theory of motivation.

Module IV: The groups, conflict and stress management 08L Hrs

Definition and classification of groups, Factors affecting group formation, stages of group development, Norms, Hawthorne studies, group processes, group tasks, group decision making. Definition of conflict, functional and dysfunctional conflict, stages of conflict process. Sources of stress, fatigue and its impact on productivity. Job satisfaction, job rotation, enrichment, job enlargement and reengineering work process

Module V: Principles of Communication **10L Hrs**

Useful definitions, communication principles, communication system, role of communication in management, barriers in communication, how to overcome the barriers, rule of effective communication.

Text books

1. Organizational behavior-Afsaneh Nahavandi, Robert Denhardt, Janet Denhardt, Maria Aristigueta- SAGE publications 2015
2. Organizational behavior- Stephen Robbins and Timothy Judge

Reference books

1. Business and professional communication- Sthephen A Beebe, Timothy P Mottet
2. Organizational behaviour and Management- John Martin

SEMESTER : VIII
COURSE CODE : 16ME482
TITLE OF THE COURSE : SEMINAR
L: T/A:P: C : 0 : 0 : 2 : 1

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- Each candidate shall deliver seminar as per the Scheme of Teaching and Examination on the topics chosen from the relevant fields for about 30 minutes.
- The Head of the Department shall make arrangements for conducting seminars through concerned faculty members of the Department.

The committee constituted for the purpose by the Head of the Department shall award the CIA marks for the seminar. The committee shall consist of three faculty from the Department and the senior most acting as the Chairman/Chairperson.

Topic Selection
Topic should be based on the literature survey on any topic relevant to Mechanical Engineering. At least five journal papers should be referred for topic selection. It is desirable that the selected topic may be leading to selection of a suitable topic of dissertation. Each student has to prepare a write-up of about 25to 50 pages. The report typed on A4 sized

Report: Each student has to prepare a write sheets and bound in the necessary format, should be submitted after approved by the guide and endorsement of the Head of Department.

Seminar Delivery: The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

SEMESTER : VIII
COURSE CODE : 16ME483
TITLE OF THE COURSE : PROJECT WORK STAGE - II
L: T/A:P: C : 0 : 0 : 2 : 1

Course Learning Objective

The main objective of the Project Work is for the students to learn and experience all the major phases and processes involved in solving "real life engineering problems".

Course Outcomes

Students must have acquired:

- System integration skills
- Documentation skills
- Project management skills
- Problem solving skills

The project work shall be spread over in B.Tech VII semester and B.Tech VIII semester. The project work shall be somewhat innovative in nature, exploring the research bent of mind of the student. A project batch shall comprise of not more than four students. The project work shall be evaluated for 100 marks out of which 100 marks for internal evaluation and 100 marks for end-semester evaluation.

The Departmental Committee (DC) consists of HOD, Supervisor and two senior experts in the department. The committee monitors the progress of Project Work. The DC is constituted by the Principal on the recommendations of the department Head.

A candidate will continue the Project Work in B.TechVIII semester (Stage - II) and submit a Project report at the end of Stage - II after approval of the Departmental Committee. During Stage - II, the teams shall submit status report in addition to oral presentation before the DC. The DC shall evaluate the project for internal marks based on the progress, presentations and quality of work.

The report generally contains:

- Cover
- Title page
- Certificate(s)
- Acknowledgements
- Abstract
- Contents page
- List of figures or Tables
- Introduction
- Literature survey
- Methodology
- Results and Discussion
- Conclusion and scope of future work.
- Reference list / Bibliography
- Appendices.

Avoiding plagiarism

1. Plagiarism is taking the words, theories, or ideas of another person and passing them off as your own.
2. Plagiarism can be copying inadvertently/advertently a passage from a book or journal or pasting something from the internet into report without referencing the original source.
3. Plagiarism can also result from wrong referencing**.**

Avoiding plagiarism

The guide/supervisor shall certify that the report is checked for plagiarism and is within 25% of the content.

The project work shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed. It is expected that students should refer national and international journals, proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work/experimentation carried out on the thesis topic. Student should submit the project work covering the content discussed above and highlighting the features of work to be carried out in the work. Student should follow standard practice of thesis writing. At the end of successfully finishing the work he/she has to submit a detailed report and has to present for a viva–voce.

Every candidate doing B.Tech. shall be encouraged to send a paper for publication in a journal or a conference - preferably a concept paper related to their topic highlighting their contribution and the results of their work. An acknowledgement from the Supervisor for having communicated to the journal or conference shall be attached to the report of the Project Work.

INSTITUTION ELECTIVES

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE401
TITLE OF THE COURSE : ARTIFICIAL INTELLIGENCE
L: T/A: P: C : 3 :0 : 0 : 3

COURSE OBJECTIVES:

To search and discover intelligent characteristics of existing AI projects, map a new problem – as search and create an animation – showing different search strategies for a problem, program a new game/ problem in Prolog, evaluate different Knowledge Representation schemes for typical AI problems, design and implement a typical AI problem to be solved Using Machine Learning Techniques, design and implement a futuristic AI application

COURSE OUTCOMES: At the end of the course students will be able to

1) Understand the concepts of AI and problem solving techniques
2) Get to know the representation of knowledge
3) Understand Machine Learning and different techniques of learning
4) Use of ANN and it's applications in real life situation

Module I **09 Hrs**

INTRODUCTION

Introduction – Definition - Future of Artificial Intelligence – Characteristics of Intelligent Agents –Typical Intelligent Agents – Problem Solving Approach to Typical AI problems

PROBLEM SOLVING METHODS

Problem solving Methods - Search Strategies- Uninformed - Informed – Heuristics-Local Search Algorithms and Optimization Problems - Searching with Partial Observations

Constraint Satisfaction Problems – Constraint Propagation - Backtracking Search-Game Playing -Optimal Decisions in Games -Alpha--Beta Pruning -Stochastic Games

Module 2 **09 Hrs**

KNOWLEDGE REPRESENTATION

First Order Predicate Logic – Prolog Programming - Unification

Forward Chaining -Backward Chaining - Resolution –Knowledge Representation

Ontological Engineering - Categories and Objects-Events - Mental Events and Mental Objects

Module 3 **09 Hrs**

Reasoning Systems for Categories - Reasoning with Default Information

Machine Learning

Probability basics - Bayes Rule and its Applications - Bayesian Networks – Exact and Approximate Inference in Bayesian Networks

Hidden Markov Models - Forms of Learning - Supervised Learning - Learning Decision Trees - Regression and Classification with Linear Models

Module 4 **09 Hrs**

Artificial Neural Networks - Nonparametric Models - Support Vector Machines - Statistical Learning - Learning with Complete Data

Learning with Hidden Variables- The EM Algorithm – Reinforcement Learning

APPLICATIONS

AI applications – Language Models - Information Retrieval - Information Extraction

Module 5 **09 Hrs**

Natural Language Processing - Machine Translation – Speech recognition

Robot – Hardware – Perception – Planning – Moving

TEXT BOOKS:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 3rd Edition, 2009

2. Bratko, I., Prolog Programming for Artificial Intelligence (International Computer Science Series), Addison-Wesley Educational Publishers Inc; 4th edition, 2011.

3. David L. Poole, Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.

REFERENCES:

1. M. Tim Jones, Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc; 1 edition, 2008

2. EthemAlpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning series), The MIT Press; second edition, 2009

3. Nils J. Nilsson, the Quest for Artificial Intelligence, Cambridge University Press, 2009.

4. William F. Clocksin, and Christopher S. Mellish, "Programming in Prolog: Using the ISO Standard, Fifth Edition, Springer, 2003.

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE402
TITLE OF THE COURSE : DATA STRUCTURES & ALGORITHMS
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:

1) To study Data Structures, and their implementation
2) To learn Graphs and Trees
3) To study algorithms using the Divide and Conquer and Greedy strategies

COURSE OUTCOMES: At the end of the course students will be able to

1. Understand different data structures such as arrays, stack, queues, dynamic data structures and implement them
2. Understand the fundamental concepts of graphs and trees and their implementation
3. Will be understand divide and conquer principle and Greedy Strategy and apply them in solving problems

Module I **09 Hrs**

Introduction to Data structures:

Data structures: Definition, Types. Algorithm design, Complexity, Time-Space Tradeoffs. Use of pointers in data structures. Array Definition and Analysis

Representation of Linear Arrays in Memory, Traversing of Linear Arrays, Insertion And Deletion, Single Dimensional Arrays, Two Dimensional Arrays, Multidimensional Arrays

Function Associated with Arrays, Character String in C, Character String Operations, Arrays as parameters, Implementing One Dimensional Array, Sparse matrix.

Module 2 **09 Hrs**

Introduction to Stacks and queue

Stack: Definition, Array representation of stacks, Operations Associated with Stacks- Push & Pop, Polish expressions, Conversion of infix to postfix, infix to prefix (and vice versa) Tower of Hanoi problem.

Queue: Definition, Representation of Queues, Operations of queues- QInsert, QDelete, Priority Queues, Circular Queue, Deque.

Dynamic Data Structure: Linked list, Introduction to Singly linked lists: Representation of linked lists in memory, Traversing, Searching, Insertion into, Deletion from linked list.

Module 3 **09 Hrs**

Dynamic Data Structure (continued)

Linked list: doubly linked list, circular linked list, generalized list. Applications of Linked List polynomial representation using linked list and basic operation. Stack and queue implementation using linked list.

Trees & Graphs: Basic Terminology, Binary Trees and their representation, expression evaluation, Complete Binary trees, extended binary trees,

Traversing binary trees, Searching, Insertion and Deletion in binary search trees.

Module 4 **09 Hrs**

Trees and Graphs (continued)

Trees General trees, AVL trees,

Graphs: Terminology and Representations, Graphs &Multigraphs, Directed Graphs, Sequential representation of graphs, Adjacency matrices, Graph Transversal, Connected Components and Spanning trees.

Sorting: Insertion sort, Quick sort, merge sort, and heap sort. Hashing techniques

Module 5 **09 Hrs**

Divide and Conquer and Greedy Algorithms
Structure of divide-and-conquer algorithms: examples; Binary search, quick sort, Merge sort**,** Strassen Multiplication; Analysis of divide and conquer run time recurrence relations.

Greedy Method

Overview of the greedy paradigm examples of exact optimization solution, (minimum cost spanning tree), Approximate solution (Knapsack problem), Single source shortest paths, travelling salesman

Text Books

1. Horowitz Anderson-Freed, and Sahni, "Fundamentals of Data structures in C", 2nd Edition, Orient Longman, 2008
2. Data Structures and Algorithm analysis in C by Mark Allen Weiss, Published by Addison Wesley (3rd Indian Reprint 2000).

REFERENCES:

1. A M Tannenbaum, Y Langsam, M J Augentien "Data Structures using C ", Pearson, 2013
2. R.L. Kruse, B.P. Leary, C.L. Tondo, "Data structure and program design in C" PHI
3. File Structures An object-Oriented Approach with C++ by Michael J. Folk, Bill Zoellick, BregRiccardi, Published by Addison Wesley (1st ISE Reprint,1999).
4. D E Knuth, The Art of Computer Programming, Volume 1, Addison-Wesley Publishing, 2013

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE403
TITLE OF THE COURSE :WEB TECHNOLOGIES
L: T/A: P: C : 3 :0 : 0 : 3

COURSE OBJECTIVES:

1) To study XHTML, Dynamic HTML
2) To introduce Java Script and XML,
3) To get exposed to Web Services and Multimedia

COURSE OUTCOMES: At the end of the course students will be able to

1) Understand, analyze and build dynamic and interactive web sites
2) Install and manage server software and server side tools.
3) Understand current and evolving Web languages for integrating media and user interaction in both front end and back end elements of a Web site
4) Analysis and reporting of web data using web analytics
5) Applying different testing and debugging techniques and analyzing the web site effectiveness.

MODULE 1: 08 Hrs

Creating home pages, Introduction to XHTML- Editing XHTML, First XHTML Example, W3C XHTML Validation Service, Headers, Linking, Images, Special Characters and More Line Breaks, Unordered Lists, Nested and Ordered Lists, Internet and World Wide Web Resources.

MODULE 2: 09 Hrs

Dynamic HTML: Object Model and Collections- Introduction, Object Referencing, Collections all and children, Dynamic Styles, Dynamic Positioning, Using the frames Collection, navigator Object, Summary of the DHTML Object Model, Dynamic HTML: Event Model- IntroductionEvent onclick, Event onload, Error Handling with onerror, Tracking the Mouse with Event onmousemove, Rollovers with onmouse over and onmouse out, Form Processing with onfocus and onblur, More Form Processing with onsubmit and onreset, Event Bubbling, More DHTML Events. Dynamic HTML Filters and transitions, Dynamic HTML Data binding with tabular data control, Structured graphics and active X control.

MODULE 3 09 Hrs

JavaScript: Functions- Introduction, Program Modules in JavaScript, Programmer-Defined Functions, Function Definitions, Random-Number Generation, Example: Game of Chance, Duration of Identifiers, Scope Rules, JavaScript Global Functions, Recursion, Example Using Recursion: Fibonacci Series, Recursion vs. Iteration, JavaScript Internet and World Wide Web Resources. JavaScript arrays, JavaScript objects.

Module 4 **09 Hrs**

Extensible Markup Language (XML)- Introduction, Structuring Data, XML Namespaces, Document Type Definitions (DTDs) and Schemas, Document Type Definitions, W3C XML Schema Documents, XML Vocabularies, Chemical Markup Language (CML), Other Markup CO1 Understand, analyze and build dynamic and interactive web sites CO2 Install and manage server software and server side tools. CO3 Understand current and evolving Web languages for integrating media and user interaction in both front end and back end elements of a Web site CO4 Analysis and reporting of web data using web analytics CO5 Applying different testing and debugging techniques and analyzing the web site effectiveness. Languages, Document Object Model (DOM), DOM Methods, Simple API for XML (SAX), Extensible Style sheet Language (XSL), Simple Object Access Protocol (SOAP), Internet and World Wide

Module 5 **08 Hrs**

Web Resources, Web Servers (IIS, PWS and Apache)- Introduction, HTTP Request Types, System Architecture, Client-Side Scripting versus Server-Side Scripting, Accessing Web Servers, Microsoft Internet Information Services (IIS), Microsoft Personal Web.

Multimedia, PHP, String Processing and Regular Expressions, Form processing and Business logic, Dynamic content, Database connectivity, Applets and Servlets, JDBC connectivity, JSP and Web development Frameworks.

Text Books:

1. Deitel, Deitel and Nieto, Internet and Worldwide Web - How to Program, 5th Edition, PHI, 2011.

2. Bai and Ekedhi, The Web Warrior Guide to Web Programming, 3rd Edition, Thomson, 2008

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE404
TITLE OF THE COURSE : MANAGEMENT INFORMATION SYSTEMS
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:

1) To learn Computer Systems, fundamentals of Information Systems, Telecommunications and Networks,
2) To study and understand the Data Source Management and DSS and Business Applications

COURSE OUTCOMES: At the end of the course students will be able to

1. Understand Computer Systems, Networks and fundamentals of Information Systems
2. Know the Data Resource Management and Decision Support System and apply them to Business Applications

Module 1:Computer System 07 Hrs

Introduction to computer technology, Computer System Concepts, Types of Computer Systems, Computer System Concepts, Memory (Primary Storage, Secondary Storage, Cache), CPU-Central Processing Unit, Hardware (input Devices, output Devices, Software and its Classification, Types of Computer System.

Module 2: Foundation of Information System 09 Hrs

Data, Data processing, Information, Information System, Characteristics of Information System, Need of Information Systems in Business, Fundamental Resources of Information System, Potential Risks for Information System, Types of Information System(TPS,MIS,DSS,ESS),Definition, objectives of MIS, Characteristics, Applications of MIS, Benefits and Limitations of MIS, Approaches of MIS Development, Implementations of MIS, System Development Life Cycle (SDLC) and its Stages, Success and Failure of MIS.

Module 3: Telecommunication and Network 07 Hrs

Networking the Enterprise, The Concept of a Network, The Business value of Telecommunications Networks, Types of Telecommunications Networks, Telecommunications Media, Network Topologies , Trends in Telecommunications.

Module 4: Data Resource Management and DSS **12 Hrs**

Fundamental Data Concepts, Database structures, Database Development, Types of Databases, Technical Foundation of Database Management, Data warehouses and Data Mining, Decision Support in Business, Decision Structures, Decision Support Trends Decision Support Systems, online Analytical Processing. Using Decision support systems. Practical: Microsoft Access, Database Creating New Database, Setting up Tables, Form and Report Design.

Module 5: Business Applications **11 Hrs**

E-business systems, Customer Relationship Management Customer Relationship Management CRM, Three Phases of CRM. Benefits and Challenges of CRM, Trends in CRM, Enterprise Resource Planning Enterprise Resource Planning ERP Benefits and Challenges of ERP, Trends in ERP supply Chain Management SCM, Roles of SCM, Benefits and Challenges of SCM, Trends in SCM, Ecommerce Systems E-Commerce and its scope, Essential e-Commerce Processes, Electronic Payment Processes.

Applications and Case Studies : Introduction to Hospitality Information System, Characteristics of Hospitality Information System, Computer Reservation System (CRS), Global Distribution System (GDS), Property Management Systems (PMS), Point of sales Systems(POS)

Text Book :

1. O'Brien, J. A, Marakas, G. M. Management Information systems (10th Edition)

McGraw Hill,New Work: 2011

Reference Book:

1. Kenneth, C. L. Jane P. L Management Information Systems (12th Edition) Pearson Education, New Jersey 2010
2. Tesone, D. F. Hospitality Information System & E-commerce John Wiley & Sons, New Jersey, 2006

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE421
TITLE OF THE COURSE : SENSORS, NETWORKS & PROTOCOLS
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:

1. Understand the basic principles and performance issues in sensor operation.
2. Detailed discussion of communication in wired and wireless embedded system
3. Understand the wireless network communication stack, protocols and sensor network applications

COURSE OUTCOMES:

1. grasp of the principles and practical implementation of interfacing the microcontroller with real world signals
2. Gain insight into various concepts of wireless and embedded Networks
3. Challenges with deploying sensors
4. Gain insight into Ethernet
5. Gain insight into Ethernet GSM Architecture, Protocols,

UNIT- I:
INTRODUCTION TO SENSORS (10 Hrs)
Explanation and examples of sensors, Theory on how sensors work Sensor arrays, grids and WSNs, Challenges with deploying sensors - Calibrating sensors, signal conditioning, replacement, etc. Choosing sensors -Parameters to keep in mind, survey of sensor input mechanisms & signal conditioning

UNIT- II:
EMBEDDED COMMUNICATION PROTOCOLS: (10 Hrs)
Embedded Networking: Introduction, Serial/Parallel Communication, Serial communication protocols, RS232 standard, RS485, Synchronous Serial Protocols-Serial Peripheral Interface (SPI), Inter Integrated Circuits (I2C), PC Parallel port programming, ISA/PCI Bus protocols, Fire wire.

UNIT- III:
ETHERNET BASICS: (10 Hrs)
Elements of a network, Inside Ethernet, Building a Network: Hardware options: Cables, Connections and network speed, Design choices: Selecting components, Ethernet Controllers. Using the internet in local and internet communications, Internet protocol, UDP and TCP concepts, Serving web pages with Dynamic Data, Serving web pages that respond to user Input, Email for Embedded Systems, Using FTP, Keeping Devices and Network secure.

UNIT- IV:

WIRELESS EMBEDDED NETWORKING: (10 Hrs)

Wireless sensor networks: Introduction, Applications, Network Topology, Localization ,Time Synchronization , Energy efficient MAC protocols , SMAC, Energy efficient and robust routing , Data Centric routing, Wireless LAN – IEEE 802.11 Standard-Architecture, Services – AdHoc Network , Hiper LAN, Blue Tooth.

UNIT- V:

MOBILE NETWORKS: (10 Hrs)

Cellular Wireless Networks, GSM Architecture, Protocols, Connection Establishment, Frequency Allocation, Routing, Handover, Security GPRA

TEXT BOOKS:

1. Frank Vahid, Givargis 'Embedded Systems Design: A Unified Hardware/Software Introduction', Wiley Publications, 2002
2. Robert B. Northrop: "Introduction to Instrumentation and Measurements", 2nd edition, CRC press

REFERENCES:

1. Jan Axelson, 'Parallel Port Complete' , Penram publications, 2006
2. Dogan Ibrahim, 'Advanced PIC microcontroller projects in C', Elsevier 2008
3. Bhaskar Krishnamachari, 'Networking wireless sensors', Cambridge press 2005
4. KavehPahlavan, Prasanth Krishnamoorthy, " Principles of Wireless Networks' PHI/Pearson Education, 2003

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE422
TITLE OF THE COURSE : IMAGE PROCESSING AND COMPUTER VISION
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:

1. To make students understand image fundamentals and how digital images can be processed
2. To understand Image enhancement techniques and its application, Image compression and its applicability, fundamentals of computer vision, geometrical features of images, object recognition
3. Application of real time image processing.

COURSE OUTCOMES:

1. Fundamentals of image processing.
2. Basic skills to enhancing images.
3. Fundamental and state of the art image compression standards.
4. Real time image processing with computer vision.
5. Image Recognition using Tensor flow

UNIT - Introduction: (10 Hrs)

Digital image representation, fundamental steps in image processing, elements of digital image processing systems digitization.

UNIT -2 Digital Image fundamentals: (10 Hrs)

A Simple Image Model, Sampling and Quantization, Relationship between Pixel, Image Formats, Image Transforms

UNIT -3 Image Enhancement: (10 Hrs)

Histogram processing, image subtraction, image averaging, smoothing filters, sharpening filters, enhancement in frequency and spatial domain, low pass filtering, high pass filtering.

UNIT -4 Image Compression: (10 Hrs)

Fundamentals, Image Compression Models, Elements of Information Theory, Error-Free Compression, Lossy Compression, Recent Image Compression Standards. Image recognition Case Study using Tensor flow

UNIT -5 Computer Vision: (10 Hrs)

Imaging Geometry; Coordinate transformation and geometric warping for image registration, Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal Component Analysis, Shape priors for recognition.

Text Books

1. Gonzalez, R.C.,and Woods, R.E., Digital Image Processing, Dorling Kingsley (2009)3rd ed.
2. Jain A.K., Fundamentals of Digital Image Processing, Prentice Hall (2007).
3. Sonka M., Image Processing and Machine Vision, Prentice Hall (2007) 3rd ed.
4. D. Forsyth and J. Ponce, Computer Vision - A modern approach, Prentice Hall.
5. B. K. P. Horn, Robot Vision, McGraw-Hill.
6. E. Trucco and A.Verri, Introductory Techniques for 3D Computer Vision, Prentice Hall.
7. Richard Szeliski, Computer Vision: Algos and Applications, Springer.

Reference Books

1. Tekalp A.M., Digital Video Processing, Prentice Hall (1995).
2. Ghanbari M., Standard Codecs: Image Compression to Advanced Video Coding, IET Press (2003).

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE423
TITLE OF THE COURSE : AUTOMOTIVE EMBEDDED SYSTEMS
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:

1. To provide the students the requisite skill to design and implement automotive embedded applications using micro-controllers.
2. To develop automotive applications using microcontrollers
3. To understand typical embedded microcontroller used in automotive industries, hardware interfacing and microcontroller programming in C and assembly languages are taught in detail.

COURSE OUTCOMES:

1. Explain real-time system principles, issues involved in the development of real-time
2. Analyse different features, architecture, peripheral interfacing and programming of embedded microcontrollers for automotive applications
3. Design, develop and implement automotive embedded systems by interfacing required peripherals with embedded microcontroller
4. Gain Insight in to Embedded Software development cycle
5. Gain Insight in to Architecture of Embedded Microcontroller

INTRODUCTION TO AUTOMOTIVE ECU SOFTWARE DEVELOPMENT USING ADVANCE MICROCONTROLLER

(10 Hrs)

Basics of ECU HW -Microcontroller/microprocessor -Signal conditioning circuits (input/output circuits) - Memory Layouts (RAM/ROM/Flash) -Understanding schematics of an ECU

ARCHITECTURE OF 16-BIT EMBEDDED MICRO-CONTROLLERS (10 Hrs)

Introduction to 68HC12 Family of Micro controllers -68HC12 in automotive applications –Architecture – Registers - 68HC12/68HCS12 - assembly language programming - 16-bit HCS12 CPU -SIM (System Integration module) -Clocks and Reset Generator (CRG) - Memory, Peripheral -On-chip Voltage Regulator

PERIPHERAL INTERFACING WITH 16-BIT MICRO-CONTROLLER (10 Hrs)

Timer -parallel port programming -Stepper motors – LCD – Keyboard - Serial Port – ADC – DAC - Sensor Interfacing - Interrupt handling - PWM generation - DC motor control - automotive embedded system Application development using IO and related programming –UART – SPI - I2C - Various ways to use the CAN module in HCS12 - Micro-controller based system development using IO related programming

TIMERS, ALARMS, COUNTERS, EVENTS, INTERRUPTS, EXCEPTIONS (10 Hrs)
Implementation of Timer – Alarms – Counters – Events - Interrupts and Exceptions in a Microcontroller

EMBEDDED SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC) (10 Hrs)
V Model Water fall - Requirement Engineering - Requirement gathering - Requirement analysis - Software Architecture - Software Prototyping - Software design - High level - Low level -Software Implementation - Software verification and validation -Software Development Practices - Basics of Project/Product Management -Software estimation - Resource planning and management - Risk Management - Software Quality processes - Requirement change management - Software Configuration management.

TEXT BOOK:

1. Frank Vahid and Tony Givargis, Embedded System Design: A Unified hardware/Software Introduction, John Wiley &Sons. (2002)
2. Muhammad Ali Mazidi, Danny Causey and Janice Mazidi. HCS12 Microcontrollers and Embedded Systems, Prentice Hall. (2008)

REFERENCES:

1. International Journal for Automotive Technology
2. IEEE Transactions on Vehicular Technologies
3. David E. Simon, (1999), an Embedded Software Primer, Pearson Education
4. The HCS12 - 9S12 - An Introduction to Software and Hardware Interfacing 2nd Edition - Huang

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE424
TITLE OF THE COURSE : EVOLUTION OF TELECOMMUNICATIONS
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:
1. To study the concept of Mobile radio propagation, cellular system design.
2. To understand mobile technologies like GSM and CDMA.
3. To know the mobile communication evolution of 2G, 3G and 3 GPP in detail.
4. To have overview of immerging technologies for 4 G standards.

COURSE OUTCOMES:
1. Understand GSM concepts and architecture, frame structure, system capacity, services provided.
2. Evolution of mobile communication generations 2G, 2.5G, 3G with their characteristics and limitations.
3. Understand CDMA concepts and architecture
4. Understand emerging technologies required for fourth generation mobile systems such as SDR, MIMO etc.
5. Long Term Evolution Technologies (LTE):

UNIT- I: (08 Hrs)
Introduction: Evolution of Telecommunications, Simple Telephone Communication, Manual switching system, major telecommunication Networks, Strowger Switching System, Crossbar Switching

UNIT – II: (10 Hrs)
Introduction to wire1ess communication
Fundamentals of Mobile Communication
Frequency Division Multiple access, Time Division Multiple access, Spread Spectrum Multiple access, Space Division Multiple access, and OFDM

UNIT- III: (10 Hrs)
2G Technologies
GSM Network architecture, signaling protocol architecture, identifiers, channels, introduction frame structure, speech coder RPE-LTP.
GSM evolution in GPRS and EDGE: Architecture and services offered.
IS-95 A& B(CDMA-1): Frequency and channel specifications of forward and reverse CDMA channel

UNIT –IV: (10 Hrs)
3G Technology
Network architecture, air Interface specification, forward and reverse channels in W-CDMA and CDMA 2000
Cell search and synchronization, establishing a connection, hand off and power control in 3G system, 3GPP LTE Introduction and system overview

UNIT – V: **(10 Hrs)**

4G Technology

4G Introduction and vision, Overview of 4G research initiatives and developments.
Long Term Evolution Technologies (LTE):
OFDM,MIMO channels, Space Time Codes, LTE Advanced

Text Books:

1. Theodore S. Rappaport, —Wireless Communications, Prentice Hall of India, PTR publication
2. Andreas Molisch, Wireless Communications, Wiley, Student second Edition.
3. Vijay Garg, Wireless Network Evolution 2G-3G, Pearson Education.
4. Young Kyun Kim and Ramjee Prasad, 4 G Roadmap and Emerging Communication Technologies, Artech house.

Reference Books:

1. Raj Pandya, —Mobile And Personal Communications Systems and Services, Prentice hall.
2. Singhal, —Wireless Communication, TMH
3. C.Y Lee, —Mobile Communication, Wiley
4. The evolution to 4G cellular systems: LTE-Advanced. Ian F. Akyildiz, David M. GutierrezEstevez, Elias Chavarria Reyes. Broadband Wireless Networking Laboratory, School of Electrical and Computer Engineering, Georgia Institute of Technology.
5. Vijay K. Garg, Wireless Communications and Networking, Morgan Kaufmann Publishers, 2007, ISBN 978-0-12-373580-5

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE441
TITLE OF THE COURSE : ENTREPRENEURSHIP MANAGEMENT
L: T/A: P: C : 3 : 0 : 0 : 3

Course Objectives

1. This course is designed to provide a comprehensive introduction to Entrepreneurship, entrepreneurship mind set, entrepreneurial strategy
2. Course introduces students to idea to Introduction to business opportunity to business plan to funding the venture to Funding the Venture to Launching, Growing, and Ending the New Venture

Course outcomes

At the end of the course student will be able to

1. Understand the terminologies entrepreneurship, entrepreneurship mind set, and entrepreneurial strategy.
2. Identifying opportunities from the idea.
3. Preparing the business plan, marketing, organizational and financial plans.
4. Various means of funding the venture.

Module 1 The Entrepreneurial perspective (09 Hrs)

a) Entrepreneurship and The Entrepreneurial mind-set
b) Corporate Entrepreneurship
c) Entrepreneurial Strategy: Generating and Exploiting New Entry Opportunities

Module 2 From Idea to the Opportunity (08 Hrs)

a) Creativity and the Business Idea
b) Identifying and Analyzing Domestic and International Opportunities
c) Protecting the Idea and Other Legal Issues for the Entrepreneur

Module 3 From the Opportunity to the Business (10 Hrs)

a) The Business Plan Creating and Starting the venture
b) The Marketing Plan
c) The Organizational Plan
d) The Financial Plan

Module 4 From Business Plan to Funding the Venture (08 Hrs)

a) Sources of Capital
b) Informal Risk Capital, Venture Capital, and Going Public

Module 5 (10 Hrs)

From Funding the Venture to Launching, Growing, and Ending the New Venture

a) Strategies for Growth and Managing the Implications of Growth
b) Accessing Resources for Growth from External Sources
c) Succession Planning and Strategies for harvesting and Ending the Venture

Text Book:

1. Robert D. Hesrich, Mathew J. Manimala, Michael P Peters, Dean A. Shepherd,
2. Entrepreneurship, 7^{th} Edition, MGH Education, 2014

Reference Books

1. Joe Abraham, Entrepreneurial DNA, MGH, 2011

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE442
TITLE OF THE COURSE : INNOVATION & ENTREPRENEURSHIP
L: T/A: P: C : 3 : 0 : 0 : 3

Course Objectives

1. This course introduces student's innovation.
2. Types of innovation, seven sources of innovation opportunity, the practice of innovation, the practice of Entrepreneurship and
3. Entrepreneurial strategies.

Course outcomes

At the end of the course the students will be able to

1. Know about innovation , different types of innovation.
2. Understand different sources where innovation can happen,
3. Know about the strategies to convert the innovation into a business.

Module 1: Introduction: (10 Hrs)
What is innovation, What are the skills of innovators? Can innovation skills be learnt? How is the Innovation generation different? How do we develop young people
to become innovators, Portrait of the young Innovator as a Young man, STEM Innovators

Module 2: **Practice of Innovation: (10 Hrs)**
Systematic Entrepreneurship; Purposeful Innovation and the seven sources for Innovation Opportunity; source: The Unexpected; source: Incongruities, source: Process Need;

Module 3 (09 Hrs)

The Practice of Innovation (Continued): Source: Industry and Market Structures; source: Demographics; source: The Changes in Perception; source: New Knowledge ;The Bright Idea; Principles Of Innovation;

Module 4 (09 Hrs)

The Practice of Entrepreneurship Entrepreneurial Management; the entrepreneurial Business; Entrepreneurship in theServices Institution; the New Venture.

Module 5 Entrepreneurial Strategies: (08 Hrs)

'Fustest with the Mostest' ; 'Hit Them Where They Ain't' ;
Ecological Niches; Changing Values and Characteristics

Text Books

1. Peter F Drucker, Innovation and Entrepreneurship, Routledge Taylor & Fransis Group, 2007.
2. Creating Innovators, Tony Wagner, Scribner Publications, 2015

Reference Books

1. Heike Mayer, Entrepreneurship and Innovation in Second Tier Regions, Edward Elgar, 2011.
2. Clayton M. Chrestensen, The Innovator's Dilemma, Harvard Business School Press, 1997.

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE443
TITLE OF THE COURSE : LOGISTICS & SUPPLY CHAIN MANAGEMENT
L: T/A: P: C : 3 : 0 : 0 : 3

Course objectives

1. To introduce various concepts related to the supply chain management.
2. To educate the importance of supply chain decision such as design, planning, and operations of a firm.
3. To give the students an understanding of the analytical tools necessary to solve supply chain problems.
4. To showcase the ways by which the companies use different supply chain drivers to improve their performance.

Course outcomes

1. The students would have learned about various concepts related to the supply chain management.
2. The students would have got educated about the strategic importance of supply chain design, planning and operational decisions.
3. Understanding and applications of the analytical tools to solve supply chain problems would have taken place.
4. Various case studies and illustrations would have inculcated the importance of supply chain drivers in improving the performance of an organization.

Module 1 INTRODUCTION TO SUPPLY CHAIN MANAGEMENT (08 Hrs)

Supply chain – historical perspective - objectives – importance – decision phases – process view – impellers of supply chain – financial measures of performance – drivers of supply chain performance – framework for structuring drivers – facilities – inventory – transportation – information – sourcing – pricing.

Module 2 DESIGNING DISTRIBUTION NETWORKS AND NETWORK DESIGN (10 Hrs)

Role of distribution – factors influencing distribution network design – design options for a distribution network – online sales and the distribution network – Distribution channels in Indian agricultural, FMCG and commodity sectors – Role of network design – factors influencing network design decisions – framework for network design decisions.

Module 3 DEMAND FORECASTING AND MANAGING UNCERTAINTY (08 Hrs)

Demand Forecasting: Role – characteristics – components – approach – time series methods – measures of forecast error – role of IT.

Managing uncertainty: Safety inventory and its appropriate level – impact of supply uncertainty, aggregation and replenishment policies.

Module 4 COORDINATION IN A SUPPLY CHAIN (10 Hrs)

Lack of supply chain coordination and the Bullwhip effect – Effect on performance – obstacles to coordination – managerial levers – continuous replenishment and vendor-managed inventories – collaborative planning, forecasting and replenishment – Indian experience.

Module 5 TRANSPORTATION AND SOURCING (10 Hrs)

Role of transportation – modes and their performance – design options and their trade-offs – Tailored transportation. Sourcing – In-house or Outsource – 3rd and 4th PLs – Scoring and assessing suppliers.
Case studies in SCM

Text books:

1. Sunil Chopra, Peter Meindl and Kalra D V, Supply Chain Management–Strategy, Planning and Operation, Pearson, 5th Edition, 2013.

2. Janat Shah, Supply Chain Management: Text and Cases, Pearson, 1st Edition, 2009.

Reference Books:

1. Donald J Bowersox, David J Closs, Bixby Cooper M, Supply Chain Logistics Management, Tata McGraw Hill, 2nd Edition, 2008.
2. Sople V V, Supply Chain Management – Text and Cases, Pearson Education, 2012.
3. Jeremy F Shapiro, Modeling the Supply Chain, Cengage Learning, 2nd Edition, 2007.
4. Coyle, Bardi, Longley, The management of Business Logistics–A supply Chain Perspective, Thomson Press, 7th Edition, 2006.

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE444
TITLE OF THE COURSE : DIGITAL MARKETING
L: T/A: P: C : 3 : 0 : 0 : 3

Course objectives

To learn how to do marketing online- Boost website traffic, generate potential leads & increase sales revenue with better brand awareness using internet platforms like Social Media, Email Marketing, Mobile Marketing, Ecommerce Marketing and Affiliate Marketing.

Course outcomes

1. Appreciate the challenges required for effective Marketing Management
2. Understand and apply the tools and techniques used in Marketing management
3. Anticipate Marketing and Sales problems and issues common in the modern workplace
4. implement Digital Marketing strategy for client requirements

UNIT-1

Digital Marketing Overview (07 Hrs)

Introduction, Key terms and concepts, What is marketing?, What is digital marketing? Why Digital Marketing wins over traditional Marketing ,Understanding marketing strategy, The building blocks of marketing ,

Understanding Digital Marketing Process: Increasing Visibility, Visitors engagement

UNIT-2

Search Engine Optimization and Search Markets (10 Hrs)

Stakeholders in Search, Customer Insights, On & off-page Optimization, Meta Tags, Layout, Content Updates, Inbound Links & Link Building, Goal Configuration &Funnels, Intelligence Reporting, Conversions, Bounce Rate, Traffic Sources, Scheduling etc.

UNIT-3

Social Media (10 Hrs)

What is Social Media Marketing? Overview of Facebook, Twitter, LinkedIn, Blogging, Youtube and Flickr, building Brand Awareness Using Social Media, Social Media Management, Insights and Analytics, Best Practice Examples & case Studies

UNIT-4 Website Analytics (09 Hrs)

Goal Configuration &Funnels, Intelligence Reporting, Conversions, Bounce Rate, Traffic Sources, Scheduling etc

UNIT-5 Email and Mobile Marketing (08 Hrs)

User Behavior, Segmentation, Key Metrics, Best Practice Case Studies, Split Testing, Campaign Process Optimization, SMS Strategy, Mobile Advertising, Mobile Optimized Websites, 7 Step Process for Mobile Apps, Proximity Marketing, Strategic Steps, Review & Testing

Text Books:

1. Digital Marketing, Vandana Ahuja, Oxford University Press
2. The Art of Digital Marketing: The Definitive Guide to Creating Strategic, Targeted, and Measurable Online Campaigns, Ian Dodson, Wiley 2016

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE461
TITLE OF THE COURSE : INDUSTRIAL ROBOTICS AND AUTOMATION
L: T/A: P: C : 3 : 0 : 0 : 3

Course Objectives

- To understand the various components of robotics and automation.
- To study the various sensors and controls.
- To study the robot actuation and feedback components.
- To know the future scenario of robots technology and artificial intelligence.

Course Outcomes

- Have comprehensive knowledge of robotics and automation from application point of view in industries.

- Understand automation with focus on the industrial end processes.
- Understand future of robotics technology & Artificial Intelligence.

Module I: Introduction to Industrial Robotics 10L Hrs

Robotics - Definition of Robot, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration. Robot motions, Joints, Work volume, Robot drive systems, Precision of movement – Spatial resolution, Accuracy, Repeatability, End effectors – Tools and grippers.

Module II : Introduction to Industrial Automation 08L Hrs

Automation -History of Automation, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies

Industrial Automation Systems: Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS.

Module III: Controllers, Actuators and feedback components 08L Hrs

Controllers and Actuators

Basic Control System concepts and Models, Transfer functions, Block diagrams, characteristic equation, Types of Controllers: on-off, Proportional, Integral, Differential, P-I, P-D, P-I-D controllers. Control system and analysis.

Robot actuation and feedback components

Position sensors – Potentiometers, resolvers, encoders, velocity sensors. Actuators - Pneumatic and Hydraulic Actuators, Electric Motors, Stepper motors, Servomotors, Power Transmission systems.

Module IV: Robot Sensors and Machine vision system 10L Hrs

Sensors in Robotics - Tactile sensors, Proximity and Range sensors, use of sensors in robotics.

Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems.

Module V: Robots Technology & Artificial Intelligence 08L Hrs

Robots Technology of the future: Robot Intelligence, Advanced Sensor capabilities, Telepresence and related technologies, Mechanical design features, Mobility, locomotion and navigation, the universal hand, system integration and networking.

Artificial Intelligence: Goals of AI research, AI techniques – Knowledge representation, Problem representation and problem solving, LISP programming, AI and Robotics, LISP in the factory.

Text books

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 1996.
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

Reference books

1. Ghosal A, Fundamental Concepts and Analysis, Robotics, Oxford, 2006.
2. Deb.S.R., Robotics technology and flexible Automation, John Wiley, USA 1992.

3. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.
4. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – An integrated approach,Prentice Hall of India, New Delhi, 1994.
5. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.
6. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., Robotics control, sensing, vision and intelligence, McGraw Hill Book co, 1987.

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE462
TITLE OF THE COURSE : TOTAL QUALITY MANAGEMENT
L: T/A: P: C : 3 : 0 : 0 : 3

Course Objectives

1. To provide the foundation concepts on total quality management.
2. To train on problem solving techniques for continuous improvement.

Course Outcomes

- Students will have the knowledge on quality tools.
- Students will be able to know the philosophies of quality management
- Students able to use the concepts of stastical process and quality control systems

Module I: Introduction to Quality Management 08L Hrs

Definitions – TOM framework, benefits, awareness and obstacles. Quality – vision, mission and policy statements. Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality.

Module II : Principles and Philosophies of Quality Management 08L Hrs

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle, Japanese 5S principles and 8D methodology.

Module III: Statistical Process Control and Process Capability 10L Hrs

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed.

Process capability – meaning, significance and measurement – Six sigma concepts of process capability.Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve.Total productive maintenance (TMP) – relevance to TQM, Terotechnology. Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.

Module IV: Tools And Techniques For Quality Management 10L Hrs

Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation. Seven old (statistical) tools. Seven new management tools. Bench marking and Poka Yoke.

Module V: Quality Systems Organizing and Implementation 08L Hrs

Quality Management Systems: ISO 9000 series of standard; ISO 14000 series of standards, guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward- Introduction to software quality.

Text books

1. Dale H.Besterfiled, et at., "Total Quality Management", Pearson Education Asia,Third Edition, Indian Reprint (2006).
2. ShridharaBhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.

Reference books

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, (2003).
3. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt. Ltd. (2006)

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE463
TITLE OF THE COURSE : AUTOMOBILE ENGINEERING
L: T/A: P: C : 3 : 0 : 0 : 3

Course Objectives

The course will enable the students to:

- Understand basics of Automobile Engineering & various Automotive system.
- Understand vehicle layout, vehicle specifications & important of automobile.
- Make the student conversant with drive train & transmission.
- Make the student conversant with Suspension, Steering, Brakes systems & Tyre Wheel assembly.
- Make the student conversant with Vehicle Maintenance & Garage Practice.
- Understand the various Automobile Electrical System, Vehicle performance & their safety.

Course Outcomes

After completion of the course student would be able to

- Handle technical & management problems in automotive industries.
- Diagnosis the faults of automobile vehicles.
- Understand various transmission systems, Suspension, brakes, Vehicle Performance, Vehicle Safety.

Module I: Introduction to Automobile Engineering 07L Hrs

Automobile history and development, current scenario in Indian auto/ ancillary industries, Role of the automobile industry in national growth, Classification, types of chassis layout with reference to power plant locations and drive, Vehicle frames, Various types of frames. Constructional details, Unitised frame body construction, Loads acting on vehicle frame, details of chassis material.

Module II : Drive Train & Transmission 09L Hrs

Classification of clutches, Single plate & with dual flywheel effect, Multi plate, Cone, diaphragm spring, Centrifugal, Clutch materials, Clutch plate, Electromagnetic, vacuum operated, Necessity of gear box, Manual gear box-Constant mesh, Sliding mesh, Synchromesh, Epicyclic, fluid flywheel, Torque convertor, Continuous variable transmission, Electronic transmission control, overdrive, Propeller Shaft, Universal Joint, Differential and final drive, hotchkiss drive, torque tube drive.

Module III: Front & Rear Axle, Steering System, Suspension & Brakes System 12L Hrs

Axle: Purpose and requirement of front & rear axle, live and dead axles types & arrangement, types of loads acting on rear axles, full floating, three quarter floating and semi floating rear axles.

Steering System: Steering mechanism, steering geometry, cornering force, slip angle, scrub radius, steering characteristic, steering linkages & gearbox, power steering, collapsible steering, reversibility of steering, four wheel steering.

Suspension: Sprung and unsprung mass, types of suspension linkages, types of suspension springs- leaf, coil, air springs, hydro gas, rubber suspension, interconnected suspension, self levelling suspension (active suspension), damping and shock absorbers

Brakes: Types of brake systems - drum, disc, operation-mechanical, hydraulic, air brakes, servo and power braking, hand brake, ABS.

Module IV: Vehicle Performance, Safety & Modern Trends 08L Hrs

Vehicle performance parameters, road resistance, traction and tractive effort, power requirement for propulsion, road performance curves(Numerical treatment expected), Stability of vehicles, roll over safety regulations, Vehicle safety- active, passive safety, air bags, seat belt, Vehicle interior and ergonomics, comfort, NVH in automobiles, electrical car layout, hybrid vehicles, Solar operated vehicle, measuring instruments for wear, speed, acceleration, vibration, noise.

Module V: Electrical System & Vehicle maintenance 08L Hrs

Batteries: Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods.

Lighting System & Accessories: Insulated & earth return systems, positive & negative earth systems, electrical fuel pump, speedometer, fuel, oil & temperature gauges, horn, wiper system, trafficator, sensors and actuators, electronic control unit, traction control devices.

Vehicle maintenance Schedule maintenance chart of a vehicle, maintenance, overhauling & servicing of chassis, clutch, gear box, propeller shaft, differential, axles, steering system, wheels, tyres, suspension, brakes system, electrical system.

Text books

1. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House.
2. Automobile Electrical Equipment -P. S. Kohali, Tata McGraw Hill Publishing House.

Reference books

1. K. Newton and W. Seeds, T.K. Garrett, "Motor Vehicle", 13thEdition, Elsevier publications.
2. Hans Hermann Braess, Ulrich Seiffen, "Handbook of Automotive Engineering ", SAE Publications
3. Narang G. B. S , " Automobile Engineering", S. Chand and Company Ltd.
4. Dr.Kirpal Singh, "Automobile Engineering", Volume 1, Standard Publishers distributors.

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE464
TITLE OF THE COURSE : RENEWABLE ENERGY SOURCES
L: T/A: P: C : 3 : 0 : 0 : 3

Course Objectives

1. To educate the students scientifically the new developments in renewable energy studies
2. To make an understand the new developments in non-conventional and renewable energy studies.
3. To emphasize the significance of Green Energy Technologies

Course Outcomes

1. To understand importance of solar energy applications
2. To know the principles of power generation by wind energy
3. To know ocean energy technologies to harness power
4. To appreciate the use of hydrogen as renewable energy source

Module I: Solar Energy 08 Hrs

Solar Energy- Solar radiation its measurements and prediction - solar thermal collectors - flat plate collectors, concentrating collectors – applications - heating, cooling, desalination, drying, cooking, etc. Principle of photovoltaic conversion of solar energy - types of solar cells and fabrication -photovoltaic applications - battery charging, domestic lighting, street lighting.

Module II :Wind Energy 09 Hrs

Wind Energy- Wind energy - energy chains - application - historical background, merits and limitations - nature of wind - planetary and local day / night winds - wind energy quantum - power in wind- turbine efficiency - torque thrust calculations - velocity at different heights - site selection - components of wind energy conversion system (WECS).

Module III: Energy from Biomass **09 Hrs**

Energy from biomass - biomass as renewable energy source - types of bio mass fuels - solid, liquid and gas - biomass conversion techniques- wet process, dry process-photosynthesis - biogas generation - factors affecting bio- digestion - classification of bio gas plant - continuous, batch and fixed dome types - advantages and disadvantages.

Module IV: Tidal, Ocean Thermal Energy, Hydel and Geothermal Energy Conversion **09 Hrs**

Tidal Energy: tide – spring tide, neap tide – tidal range – tidal power – types of tidal power plant – single and dual basin schemes – requirements in tidal power plant - ocean thermal energy conversion (OTEC): principle - open and closed OTEC cycles - hydel energy: micro hydro - geothermal energy: geothermal energy sources - power plant and environmental issues.

Module V: New Energy Sources **09 Hrs**

Hydrogen as a renewable energy source - sources of hydrogen - fuel for vehicles - hydrogen production - direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production - storage of hydrogen - gaseous, cryogenic and metal hydride - fuel cell – principle of working, construction and applications.

Text books

1. Rai.G.D, Non- conventional resources of energy, Khanna publishers, Fourth edition, 2010.
2. Khan. B.H, Non-Conventional Energy Resources, McGraw Hill, Second edition, 2009.

Reference books

1. Rao.S &Parulekar, Energy Technology, Khanna publishers, Fourth edition, 2005.
2. Pai.B.R and Ram Prasad.M.S, Power Generation through Renewable Sources of Energy, Tata McGraw Hill, New Delhi, 1991.
3. Godfrey Boyl, Renewable Energy: Power Sustainable Future, Oxford University Press, Second edition, 2006.

SEMESTER/YEAR : 7TH SEM OR 8TH / 4TH YEAR
COURSE CODE : 16IE465
TITLE OF THE COURSE : PRODUCT AND INDUSTRIAL DESIGN
L: T/A: P: C : 3 : 0 : 0 : 3

Course Objectives

1. Identify the customer needs, formulate the specifications and carry out need analysis.
2. To generate, screen and test the concepts.
3. To understand the overview of all the product development processes & knowledge of concept generation.

Course Outcomes

1. Solve problems independently and identification of customer needs for the product growth
2. Have a basic knowledge of concept generation and prototyping for small product business
3. Understanding the process of product planning and specifications
4. understand product development with focus on the front end processes

Module I: Introduction 08L Hrs

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.

Module II : Identifying Customer Needs 09L Hrs

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking- quality function deployment-house of quality- product design specification-case studies.

Module III: Creative Thinking 09L Hrs

Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition –functional representation –morphological methods-TRIZ- axiomatic design.

Module IV: Decision Making and Theory **09L Hrs**

Decision making –decision theory –utility theory –decision trees –concept evaluation methods –Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture.

Module V:Industrial Design **09L Hrs**

Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing.

Text books

1. Karl T Ulrich, Steven D Eppinger and Anita Goyal, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education.
2. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education.
3. George E.Dieter and Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009.

Reference books

1. Chitale, A. C. and Gupta, R. C., Product Design and Manufacturing, PH1, 3rd Edition, 2003.
2. YousefHaik and T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010.
3. Clive L.Dym and Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009.
   GeofferyBoothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacture and Assembly

DEPARTMENTAL ELECTIVES

SEMESTER/YEAR : V SEM/III YEAR
COURSE CODE : 16ME339
TITLE OF THE COURSE : FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE & MACHINE LEARNING
L: T/A: P: C : : 3 :0 :0 :3

COURSE OBJECTIVES:

The objective of this course is to present the fundamental principles and practices of AI and ML to address the real-world mechanical engineering problems. The course is designed to develop a basic understanding of problem solving, knowledge representation, reasoning and learning methods of AI. design and implement a typical AI problem to be solved Using Machine Learning Techniques

COURSE OUTCOMES: At the end of the course students will be able to

1. Comprehend the ideas of AI and problem-solving techniques
2. Understand the representation of knowledge and reasoning
3. Hand-on experience on Python Programming
4. Realize Machine Learning techniques in supervised and unsupervised learning
5. Recognise the importance of data science, AI & ML in Mechanical Engineering

Module I 08 Hrs

INTRODUCTION

Introduction to AI - History – Applications, Intelligent Agents: Characteristics and types, Problem Solving with AI: AI models-Data Acquisition and Learning Aspects in AI.

Python programming for AI.

Module II 10 Hrs

PROBLEM SOLVING WITH AI

Problem Solving Process - Formulating Problems - Problem Types and Characteristics-Problem Analysis and Representation. Problem Solving Search Strategies: Uninformed Search Methods - BFS - Greedy BFS-Uniform cost search- DFS - Depth limited search - Iterative deepening, Informed Search Methods- A* Search, Branch-and-Bound Search - Optimal search algorithm A* and iterative deepening A*, Local Search Algorithms and Optimization Problems - Hill climbing and Simulated Annealing

Module III 12 Hrs

KNOWLEDGE REPRESENTATION & DECISION MAKING

Knowledge organization, manipulation and acquisition. Knowledge Representation: Logic-Propositional-Predicate-Unification- Representing Knowledge using Rules -

Forward Chaining -Backward Chaining - Resolution – Semantic Networks- Frame Systems - Inference - Types of Reasoning

PLANNING & DECISION MAKING

Introduction to Planning - Plan Space Planning - Planning Graph and Graph Plan - Practical Planning and Acting - Sequential Decision Problems - Making Complex Decisions

Module IV 08 Hrs

MACHINE LEARNING

Introduction to Machine Learning – Unsupervised learning, Supervised learning: Decision Trees - Linear Regression - Support Vector Machines - Bayesian Networks - Neural Networks - Reinforcement Learning - Deep Learning: a brief overview

Module V 10 Hrs

AI & ML APPLICATIONS

AI applications - Language Models - Vision or Robotics - Self driving car: a brief overview. Machine learning application using python for mechanical engineering datasets: mechanical vibrations - heat transfer - fluid mechanics - manufacturing process.

AI Ethics: Humans vs Robots, Robustness & transparency of AI systems, Accountability, Privacy & Human-AI interaction

TEXT BOOKS:

1. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
2. Nagy Z. Artificial Intelligence and Machine Learning Fundamentals: Develop real- world applications powered by the latest AI advances. Packt Publishing Ltd; 2018.

REFERENCES:

1. David L. Poole, Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.
2. Nils J. Nilsson, the Quest for Artificial Intelligence, Cambridge University Press, 2009.
3. Richard E Neapolitan; Xia Jiang Artificial Intelligence: With an Introduction to Machine Learning, Chapman and Hall/CRC Press, 2018.