COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

VISION AND MISSION OF THE INSTITUTE

VISION

The Institute strives to inculcate a sound knowledge in engineering along with realised social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

MISSION

The Mission of the Institute is to impart high quality education and training to its students to make them World-class engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the nation and the world at large.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

The Mechanical Engineering Department of CIT aims to provide quality education and be recognized by the society at large as one of the top ranking Mechanical Engineering Programmes in the globe.

MISSION

The Department imparts sound knowledge in Mechanical Engineering along with realized social responsibilities to enable its students to address the current and impending challenges faced globally.

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Program Educational Objectives are designed based on the Department Mission to prepare the students to become graduates

PEO 1 : For successful professional practice in entry-level engineering jobs or for pursuing higher studies, with an aptitude for life-long learning.

PEO 2 : To demonstrate their capabilities in mathematics, scientific knowledge and fundamental concepts of Mechanical Engineering.

PEO 3 : To carry out research, design, development, testing, analysis, evaluation, and implementation of engineering solutions to problems that are encountered in professional practice.

PEO 4 : To be effective innovators, entrepreneurs and collaborators, who can lead or participate in efforts to address social, ethical, technical and business challenges.

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAMME OUTCOMES (POs)

PO1 : Acquire Knowledge of fundamental mathematics, science, and engineering principles and the ability to apply the acquired knowledge in solving mechanical engineering problems.

PO2 : Ability to design and conduct experiments, as well as to demonstrate, analyze and interpret data.

PO3 : Ability to design and visualize thermal and mechanical components, systems, or processes to meet desired needs and realistic constraints such as economical, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

PO4 : Ability to function on multi-disciplinary teams towards the goal to be achieved.

PO5 : Ability to identify, formulate and solve problems encountered in Mechanical Engineering.

PO6 : Understanding of professional and ethical responsibility.

PO7 : Ability to communicate effectively.

PO8 : Ability to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

PO9 : Recognition of the need for, and an ability to engage in life-long learning.

PO10 : Knowledge of contemporary issues.

PO11 : Ability to use the techniques, skills, and be familiar with modern engineering tools and software necessary for Mechanical Engineering practice.

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

B.E. MECHANICAL ENGINEERING

Curriculum from the Academic Year 2013 - 2014 onwards

Semester I

S. No.	Subject Code	Course Title	L	T	P	C
1	13FY11	MATHEMATICS - 1	3	1	0	4
2	13FY12	TECHNICAL ENGLISH	2	0	2	3
3	13FY13	ENGINEERING PHYSICS	3	0	0	3
4	13FY14	ENGINEERING CHEMISTRY	3	0	0	3
5	13FY15	(S-4) BASICS OF THERMODYNAMICS	3	1	0	4
6	13FY16	(S-14) BASIC C PROGRAMMING	2	0	3	4
7	13FY27	ENGINEERING GRAPHICS	1	0	3	--
8	13FY28	PHYSICS LABORATORY	0	0	3	--
9	13FY29	CHEMISTRY LABORATORY	0	0	3	--
10	13FY30	WORKSHOP	0	0	3	--
		TOTAL CREDITS	**17**	**2**	**17**	**21**

Semester II

S. No.	Subject Code	Course Title	L	T	P	C
1	13FY21	MATHEMATICS - II	3	1	0	4
2	13FY22	PROFESSIONAL ENGLISH / GERMAN	2	0	2	3
3	13FY23	MATERIAL SCIENCE	3	0	0	3
4	13FY24	PRINCIPLES OF ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	3
5	13FY25	(S-7) ELECTRICAL ENGINEERING	3	0	0	3
6	13FY26	(S-10) BASIC ELECTRONICS AND COMMUNICATION ENGINEERING	3	0	0	3
7	13FY27	ENGINEERING GRAPHICS	1	0	3	4
8	13FY28	PHYSICS LABORATORY	0	0	3	2
9	13FY29	CHEMISTRY LABORATORY	0	0	3	2
10	13FY30	WORKSHOP	0	0	3	2
		TOTAL CREDITS	**18**	**1**	**14**	**29**

Semester III

S. No.	Subject Code	Course Title	L	T	P	C
1	13CE31	MATHEMATICS - III	3	1	0	4
2	13ME32	FLUID MECHANICS	3	1	0	4
3	13ME33	ELECTRICAL MACHINES AND DRIVES	3	0	0	3
4	13ME34	INTRODUCTION TO STATICS AND DYNAMICS	3	1	0	4
5	13ME35	ENGINEERING MATERIALS	3	0	0	3
6	13ME36	APPLIED THERMODYNAMICS	3	1	0	4
7	13ME37	ENGINEERING MATERIALS LABORATARY, APPLIED THERMODYNAMICS LABORATORY AND COMPUTER GRAPHICS LABORATORY - 1	0	0	3	2
8	13ME38	FLUID MECHANICS LABORATORY, ELECTRICAL MACHINES AND DRIVES LABORATORY	0	0	3	2
9	13CE49	SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS	2	0	0	--
		TOTAL CREDITS	**20**	**4**	**6**	**26**

Semester IV

S. No.	Subject Code	Course Title	L	T	P	C
1	13ME41	MATHEMATICS - IV	3	1	0	4
2	13ME42	STRENGTH OF MATERIALS	3	1	0	4
3	13ME43	MECHANISMS AND MACHINES	3	1	0	4
4	13ME44	PRINCIPLES OF MANUFACTURING PROCESSES - I	3	0	0	3
5	13ME45	EMBEDDED PROCESSOR ARCHITECTURE AND PROGRAMMING	3	0	0	3
6	13ME46	COMPRESSIBLE FLUID FLOW	3	1	0	4
7	13ME47	STRENGTH OF MATERIALS LABORATORY, MECHANISMS AND MACHINES LABORATORY AND COMPUTER GRAPHICS LABORATORY - 2	0	0	3	2
8	13ME48	EMBEDDED PROCESSOR ARCHITECTURE AND PROGRAMMING LABORATORY	0	0	3	2
9	13CE49	SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS	2	0	0	2
		TOTAL CREDITS	**20**	**4**	**6**	**28**

Semester V

S. No.	Subject Code	Course Title	L	T	P	C
1	13ME51	OPTIMIZATION FOR ENGINEERING DESIGN	3	1	0	4
2	13ME52	MANUFACTURING SCIENCES	3	1	0	4
3	13ME53	TURBO MACHINERY	3	1	0	4
4	13ME54	PRINCIPLES OF MANUFACTURING PROCESSES - II	3	0	0	3
5	13ME55	DESIGN OF MACHINE ELEMENTS - I	3	1	0	4
6	13ME56	ECONOMICS AND COST ACCOUNTING FOR ENGINEERS	3	0	0	3
7	13ME57	DESIGN AND MACHINE DRAWING	1	0	3	3
8	13ME58	WORKSHOP (LATHE) LABORATORY, FOUNDRY AND WELDING LABORATORY	0	0	3	2
9	13ME69	MINI PROJECT	0	0	3	--
		TOTAL CREDITS	**19**	**4**	**9**	**27**

Semester VI

S. No.	Subject Code	Course Title	L	T	P	C
1	13ME61	FINITE ELEMENT ANALYSIS	3	1	0	4
2	13ME62	HEAT AND MASS TRANSFER	3	1	0	4
3	13ME63	ENGINEERING POLYMERS, COMPOSITES AND ALLIED MANUFACTURING PROCESSES	3	0	0	3
4	13ME64	PRODUCTION PLANNING AND CONTROL	3	1	0	4
5	13ME65	DESIGN OF MACHINE ELEMENTS - II	3	1	0	4
6	13ME66	QUALITY ASSURANCE AND RELIABILITY	3	0	0	3
7	13ME67	HEAT TRANSFER LABORATORY, FLUID MACHINERY LABORATORY	0	0	3	2
8	13ME68	METROLOGY LABORATORY,SPECIAL MACHINES LABORATORY	0	0	3	2
9	13ME69	MINI PROJECT	0	0	3	2
		TOTAL CREDITS	**18**	**4**	**9**	**28**

Semester VII

S. No.	Subject Code	Course Title	L	T	P	C
1	13ME71	COMPUTER AIDED DESIGN AND MANUFACTURING	3	0	0	3
2	13ME72	OPERATIONS RESEARCH	3	1	0	4
3	13ME73	CONTROL THEORY AND MECHATRONICS	3	1	0	4
4	13ME74	PROJECT MANAGEMENT	3	0	0	3
5	13ME75	ELECTIVE - I	3	0	0	3
6	13ME76	ELECTIVE - II	3	0	0	3
7	13ME77	MECHATRONICS LABORATORY, CAD/CAM LABORATORY	0	0	3	2
8	13ME87	PROJECT WORK	0	0	6	--
		TOTAL CREDITS	**18**	**2**	**9**	**22**

Semester VIII

S. No.	Subject Code	Course Title	L	T	P	C
1	13ME81	AUTOMOBILE ENGINEERING	3	0	0	3
2	13ME82	QUANTITY PRODUCTION METHODS	3	0	0	3
3	13ME83	ALTERNATIVE ENERGY RESOURCES	3	0	0	3
4	13ME84	ELECTIVE - III	3	0	0	3
5	13ME85	ELECTIVE - IV	3	0	0	3
6	13ME86	ELECTIVE LABORATORY	0	0	3	2
7	13ME87	PROJECT WORK	0	0	6	6
		TOTAL CREDITS	**15**	**0**	**9**	**23**

LIST OF ELECTIVES

Subject Code	Course Title	L	T	P	C
13MEE01	RAPID PROTOTYPING	3	0	0	3
13MEE02	ADVANCED FOUNDRY TECHNOLOGY	3	0	0	3
13MEE03	ADVANCED WELDING TECHNOLOGY	3	0	0	3
13MEE04	DESIGN OF JIGS AND FIXTURES	3	0	0	3
13MEE05	MECHANICAL HANDLING SYSTEMS AND EQUIPMENTS	3	0	0	3
13MEE06	NON-TRADITIONAL MACHINING	3	0	0	3
13MEE07	NON-DESTRUCTIVE EVALUATION AND IMAGING	3	0	0	3
13MEE08	ROBOTICS	3	0	0	3
13MEE09	MACHINE TOOL DESIGN	3	0	0	3
13MEE10	FLUID POWER CONTROL SYSTEMS	3	0	0	3
13MEE11	ADVANCED FLUID MECHANICS	3	0	0	3
13MEE12	REFRIGERATION AND AIR CONDITIONING	3	0	0	3
13MEE13	CRYOGENICS	3	0	0	3
13MEE14	ADVANCED THERMODYNAMICS	3	0	0	3
13MEE15	COMBUSTION AND INTERNAL COMBUSTION ENGINES	3	0	0	3
13MEE16	ENERGY CONSERVATION AND WASTE HEAT RECOVERY	3	0	0	3
13MEE17	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3
13MEE18	DESIGN OF HEAT EXCHANGERS	3	0	0	3
13MEE19	SOLAR ENERGY TECHNOLOGY	3	0	0	3
13MEE20	MANAGEMENT OF INVENTORY CONTROL	3	0	0	3
13MEE21	WORK SYSTEM DESIGN	3	0	0	3
13MEE22	SUPPLY CHAIN MANAGEMENT	3	0	0	3
13MEE23	ADVANCED OPERATIONS RESEARCH	3	0	0	3
13MEE24	MECHANICAL VIBRATIONS AND CONTROL	3	0	0	3
13MEE25	COMPOSITE MATERIALS	3	0	0	3
13MEE26	ADVANCED BIOMATERIALS	3	0	0	3
13MEE27	ADVANCED STRENGTH OF MATERIALS	3	0	0	3
13MEE28	PROCESS DYNAMICS AND ADAPTIVE CONTROL	3	0	0	3
13MEE29	EXPERIMENTAL STRESS ANALYSIS	3	0	0	3
13MEE30	SUSTAINABLE DEVELOPMENT	3	0	0	3
13MEE31	FATIGUE, CREEP AND FRACTURE	3	0	0	3
13MEE32	TRIBOLOGY	3	0	0	3
13MEE33	MICRO AND SMART SYSTEMS	3	0	0	3

13CE31 - MATHEMATICS- III

(Common to third semester B.E., / B.Tech, all branches)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

- *To incorporate the ideas of Complex variables that is imperative for the effective understanding of Mechanical Engineering.*
- *To enrich the concepts of partial differential equations those are vital for the study of engineering subjects.*
- *To study the concepts of Fourier Transforms which have got a direct leverage over all branches of Engineering and its study.*
- *To imbibe the concepts of boundary value problems which are inevitable for the study of engineering subjects.*
- *To gain knowledge on basic tools useful for specialized studies in mechanical engineering.*

COURSE OUTCOMES

At the end of this course, the students will be able

CO1 *: Become familiar in applying complex variable concepts to understand and solve mechanical engineering problems.*

CO2 *: Apply partial differential equation ideas in modeling and solving mechanical engineering problems.*

CO3 *: Gain knowledge in Fourier transforms ideas to analyze and study their areas.*

CO4 *: Solve problems related with the above mentioned areas and can identify the areas in their disciplines wherein these ideas could be directly applied.*

COMPLEX DIFFERENTIATION

Analytic functions-Definitions and properties-Cauchy Riemann equations in Cartesian and polar coordinates-construction of analytic functions- Conformal mappings-Bilinear Transformation -the mappings of the form w= z+a, az, 1/z, z^2, e^z, sinz, cosz, -Simple problems. **(12)**

COMPLEX INTEGRATION

Cauchy's integral theorem-Integral formula-Taylor's and Laurent's series (without proof)-Types of singularities, Poles and residues-Cauchy's residue theorem-Applications-Contour integration using circular and semicircular contours. **(12)**

PARTIAL DIFFERENTIAL EQUATIONS

Formation by elimination of arbitrary constants and functions-solution by direct method-solution of first order non-linear PDE-standard types-Lagrange linear equation-Linear higher order homogeneous PDE with constant coefficients. **(12)**

FOURIER TRANSFORMS

Fourier integral theorem (without proof)-Infinite Fourier transform-Infinite Fourier sine and cosine transforms-properties and problems-Convolution theorem-Parseval's identity-Finite Fourier sine and cosine Transforms- properties and problems. **(12)**

BOUNDARY VALUE PROBLEMS

Vibration of strings-one dimensional wave equations, one dimensional heat flow- unsteady state and steady state -Two dimensional heat flow steady state in Cartesian coordinates-Separation of variables-Fourier series solution. **(12)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Kandasamy P.,et al., "Engineering Mathematics", Volume - III (Transforms and Partial Differential Equations) S.Chand& Co., Reprint with correction, 2013.
2. Veerarajan T., "Engineering Mathematics", For Semester I & II, Third Edition, Tata McGraw- Hill Publishing company Ltd., - 2012.
3. Veerarajan T., "Engineering Mathematics", for Semester III, Transforms and Partial Differential Equations, Tata. McGraw-Hill publishing company Ltd, Fifth Edition updated, 2012.

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", (10th Edition) Wiley India Pvt Ltd- (2011).
2. Grewal B.S., “Higher Engineering Mathematics”, 42nd Edition, Khanna Publishers - (2012).
3. Venkataraman M.K., "Engineering Mathematics III", for B.E., Third Semester, Revised and Enlarged Fourteenth Edition, The National Publishing Company - 2008.
4. Venkataraman M.K., "Engineering Mathematics III-A", Eleventh Edition, The National Publishing Company - 2008.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X			X	X				X	X	X
2	X	X		X	X		X		X	X	X
3	X			X	X	X		X	X	X	X
4	X	X	X	X	X						X

13ME32 - FLUID MECHANICS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study the fundamentals of fluid statics and fluid motion, and their applications in a variety of engineering fields.

COURSE OUTCOMES

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

CO1 : *Apply the knowledge of fluid properties in a real situation.*

CO2 : *Apply the knowledge attained in solving field problems in the area of storage.*

CO3 : *Apply similitude and model study in a practical situation.*

CO4 : *Apply the knowledge attained in solving field problems in the area of liquid flow.*

PROPERTIES OF FLUIDS AND FLUID STATICS

Basic concepts and properties - fluid - definition - properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension. Fluid statics - concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges. Hydrostatic forces on submerged surfaces, stability of floating bodies. **(11)**

FLUID FLOW CONCEPTS

Fluid kinematics - flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms) - equation of streamline - stream function - velocity potential function - circulation flow net. Fluid dynamics - equation of motion - Euler's equation along a streamline - Bernoulli's equation, applications - venturi meter, orifice meter, Pitot tube. **(10)**

DIMENSIONAL ANALYSIS AND MODEL STUDIES

Dimensional analysis - Buckingham's Pi theorem - applications - similarity laws and models. **(7)**

LAMINAR AND TURBULENT FLOW CONCEPTS

Incompressible fluid flow - viscous flow - Navier-Stoke's equation - Shear stress, pressure gradient relationship - laminar flow between parallel plates - laminar flow through circular tubes (Hagen - Poiseulle's equation). Hydraulic and energy gradient - flow through pipes in series and in parallel - power transmission. **(11)**

BOUNDARY LAYER AND FLOW AROUND BLUFF BODIES

Boundary layer flows, boundary layer thickness and separation. Drag and lift coefficients. **(6)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Som S.K., Biswas G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2008.
2. Kumar K.L., "Engineering Fluid Mechanics", 6th edition, S. Chand Ltd., 2008.

REFERENCE BOOKS

1. Fox R.W., McDonald A.T., Pritchard P.J., "Introduction to Fluid Mechanics", 6th edition, Wiley, 2005.
2. Munson B.R., Young D.F., Okiishi T.H., "Fundamentals of Fluid Mechanics: Student Solutions Manual", 5th edition, John Wiley & Sons Ltd., 2006.
3. Massey B.S., Ward-Smith J., "Mechanics of Fluids", 7th edition, Stanley Thornes, 1998.
4. Bansal R.K., "A Textbook of Fluid Mechanics and Hydraulic Machines", 9th edition, Laxmi Publications, 2005.
5. NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video sources on Fluid mechanics.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X					X			X		X
2	X	X	X	X	X		X				X
3	X		X	X	X			X	X	X	X
4	X	X	X		X	X	X		X	X	X

13ME33 - ELECTRICAL MACHINES AND DRIVES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on electric machines and drives imparts knowledge on the working principles, construction and design of electric motors, generators and other electrical machines, its control strategies based upon fundamental theories. It supplements the basic electric machine theory for advanced courses in electric machines.

COURSE OUTCOMES

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

CO1 : *Design a electrical drives and related system, component or process to meet desired needs*

CO2 : *Use the techniques, skills and modern engineering tools necessary for engineering practice.*

CO3 : *Use the computer / IT tools relevant to the discipline along with an understanding of their processes and limitations.*

CO4 : *Design and conduct experiments.*

CO5 : *Give a general idea on topics like mechanical, manufacturing and future challenges for machine design.*

THREE PHASE MACHINES

Alternator Construction, principle and EMF equation. Three phase induction motors - types-construction - speed - torque characteristics - speed control methods. **(9)**

SINGLE PHASE MACHINES

Operating principle, characteristics and speed control of: capacitor start induction motor - servomotors - synchros - stepper motor - universal motor. **(9)**

ELECTRIC DRIVE FUNDAMENTALS

Drive systems - comparison - concept of electric drive - classification - AC and DC drives - principal factors affecting the choice of drive - selection of power rating of motor - drive system based on temperature and load variation factors. **(9)**

DC AND AC DRIVES

DC drives - introduction - control strategies - single phase and three phase converter fed DC drives - chopper fed DC drives - chopper fed control of separately excited DC motor. AC drives - introduction - control strategies - stator control: AC - DC inverters fed three phase induction motor drive. Rotor control: Rotor resistance control. **(9)**

APPLICATIONS

Selection of motor and drive system for major industrial applications: cranes and electric traction, centrifugal pumps, paper and pulp industry, cement industry, steel industry and sugar mills - wind mills. **(9)**

TOTAL : 45

TEXT BOOKS

1. Theraja B.L. and Theraja A.K., "A Text Book of Electrical Technology", Vol. 2, 23rd edition, S. Chand Publications (P) Ltd., New Delhi, 2005.
2. Dubey G.K, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2007.

REFERENCE BOOKS

1. Nagrath I.J. and Kothari D.P., "Electrical Machines", 2nd edition, Tata McGraw-Hill Publishing Company, 2005.
2. Pillai S.K., "A First Course on Electrical Drives", 2nd edition, New Age International Publishers, 2004.
3. Vedham Subramnyam, "Electric Drives Concept and Applications", 2nd edition, Tata McGraw-Hill Publishing Company, 2010.
4. Ion Boldea S.K. and Nasar S.A., "Electric Drives", CRC Press LLC, New York, 2005.
5. Bose B.K., "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2006.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1			X		X	X			X	X	X
2	X		X					X	X	X	X
3	X		X	X	X	X	X	X	X		X
4	X	X			X			X			X
5		X		X		X		X	X	X	X

13ME34 - INTRODUCTION TO STATICS AND DYNAMICS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course is aimed at providing engineering students a smooth transition from science-based mechanics problems to engineering-based mechanics problems. The course emphasizes the correct and efficient free-body representation of the members in the structural system, along with formatted but logical solution techniques for the problems.

COURSE OUTCOMES

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

CO1 *: Gain knowledge of science and engineering fundamentals*

CO2 *: Acquire in-depth technical competence in usage of statics and dynamics principles*

CO3 *: Use appropriate techniques and resources to solve engineering problems*

CO4 *: Undertake problem identification, formulation and solution of mechanics*

STATICS OF PARTICLES

Statics - basic concepts and fundamental principles: vector algebra, Newton's laws of gravitation, force, couple, moment, Varignon's theorem, resultant of concurrent and non-concurrent coplanar forces, static equilibrium, free body diagram, reactions. Problem formulation concept; 2D statics, two and three force members, equilibrium equations, constraints and static determinacy; 3D statics. **(7)**

TRUSS ANALYSIS

Analysis of trusses: assumptions; simple truss (plane and space), analysis by method of joints & method of sections; compound truss - (statically determinate, rigid and completely constrained). **(7)**

FRICTION

Friction - dry friction laws, simple surface contact problems, friction angles, types of problems, wedges. Sliding friction and rolling resistance. **(4)**

DISTRIBUTED FORCES : MOMENT OF INERTIA

Moment of inertia - first moment of mass and centre of mass - centroid of lines, areas, volumes, composite bodies. Area moments and products of inertia, radius of gyration, transfer of axes, composite areas. Rotation of axes, principal area, moments of inertia. Second moment of mass, mass moments and products of inertia, radius of gyration, transfer of axes, flat plates (relation between area and mass moments, and products of inertia), composite bodies. **(7)**

METHOD OF VIRTUAL WORK

Virtual work and energy method - virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium. **(7)**

REVIEW OF PARTICLE DYNAMICS

Review of particle dynamics - rectilinear motion; plane curvilinear motion (rectangular, path, and polar coordinates). 3D curvilinear motion; relative and constrained motion; Newton's second law (rectangular, path, and polar coordinates). Work - kinetic energy, power, potential energy. Impulse - momentum (linear, angular); Impact (Direct and oblique). Plane kinematics of rigid bodies - rotation and parametric motion. Relative Velocity, instantaneous centre of rotation. Relative acceleration, rotating reference frames. **(7)**

KINEMATICS OF RIGID BODIES

Plane kinetics of rigid bodies - kinetics of system of particles and derivation of moment equation. Translation; fixed axis rotation; general planar motion. Work - kinetic energy, potential energy, power; impulse-momentum. Impact; combination problems. **(6)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Johnston R.E., Beer F., Eisenberg E.R., Mazurek D., "Vector Mechanics for Engineers: Statics and Dynamics", McGraw-Hill, 10th edition, 2013.
2. Meriam J.L., Kraige L.G., "Engineering Mechanics: Statics & Engineering Mechanics: Dynamics", Wiley, 7th edition, 2012.

REFERENCE BOOKS

1. Hibbeler R.C., "Engineering mechanics: Statics and Dynamics", Prentice Hall, 12th edition, 2009.
2. Irving H. Shames, "Engineering Mechanics - Statics and Dynamics", Prentice-Hall of India, 2009.
3. Palanichamy M. S., Nagan S., "Engineering Mechanics - Statics & Dynamics", Tata McGraw-Hill, 2004.
4. Rajasekaran S., Sankarasubramanian G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Private Ltd., 2010.
5. McLean, "Engineering Mechanics", Schaum Series, McGraw-Hill, 6th edition, 2010.
6. www.nptel.iitm.ac.in/syllabus/syllabus.php?subjectId=112103108.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X			X	X			X		X	X
2	X	X	X	X	X						
3	X	X			X	X		X	X		X
4	X	X	X	X	X	X	X	X		X	X

13ME35 - ENGINEERING MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study the fundamentals of engineering materials, emphasizing on the basic knowledge of material microstructures, physical behavior and it's variation with temperature and time, with application in a variety of engineering fields. The course aims to impart necessary skills in the use of scientific methods to solve major industrial and research projects within the subject domain.

COURSE OUTCOMES

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

CO1 : *Classify materials with respect to properties and applications.*

CO2 : *Understand the relationship between microstructure, characterization, properties and processing and design of materials.*

CO3 : *Apply knowledge about the properties of materials, types of alloys and heat treatments to be given to the ferrous and non ferrous alloys for selection of materials for various engineering applications.*

CO4 : *Identify appropriate strengthening methods for the material selected for the required application.*

BASIC CRYSTALLOGRAPHY

Crystallography - crystal imperfections - point, line, planar and volume defects - grain size, ASTM grain size number. Dislocations - slip and twinning - Burger vectors. Strain hardening, seasons cracking, Bauschinger's effect, yield point phenomenon, cold / hot working, recovery, re-crystallization and grain growth, strengthening of metals. **(6)**

ALLOY AND PHASE DIAGRAMS

Constitution of alloys and phase diagrams - constitution of alloys - solid solutions - substitutional and interstitial. Phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions. Iron-carbon equilibrium diagram. Classification of steel and cast iron - microstructure, properties and application. **(6)**

HEAT TREATMENT

Heat Treatment - full annealing, stress relief, recrystallisation and spheroidizing - normalising, hardening and tempering of steel. Isothermal transformation diagrams - cooling curves superimposed on CCR diagram. Hardenability - Jominy end quench test - austempering, martempering. Case hardening, carburising, nitriding, cyaniding, carbonitriding - flame and induction hardening. **(6)**

Ferrous and non ferrous metals - effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels - HSLA. Grey, white, malleable, spheroidal, graphite, alloy cast-iron. Copper and copper alloys - brass, bronze and cupronickel. Aluminium and Al-Cu - precipitation strengthening treatment - bearing alloys. **(7)**

NON-METALLIC MATERIALS

Non-metallic materials - polymers, types of polymer, commodity and engineering polymers. Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE polymers. Urea and phenol formaldehydes. Engineering Ceramics - properties and applications of Al2O3, SiC, Si3N4, PSZ etc. Fibre and particulate reinforced composites and resin plastics. Powder metallurgy - manufacturing process, compacting, sintering, vacuum processing. Properties of powder processed materials, high energy compaction. Metal matrix composites, preparation, properties and uses. **(8)**

MECHANICAL PROPERTIES AND TESTING

Mechanical properties and testing - mechanism of plastic deformation, slip and twinning. Types of fracture - testing of materials under tension, compression and shear loads. Hardness tests - Brinell, Vickers and Rockwell tests. Impact test - Izod and Charpy. Fatigue and creep tests. **(6)**

INTRODUCTION TO SCIENCE AND TECHNOLOGY

Nano materials - nano structured materials, low-dimensional structures: quantum wells, quantum wires, and quantum dots, nano clusters &nano crystals. Electronic and optical properties of nano crystallites, metallic and semiconducting super lattices. Synthesis of nanostructured materials, fabrication and characterization of nano electronic devices and MEMS.Basics of synthesis and characterization of nano-multi-component systems for sensors (Magnetic, Electronic and Optical) and electrodes. Synthesis and fabrication of carbon nano structures for fuel cell and energy storage applications. **(6)**

TOTAL : 45

TEXT BOOKS

1. William D. Callister, "Material Sciences and Engineering", 8th edition John Wiley and Sons, 2010.
2. Agarwal B.K., "Introduction to Engineering Materials", Tata McGraw-Hill Publishing Company, New Delhi, 24th Reprint, 2008.
3. Avner S. H., "Introduction to Physical Metallurgy", Tata McGraw-Hill Publishing Company, New Delhi, 2nd Edition, 26th reprint 2009.

REFERENCE BOOKS

1. Lakhtin Y., Weinstein N., "Engineering Physical Metallurgy", University Press of the Pacific, 2000.
2. Koch C.C., "Nanostructured materials: processing, properties, and applications", 2nd Edition, William Andrew Pub., 2007.
3. Guy A.G., "Elements of Physical Metallurgy", Oxford - IBH Publishing Co., 1993.
4. Raghavan V., "Physical Metallurgy", Prentice Hall of India Pvt. Ltd., New Delhi, 2007.
5. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice - Hall of India, 2010
6. NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112: related web and video resources under Mechanical Engineering & Metallurgy and Material Science categories.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X	X		X				X	
2	X	X	X	X		X	X	X	X		X
3		X		X	X		X				X
4	X		X	X		X	X	X	X	X	X

13ME36 - APPLIED THERMODYNAMICS

(Use of steam table, refrigerant table, and charts permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course aims to provide an introduction to the essential theoretical knowledge on thermodynamics, its application to a range of problems of practical relevance. The course equips the students with basic tools and methodologies for carrying out thermodynamic analysis of engineering systems.

COURSE OUTCOMES

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

CO1 : *Demonstrate understanding of the nature and operating principles of work absorbing and work rendering machines.*

CO2 : *Describe and apply basic thermodynamic principles to analysing and predicting performance of idealised forms of thermodynamic systems*

CO3 : *Describe and assess benefits of improvements to thermodynamic cycles.*

CO4 : *Relate idealised thermodynamic system models to corresponding real systems.*

CO5 : *Depict Thermodynamic Processes on property diagrams*

I. C. ENGINES

Air Standard Otto & Diesel Cycles, Classification and working principle of four stroke and two stroke SI and CI Engines - indicator diagrams, valve timing and port timing diagrams. Comparison of petrol and diesel engines - four stroke and two stroke engines - testing and performance of internal combustion engines - principle of supercharging. **(9)**

RECIPROCATING COMPRESSORS

Working principle - equations for shaft work and efficiencies - effect of clearance on volumetric efficiency. Working principle of multistage reciprocating compressors, inter-cooler, optimum intermediate pressure in a two stage compressor and performance of multi stage compressor. **(9)**

GAS TURBINE POWER PLANTS

Gas Turbine Cycles - ideal Brayton cycle - non-ideal Brayton cycle - open and closed cycle gas turbines - modifications of the Brayton cycle - regeneration - compressor inter-cooling - turbine reheat - water injection - design for high temperature - materials - cooling - air cooling - water cooling - fuels - combined cycles - combined cycles with heat recovery boiler - combined cycles with steam and nuclear power plants. Effect of operating variables on thermal efficiency. Advantages of gas turbines over IC engines - gas turbines for jet propulsion. **(9)**

STEAM TURBINE POWER PLANTS

Ideal Rankine cycle - externally irreversible Rankine cycle - superheat - reheat - regeneration - internally irreversible Rankine cycle - open or direct contact feed water heaters - closed type feed water heaters

with drains cascaded backward - closed type feed water heaters with drains pumped forward - choice of feed water heaters - efficiency and heat rate - placement of feed water heaters - supercritical pressure cycle - cogeneration - types of cogeneration - economics of cogeneration. Classification of boilers - low pressure and high pressure boilers. Flow of steam through nozzles - effect of friction, critical pressure ratio, super saturated flow of steam. **(9)**

REFRIGERATION AND AIR CONDITIONING

Methods of refrigeration - air refrigeration, Bell Coleman cycle, vapour compression refrigeration cycle, use of T-s and P-h diagrams - under cooling and superheating. Performance calculations. Study of absorption refrigeration system. Refrigerants - selection and properties. Requirements for comfort and industrial air conditioning, air washer, by-pass factor, summer and winter air conditioning systems. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Nag P.K., "Engineering Thermodynamics", 5th edition, Tata McGraw-Hill, 2013.
2. Richard E. Sonntag, Claus Borgnakke, Gordon J. Van Wylen, Fundamentals of Thermodynamics, 6th edition, Wiley 2002.
3. Rudramurthy R., "Thermal Engineerring", McGraw-Hill Companies, Inc., 2007.

REFERENCE BOOKS

1. Kothandaraman C P and Domkundwar, "Thermodynamics and Thermal Engineering", DhanpatRai and Sons, 2006.
2. Rajput R. K., "Thermal Engineering", Laxmi Publications, 2007.
3. Ganesan V., "Internal Combustion Engines", Tata McGraw-Hill, 2005.
4. Mathur M. L. and Sharma R. P., "Internal Combustion Engines", DhanpatRai and Sons, 2004.
5. Ballaney P. L., "Thermal Engineering", Khanna Publishers, 24th edition, 2003.
6. Ganesan V., "Gas Turbines", Tata McGraw-Hill, New Delhi, 2005.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X			X	X	X	X
2	X	X			X						X
3	X	X	X	X	X	X	X	X	X	X	
4	X				X	X	X	X	X		X
5		X	X	X	X		X	X	X	X	X

13ME37 - ENGINEERING MATERIALS LABORATORY, APPLIED THERMODYNAMICS LABORATORY AND COMPUTER GRAPHICS LABORATORY - I

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVES

The laboratory course on engineering materials aims to impart knowledge on mechanical testing and evaluation of engineering materials. Laboratory course enables to study the various experimental procedures on material fabrication, preparation and perform micro- structural analysis of different materials.

COURSE OUTCOMES

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

CO1 : *Demonstrate the relationships among materials structure, its properties, processing, and performance.*

CO2 : *Extend this knowledge; and apply it in materials analysis, development, selection, and design*

CO3 : *Demonstrate the knowledge and experience in using basic laboratory tools, computers, and databases for materials analysis, development, and selection*

CO4 : *Demonstrate the skills in writing, speaking, reading, and listening, needed to communicate logically and effectively*

LIST OF EXPERIMENTS

1. Study of microscopes -Optical microscope , Scanning electron microscope & Study of specimen mounting press
2. Preparation of specimen and Microstructure of ferrous materials - Plain carbon steels (Low carbon steel, Medium carbon steel, High carbon steel),
3. Preparation of specimen and Microstructure of Alloy steels (Tool steel, Austenitic Stainless steel, Martensitic Stainless steel) and Cast iron (Grey cast iron, Nodular cast iron)
4. Preparation of specimen and Microstructure of non-ferrous materials - Aluminium alloys and Copper alloys (Brass, Aluminium Bronze, Lead Bronze)
5. Non-Destructive testing - Liquid penetrant testing and Magnetic particle testing
6. Particle size measurement
7. Micro-hardness measurement
8. Metallurgical failure analysis

TEXT BOOK

Engineering Materials Laboratory Manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X			X	X		X
2	X	X	X	X	X	X	X	X	X	X	X
3	X	X	X	X	X			X		X	X
4			X		X	X	X	X	X		X

13ME37 - APPLIED THERMODYNAMICS LABORATORY

COURSE OBJECTIVES

The laboratory course on thermal engineering aims to impart practical knowledge on testing and evaluation of thermal systems along with the evaluation of thermal properties such as flash, fire and viscosity of a given fuel. Laboratory course enables to study the various experimental procedures on testing, development of characteristics curves and determination of efficiency for various loading conditions for a given thermal system

COURSE OUTCOMES

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

CO1 : *Demonstrate the knowledge in areas of thermal sciences with relevance to devices such as engines, heat pumps, air conditioner, refrigerator, turbines, pumps, and compressors, etc. and be able to apply and extend this knowledge*

CO2 : *Conduct experiments to find the performance of these thermal engineering devices during their design and development*

CO3 : *Interpret and analyze the results obtained during experiments in terms of performance of these thermal engineering devices.*

CO4 : *Function effectively on problem-solving teams and to coordinate and provide leadership for teams, including multidisciplinary teams.*

CO5 : *Develop skills in writing, speaking, reading, and listening, needed to communicate logically and effectively*

LIST OF EXPERIMENTS

1. Heat balance test on four stroke single-cylinder Diesel engine.
2. Heat balance test on four stroke multi-cylinder Petrol engine.
3. Port timing diagram of two-stroke engine.
4. Valve timing diagram of four-stroke engine.
5. Construction of volume crank-angle and pressure crank-angle diagram of single cylinder Diesel engine.
6. Determination of volumetric efficiency of reciprocating air compressor.
7. Calibration of pressure gauge and vacuum gauge.
8. Flash and fire point - open and closed cup.
9. Economic speed test on multi-cylinder Petrol engine.
10. Morse test on multi-cylinder Petrol engine
11. Viscosity of lubricating oil - Redwood viscometer No. 2.
12. Performance test on vapor compression refrigeration system.

TEXT BOOK

Thermal Engineering Laboratory Manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X	X		X			X
2	X	X	X		X		X	X			X
3		X	X		X	X	X	X	X	X	
4		X	X	X	X	X				X	
5	X	X		X	X		X	X	X	X	X

13ME37 - COMPUTER GRAPHICS LABORATORY - I

COURSE OBJECTIVES

The laboratory course on computer graphics aims to impart knowledge on graphics skills necessary for communication of concepts, ideas and design of engineering products and to understand existing standards related to technical drawings. The course will also help in development of detailed orthographic drawings and isometric drawings

COURSE OUTCOMES

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

CO1 : *Appreciate the use of CAD software and be on-line with the latest developments in the drafting and modeling techniques.*

CO2 : *Demonstrate his/her knowledge in computer applications in drafting, development and manufacturing*

CO3 : *Engage in product development using the help of CAD*

CO4 : *Engage in design and drafting skills*

CO5 : *Improve student prospects and avenues in the engineering industries.*

EXPERIMENTS

1. Introduction to Auto Cad
2. Drafting practice to using basic commands.
3. Practice to use edit commands
4. Advanced editing commands - object controlling commands, hatching and blocks.
5. Creating Text and Inquiry Commands & Geometric Dimensioning and System Variables
6. Isometric Drawings ,Advanced Drawing Commands ,Script Files and Plotting Commands
7. Creation of 2d sectional drawing.

TEXT BOOKS

1. CIT, "VRET Training Centre Manual, AutoCAD Level-I", (Preliminary Level).

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X									X
2	X		X	X			X			X	
3		X				X			X	X	
4	X		X		X		X				X
5		X		X		X	X	X	X		

13ME38 - FLUID MECHANICS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVES

The laboratory course on fluid mechanics aims to impart practical knowledge on the mechanics associated with the flow of fluids. Experimental investigations on determination of discharge coefficient, friction losses, testing and performance analysis of pumps are carried out in the course. Characteristics curves and determination of efficiency for pumps for various loading conditions are analyzed.

COURSE OUTCOMES

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

CO1 : *Apply the gained knowledge in velocity and pressure measuring devices.*

CO2 : *Apply the knowledge attained in solving field problems in the area of storage..*

CO3 : *Apply the knowledge attained in solving field problems in the area of liquid flow.*

CO4 : *Apply the knowledge in finding out the losses occurred in pipe flow.*

CO5 : *Determine the performance of various pumps and perform appropriate selection of pump for a given application.*

LIST OF EXPERIMENTS

1. Venturimeter - Determination of coefficient of Discharge
2. Pipe friction - Determination of coefficient of Friction
3. Minor losses - Determination of coefficient of Losses
4. Determination of coefficient of discharge - Rectangular notch, Orifice & Mouth piece
5. Bernoulli"s Theorem - Verification
6. Performance test on - Centrifugal pump, Reciprocating pump & Jet pump

TEXT BOOK

1. Fluid mechanics laboratory Manual, Department of Civil Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	x	x			x	x	x		x	x	x
2	x		x	x	x						x
3	x	x			x		x	x	x		x
4	x	x	x	x	x					x	x
5	x	x	x	x	x	x	x	x	x	x	x

13ME38 - ELECTRICAL MACHINES AND DRIVES LABORATORY

COURSE OBJECTIVES

The laboratory course on electrical machines and drives aims to impart practical knowledge on testing and evaluation of performance characteristics of DC and AC machines at no load and loaded conditions and conduct experiments with DC and AC drives and motors, and the concepts of energy conversion and speed control using power electronic controllers, with specific reference to selection of appropriate drives for a given application.

COURSE OUTCOMES

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

CO1 : *Analyze the working performance of DC and AC machines during no-load and various loaded conditions.*

CO2 : *Select and implement the proper speed control techniques to DC and AC motors.*

CO3 : *Select suitable electric motor drive system using power electronic controller for various industry process applications.*

LIST OF EXPERIMENTS

1. No load speed characteristics of DC shunt motor.
2. Load test on DC shunt motor.
3. Load test on single phase capacitor start IM.
4. Load test on 3 phase squirrel cage IM.
5. AC voltage controller for fan speed control.
6. Study of DC drives.
7. Study of AC drives.
8. DC servo motor position control system.
9. Transfer function of DC servo motor.
10. Transfer function of two phase AC servo motor.
11. AC servo motor position control system.
12. Stepper motor control system.

TEXT BOOKS

1. Electrical Drives and Controls laboratory manual, Department of Electrical Engineering, CIT.

REFERENCE BOOKS

1. Theraja B. L. and Theraja A. K, " A Text Book of Electrical Technology", Vol. 2, 23rd edition, S. Chand Publications (P) Ltd., New Delhi, 2005.
2. Dubey G. K., "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2007.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X		X		X		X	X	X	X
2		X		X			X	X		X	
3	X	X	X	X	X			X	X	X	X

13ME41 - MATHEMATICS-IV

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on mathematics aims to impart the numerical method ideas required for solving engineering problems which do not have closed form solution, the concepts of the basic statistical ideas those are imperative to effective conclude the experimental results. Sampling theory, the concepts of Z - transformations are inevitable for the understanding of Mechanical engineering courses.

COURSE OUTCOMES

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

CO1 : *Apply numerical methods to solve various problems in their disciplines*

CO2 : *Apply statistical ideas to study and analyze the behaviour of the developed system.*

CO3 : *Demonstrate knowledge of sampling theory ideas to analyze and solve problems.*

CO4 : *Possess adequate knowledge in Z-transforms ideas to analyze and study their areas.*

CO5 : *Solve problems related and to identify the areas in their discipline wherein these ideas could be directly applied.*

NUMERICAL METHODS - I

Linear simultaneous equations: Gauss elimination method - Gauss Jordan method - Crout's method - Gauss Seidal method - relaxation method.Ordinary differential equations: Taylor's series - modified Euler's - Runge-Kutta fourth order methods - Milne's predictor - corrector method. **(9)**

NUMERICAL METHODS - II

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

TWO DIMENSIONAL RANDOM VARIABLES

Probability mass function - probability distribution function - cumulative distribution function - marginal probability functions - conditional distribution - expectation of two dimensional random variables - covariance - correlation - regression - curve fitting - least square technique - only curve of the form or reducible to the form. **(9)**

SAMPLING THEORY

Elements of sampling - large sample - test for mean - proportion - standard deviation. Small sample test - t, F and Chi - square tests - contingency table - test for independence. **(9)**

Z - TRANSFORMS

Definition and properties - inverse Z transforms - initial and final value theorems - convolution - solution of difference equations with constant coefficients. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Kandasamy P., et al., "Numerical methods", S Chand and Company, (2013).
2. Kandasamy P., et al, "Probability Statistics and Random Process", S Chand and Company, (2008).
3. Veerarajan T, "Engineering Mathematics", (for Semester III) (Transforms and Partial Differential Equations) Tata Mc Graw-Hill publishing company Ltd Fifth Edition (updated) (2012).
4. Veerarajan T, "Probability Statistics and Random Process," (Third edition) McGrawHill Eductaion (India) Private Limited, New Delhi, (2013).(sixth print)
5. Venkataraman M. K., "Higher mathematics for Engineering and Science" National Publishing Company, (2000).

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd. 2011.
2. Grewal B.S, "Higher Engineering Mathematics" 42nd Edition, Khanna Publishers. 2012.
3. Kapoor J.N and Saxena H.C., "Mathematical Statistics" 12th Edition, S Chand and Company 2003.
4. Grewal B.S., "Numerical Methods in Science and Engineering", 40th Edition, Khanna Publishers 2007.
5. Trivedi K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications, Prentice-Hall, Inc., Englewood Cliffs, New Jercy 2003.
6. Venkataraman M. K., "Numerical Methods in Science and Engineering", 5th edition, National Publishing Company, 2008.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X		X	X	X			X	X	X
2	X	X	X	X	X	X	X	X	X	X	X
3	X	X	X	X	X				X	X	X
4	X			X	X				X	X	X
5	X	X	X	X	X	X	X	X	X		X

13ME42 - STRENGTH OF MATERIALS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

The course is designed to understand the basic concepts of stress, strain and its variations for different loading pattern. Mechanical properties such as elastic modulus, bulk modulus, modulus of rigidity and Poisson's ratio, along with their behaviour in combined stress and strain, principal stress, principal plane, bending moment and shear force in beam under various loading conditions are studied. Understanding of torsional shear stress in solid and hollow shaft; principal and maximum shear stress in a circular shaft subjected to combined stresses, stresses in struts and columns subjected to axial load; bending stress, slope and deflection under different loading and supporting conditions.

COURSE OUTCOMES

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

CO1 : *Demonstrate the capabilities to apply mathematics and engineering fundamentals to analyze and calculate complex structure stress field, strain distribution as well as deflection.*

CO2 : *Select appropriate models and methods for the stress - strain analysis.*

CO3 : *Discuss the relationship between stress and strain in different types of materials and able to solve the deformations of structural components under axial, transverse and torsion loadings.*

CO4 : *Evaluate the stress under a rotation of axes and its application to the solution of engineering problems and examine the principal stresses in beams, transmission shafts that are subjected to combined loading.*

CO5 : *The student is expected to analyze different stresses, strains and deflection for designing a simple mechanical element under various loading conditions.*

SIMPLE STRESS AND STRAIN

Concept of stress and strain, St. Venant's principle, stress and strain diagram, Hooke's law, Young's modulus, Poisson's ratio, stress at a point, stresses and strains in bars subjected to axial loading, modulus of elasticity, stress produced in compound bars subjected to axial loading. Temperature stress and strain calculations due to applications of axial loads and variation of temperature in single and compound bars. **(6)**

COMPOUND STRESSES AND STRAINS

Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications. Two dimensional stress-strain systems, principal strains - circle of strain. Relationship between elastic constants. **(6)**

SHEAR AND BENDING STRESS IN BEAMS

Types of loading - supports and reactions, shear force and bending moment - diagrams - singularity functions. Theory of bending stresses - simple bending theory - derivation. Application to beams of rectangular, circular and channel sections, composite beams. Shear stress distribution in beams. Combined stresses in beams. **(8)**

SLOPE AND DEFLECTION

Relationship between moment, slope and deflection, moment area method, Macaulay's method.Use of these methods to calculate slope and deflection for determinant beams. **(7)**

TORSION

Torsional equation - applications to hollow and solid circular shafts, torsional rigidity. Combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion. Analysis of close-coiled-helical springs. **(7)**

THIN AND THICK CYLINDERS

Thin cylinders and spheres - derivation of formulae and calculations of hoop stress, longitudinal stress in a cylinder, and sphere subjected to internal pressures. Thick cylinders. **(5)**

ANALYSIS OF COLUMNS

Columns under uni-axial load, Buckling of columns, slenderness ratio and conditions. Euler's equation for elastic buckling load, equivalent length. Rankine Gordon 's empirical equations. **(6)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Dr. Singh J. P., "A Text Book of Mechanics of Solids", Khanna Publishers, 2-B, Nath Market, Nai Saral, Delhi - 110006.
2. Rajput R. K., "Strength of Materials", S. Chand & Company Ltd, Ram Nagar, New Delhi - 110055.

REFERENCE BOOKS

1. Pytel A. H. and Singer F. L., "Strength of Materials", Harper Collins, New Delhi.
2. Beer P. F. and Johston (Jr.) E. R., "Mechanics of Materials", SI version, McGraw Hill, NY.
3. Popov E. P., "Engineering Mechanics of Solids", SI version, Prentice Hall, New Delhi.
4. Timoshenko S. P. and Young D. H., "Elements of Strength of Materials", East West Press, New Delhi.
5. Shames I. H., Pitarresi, J. M., "Introduction to Solid Mechanics," Prentice-Hall, NJ.
6. NPTEL courses, http://nptel.iitm.ac.in/courses.php, web and video courses on "Strength of Materials" by Prof. Sharma S. C., and Prof. Harsha S. P.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X			X				X		X
2	X				X		X		X	X	X
3	X	X	X	X	X	X	X	X	X	X	X
4	X				X				X	X	X
5	X	X	X	X	X		X	X	X	X	X

13ME43 - MECHANISMS AND MACHINES

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on mechanism and machines, expand the student's background in kinematic synthesis and dynamics analysis by providing significant skills and experience in creating and modelling mechanisms. It add significant analytical skills resulting in developing the computational algorithms to automate the motion design process and provide the tools necessary for dynamic analysis of mechanisms, and the skills necessary to consider the role of dynamics in the design. The course also provide an exposures on computer analysis in the mechanism synthesis

COURSE OUTCOMES

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

CO1 : *Identify the design parameters inherent in basic mechanism types*

CO2 : *Understand the analytical techniques of basic linkage synthesis, including optimal synthesis*

CO3 : *Synthesize mechanisms analytically for a variety of tasks for a variety of constraints*

CO4 : *Evaluate forces/ torques and other relevant parameters in working mechanisms and machines.*

CO5 : *Understand the fundamentals of engine dynamics and correlation to other machines*

CO6 : *Analyse static and dynamic balancing of both reciprocating and rotary systems.*

CO7 : *Gain experience and exposure in application of mechanisms and machines, in new fields of research in motion control*

INTRODUCTION TO MECHANISM

Introduction - kinematic links - pairs, mechanism and machines. Degrees of Freedom (DOF) - Grubler's rule for degree of freedom, criterion for mobility determination, effect of number of links on DOF, inversions - Grashoff mechanism - 3R-P, 2R-2P chains. Mechanism of lower pairs - exact and approximate straight line mechanisms. **(6)**

KINEMATICS OF MECHANISM

Kinematic analysis - graphical (using AutoCAD) & analytical approach - velocity and acceleration of planar mechanisms - Coriolis acceleration - Klein's construction for slider crank mechanism. **(6)**

DYNAMICS OF MECHANISM

Dynamic analysis - static force analysis - dynamically equivalent two mass systems - center of percussion. Effective force and inertia - dynamic analysis of planar mechanism - four bar & slider-crank mechanisms (using AutoCAD). Analytical expression of slider crank mechanism - piston effort, crank effort, pin effort. **(6)**

CAM ANALYSIS

Cams - classification - analytical treatments of followers with uniform motion, parabolic motion, SHM and cycloidal motion, and pressure angle - parameters affecting pressure angle. **(5)**

ANALYSIS OF GEARS

Gears - nomenclature - law of gearing - length and arc of contact, involutes & cycloidal profile, interference. Helical, spiral and worm gears, simple, compound gear trains. Epicyclic gear trains - analysis. **(5)**

DYNAMIC ANALYSIS OF REVOLVING AND RECIPROCATING SYSTEMS

Balancing - static and dynamic balancing. Balancing of revolving & reciprocating masses in single and multi-cylinder engines. **(5)**

GYROSCOPES

Gyroscopes - basic concepts gyroscopic law, effect of gyroscopic couple on automobiles, ships, aircrafts. **(5)**

VIBRATIONS

Vibrations - vibration analysis of single degree of freedom systems - natural and damped - forced vibrations - base-excited vibrations, transmissibility ratio. Critical speeds of shaft - multi- degrees of freedom - torsional vibrations - approximate methods - Rayleigh's method, Dunkerley's method - simulation using simulink. **(7)**

Note:

For internal evaluation and not to be included in final examination - simulation of mechanisms using Matlab & AutoCAD.

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Ashok Ambekar, "Mechanisms and Machine Theory", Prentice hall, 2004.
2. Rao J. S and Gupta K, "Introductory Course on Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd., New Delhi, 2013.

REFERENCE BOOKS

1. Thomas Bevan, "Theory of Machines", CBI publishers, 2009.
2. Amitabha Ghosh and Asok kumar Mallik, "Theory of Mechanism and Machines", affiliated East - West Press Private Ltd., 2009.
3. Rao J. S. and Dukipati R. V., "Mechanism and Machine Theory", New age International Publishers, 2012.
4. John Hannah and Stephers R. C., "Mechanics of Machines", Viva low priced students ed. 1998.
5. Rattan S. S, "Theory of Machines", McGraw-Hill, 2012.
6. NPTEL courses: http://nptel.iitm.ac.in/courses.php, related web and video resources on Kinematics of Machines and Dynamics of Machines.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X						X
2	X	X		X	X					X	
3	X	X	X		X	X	X	X			X
4	X	X	X		X						X
5	X	X	X	X	X				X	X	X
6	X	X	X	X	X	X		X			X
7	X			X		X	X			X	

13ME44 - PRINCIPLES OF MANUFACTURING PROCESSES-I

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course is designed to provide students with an overview of a wide variety of general manufacturing processes practiced in the production process. The students will learn principles, operations and capabilities of different metal casting, forming, joining and machining processes, along with merits/ demerits, defects - their causes and remedies for the processes.

COURSE OUTCOMES

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

CO1 : *Demonstrate the importance of the manufacturing processes and to suggest suitable production process based on different constraints.*

CO2 : *Demonstrate the inter-relationships between material properties and manufacturing processes.*

CO3 : *Apply the knowledge to identify the appropriate techniques for new product development.*

CO4 : *Suggest alternatives to improve the productivity of the manufacturing system, considering the available resources.*

INTRODUCTION TO MANUFACTURING PROCESS AND METAL CASTING

General introduction - manufacturing; definition and broad classification, selection - typical examples of applications. Expendable molding - pattern, types, materials, allowances; green sand molding - sand types, composition, properties & testing, core - core print; melting practice and furnace; other expendable molding process - dry CO_2, shell mold, investment mold, centrifugal - semi centrifugal and centrifuge; permanent die casting - hot and cold chamber, slush casting, squeeze casting; casting defects - yield of a casting. **(10)**

METAL FORMING PROCESS

Hot, warm and cold working processes: - forging - forging operations, tools and equipment, drop forging and press forging (pressing) methods and uses; forging dies; types, materials - forging defects. Rolling: introduction - types, characteristics and applications of rolling and rolling defects; extrusion and wire drawing - principles and requirements, classification, methods and applications. Forming - hydro forming, magneto forming, explosive forming. **(9)**

SHEET METAL OPERATION

Basic principles, system, applications and operations - shearing, parting, notching, blanking, piercing and bending. Cup drawing, deep drawing, coining and embossing. Other forming processes - principles, methods, essential requirements and applications of spinning. **(8)**

METAL JOINING PROCESS

Mechanical joining - temporary, semi-permanent and permanent - welding, brazing and soldering, adhesive bonding, fusion welding - introduction, basic principle, definition and major classification, characteristics and applications of different fusion welding processes using different heat sources - chemical, gas welding,

thermit welding. Electrical arc welding- manual arc welding, submerged arc welding; TIG and MIG; induction welding; plasma arc welding; resistance welding; spot welding; butt welding; seam welding; projection welding.

Laser beam welding and electron beam welding; solid state welding: - principles, methods, requirements and application of different types. Forge welding; friction welding; diffusion welding - ultrasonic welding, pressure welding, explosive welding; welding defects - types, causes, defects and remedy. **(10)**

MATERIAL REMOVAL PROCESS

Machining of circular parts - turning process:- lathes and lathe operations, boring and boring machines, drilling and drilling machines, reaming and reamers, tapping and taps; machining of non-circular parts: Introduction, milling and milling machines, planing and shaping, broaching and broaching machines, sawing, gear manufacturing - principles of generation and forming. **(8)**

TOTAL : 45

TEXT BOOKS

1. Rao P. N, "Manufacturing Technology", vol. 1, 4th edition, Tata McGraw-Hill, 2013.
2. Rao P .N, "Manufacturing Technology", vol. 2, 3rd edition, Tata McGraw-Hill, 2013.

REFERENCE BOOKS

1. Serope Kalpakjian, Steven R. Schmid, "Manufacturing Processes for Engineering Materials", 5th edition, Pearson Education, 2009.
2. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, PHI Learning, 2008.
3. Timings R. L, Wilkinson S. P., "Manufacturing Technology", Volume 1, 2nd Edition, Longman, 1998.
4. Timings R. L, Wilkinson S. P. , "Manufacturing Technology", Volume 2, 3rd Edition, Longman, 2000.
5. Prashant P. Date, "Introduction to Manufacturing Technologies: Principles & Practice", Jaico Publishing House, 2010

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X					X			X
2			X	X	X	X	X	X	X	X	X
3	X	X	X	X				X	X	X	X
4	X	X	X		X	X	X	X		X	X

13ME45 - EMBEDDED PROCESSOR ARCHITECTURE AND PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study ARM processors that is widely used in embedded systems

COURSE OUTCOMES

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

CO1 *: Identify the different embedded processors, their advantages and disadvantages*

CO2 *: Demonstrate the knowledge on ARM processor architecture and programming*

CO3 *: Interface simple systems ARM processors.*

INTRODUCTION

Introduction to CPU: ALU and control unit - instruction set design - Complex Instruction Set Computer (CISC) - Reduced Instruction Set Computer (RISC) architecture - advantages - disadvantages. **(9)**

ARM ARCHITECTURE

ARM Programmer's model - registers - ARM memory organization - load-store architecture -ARM instruction set - ARM exceptions - ARM development tools. **(9)**

ARM ASSEMBLY LANGUAGE PROGRAMMING

Data processing instructions - types of operands - data transfer instructions - addressing modes - control flow instructions - branch - conditional branch instructions - subroutine and return instructions - writing simple assemble language programs. **(9)**

ARM ORGANIZATION

3-stage pipeline organization - 5-stage pipeline organization - ARM instruction execution - data processing instructions - data transfer instructions - branch instructions - adder - ALU functions - barrel shifter - multiplier - data path layout. **(9)**

TYPICAL APPLICATIONS

Interfacing examples - LED - Analog to Digital converters - Digital to Analog converters - stepper motor - seven segment display - PWM based speed control. **(9)**

TOTAL : 45

TEXT BOOKS

1. Steve Furber, "ARM System-on-Chip Architecture", 2nd edition, Pearson Education Limited, 2012.
2. Andrew Sloss, "ARM System Developer's Guide", Morgan Kaufmann Publishers, 2005.

REFERENCE BOOKS

1. David E. Simon, "An Embedded Software Primer", Pearson Education Asia, 2000.
2. Raj Kamal, "Embedded Systems Architecture, Programming and Design", Tata McGraw Hill, 2003.
3. Jonathan W. Valvano, "Introduction to ARM Cortex - M Microcontrollers", 4th edition, 2013.
4. Carl Hamacher, Zvonko Vranesic and Safwat Zaky "Computer Organization and Embedded Systems", McGraw Hill, 2002.
5. ARM Architecture reference manual.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X			X	X					X	X
2		X	X	X	X	X	X	X	X	X	X
3	X	X	X	X		X	X	X		X	X

13ME46 - COMPRESSIBLE FLUID FLOW

(Use of approved gas tables permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

The course aims at introducing low speed gas dynamics and propulsion systems used in aircrafts and jet engines. The scope on chapters on gas dynamics includes analyzing compressible fluid flow as quasi one-dimensional for geometries of variable and constant cross-sectional area, including effect of irreversibility. The chapter on propulsion discusses various kinds of propulsion systems for air-breathing and non-air-breathing vehicles and their performance parameters.

COURSE OUTCOMES

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

CO1 : *Understand the basic concepts from which a study of gas dynamics proceeds*

CO2 : *Obtain and simplify the integral forms of the continuity, momentum and energy equations with the basic concepts*

CO3 : *Identify the problem and develop good problem - solving skills*

CO4 : *Compute significant performance parameters for an air-breathing propulsion systems and rocket systems when given appropriate known parameters*

INTRODUCTORY THOUGHTS, INTEGRAL FORMS OF THE CONSERVATION EQUATIONS FOR INVISCID FLOWS

Historical high-water marks - definition of compressible flow - flow regimes - a brief review of thermodynamics - perfect gas - internal energy and enthalpy - first law of thermodynamics - entropy and the second law of thermodynamics - calculation of entropy - isentropic relations. Philosophy - approach - finite control volume - continuity equation - momentum equation - a comment - energy equation - final comment. **(6)**

ONE-DIMENSIONAL FLOW - ISENTROPIC FLOW AND STANDING NORMAL SHOCK

Introduction - one dimensional flow equations - speed of sound and Mach number - some conveniently defined flow parameters (stagnation and sonic flow reference parameters) - alternative forms of the energy equation - isentropic flow properties table. Standing normal shock - analysis and working relations for perfect gas - Prandtl relation for standing normal shock - Hugoniot equation - standing normal shock table. **(11)**

ONE-DIMENSIONAL FLOW - RAYLEIGH FLOW AND FANNO FLOW

One-dimensional flow with heat addition - analysis and working equations for perfect gas - thermal choking - standing normal shock in Rayleigh flow - reference state and Rayleigh table. One-dimensional flow with friction - analysis and working relations for perfect gas - limiting point - friction chocking - standing normal shock in Fanno flow - reference state and Fanno table. **(9)**

OBLIQUE SHOCK AND EXPANSION WAVES, QUASI-ONE-DIMENSIONAL FLOW

Introduction - source of oblique shock waves and expansion waves (wave propagation). Introduction - governing equations - area velocity relation - nozzles - isentropic subsonic supersonic flow of a perfect gas through nozzles - effect of different pressure ratios across a given nozzle - flow in convergent divergent nozzle with standing normal shock - diffusers. **(9)**

PROPULSION SYSTEMS

Introduction - Brayton Cycle - basic (ideal) closed cycle - cycle improvements - real cycles - open Brayton cycle for propulsion systems - propulsion engines - turbojet - turbofan - turboprop - ramjet - pulsejet - rocket - general performance parameters - thrust considerations - analysis of fluid - analysis of enclosure - power considerations - efficiency considerations - air breathing propulsion systems performance parameters - specific fuel consumption - rocket propulsion systems performance parameters - effective exhaust velocity - specific impulse. **(10)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. John D. Anderson, Jr., "Modern Compressible Flow with Historical Perspective", McGraw- Hill, Third edition 2004.
2. Yahya S. M., "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International (P) Ltd., Third edition, 2003.
3. Ganesan V., "Gas Turbine", Tata McGraw-Hill, New Delhi, 2005.

REFERENCE BOOKS

1. Robert D. Zucker, Oscar Biblarz, "Fundamentals of Gas Dynamics", Wiley India Pvt. Ltd., Second edition, 2011.
2. Radhakrishnan E., "Gas Dynamics", Prentice Hall of India, New Delhi, 2006.
3. Saravanamuttoo, GFC Rogers, and Cohen. H, "Gas Turbine Theory", Pearson Education, Fifth edition, 2003.
4. Philip Hill, Carl Peterson, "Mechanics and Thermodynamics of Propulsion", Pearson Education, Second edition, 2011.
5. Babu V., "Fundamentals of Gas Dynamics", ANE Books India, 2008.
6. Oosthuizen P. H. and Carscallen W.E., "Compressible Fluid Flow", McGraw Hill, 1997.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X				X						
2	X	X	X		X	X	X	X	X	X	X
3	X	X	X		X		X	X			X
4	X	X	X	X	X	X	X	X	X	X	X

(a) 13ME47 - STRENGTH OF MATERIALS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVES

The laboratory course on strength of materials aims to impart practical knowledge on the behavior of materials to various loading conditions and to have a sound knowledge on the mechanical testing procedures to determine the material properties.

COURSE OUTCOMES

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

CO1 : *Apply the gained knowledge in materials for different kinds of loading conditions.*

CO2 : *Apply the knowledge acquired on different failure pattern of various materials.*

CO3 : *Apply the knowledge acquired on various types of loading conditions to evaluate its behaviour.*

CO4 : *Apply the knowledge acquired in the determination of material properties during the selection process in design of new products.*

LIST OF EXPERIMENTS

1. Tension test on mild steel rod.
2. Shear test on mild steel rod.
3. Hardness test - Brinell hardness number.
4. Hardness test - Rockwell hardness number.
5. Impact flexure test on metals.
6. Test on wood - wood universal testing machine.
7. Test on helical spring.
8. Deflection test on wooden beams.
9. Flexure test on cantilever beams.
10. Torsion test on mild steel rod.

TEXT BOOK

1. Strength of Materials Laboratory Manual, Department of Civil Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X			X						X
2	X	X	X		X						X
3	X	X	X		X			X	X	X	X
4		X	X	X	X	X	X			X	

(b) 13ME47 - MECHANISM OF MACHINES LABORATORY

COURSE OBJECTIVES

The laboratory course on mechanism of machines aims to impart practical knowledge on the various forces acting in mechanisms, their controls and its influence on the mechanism.

COURSE OUTCOMES

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

CO1 : *Analyze the balancing of rotating masses in a real-time dynamic system.*

CO2 : *Appreciate the effect of vibration and implement the necessary measures to control them in practical systems.*

CO3 : *Develop various cams and governors for actuation and control mechanisms.*

LIST OF EXPERIMENTS

1. Study of gyroscopic couple using motorized gyroscope apparatus.
2. Balancing unbalanced mass using static and dynamic balancing apparatus.
3. Finding the whirling speed of a shaft using whirling of shafts demonstrator.
4. Using universal vibration apparatus,
    a. Study of oscillations of simple pendulum;
    b. Determining the radius of gyration of a compound pendulum;
    c. Determining the radius of gyration of a body using bifilar suspension;
    d. Determining the radius of gyration of a body using tri-filar suspension;
    e. Study of torsional vibrations of a single rotor system;
    f. Study of forced damped vibrations of a simply supported beam.
5. Study of different types of cams and followers.
6. Finding the controlling force at a given speed, sensitiveness at given limits of lift and governor effort and power of various type of governors.
7. Determining the Coriolis component of acceleration using Coriolis component of acceleration apparatus.
8. Using universal vibration apparatus,
    a. Study of Torsional vibrations of two rotor system;
    b. Study of un-damped free vibrations of a spring;
    c. Study of natural vibrations of a spring mass system;
    d. Study of forced damped vibrations of a spring mass system;
    e. Verification of Dunkerley's rule for transverse vibrations.
9. Study of - helical gear, worm gear, epi-cyclic gear, four bar mechanism and Scotch yoke mechanism.
10. Determining the natural frequency and the critical speed of the vibration table.

TEXT BOOKS

1. Dynamics Laboratory manual, department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X			X	X	X	X
2	X	X	X	X	X	X		X	X		X
3	X	X	X	X	X		X			X	X

(c) 13ME47 - COMPUTER GRAPHICS LABORATORY - II

COURSE OBJECTIVES

The laboratory course on thermal engineering aims to impart knowledge on graphics skills necessary for communication of concepts, ideas and design of engineering products and to understand existing standards related to technical drawings. The course will also help in development of detailed orthographic drawings and isometric drawings

COURSE OUTCOMES

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

CO1 : *Appreciate the use of CAD software and be on-line with the latest developments in the drafting and modeling techniques.*

CO2 : *Demonstrate his/her knowledge in computer applications in drafting, development and manufacturing*

CO3 : *Engage in product development using the help of CAD*

CO4 : *Engage in design and drafting skills, and to improve their prospects and avenues in the engineering industries.*

EXPERIMENTS

1. Surface Modeling and the User Coordinate System (WCS, UCS)
2. Solid Modeling, Viewports, Model space, Paper space and Layouts
3. Blocks Attributes and External Reference
4. Menus, Macros and Advanced Rendering and Animation

TEXT BOOKS

1. CIT, "VRET Training Centre Manual", AutoCAD Level-II (Intermediate Level).

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X							X		X
2	X		X			X	X	X		X	X
3		X		X					X	X	
4	X		X		X	X	X	X			X

13ME48 - EMBEDDED PROCESSOR ARCHITECTURE AND PROGRAMMING LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVES

To understand ARM processor programming and interfacing techniques

COURSE OUTCOMES

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

CO1 *: Develop simple programs for ARM processor*

CO2 *: Interface input and output modules with the processor*

CO3 *: Understand the program development and downloading procedure for ARM processor*

LIST OF EXPERIMENTS WITH ARM PROCESSOR

1. Simple arithmetic programs
2. Simple logical functions
3. LED interfacing
4. LCD interfacing
5. Temperature sensor interfacing
6. Stepper motor interfacing
7. PWM based controls
8. External interrupt programming
9. ADC / DAC interface
10. Inductive pick up based speed measurement
11. Bluetooth interface

TEXT BOOK

1. Embedded processor architecture and programming laboratory Manual, Department of Electrical Engineering, CIT.

REFERENCES

1. Jonathan W. Valvano, "Introduction to ARM Cortex - M Microcontrollers", 4th edition, 2013.
2. Joseph Yiu, "A Definitive guide to the ARM Cortex-M0", Newnes, 2011.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X		X			X			X	X
2	X		X	X	X	X		X		X	X
3		X		X			X		X	X	X

13CE49 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
2	0	0	2

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course aims to inculcate among the students the importance of spirituality, yoga and procedures to manage stress and strain, impart the knowledge of professional and management skills and develop their ethical values and make them a responsible human to the welfare of nature

COURSE OUTCOMES

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

CO1 : *The students will be able to manage stress & strain in their profession in future*

CO2 : *The students will be able to have knowledge of introspection procedures, practical considerations and guidelines for their living*

CO3 : *The students will be able to understand the principles of professional ethics*

CO4 : *The students will be able to activate in the areas of protecting the public health, safety and welfare of people, respect the copyright and patents*

CO5 : *The students will be able to understand the impact of social sciences and humanities on the quality of life and physical environment*

INTRODUCTION

Science of creativity and personality development - objectives - evolution of the universe - creation theory - evolution theory - theory of permanence - theory of mithya - big-bang theory - static and dynamic states - ethereal particles - panchabhudas - evolution of life - science and spiritualism - physical transformation of bio-magnetism - harmony in life - self, family, society and nature - cause and effect system. **(6)**

LIFE FORCE, MIND AND CONSCIOUSNESS

Life force - origin - potentiality of the life force - pathway to realize universal force - primordial state - almighty - mind - existence and purpose of mind - greatness and mystery - role of mind in shaping one's personality - ten stages - totality - wisdom - consciousness - sixth sense - action, word and deed - six temperaments. **(6)**

TECHNIQUES FOR SELF EVALUATION

Blockades for personality development - six impurities - introspection - analysis of thought - moralization of desire - eradication of worries - neutralization of anger - realization of self or actualization of the universe - understanding of morality, duty and charity - yoga - different types - kundalini yoga - nine centers - removal of six imprints - meditation and its benefits. **(6)**

HUMAN BODY

Body structure - endocrine glands and six chakras - seven thadus - health and nature - medicines - understanding the need, habit, environmental conditions, society and evolutionary process of life - physical exercise and its importance - regulating food, work, rest, sex and thought. **(6)**

Professional Ethics: Engineering ethics - variety of moral issues - moral autonomy -professions and professionalism - professional ideas & virtues - engineers as responsible experiments - safety & risk - reducing risk - collegiability and loyalty - professional rights - intellectual property rights - multinational corporations - environmental ethics - engineers as managers. **(6)**

TOTAL : 30

TEXT BOOKS

1. Yogiraj Vethathiri Maharishi, "Karma Yoga - The Holistic Unity", Vethathiri Publications, 1986.
2. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York, 2004.

REFERENCE BOOKS

1. Charles D. Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999.
2. Laura Schlesinger, "How Could You Do That: The Abdication of Character, Courage, and Conscience", Harper Collins, New York, 1996.
3. Stephen Carter, "Integrity", Basic Books, New York, 1996.
4. Tom Rusk, "The Power of Ethical Persuasion: From Conflict to Partnership at work and in Private Life", Viking, New York, 1993.
5. Naagarazan R. S., "A Textbook on Professional Ethics and Human Values", New Age International Publishers, New Delhi, 2009.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X	X	X			X		X	X	
2	X			X		X		X	X	X	X
3	X	X	X	X		X					
4			X		X			X	X	X	
5	X					X	X		X	X	

13ME51 - OPTIMIZATION FOR ENGINEERING DESIGN

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on optimization for engineering design aims to understand the major capabilities and limitations of deterministic operations research modeling as applied to engineering applications. It aims to provide knowledge on formulation of a design problem for optimization, understand the Basic principles of optimal design for linear/ non linear - unconstrained and constrained problems.

COURSE OUTCOMES

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

CO1 : *Formulate engineering design problems as mathematical optimization problems andUse mathematical software for the solution of engineering problems.*

CO2 : *Demonstrate the basic understanding of numerical optimization algorithms andgainmastery in techniques, skills and modern tools used in optimization.*

CO3 : *Apply the knowledge and adapt to emerging applications in the field of engineering and technology.*

CO4 : *Apply creativity in the design of systems, components or processes appropriate to program objectives.*

CO5 : *Identify, analyze and solve technical problems.*

INTRODUCTION

Problem formulation - design variables, constraints, constraint surfaces, objective functions, objective function surfaces. Classification of optimization - based on existence of constraints, nature of design variables, structure of the problem, nature of equation involved, permissible value of the design variables, deterministic nature of the variables, separability of the functions and the number of objective functions. Example of engineering optimization problems. **(10)**

SINGLE VARIABLE OPTIMIZATION

Optimal criteria - bracketing method - exhaustive search method, region elimination method - interval halving, Fibonacci, golden search method, point estimation method - successive quadratic approximation, gradient search method - Newton Raphson's method. **(9)**

MULTIVARIABLE OPTIMIZATION WITH CONSTRAINTS

Multivariable optimization - semi definite case - saddle point. Multivariable optimization with equality constraints - solution by direct substitution - solution by the method of constrained variation - solution by the method of Lagrange multipliers. Multivariable optimization with inequality constraints - Kuhn-Tucker conditions, constraint qualification. **(9)**

UNCONSTRAINED OPTIMIZATION

Introduction - classification of unconstrained minimization methods - general approach - rate of convergence - scaling of design variables. Direct Search Methods - random search methods - random walk method

with direction exploitation - advantages of random search methods. Indirect Search Methods - gradient of a function - evaluation of the gradient - rate of change of a function along a direction - steepest descent (Cauchy) method. **(10)**

Only for internal evaluation and not for final exam - Formulation and solving optimization problems using MATLAB. **(7)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Rao S. S., "Optimization: Theory & Application", 4th Edition, Wiley Eastern, 2009.
2. Deb K., "Optimization for Engineering Design", Prentice Hall India, 2005.

REFERENCE BOOKS

1. Arora J. S., "Introduction to Optimum Design", McGraw-Hill, 2004.
2. Adeli H., "Advances in Design Optimization", Chapman and Hall, 2007.
3. Robert F. Rhyder, "Manufacturing Process Design and Optimization", Marcel Dekker: New York, 1997.
4. Mohan C. Joshi & Kannan. Moudgalya M., "Optimization Theory and Practice", Narosa Publishing House, 2004.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X		X	X	X	X	X
2	X	X	X		X		X	X	X	X	X
3	X	X	X	X	X	X	X	X	X	X	X
4	X	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X		X	X	X	X	X

13ME52 - MANUFACTURING SCIENCES

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on manufacturing sciences, aims to impart the designing of various manufacturing process. The course imparts knowledge on dependent and independent variables that control materials casting in a production setting, factors influencing the forming operation, parameter affecting joining process and the principles and operations of cutting parameters in machining processes.

COURSE OUTCOMES

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

CO1 : *Determine the optimal design parameters in the process of developing the process controls in various manufacturing systems.*

CO2 : *Demonstrate knowledge on processes to be used for producing a particular product using a specific material or class of material and their advantages and limitations.*

CO3 : *Identify, analyze and solve technical problems, and a commitment to quality, timeliness and continuous improvement.*

CO4 : *Evaluate the influence of process parameters and calculate relevant data of manufacturing process.*

CO5 : *Applies knowledge that considers professional societal, and/ or global impact.*

METAL CASTING PROCESS

Pattern design - pattern allowances - types. Cores - core print size, gating design - top, bottom and middle gating - gating ratio - aspiration effect - effect of friction and velocity distribution. Mechanism of solidification - rate of solidification - directional solidification - riser design - riser placements. Residual stress in casting. Melting practice - fluidity of molten metal - charge calculations. **(11)**

METAL FORMING PROCESS

Elastic and plastic deformation of materials - theory of plasticity - yield criteria - Tresca's & Von Misses criteria. Analysis of forging process - sliding friction - sticking friction - high friction - on rectangular and circular cross section, forging force calculations. Analysis of rolling - effect of friction - maximum draft - neutral point - forces in rolling. Analysis of extrusion - effect of friction on direct and indirect extrusion - shape factor - extrusion force as a function of the billet. Wire drawing - drawing force - optimal reduction in cross sectional area. Sheet metal operations - punching & blanking - punch and die clearance - blank holding force - drawing force. **(12)**

MACHINING PROCESS

Mechanics of chip formation - merchant diagram - cutting forces - relationship between friction, shear and rake angle. Heat generation and cutting tool temperature analysis. Cutting fluid, failure of cutting tools, tool wear - tool life and machinability - surface finish - cutting tool materials. Analysis of cutting forces in shaping, planning, turning, boring, drilling, milling, and other multipoint machining processes - problems. **(11)**

JOINING PROCESSES

Arc welding - emission and ionization of arc - characteristics and power, thermal and metallurgical aspects of welding - peak temperature - macro and microstructure of weld, HAZ and base metal. Residual stresses and distortion in welding - thermal expansion and contraction - transverse shrinkage - angular distortion and longitudinal bowing. Effect of heat distribution. Resistance welding - design for spot welding. Science in adhesive bonding. **(11)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Amitabha Ghosh and Asok Kumar Mallik, "Manufacturing Sciences", 2nd edition, East - West Press Pvt. Ltd., 2010.
2. Khan M. I. and Serajul Haque, "Manufacturing Sciences", PHI Learning Pvt. Ltd., 2011.

REFERENCE BOOKS

1. Rao P. N., "Manufacturing Technology: Vol. 1", 4th edition, Tata McGraw-Hill, 2013.
2. Rao P. N., "Manufacturing Technology: Vol. 2", 3rd edition, Tata McGraw-Hill, 2013.
3. Serope Kalpakjian, and Steven R. Schmid, "Manufacturing Processes for Engineering Materials", 5th edition", Pearson Education, 2009.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, PHI Learning, 2008.
5. Timings R. L. and Wilkinson S. P., "Manufacturing Technology: Vol. 1", 2nd edition, Longman, 1998.
6. Timings R. L. and Wilkinson S. P., "Manufacturing Technology: Vol. 2", 3rd edition, Longman, 2000.
7. Prashant P. Date, "Introduction to Manufacturing Technologies: Principles & Practice", Jaico Publishing House, 2010.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X	X		X			X
2		X	X	X				X	X	X	X
3	X	X	X		X	X	X	X	X	X	X
4	X		X	X	X	X	X	X			X
5	X		X	X		X	X		X	X	X

13ME53 - TURBO MACHINERY

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

The course aims at introducing thermodynamics and fluid-dynamic principles of turbomachines. The scope of the course covers the working principle, geometric configurations and performance analysis of axial and radial flow work-absorbing and work-delivering machines.

COURSE OUTCOMES

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

CO1 *: Explain the working principle of turbo machines with suitable energy equations.*

CO2 *: Arrive at fluid-dynamic design of a turbo machine for the required practical situations.*

CO3 *: Compare the performance of different turbo machines.*

CO4 *: Draw inlet and outlet velocity triangles of turbo machines.*

CO5 *: Construct and interpret the performance curves of turbo machines.*

INTRODUCTION

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

AXIAL AND CENTRIFUGAL COMPRESSOR

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

AXIAL AND CENTRIFUGAL PUMPS

Axial flow pumps: expression for degree of reaction; velocity triangles for different values of degree of reaction. Centrifugal pumps: definition - manometric head, suction head, delivery head, pressure rise, efficiency, slip, priming, cavitations, and NPSH. **(6)**

THERMODYNAMIC FLUID FLOW, THERMODYNAMIC ANALYSIS OF COMPRESSION AND EXPANSION PROCESSES

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

STEAM TURBINES

Classification - single stage impulse turbine, condition for maximum blade efficiency, stage efficiency. Compounding - need for compounding, method of compounding. Impulse staging - maximum utilization

factor for multistage turbine with equiangular blades, effect of blades and nozzlelosses. Reaction turbine-maximum blade efficiency. **(9)**

HYDRAULIC TURBINES

Classification - Pelton, Francis and Kaplan turbines - velocity triangles, design parameters - efficiency-different blade speeds. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Seppo A. Korpela, "Principles of Turbo Machinery", John Wiley& Sons, 2011.
2. Venkanna B.K., "Fundamentals of Turbo Machinery", PHI Learning, 2009.
3. Dixon D.L., "Turbo Machinery", Pergamaon Press, 2007.
4. Earl Logan, "Handbook of Turbo Machinery", CRC Press, 2003.
5. Lewis R.I., "Turbo Machinery - Performance Analysis", Elsevier Science & Technology Books, 1996.

REFERENCE BOOKS

1. Stepanoff A.J., "Turbo Blowers", John Wiley and Sons, 1970.
2. Brunoeck, "Fans", Pergamon Press, 1973.
3. Austin H. Church, "Centrifugal Pumps and Blowers", John Wiley and Sons, 1980.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X						X		X	X	
2	X	X	X	X	X	X		X	X	X	X
3	X		X			X	X	X		X	
4	X	X	X	X	X	X	X	X		X	X
5	X	X	X	X	X	X	X				

13ME54 - PRINCIPLES OF MANUFACTURING PROCESSES-II

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course aims to provide fundamental knowledge on operations that are performed in concurrence with the conventional manufacturing process. It also provides an insight to the recent advancements in manufacturing namely layer manufacturing, metrology and allied surface treatment techniques.

COURSE OUTCOMES

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

CO1 : *Identify, analyze and solve technical problems and a commitment to quality, timeliness and continuous improvement*

CO2 : *Suggest suitable alternative manufacturing techniques for a given product considering the manufacturing constraints.*

CO3 : *Suggest suitable prototyping methods for product development during the design process*

CO4 : *Suggest appropriate measurement and inspection techniques and design appropriate process for effective evaluation of the process parameters and quality control.*

MACHINING PROCESS

Geometry and kinematics of machining operations such as turning, drilling, reaming, milling, broaching and grinding - cutting tool geometry and design of single and multi point cutting tools - problems. Optimizing the cutting parameters for minimum cost, maximum production and maximum efficiency - problems.**(9)**

RAPID-PROTOTYPING PROCESSES, OPERATIONS & NUMERICAL CONTROL MACHINE TOOLS

Introduction - Subtractive Processes - Additive Processes - Virtual Prototyping - Direct Manufacturing and Rapid Tooling. Basic concepts, CNC systems, CNC part programming, high speed machining **(9)**

ADVANCED MACHINING PROCESSES

Introduction - Chemical Machining - Electro-Chemical Machining - Electro-Chemical Grinding - Electrical-Discharge Machining - Laser-Beam Machining - Electron-Beam Machining - Water-Jet Machining - Abrasive-Jet Machining - Hybrid Machining Systems - Economics of Advanced Machining Processes. **(9)**

SURFACE TREATMENT, COATINGS AND CLEANING

Introduction - Mechanical Surface Treatments - Mechanical Plating and Cladding - Case Hardening and Hard Facing Thermal Spraying - Vapor Deposition - Ion Implantation and Diffusion Coating - Laser Treatments - Electroplating, Electro-less Plating, and Electro-forming - Conversion Coatings - Hot Dipping - Porcelain Enameling; Ceramic and Organic Coatings - Diamond Coating and Diamond like Carbon - Surface Texturing - Painting - Cleaning of Surfaces. **(9)**

ENGINEERING METROLOGY AND INSTRUMENTATION

Introduction - Measurement Standards - Geometric Features of Parts; Analog and Digital Measurements - Traditional Measuring Methods and Instruments - Modern Measuring Instruments and Machines -

Automated Measurement and Inspection - General Characteristics and Selection of Measuring Instruments - Geometric Dimensioning and Tolerance. **(9)**

TOTAL : 45

TEXT BOOKS

1. Amitabha Ghosh and Asok Kumar Mallik, "Manufacturing Sciences", 2nd edition, East - West Press Pvt. Ltd. 2011.
2. Serope Kalpakjian, Steven R. Schmid, "Manufacturing Engineering and Technology", 7th edition, Pearson Education, 2013.

REFERENCE BOOKS

1. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, PHI Learning, 2008.
2. Timings R. L., Wilkinson S. P., "Manufacturing Technology: Volume 1", 2nd edition, Longman, 1998.
3. Timings R. L., Wilkinson S. P., "Manufacturing Technology: Volume 2", 3rd edition, Longman, 2000.
4. Prashant P. Date, "Introduction to Manufacturing Technologies: Principles & Practice", Jaico Publishing House, 2010.
5. Khan M. I., Serajul Haque, "Manufacturing Sciences", PHI learning Pvt. Ltd., 2011.
6. Rao P. N., "Manufacturing Technology: Vol. 1", 4th edition, Tata McGraw Hill, 2013.
7. Rao P. N., "Manufacturing Technology: Vol. 2", 3rd edition, Tata McGraw Hill, 2013.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X	X	X	X			X			X
2	X	X	X	X		X	X			X	
3	X		X	X	X	X		X	X		X
4	X	X	X		X	X	X	X	X	X	X

13ME55 - DESIGN OF MACHINE ELEMENTS - I

(Use of approved design data book is permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on machine design enables the student to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.

COURSE OUTCOMES

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

CO1 : *Demonstrate a systematic approach in the process of design.*

CO2 : *Analyze loads, stresses and deformation of machine elements under static or dynamic loading conditions.*

CO3 : *Identify and quantify failure modes for mechanical parts.*

STRESSES IN MACHINE ELEMENTS

Introduction to design process-factors influencing machine design - types of stresses, stress-strain diagram in tension, mechanical properties of materials, static stress equation in axial, bending and torsional loading, factor of safety. Combination of normal stresses, eccentric loading of members, combination of normal and shear stresses, principal stresses, theories of failure. Mechanism of fatigue failure - fatigue limit and fatigue strength, S-N curves, types of stress variations, Soderberg, Goodman and Gerber equations, stress concentration factor, notch sensitivity factor, factors affecting fatigue limit, equivalent stress, combined variable stress. **(9)**

SHAFTS AND COUPLINGS

Forces on shafts due to gears, belts and chains - design of shafts based on strength, torsional rigidity - critical speed. Design of square and taper key - use of standards - design of rigid coupling, flexible couplings and applications. **(9)**

DESIGN OF ENERGY STORING DEVICES

Helical spring and leaf spring - stresses and deflection in round wire helical springs - accounting for variable stresses - concentric springs. Design of leaf springs - stress and deflection equation - design of flywheel - fluctuation of speed - energy stored - stresses in rims and arms for engines and punching machines. **(9)**

DESIGN OF JOINTS

Joint strength equations, efficiency, design of riveted joints - joints of uniform strength, eccentrically loaded riveted joints. Welded joints - strength of welds, centrally loaded, unsymmetrical sections, axially loaded and eccentrically loaded joints - design of bolted joints. **(9)**

DESIGN OF BEARINGS

Design of hydrodynamic and hydrostatic bearings - effect of friction under uniform pressure and wear conditions - torque calculations - theory of lubrication, McKee's equation, Sommerfeld number - static and dynamic load capacity, cubic mean load, variable load, probability of survival, selection of deep groove and angular contact ball bearings. Design of rolling contact bearings. Introduction to needle and air-thrust bearings. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Bhandari V. B., "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Publishing Ltd., New Delhi, 2010.
2. Spotts M. F., Shoup, T. E., & Hornberger, L. E. "Design of machine elements", 8th Edition, Pearson / Prentice Hall., 2004.

REFERENCE BOOKS

1. Wadhwa S. S., Er. Tolly S. S., "Machine Design", Dhanpat Rai & Co, Delhi, 2008.
2. Robert L Norton, "Machine Design - An Integrated Approach", 5th Edition, Prentice Hall, New Delhi, 2013.
3. Shigley J. E. and Mischkee C. R., "Mechanical Engineering Design", 7th Edition, McGraw-Hill, Inc., New Delhi, 2004.
4. John M. Barson and Stanley T. Rolfe, "Fracture and Fatigue Control in Structures", 3rd Edition, Prentice Hall Inc., New Jersey, 1999.
5. Jacobson B. O., Bernard J. Hamrock and Steven R. Schmid, "Fundamentals of Machine Elements", 3rd Edition, McGraw-Hill Inc. / Taylor & Francis Group, 2013.
6. William Orthwein, "Machine Component Design", Jaico Publishing Co., 2006.
7. NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video resources on "Dynamics of Mechanical System/ Design of Machine Elements /Machine Design".

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X		X	X	X		X	
2	X	X	X	X	X		X		X	X	X
3	X	X	X		X	X	X	X	X	X	X

13ME56 - ECONOMICS AND COST ACCOUNTING FOR ENGINEERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course is an introductory course to economic principles, concepts and models. It provides opportunities to see how these are applied to a range of real world situations; and to apply them. Engineering projects often involve significant capital investment that has major financial implications for the organisations involved in those projects. The course is designed to give students an appreciation of engineering from a financial perspective.

COURSE OUTCOMES

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

CO1 : *Understand the general working of the economy.*

CO2 : *Recognise, read and use the common management accounting reports.*

CO3 : *Understand the nuance of effective use and coordination of materials and labour within organizations in the pursuit of the organization's defined objectives*

CO4 : *Gain the required skills in tackling problems involving various costs and also analyze the solution*

CO5 : *Acquire knowledge on different types of organizations and its importance with the required knowledge on production planning and control*

CO6 : *Realize the importance of teams in achieving organizational goals*

CO7 : *Be conscious of business ethics and social responsibilities of businesses*

BASIC PRINCIPLES AND METHODOLOGY OF ECONOMICS

Demand / supply - elasticity - Government policies and application. Theory of the firm and market structure. Basic macro-economic concepts (including GDP / GNP / NI / Disposable Income) and identities for both closed and open economies. Aggregate demand and supply (IS / LM). Price Indices (WPI/CPI), Interest rates, direct and indirect taxes. **(12)**

PUBLIC SECTOR ECONOMICS

Welfare, externalities, labour market. Components of monetary and financial system, central bank - monetary aggregates; commercial banks &their functions; capital and debt markets. Monetary and fiscal policy tools & their impact on the economy - inflation and Phillips curve. **(11)**

ELEMENTS OF BUSINESS / MANAGERIAL ECONOMICS AND FORMS OF ORGANIZATIONS

Cost concepts, elements of cost, cost & cost control - techniques, types of costs, budgets, break even analysis, capital budgeting, cost analysis - types, cost - effectiveness analysis, cost reduction techniques, application of linear programming. Investment analysis - NPV, ROI, IRR, payback period, depreciation, time value of money. Business forecasting - elementary techniques. Statements - cash flow, financial. Case study method. **(11)**

INDIAN ECONOMY BRIEF OVERVIEW OF POST INDEPENDENCE PERIOD - PLANS

Post reform growth, structure of productive activity. Issues of inclusion - sectors, states / regions, groups of people (M / F), urbanization. Employment - informal, organized, unorganized, public, private. Challenges and policy debates in monetary, fiscal, social, external sectors. **(11)**

TOTAL : 45

TEXT BOOKS

1. Mankiw Gregory N., "Principles of Economics", Thompson Asia, 2008.
2. Pareek Saroj, "Textbook of Business Economics", Sunrise Publishers, 2003.

REFERENCE BOOKS

1. Mote V, Paul.S, Gupta.G, "Managerial Economics", Tata McGraw-Hill, 2004.
2. Misra, S. K. and Puri, "Indian Economy", Himalaya, 2009.
3. James L. Riggs, "Engineering Economics", Tata McGraw-Hill Ltd., New Delhi, 2004.
4. Koontz, Weihrich and Aryasri, "Principles of Management", Tata McGraw-Hill Publishing Co. Ltd., 2006.
5. Pannerselvam, "Engineering Economics", Prentice Hall of India, New Delhi, 2007.
6. Ricky W. Griffin, "Management", Haughton Mifflin Publication, 2007.
7. Hillier and Frederick S., "Introduction to Management Science", Tata McGraw-Hill Publishing Co. Ltd., 2008.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X										
2								X			
3	X				X						
4				X			X				
5				X					X		
6						X	X				
7	X	X		X				X		X	

13ME57 - DESIGN AND MACHINE DRAWING

L	T	P	C
1	0	3	3

ASSESSMENT : THEORY & PRACTICAL

COURSE OBJECTIVES

This course on design and machine drawing comprises of design and drafting of basic machine components. It aims to make students understand the principles and requirements of production drawings and learning how to assemble and disassemble important parts used in major mechanical engineering applications.

COURSE OUTCOMES

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

CO1 : *Conversant with the drawing conversions and able to read and interpret a given drawing.*

CO2 : *Demonstrate the knowledge on limits fits and tolerances and design appropriate dimensions for a given type of assembly.*

CO3 : *Visualize and prepare detail drawing of a given object.*

CO4 : *Draw details and assembly of mechanical systems with simple joints, cam and followers.*

CO5 : *Create 2-D and 3-D models using any standard CAD software with manufacturing.*

CONVENTIONS & SECTION VIEWS

BIS / ISO code of practice for engineering drawing - conventional for materials, hole types, internal and external threads, thread types, undercuts, grooves, chamfers, fillet radii and keyways. Conventions of various machine components. Sections - types of sectional views, sectioning. Missing views. **(5)**

LIMITS, FITS AND TOLERANCES

Limits, fits and tolerances - fundamental of deviations - shaft and hole terminology - representation of tolerances on drawing, calculation of minimum and maximum clearance and allowance, selection of fits - representation of fits. Geometric tolerance - uses, types of form and position tolerances, symbols - geometric tolerances. Surface finish symbols - surface roughness and textures. **(5)**

DESIGN AND REPRESENTATION OF RIVETED JOINTS

Rivet and riveting - classification of rivet - terminology of riveted Joint - types of joints - representation of different riveted joints. **(5)**

DESIGN AND REPRESENTATION OF KEY JOINTS

Types of key joints - type of cotter joints - types of pin joints and knuckle joints - representation of key and cotter joints. **(2)**

DESIGN AND REPRESENTATION OF WELDED JOINTS

Introduction of welding process - types of welded joints - representation of welds - symbols and its conventions - representation of different weld procedures. **(3)**

DESIGN AND REPRESENTATION OF CAM PROFILES

Follower classification - motion - displacement type.CAM profile - inline & offset follower for reciprocating and oscillating follower with SHM, cycloid, uniform motion and parabolic displacement. **(6)**

PRODUCTION DRAWINGS

Definitions - difference with normal drawings - method of amendment of corrections. Assembly drawings - introduction - types of assembly - importance of BOM - assembly procedures - assembly drawings (examples) - assembly of engine parts - assembly of machine tools parts. **(12)**

ASSEMBLY USING SOLID MODELING

Introduction to computer aided modeling and assembly using software. Drawing of assemblies - plummer block, machine vice, stop valve, screw jack, tail stock, cylindrical gear box, simple drill jig. Interference check between solids. **(7)**

THEORY : 30

TUTORIAL : 15

TOTAL : 45

TEXT BOOKS

1. Bhatt N.D. and Panchal V.M., "Machine Drawing", Charotar Publishing house, Pvt. Ltd., 46th edition, 2011.
2. John K.C., "Text book on Machine Drawing", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. Sidheswar N., Kannaiah P., Sastry V.V.S., " Machine Drawing", Tata McGraw-Hill Publications, 33rd reprint, 2006.
4. Gopalakrishna K. R., "Machine Drawing", 17th edition, Subhas Stores, Bangalore, 2003.

REFERENCE BOOKS

1. Gill P.S., "Machine Drawing", Kataria.S.K & Sons, 2012.
2. BIS, SP: 46-2003, "Engineering Drawing Practice for Schools and Colleges", New Delhi, 2003.
3. Faculty of Mechanical Engineering, PSG College of Technology, "Design Data Book", M/s. DPV Printers, Coimbatore, 2000.
4. ASME Y 14.5 -2009, "Dimensioning and Tolerancing", ASME, New York, 2009.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X				X		X		X
2	X	X					X		X	X	X
3			X				X		X	X	
4	X	X	X		X			X			
5							X		X		X

13ME58 - WORKSHOP (LATHE) LABORATORY, FOUNDRY AND WELDING LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVES

This laboratory course on workshop will provide a practical exposure to the various types of machining process, machining operations carried out in different types of machines tools and in particular to lathe. In the foundry shop, the students are provided with hands on training on production of green sand moulding process, the importance of appropriate design of mould, and the melting techniques. The fundamentals of arc and gas welding and the process parameters are explained practically in the welding shop. Students understand the importance of arc gap, speed of weld, arc voltage and other relevant parameters and its influence on the quality of the welding.

COURSE OUTCOMES

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

CO1 : *Operate the lathe machines, prepare moulds for various parts and perform welding operations*

CO2 : *Conduct, analyze and interpret machining processes and apply these results to improve processes*

CO3 : *Learn commitment to quality, timelines and continuous improvement*

CO4 : *Suggest appropriate inspection techniques for effective evaluation of the process parameters and quality control*

CO5 : *Acquire required knowledge on production planning and its techniques*

(a) 13ME58 - WELDING LABORATORY

LIST OF EXPERIMENTS

1. Study of welding process and equipments.
2. Make a "Butt Joint". .
3. Make a "Lap joint" .
4. Make a "T Joint"
5. Make a"S Joint"
6. To prepare a straight line lying by oxy-acetylene welding.
7. Make a "Butt Joint"
8. Make a "Corner Joint"

(b) 13ME58 - FOUNDRY LABORATORY

LIST OF EXPERIMENTS

1. Study the layout of a mechanized foundry and function of equipments.
2. Prepare the green sand mould for the "Packing Gland" pattern.
3. Prepare the green sand mould for the "Bracket "pattern.
4. Prepare the green sand mould for the "Steeped Pulley" pattern.
5. Prepare the green sand mould for the "Bend Pipe" pattern.
6. Prepare the green sand mould by using "Loose Piece" pattern.
7. Prepare the green sand mould for the "Square Box" pattern.

(c) 13ME58 - LATHE MACHINES LABORATORY

LIST OF EXPERIMENTS

1. Study of workshop layout and machines.
2. Plain turning.
3. Step turning.
4. Taper turning.
5. Knurling and threading.

TEXT BOOK

Workshop and special machines laboratory Manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X			X				X		X
2	X	X			X					X	X
3	X	X		X	X		X	X		X	
4	X	X	X	X	X		X	X		X	X
5	X	X	X	X		X		X		X	X

13ME61 - FINITE ELEMENT ANALYSIS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on Finite element analysis aims to equip the students with the Finite Element Analysis fundamentals to formulate the design problems into FEA for solving various boundary value problems in elasticity, heat transfer and fluid mechanics for one and two-dimensional cases, perform simulation using Finite Element Analysis software. The course also enables the students to understand the ethical issues related to the utilization of FEA in the industry

COURSE OUTCOMES

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

CO1 : *Identify mathematical model for solution of common engineering problems.*

CO2 : *Formulate simple problems into finite elements and develop appropriate finite element models based on the nature of problems.*

CO3 : *Solve structural, thermal, fluid flow, impact and crash problems through FEM to obtain the approximate solutions*

CO4 : *Use commercial FEA package for analysis of complex real-life problems.*

CO5 : *Develop simple finite element codes using C/FORTRAN/MATLAB*

CO6 : *Solve complicated 3D structural problems for stress analysis under impact loads.*

BASICS OF FINITE ELEMENT METHOD

Introduction - Review of variational Calculus - Mathematical modeling - Initial Value Problems and boundary value problems - Classical methods - Variational approach - Rayleigh-Ritz method - Weighted Residual Method: Least squares, Collocation method, Galerkin methods - Strong and weak forms - Modified Galerkin method - Solving boundary value problems using finite element method. **(9)**

ONE-DIMENSIONAL ANALYSIS

Degree of freedom - steps in FEA - discretization of domain - linear and quadratic shape functions - natural co-ordinate system - derivation of element stiffness matrix for elasticity and thermal strain problems - assembly of equations - applying boundary conditions - solution and post processing - solving problems for elastically deforming bars - Extension of bar elements to solve truss problems - beam elements and problems. **(9)**

TWO-DIMENSIONAL ANALYSIS

Global and natural co-ordinates, shape functions for higher order formulations - Jacobian matrices and transformations - CST and LST elements - Four node quadrilateral elements - Isoparametric elements - element stiffness matrices and assembly - Numerical integration - Gaussian quadrature - Plane strain, plane stress and axi-symmetric analysis - Problems. **(9)**

APPLICATION TO HEAT TRANSFER AND FLUID MECHANICS

One dimensional heat transfer element - application to one-dimensional heat transfer problems- scalar variable problems in 2-Dimensions - Applications to simple heat transfer problems in 2- Dimension - Application to simple problems in fluid mechanics in 1-D and 2-D. **(9)**

DYNAMIC ANALYSIS AND COMPUTER IMPLEMENTATION

Dynamic Analysis - Equation of Motion - Mass & damping matrices - Free Vibration analysis - Natural frequencies of Longitudinal, Transverse and torsional vibration - Introduction to transient field problems. Computer implementation of FEM - Preprocessing - Solution - Post-processing, solution convergence, h-type, p-type methods. **(9)**

(For internal evaluation and not for final exam)

Use of commercial FEA packages like ANSYS, Abaqus FEA to solve real-life problems - Development of one-dimensional finite element code using C/FORTRAN/MATLAB for elastically deforming axially loaded bars - heat transfer across a bar - fluid flow through pipes.

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Fish and Belytschko, “A first Course in Finite Elements”, John Wily Sons, 2007.
2. Seshu P., "Textbook of Finite Element Analysis", Prentice Hall of India, 2003.

REFERENCE BOOKS

1. Reddy J.N., "Finite Element Method" Tata McGraw Hill, 2003.
2. Chandrupatla and Belegundu., "Introduction to Finite Elements in Engineering", PHI /Pearson Education, 2003.
3. Logan D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.
4. Cook R.D., Malkus D.S., Plesha M.E., "Concepts and Applications of Finite Element Analysis", John - Wiley Sons 2003.
5. Rao S.S., "The Finite Element Method in Engineering", Butter worth Heinemann, 2001.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X			X			X			X
2	X	X	X	X	X		X	X			X
3		X	X	X	X		X	X			X
4		X	X	X	X		X	X			X
5		X	X	X	X		X	X	X	X	X
6		X	X	X	X		X	X	X	X	X

13ME62 - HEAT AND MASS TRANSFER

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES :

To understand the basics of heat and mass transfer, the laws governing heat transfer by conduction, convection and radiation, and the transfer of mass by diffusion.

COURSE OUTCOMES :

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

CO1 *: Appreciate the need to study Heat and Mass Transfer.*

CO2 *: Perform basic calculations involving Heat and Mass Transfer, including multi-mode heat transfer.*

CO3 *: Design and conduct experiments as well as to analyze and interpret data.*

CO4 *: Use techniques and engineering tools to identify, formulate and solve practical problems.*

CONDUCTION

Introduction - Various modes of heat transfer - Fourier's, Newton's and Stefan Boltzmann's Law. Combined modes of heat transfer, thermal diffusivity, and overall heat transfer coefficient

Steady State Conduction - derivation in Cartesian, Cylindrical and Spherical coordinates - heat transfer with resistance - One dimensional heat flow through Composite slabs, Cylinder and Spheres (with and without heat generation) - Effect of Variable thermal Conductivity - Insulation - Critical thickness.

Fins - Types, Purpose and applications - One dimensional heat transfer - temperature variation - Fin efficiency - fin effectiveness.

Unsteady state heat transfer - Lumped parameter analysis- Problems using Heisler Charts, Grober Charts. **(10)**

CONVECTION

Dimensional analysis - advantages-limitation-dimensionless numbers-physical meaning.

Forced Convection: Flow over flat plate - hydrodynamic boundary layer and thermal boundary layer - Vonkarman integral momentum equation - Velocity distribution flow through pipes-heat transfer coefficient - heat transfer rate calculation using empirical correlations - Flow over pipes.

Free Convection:-Vertical surfaces - Horizontal surfaces - heat transfer coefficient - heat rate calculation using empirical correlations - Flow over pipes. **(9)**

RADIATION

Mechanism - different surfaces - Stefan boltzmann's law - Kirchhoff's Law - Emissivity-absorptivity - reflectivity - transmissivity - Intensity of radiation - emissive power - shape factor for simple geometries - Heat transfer between surfaces separated by non - absorbing medium - Radiation shields - Gas radiation. **(8)**

BOILING AND CONDENSATION

Heat Transfer with Phase Change - Boiling: Pool boiling Regimes Calculations on Nucleate boiling, Critical Heat flux and Film boiling. Condensation: Film wise and drop wise condensation, Nusselt Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations. **(6)**

HEAT EXCHANGERS

Classification of Heat exchangers - LMTD - Parallel, Counter and Cross flow, Multi passes flow - fouling factor. Effectiveness - NTU method. **(6)**

MASS TRANSFER

Mass transfer - Modes of mass transfer - Fick's Law - steady state diffusion through a plain membrane - equimolal counter diffusion - mass transfer coefficient - convective mass transfer coefficient - simple problems by using empirical correlations. **(6)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. *Frank P. Incropera, David P. Dewitt, "Heat and Mass Transfer", John Wiley and Sons (ASIA) Pvt.Ltd.,2008*
2. *Yunus. A. Cengel, "Heat Transfer", Tata McGraw Hill,2nd Edition, 2012*

REFERENCE BOOKS

1. *Holman J.P. "Heat Transfer", McGraw Hill Book Co., SI Version,1986.*
2. *Nag P.K., "Heat and Mass Transfer", - Tata McGraw-Hill Publishing Company Limited - New delhi,2008.*
3. *Ghoshdastidar P.S., 'Heat Transfer', Oxford, 2005.*
4. *Mashesh M. Rathore., "Engineering Heat and Mass Transfer", Laxmi Publication., New Delhi-2008.*
5. *Sachdeva R.C., "Fundamentals of Engineering Heat & Mass Transfer" (SI Units)- New Age International Publications, 2005.*
6. *Kothadaraman C.P., "Fundamentals of Heat and Mass Transfer", New age International Publishers, 2008.*
7. *Rajput, R.K., "Heat and Mass Transfer", S.Chand Publishers, 2002.*
8. *Christopher A Long, "Essential Heat Transfer", Pearson Education(ASIA), 2008.*

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X	X	X	X			X	X	X	X
2	X		X		X			X			X
3	X	X	X	X	X		X	X			X
4	X	X	X		X		X	X		X	X

13ME63 - ENGINEERING POLYMERS, COMPOSITES AND ALLIED MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course introduces students to processing of polymers, rubbers, composites and nano materials in general. Element of product design will also be covered in this course. The course will further discuss and explain the preparation and manufacture of fiber reinforced polymer composites.

COURSE OUTCOMES

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

CO1 : *Demonstrate the fundamental of polymer processing*

CO2 : *Examine the extrusion process, extruder components and types of extruder and analyze the flow theory, extrusion parameter and products defect.*

CO3 : *Examine the injection moulding cycle, the major injection moulding components and analyze the products defect.*

CO4 : *Outline the preparation, applications and type of fibre reinforcement.*

CO5 : *Compare and classify the composite manufacturing processes.*

CO6 : *Derive and calculate stress, strain and modulus for a given problem of unidirectional composite.*

CO7 : *Acquire knowledge about nano materials and their synthesizing methods and build nano devices by using the nano materials*

SHAPING PROCESSES FOR PLASTICS

Properties of Polymer Melts - Extrusion - Production of Sheet and Film - Fiber and Filament Production (Spinning) - Coating Processes - Injection Molding - Compression and Transfer Molding. Blow Molding and Rotational Molding - Thermoforming. Casting - Polymer Foam Processing and Forming - Product Design Considerations **(8)**

RUBBER-PROCESSING TECHNOLOGY

Rubber Processing and Shaping - Manufacture of Tires and Other Rubber Products - Product Design Considerations **(5)**

SHAPING PROCESSES FOR POLYMER MATRIX COMPOSITES

Materials for PMCs - Open Mold Processes - Closed Mold Processes - Filament Winding - Pultrusion - Other PMC Shaping Processes **(4)**

PROCESSING OF CERAMICS AND CERMETS

Processing of Traditional Ceramics - Processing of New Ceramics - Processing of Cermets - Product Design Considerations **(4)**

APPLICATION OF COMPOSITES

Composites including nano-composites for electrical, superconducting and device applications; Fabrication and processing of metal matrix (MM), polymer Matrix (PM) and ceramic matrix (CM) composites and their characterization; Fabrication of nano-composites; Secondary processing and joining of various composite materials for structural applications and their fracture behavior and safety **(9)**

POWDERS

Production and characterization of powders, Compaction of metal powders - die compaction, Isostatic pressing, powder forging, powder rolling and extrusion, Pressureless compaction techniques, Hot pressing and Hot isostatic pressing, Sintering of powder compacts, Liquid phase sintering, Sintering furnaces, Post sintering operations, Applications of P/M parts. **(7)**

INTRODUCTION TO NANO MATERIALS

Nano structured materials, Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals. Electronic and optical properties of nano crystallites, Metallic and semiconducting super lattices. Synthesis of nanostructured materials, Fabrication and characterization of nano electronic devices and MEMS. Basics of synthesis and characterization of nano-multi-component systems for sensors (magnetic, electronic and optical) and electrodes. Synthesis and fabrication of carbon nano structures for fuel cell and energy storage applications. **(8)**

TOTAL : 45

TEXT BOOKS

1. Chawala K.K., "Composite materials", 2nd Edition, Springer-Verlag, 1987.
2. Ajayan P. M.,. Schadler L. S, Braun P. V., "Nanocomposite Science and Technology", Wiley-VCH Verlag GmbH Co. KGaA, 2003.
3. Vasiliev V.V. and Morozov E.V., "Mechanics and Analysis of Composite Materials", Elsevier Science Ltd, 2001.

REFERENCE BOOKS

1. Chawala K.K., "Ceramic matrix composites", 1st Edition, Chapman & Hall, 1993.
2. Piatti G., "Advances in composite materials", Applied Science Publishers Ltd., 1978.
3. Hirschhorn J. S., "Introduction to Powder Metallurgy", American Powder Metallurgy Institute, 1976.
4. Fritz V. Lenel, "Powder Metallurgy Principles and Applications", Metal Powder Industries Federation, Princeton, N.J., 1980.
5. Upadhyaya G. S., "Powder Metallurgy Technology", Cambridge International Science Publishing, 2002.
6. Randall German, "A-Z of Powder Metallurgy", Elsevier, 2005.
7. Sperling L.H., "Introduction to Physical Polymer Science", 3rd Edition, John Wiley & Sons, 2001.

8. Ward I. M. and Sweeney J., "An Introduction to Mechanical Properties of Solid Polymers", 2nd Edition, John Wiley & Sons, 2004.

9. "Encyclopedia of Polymer Science and Technology", John Wiley & Sons, 2002.

10. Manas Chanda., Salil K. Roy., "Industrial Polymers, Specialty Polymers, and Their Applications", Taylor & Francis Group.

11. Charles A. Harper., "Modern Plastics Handbook", McGraw-Hill.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X	X		X					X
2	X		X	X				X			X
3	X	X	X	X				X		X	X
4	X			X				X			X
5	X	X	X	X						X	X
6	X	X	X	X	X		X	X		X	X
7			X	X	X	X	X	X	X	X	X

13ME64 - PRODUCTION PLANNING AND CONTROL

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course aims to address issues such as Surveys the design, development, implementation and management of production planning systems, including master production scheduling, aggregate planning, material requirements planning, capacity and inventory planning and production activity control. Students will be exposed to contemporary approaches such as just-in-time, theory of constraints and the relationship of enterprise-level planning and control systems to the overall materials flow.

COURSE OUTCOMES

At the end of this course, the students will be able to articulate and apply the following tools and practices of production planning and control

CO1 *: The elements, processes, and technologies comprising the field of Manufacturing Planning and Control (MPC).*

CO2 *: Demand management theories and techniques - forecasting, aggregate and disaggregate planning, capacity management, lot sizing and scheduling*

CO3 *: Enterprise Resource Planning (ERP) - How MPS decisions are supported by ERP*

CO4 *: Supply chain inventory management - independent demand items*

CO5 *: Using a Material Requirement Planning system*

FACILITIES LOCATION AND LAYOUT

Introduction - plant location - facilities layout - classification of layout - modular design concepts- facilities layout in manufacturing - layout design procedures - Computerized Relative Allocation of Facilities (CRAFT) - features and benefits of CRAFT. Automated layout design program (ALDEP), Computerized relationship layout planning (CORELAP) **(6)**

FORECASTING

Introduction - forecasting - Techniques - simple averaging method - moving averages - exponential smoothing - SES. Holt's linear method - Holts- Winter trend and seasonality method. Box -Jenkins method - time series - autocorrelation - autoregressive models - moving average models. **(7)**

AGGREGATE PLANNING

Introduction - Linear Decision Rules (LDR) - Alternatives for responding to fluctuation in orders - time sequence of decisions , Cost involved in planning production and employment - mathematical programming models. **(6)**

DISAGGREGATE PLANNING

Introduction - Disaggregation - Master Production Schedule (MPS) - Role of MPS - Inputs / output of MPS - an MPS approach to production strategy. MPS terminology - MPS performance measures - Bill of Materials (BOM) - types. **(6)**

CAPACITY MANAGEMENT

Introduction - measuring Capacity - available capacity. Loads - Planned and unplanned loads. Capacity expansion strategy - Capacity management - capacity control and planning. Capacity Requirement Planning (CRP) - Inputs/ outputs - scheduling strategies -finite vs infinite loads - benefits and Drawbacks of CRP. **(6)**

LOT SIZING RULES

Fixed order quantity (FOQ) - Economic Order Quantity (EOQ) - lot for lot. Fixed period requirements (FPR), Periodic Ordering Quantity (POQ), Least Unit Cost , least total cost, part period balancing, Wagner - Whitin Algorithm. **(7)**

SCHEDULING DECISION RULES

Scheduling techniques - FCFS - EDD - SPT- LIFO- LST- LT. Critical ratio - least change over cost - Single machine sequencing. Two / N - machine scheduling problems - Johnson's algorithm. Job shop scheduling **(7)**

CASE STUDIES (only class room discussions)

Design of Continuous flow manufacturing systems, Multi agent manufacturing planning and control systems, implementation of Kanban in a process plant, design and implementation of integrated production planning system.

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Mukhopadhyay SK., "Production Planning and Control: Text And Cases", Phi Learning, 2nd Ed, 2007.
2. James B. Dilworth, "Operations Management - Design, Planning And Control For Manufacturing And Services", Mcgraw Hill International Edition, 1992.

REFERENCE BOOKS

1. Samson Eilon "Elements of production planning and control", Universal Book Corpn.1984
2. Elwood S. Buffa and Rakesh K. Sarin, "Modern Production / Operations Management", 8th Ed. John Wiley and Sons, 2000.
3. Kanishka Bedi, "Production and Operations management", Oxford university press, 2nd Edition, 2007.
4. Melynk, Denzler, "Operations management - A value driven approach", Irwin Mcgrawhill.
5. Norman Gaither, Frazier G., "Operations management", Thomson learning, 9th edition IE, 2007

6. Jain K.C. & Aggarwal L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990.

7. Chary S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X			X	X	X			
2	X	X	X		X	X			X	X	
3			X	X	X	X	X	X		X	
4	X	X		X		X			X		
5		X	X	X	X	X	X	X			X

13ME65 - DESIGN OF MACHINE ELEMENTS - II

(Use of Approved design data book is permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on machine design enables the students to analyze the effect of stress and strain on simple mechanical systems such as belts and rope drives, gears and gear boxes, power screws and friction drives, to understand, identify and quantify failure modes in these mechanical parts.

COURSE OUTCOMES

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

CO1 : *Demonstrate a systematic approach in the process design*

CO2 : *Select a suitable power transmission system for the required application and design efficiently various elements of the selected system.*

CO3 : *Understand, identify and quantify failure modes in these mechanical parts.*

CO4 : *Perform and present design calculations in a neat and organized manner.*

CO5 : *Develop knowledge and capabilities for the selection of standard items from manufacturer's catalogue.*

DESIGN OF BELTS AND CHAINS

Belts - limitation, ratio of tensions - maximum effective tension & power transmitted - centrifugal tension and stresses in belts - maximum tension in belts/rope - condition for maximum power transmission. Selection of V belts for given power and velocity ratio, selection of micro V-belts, timing belts. Selection of roller chain - power speed ratio- silent chain. Poly Vee belts, HTD belts, V-belts of 3V, 5V and 8V types- Taper lock bushes and timing belts-SPZ, SPA, SPB, SPC types. **(9)**

DESIGN OF GEARS

Force analysis - Tooth stresses, determining dimensions of a spur gear pair based on strength and wear considerations- Design of helical gears - parallel axis helical gear, normal and transverse planes, helix angles, equivalent number of teeth, determining dimension of helical gear pair. Straight and spiral bevel gears design. **(9)**

WORM GEARS AND MULTI SPEED GEAR BOX

Worm gears - Nomenclature, thermal capacity, efficiency, gear forces, design of a pair of worm gears. Gear box- Ray diagram, Kinematic diagram, gear tooth profile correction, finalization of the gear train, gear tooth loads and bearing reactions. **(9)**

POWER SCREWS

Forms of threads, effect of friction on load-force analysis, square and trapezoidal threads, collar friction, design of power screws (for screw jack, lathe, etc.), selection of ball screws. **(9)**

FRICTION DRIVES

Clutches - role of clutches, positive and gradually engaged clutches, toothed claw clutches, design of single and multiple plate clutches, variable speed drives, types and selection. Brakes - Role of brakes-types of brakes-self energizing and de-energizing brakes. Design of internal expanding shoe brakes-calculation of heat generation and heat dissipation in brakes. (9)

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Robert L Norton, "Machine Design - An Integrated Approach", Pearson Education, New Delhi, 2011.
2. Shigley and Mischke, "Mechanical Engineering Design", McGraw Hill, Inc., New Delhi, 2004.

REFERENCE BOOKS

1. Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill, New Delhi, 2008.
2. Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2007.
3. Prabhu T.J., "Design of Transmission Elements", Mani offset, Chennai, 2003.
4. Darle W Dudley, "Hand Book of Practical Gear Design", CRC Press, Florida, 2002.
5. Allen S. Hall and Alfred R. Holowenko, "Schaum's Outlines of Theory and Problems of Machine Design", Tata McGraw Hill, 2006.

HAND BOOKS:

1. Faculty of Mechanical Engineering, PSG College of Technology, "Design Data Book", M/s DPV Printers, Coimbatore, 2000.
2. Use of approved data books /sheets is permitted in the examination.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X		X	X			X	
2	X	X	X	X	X		X	X	X	X	X
3	X	X	X		X	X		X		X	X
4		X	X	X		X	X		X		X
5	X	X			X		X	X	X	X	X

13ME66 - QUALITY ASSURANCE AND RELIABILITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course introduces students to concepts and methods of modern statistical quality control. Students learn to apply standard quality control tools, the theoretical statistical concepts that justify the use of particular quality control tools in particular situations. They learn theory and methods for analyzing the performance of different quality control tools.

COURSE OUTCOMES

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

CO1 : *Identify and analyze the data statistically, and decide upon action to be taken for controlling the quality and reliability.*

CO2 : *Measure the cost of poor quality, process effectiveness and efficiency to track performance quality and to identify areas for improvement.*

CO3 : *Participate in a team, research and report on some aspect of Quality/Reliability.*

CO4 : *Assess the pitfalls in implementing major change and describe world-class 'change management' methodologies*

CO5 : *Identify appropriate strategies for dealing with issues of quality*

HOUSE OF QUALITY

Definition of Quality- Quality function, Dimensions of Quality. Engineering terminology, Brief history of quality methodology, Statistical methods for quality improvement, Quality costs - category costs and hidden costs. Brief discussion on sporadic and chronic quality problems. Introduction to Quality function deployment. **(6)**

QUALITY ASSURANCE

Quality Assurance-Definition and concept of quality assurance, departmental assurance activities. Quality audit concept and audit approach. Structuring the audit program, planning and performing audit activities, audit reporting, ingradients of a quality program. **(6)**

STATISTICAL PROCESS CONTROL

Introduction to statistical process control - chance and assignable causes variation. Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational subgroups. Analysis of patterns of control charts. Case Studies on application of SPC. Process capability - Basic definition, standardized formula, relation to product tolerance and six sigma concept of process capability, Seven QC tools. **(8)**

CONTROL CHARTS FOR VARIABLES AND ATTRIBUTES

Control Charts for Variables- Control charts for X, Π and Range, statistical basis of the charts, development and use of X, Π and R charts interpretation of charts. Control charts for X bar and standard deviation (S),

development and use of X, Π and S chart. Brief discussion on pre control (X), Π and S control charts with variable sample size, control charts for individual measurements, moving-range charts.

Control Charts for Attributes- Control chart for fraction non-conformities (defects) - development and operation of control chart for constant and variable sample sizes. Choice between variables and attributes control charts. Guidelines for implementing control charts. **(9)**

ACCEPTANCE SAMPLING LEVEL

Sampling Inspection-Concept of accepting sampling, economics of inspection, Acceptance plans - single, double and multiple sampling. Operating characteristic curves - construction and use. Determination of average outgoing quality, average outgoing quality level, average total inspection, producer risk and consumer risk, published sampling plans, Gauge R&R and MSA. Statistical Theory of Tolerances- Application of statistical theory to design tolerances in random assemblies. **(9)**

RELIABILITY ENGINEERING

Reliability and Life Testing- Failure models of components, definition of reliability, MTBF, MTTR, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, parallel and series-parallel device configurations. Redundancy and improvement factors evaluations. **(7)**

TOTAL : 45

TEXT BOOKS

1. Montgomery D.C., “Introduction to Statistical Quality Control”, John Wiley and Sons.
2. Juran J M., Frank M Gryna., “Quality Planning & Analysis”, Tata McGraw Hill,
3. Naidu N.V.R., Babu K.M. and Rajendra .G., "Total Quality Management", New Age International Pvt.

REFERENCE BOOKS

1 Grant and Leavenworth "Statistical Quality Control", McGraw Hill,

2 Janet L. Novak and Kathleen C. Bosheers., "The QS9000 Documentation Toolkit", Prentice Hall PTR,

3 Suresh Dalela and Saurabh, "ISO 9000 a Manual for Total Quality Management", S. Chand Co. Kesavan R; Total Quality Management, I.K. International.

4 Srinath L.S., "Reliability engineering", Third Edition, Affliated East. West Press Pvt Ltd, New Delhi, 2005.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X	X		X	X	X		X		
2		X		X	X		X	X	X	X	X
3	X	X	X	X	X	X		X		X	
4		X		X	X	X	X		X	X	X
5	X		X	X	X	X	X	X		X	X

13ME67 - HEAT TRANSFER AND FLUID MACHINERIES LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

(a) 13ME67 - HEAT TRANSFER LABORATORY

COURSE OBJECTIVES

To understand both the basics and applications of heat transfer principles by hands-on exposure to heat transfer equipments.

COURSE OUTCOMES

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

CO1 : *Demonstrate the effect of temperature and fluid flow on heat transfer, and vice-versa by analyzing and interpreting the results obtained from experiments*

CO2 : *Conduct experiments to determine heat transfer related performance data on various energy transfer equipment such as, but not limited to heat exchangers, pipelines carrying fluids at temperatures different from ambient*

CO3 : *Function effectively on problem-solving teams and to coordinate and provide leadership for teams, including multidisciplinary teams*

CO4 : *Develop skills in writing, speaking, reading, and listening, needed to communicate logically and effectively*

LIST OF EXPERIMENTS

1. Thermal conductivity experiment (Composite walls)
2. Forced convection.
3. Natural convection / Pin-Fin Method.
4. Thermal conductivity experiment (Insulation Powder)
5. Universal heat exchanger (parallel and counter flow)
6. Unsteady state heat transfer.
7. Two slab guarded hot plate.
8. Stefan-Boltzmann.
9. Forced convection (high velocity).
10. Thermal conductivity experiment (metal rod).
11. Heat exchanger (shell and tube).
12. Critical heat flux.

TEXT BOOK

Heat and Mass Transfer Laboratory Manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X		X	X		X	X			X
2	X	X	X		X	X	X	X	X	X	X
3		X	X	X	X	X	X		X		
4	X	X	X	X	X	X	X	X			

(b) 13ME67 - FLUID MACHINERY LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study different types of turbines, pumps and structural machineries and to make them familiarize on different machine components using softwares.

COURSE OUTCOMES

CO1 : *Students will be able to operate different types of machines, and machineries and to draw the components using different mechanical engineering softwares.*

TITLE OF EXPERIMENTS

1. Performance analysis of Pelton wheel.
2. Performance of a Francis / Kaplan turbine.
3. Performance analysis of steam turbine.
4. Performance analysis of submersible pump.
5. Performance test of Centrifugal pump.
6. Performance analysis of reciprocating pump.
7. Performance test of forward curved blade centrifugal blower
8. Performance test of backward curved blade centrifugal blower
9. Performance test of axial blower
10. Study of a wind turbine.

TEXT BOOK

Fluid machinery laboratory manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X		X	X			X

13ME68 - METROLOGY LABORATORY AND SPECIAL MACHINES LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

(a) 13ME68 - METROLOGY LABORATORY

COURSE OBJECTIVES

This laboratory course on measurement and techniques, provide hands on training on various measurement instruments, and give a clear understanding of implementation of metrology standards, performance characteristics of measuring devices, calibration, error analysis, and gauging.

COURSE OUTCOMES

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

CO1 : *Demonstrate the acquired knowledge in areas of mathematics, and physics relevant to metrology and instrumentation*

CO2 : *Understand and apply relationships between metrology and instrumentation and to calibrate instruments*

CO3 : *Use basic laboratory tools, computers, and databases for instrumentation and quality control*

CO4 : *Define and solve quality-related problems during production, including design problems, within economic, environmental, and time deadline constraints*

CO5 : *Function effectively on problem-solving teams and to coordinate and provide leadership for teams, including multidisciplinary teams*

CO6 : *Develop skills in writing, speaking, reading, and listening, needed to communicate logically and effectively*

LIST OF EXPERIMENTS

1. Study of various metrological instruments.
2. Measurement of taper angle using sine bar and slip gauges.
3. Measurement of gear tooth parameters of a given spur gear using gear tooth vernier caliper.
4. Measurement of external taper angle using slip gauges and Rollers.
5. Draw P chart for given specifications and comment on the nature of the process.
6. Study of surface roughness tester and Air gauge equipment.
7. Measurement of screw thread elements using profile projector
8. Calibration of dial gauge using dial tester.
9. Measurement of height of given work piece using Vernier height gauge
10. Measurement of effective diameter of a screw thread using 3 wire methods.
11. Measurement of thread element by Tool maker's microscope

TEXT BOOK

Metrology laboratory Manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X		X	X	X	X	X
2	X	X	X	X	X		X		X	X	X
3	X	X	X		X	X	X	X	X	X	X
4	X	X	X	X	X		X	X	X	X	X
5	X	X		X		X	X		X		
6			X	X		X	X	X		X	X

(b) 13ME68 - SPECIAL MACHINES LABORATORY

COURSE OBJECTIVES

This laboratory course on workshop will provide a practical exposure to the various types special machines and the operations carried out in different types of machines tools. In the foundry shop, the students are provided with hands on training various machining techniques along with the principles of operations, process parameters, limitations and advantages compare to general purpose machine tools.

COURSE OUTCOMES

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

CO1 : *Gain knowledge in areas of mathematics, and physics relevant to metrology and instrumentation, and be able to apply and extend this knowledge.*

CO2 : *Operate the different types of conventional & special machines.*

CO3 : *Conduct, analyze and interpret machining processes and apply these results to improve processes.*

CO4 : *Define and solve quality-related problems during production, including design problems, within economic, environmental, and time deadline constraints.*

CO5 : *Function effectively on problem-solving teams and to coordinate and provide leadership for teams, including multidisciplinary teams.*

CO6 : *Develop skills in writing, speaking, reading, and listening, needed to communicate logically and effectively.*

LIST OF EXPERIMENTS

LATHE

1. Basic Turning operations - Plain turning, Step turning, Taper turning.
2. Threading operations - knurling, drilling & tapping, external threading.
3. Form turning - Convex / concave, knurling, taper turning

MILLING EXERCISE AND GEAR HOBBING

1. To machine a square, a pentagon, a hexagon, and a triangular head
2. To machine a spur gear and bevel gear

SLOTTING EXERCISE

1. To machine a hexagon and square keyway.

SHAPING EXERCISE

1. To machine a cube, stepped slide, male and female stepped slide, angular slide and curve slide.

TEXT BOOK

Special Machines and Workshop Manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X		X	X	X
2	X	X	X		X			X		X	X
3	X	X	X		X	X		X	X	X	X
4	X	X	X	X	X		X	X	X	X	X
5	X	X	X	X	X	X	X	X	X	X	X
6	X	X		X	X	X	X	X	X	X	

13ME69 - MINI PROJECT

L	T	P	C
0	0	3	2

ASSESSMENT : MINI PROJECT

COURSE OBJECTIVES

This two credit course aims to inculcate and develop, the arts of systematic analysis and examining the problems faced in the engineering career and to find suitable solutions by apply mechanical engineering knowledge and work with team members for sharing ideas and knowledge transfer. The project also helps to gain project management skills and enhance the technical writing skills that will be useful for final year project

COURSE OUTCOMES

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

CO1 : *Refresh the mechanical engineering fundamental concepts and principles related to the project work.*

CO2 : *Enhance the management skills to achieve the project goal by working as a team and also improve technical writing skills.*

CO3 : *Demonstrate the technical skills to provide feasible solutions for real-life problems*

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X		X	X		X	
2	X	X		X			X		X		
3	X	X	X		X	X		X	X	X	

13ME71 - COMPUTER AIDED DESIGN AND MANUFACTURING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course will advance the students' knowledge on application of computers in design and manufacturing development of the product. They learn the basic concepts of CAD/CAM technology, modeling techniques, methods of product design using CAD packages, hardware configuration of design workstation and software transformation principles, along with CAM, CNC, DNC, FMS, CAPP concepts in order to understand various manufacturing operations, production management modules, scheduling techniques and MRP concepts.

COURSE OUTCOMES

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

CO1 : *Demonstrate the knowledge of key design and manufacturing technologies and their underlying principles applied in current manufacturing industry,*

CO2 : *Will be comfortable with using commercial CAD and CAD/CAM systems to solve real world problems.*

CO3 : *Develop the ability to work in industrial environment to design programs for various models and various (multi-axis) CNC machine tools.*

CO4 : *Develop a surface related design for a particular real time application.*

CO5 : *Apply the knowledge of integrating management techniques with providing a CAD / CAM problem solutions.*

INTRODUCTION

Introduction- Need and Scope of Computer Aided Design, Fundamental of CAD and computer graphics- Application areas, Hardware and software- overview of graphics systems, video-display devices, and raster-scan systems, random scan systems, graphics monitors and workstations and input devices. Interactive hardware/software techniques, Drawing standards, dimensioning and text writing, concept of layers, advanced concepts of CAD software- blocks, UCS, 3D-line, 3D object, DXF & DXB file formats. Output primitives- Points and lines, line drawing algorithms, mid-point circle and ellipse algorithms. Filled area primitives, Scan line polygon fill algorithm, boundary fill and flood-fill algorithms. **(9)**

2D GEOMETRICAL TRANSFORMATIONS OF ENTITIES

2-D geometrical transforms - Translation, scaling, rotation, reflection and shear transformations. Matrix representations and homogeneous coordinates, composite transforms, transformations between coordinate systems. 2-D viewing- The viewing pipeline, viewing coordinate reference frame. Window to view port coordinate transformation, viewing functions. Cohen-Sutherland and Cyrus-beck line clipping algorithms, Sutherland - Hodgeman polygon clipping algorithm. **(7)**

3D - GEOMETRICAL REPRESENTATION

3-D Object Representation - Polygon surfaces, quadric surfaces, spline representation. Hermite curve, Bezier curve and B-Spline curves, Bezier and B-Spline surfaces. Basic illumination models, polygon -

rendering methods. 3-D viewing - Viewing pipeline, viewing coordinates, view volume and general projection transforms and clipping. **(7)**

3D - GEOMETICAL TRANSFORMATIONS

3-D Geometric transformations- Translation, rotation, scaling, reflection and shear transformations, composite transformations. Visible surface detection methods- Classification, back-face detection, depth buffer, scan-line, depth sorting, BSP-tree methods, area sub-division and octree methods. **(7)**

COMPUTER AIDED MANUFACTURING (CAM)

Introduction to CNC, DNC and adaptive control systems-types and features-FMS, types and characteristics-Automated Process Planning-structure-information, operation, types, software-Group Technology-coding system-types and structure-design table and decision trees-implementation procedures. **(8)**

COMMUNICATION, INFORMATION AND PRODUCTION MANAGEMENT SYSTEM

Materials Requirement Planning (MRP), MRP-II, software, industry specific applications, networking, techniques, standards, principles, methods and components-operating system, security, engineering change control, management of systems-shop floor control system-data acquisition system, supervisory and hierarchical computer system. Scheduling and its importance. **(7)**

TOTAL : 45

TEXT BOOKS

1. Mikell P. Groover and Emory Jimmers W., "CAD/CAM", Prentice Hall of India (P) Ltd., 2009
2. Ibrahim Zeid and Sivasubramanian R., "CAD/CAM: Theory and Practice", McGraw Hill Education (P) Ltd., 2010
3. Radhakrishnan P. and Subramaniam S.,"CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., Delhi, 2010

REFERENCE BOOKS

1. McConnell J. J., "Computer graphics theory into practice", Jones and Bartlett Publishers, 2006.
2. Davis M. J., "Computer Graphics", Nova Science Pub Inc, 2011.
3. David F. Rogers and Rae A. Earnshaw, "Computer graphics techniques theory and practice", Springer-Verlag, 1990.
4. Salomon D., "Transformations and projections in computer graphics", Springer, 2006.
5. Bethune J. D., "Engineering Design and Graphics with SolidWorks", Prentice Hall, 2011.
6. Radhakrishnan P and Kothandaraman C.P., "Computer Graphics and Design", Dhanpat rai and Sons (P) Ltd., 2009
7. Rao P.N., "CAD/CAM-Principles and Applications", Tata McGraw Hill Education Ltd., New Delhi,2009
8. Banerjee K., "Computer Management and Planning", Tata McGraw Hill Education (P) Ltd, New Delhi 2010
9. NPTEL courses http//nptel.iitm.ac.in/courses.php- web and video resources on Computer Aided Design and Manufacturing.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X	X	X	X	X
2	X	X		X	X						X
3	X	X	X	X	X	X	X	X	X	X	
4	X		X		X	X		X	X		X
5	X	X	X	X			X	X	X	X	X

13ME72 - OPERATIONS RESEARCH

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

Operations research helps in solving problems in different environments that needs decisions. The module contains topics that include: linear programming, Transportation, Assignment, and CPM/ MSPT techniques. Analytic techniques and computer packages will be used to solve problems facing business managers in decision environments. This module aims to introduce students to use quantitative methods and techniques for effective decisions-making; model formulation and applications that are used in solving business decision problems.

COURSE OUTCOMES

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

CO1 : *Demonstrate proficiency with tools from optimization, including fundamental applications of those tools in industry and the public sector in contexts involving uncertainty and scarce or expensive resources.*

CO2 : *Demonstrate Facility with mathematical and computational modeling of real decision-making problems, including the use of modeling tools and computational tools, as well as analytic skills to evaluate the problems.*

CO3 : *Facility with the design, implementation, and analysis of computational experiments.*

CO4 : *Work on various OR tools in making decisions and to formulate engineering problems into OR models for seeking optimal solutions.*

LINEAR PROGRAMMING

Linear programming formulation, graphical solutions, the essence of simplex method, setting up the simplex method, the simplex method in tabular form, Theory of simplex method, Big M Method, Two Phase Method. **(7)**

DUALITY AND SENSITIVITY ANALYSIS

Primal - Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis. **(6)**

TRANSPORTATION AND ASSIGNMENT

Formulation of Transportation Problem, Initial Feasible Solution Methods, Optimality Test, Degeneracy in TP; Assignment Problem, Hungarian Method, Traveling Salesman Problem. **(6)**

NETWORK MODELS

Definition of network models - minimal spanning tree algorithm, shortest route algorithm, maximal flow algorithms, PERT, CPM - LP formulation of minimal spanning, maximum flow and PERT, CPM calculations. **(8)**

INVENTORY AND MODELS

Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model, Newsboy Problem. **(6)**

GAME THEORY AND SEQUENCING

Two Person Zero Sum Game, Pure and Mixed Strategies, Algebraic Solution Procedure, Graphical Solution, Solving by Linear Programming; Sequencing Problem, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem **(6)**

QUEUING AND SIMULATION

Elements of Queuing Model, Pure Birth Death Model, Single Server and Multi-server Markovian Models with Infinite and Finite Capacity, Machine Repair Model, Networks of Queues. System concepts - Types of systems and models - system simulation procedure - Monte- Carlo simulation method (simple problems) - Introduction to simulation languages. **(6)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Mittal K.V. and Mohan C., "Optimization Methods in Operations Research and Systems Analysis", New Age, 2003.
2. Taha, H. A, "Operations Research - An Introduction", Prentice Hall, (8th Edition), 2009.

REFERENCE BOOKS

1. Ravindran A., Phillips D.T. and Solberg J.J., "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
2. Hiller F.S. and Liebermann G. J., "Introduction to Operations Research", Tata McGraw Hill, 2010.
3. Rao S.S., "Optimization theory and applications", Wiley Eastern Ltd, New Delhi, 2004.
4. Phillips, Ravindran, Solesberg, "Operations Research Principles and racices", Prentice Hall, 2nd Edition, 2007.
5. http://nptel.ac.in/courses/112106134/ by prof. G.Srinivasan.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	x	X		x		x	x		x	x	x
2		X	x	x	x		x		x	x	x
3	x	X	x	x	x	x	x	x	x		
4	x	X	x	x		x		x	x	x	x

13ME73 - CONTROL THEORY AND MECHATRONICS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on control theory and Mechatronics aims to understand the technologies behind modern mechatronic systems, to provide methodological fundamentals for the development of fully automated system, to teach students how to develop a robotic or automated system project focusing on the hardware and software integration, and to apply the acquired knowledge for developing a Mechatronics system.

COURSE OUTCOMES

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

CO1 : *Model and analyze the time dynamic response of electromechanical, and Mechatronics systems systematic techniques.*

CO2 : *Analyze the behaviour of interconnected dynamic systems.*

CO3 : *Analyze the stability and the transient and steady state response of feedback control systems.*

CO4 : *Design feedback control systems using classical time and frequency domain design techniques.*

CO5 : *Design feedback control systems using state space techniques.*

CO6 : *Implement and tune feedback controllers on actual devices*

INTRODUCTION TO CONTROL SYSTEMS

Introduction - closed loop and open loop control systems - Review of Laplace transformation - theorem - inverse Laplace transformation - partial transformation function with MATLAB. Dynamic modeling - transfer functions - blocks diagrams - modeling in state space - state space representation of dynamic systems. Transient-Response Analysis - First & Second order Systems - Transient-Response Analysis with MATLAB. **(8)**

BASIC CONTROL ACTIONS AND RESPONSE OF CONTROL SYSTEMS

Basic Control Actions - Integral and Derivative Controls on Higher-Order Systems - Performance - Routh's Stability Criterion - Pneumatic Controllers, Hydraulic Controllers, Electronic Controllers. Phase Lead and Phase Lag in Sinusoidal Response, Steady-State Errors in Unity-Feedback Control Systems. **(8)**

DESIGN OF CONTROL SYSTEM BY ROOT-LOCUS ANALYSIS

Root-Locus Plots - General Rules for Constructing Root Loci. Root-Locus Analysis of Control Systems with Transport Lag - Root-Contour Plots. Root locus design - Lead Compensation - Lag Compensation - Lag-Lead Compensation. **(7)**

CONTROL SYSTEMS DESIGN BY FREQUENCY-RESPONSE ANALYSIS

Bode Diagrams - Polar Plots - Closed-Loop Frequency Response. Nyquist Stability Criterion- Stability Analysis - relative Stability. Design - Lead Compensation - Lag Compensation - Lag-Lead Compensation **(7)**

SENSORS AND ACTUATORS

Strain gauge, resistive potentiometers, Tactile and force sensors, tachometers, LVDT, Piezoelectric accelerometer, Hall effect sensor, Optical Encoder, Resolver, Inductosyn, Pneumatic and Hydraulic actuators, stepper motor, DC motor, AC motor - simple problems. **(6)**

PROGRAMMABLE LOGICAL CONTROLLERS

Programmable logic controllers - basic structure - input output processing - programming - mnemonics - timers, internal relays and counters - shift registers - master and jump controls- data handling - analogue input output - selection of PLC. **(6)**

APPLICATION AND CASE STUDY

Integration of Mechatronics component subsystems into a complete Mechatronics system, Applications to CNC machines and Robotics. **(3)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. David G. Alciatore and Michael B. Histand, "Introduction to Mechatronics and Measurement Systems", Tata McGraw Hill, New Delhi.
2. Bolton W., "Mechatronics", Pearson Education Asia, New Delhi.
3. Dan Necsulescu, "Mechatronics", Pearson Education Asia, New Delhi.
4. Mahalik N.P., "Mechatronics", Tata McGraw Hill, New Delhi.

REFERENCE BOOKS

1. Wolfram Stadler, "Analytical Robotics and Mechatronics", McGraw-Hill Book Co.
2. Eronini Umez-Eronini, "System Dynamics & Control", Thomson Asia.
3. Shetty Devdas and Richard A Kolk, "Mechatronics System Design", Thomson Learning, Vikas Publishing House, New Delhi.
4. http://nptel.ac.in/courses/112103174/

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X				X			X
2	X	X	X	X	X	X			X	X	X
3	X		X	X		X	X	X		X	X
4	X	X	X	X				X	X	X	X
5	X		X	X	X	X	X			X	X
6					X		X	X	X		

13ME74 - PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course studies the concepts, issues and approaches important in effectively managing projects. Topics include project selection, project planning, negotiation, budgeting, scheduling, resource allocation, project control, project auditing, and project termination. Topics are viewed from a managerial perspective to Appreciate the variety of concepts and issues involved in project management, Understand the types of decisions a project manager must make to effectively complete a project on time and on budget. Understand the conflicting demands from different parties on the manager, Be able to use popular project management software such as Microsoft Project and apply concepts from this course to a real project management environment.

COURSE OUTCOMES

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

CO1 : *Evaluate and select the most desirable projects.*

CO2 : *Identify desirable characteristics of effective project managers.*

CO3 : *Apply appropriate approaches to plan a new project.*

CO4 : *Apply appropriate methodologies to develop a project schedule.*

CO5 : *Develop a suitable budget for a new project.*

CO6 : *Identify important risks facing a new project.*

CO7 : *Apply appropriate techniques to assess ongoing project performance.*

INTRODUCTION

Project management- an overview, project identification and Screening; Project Appraisal. Introduction to Production Systems and a Generalized Model of Production. Life cycle of a Production System and Major managerial Decisions. **(7)**

PROJECT PLANNING

Project Planning- Development of Project Network; Project Representation; Consistency and Redundancy in Project Networks; Project Scheduling- Basic Scheduling with A-O-A Networks; Basic Scheduling with A-O-N Networks; Project Scheduling with Probabilistic Activity Times. **(7)**

TIME MANAGEMENT

Time/Cost Tradeoffs in Projects -Linear Time - Cost Tradeoffs in Projects: A Heuristic Approach; Resource Considerations in Projects - Resource Profiles and leveling. Limited Resource Allocation. **(8)**

PROJECT IMPLEMENTATION

Project Implementation- Project Monitoring and Control with PERT / Cost. Team Building and Leadership in Projects; Project Completion - Project Completion, Review and Future directions. **(8)**

DECISION MAKING IN MANAGEMENT

Financial Evaluation of Production Related Decisions- Performance Measures of a Production System. Financial Evaluation of Capital Decisions. Decision Trees and evaluation of risk; Designing Products & Services - Introducing New Products and Services, Product Mix Decisions. **(8)**

MANAGEMENT CONTROLS

Fundamentals of MRP I & MRP-II, Toyota production system - evolution of JIT - Waste elimination techniques - Pull control - kanban, kaizen. Lean manufacturing - agile manufacturing, Value chain analysis, Theory of Constraints (TOC) - bottleneck vs constrained resource - bottleneck identification and elimination - drum buffer rope systems. **(7)**

TOTAL : 45

TEXT BOOKS

1. Shtub A., Bard J. F. & Globerson S., "Project management: engineering, technology, and implementation", 2nd ed Prentice Hall, 2004.
2. Lock D., "Project management", Gower Publishing Ltd., 9th Edition, 2007.
3. Kerzner H., "Project Management: A Systems Approach to Planning, Scheduling and Controlling", John Wiley & Sons, 11th Edition, 2013.

REFERENCE BOOKS

1. Murthy P.R., "Production and Operations Management", New Age International (P) Ltd. Publishers, 2nd Edition, 2006.
2. Mayer R.R., "Production management", McGraw-Hill, 1968.
3. Harding H.A., "Production management", Macdonald and Evans Ltd, 1974.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1				X	X	X			X		X
2	X	X	X			X	X	X		X	
3		X		X	X	X		X	X	X	
4			X	X		X	X		X		X
5	X	X	X			X		X		X	
6	X	X		X	X	X		X		X	X
7	X		X	X		X	X	X	X	X	

13ME77 - MECHATRONICS LABORATORY AND CAD/CAM LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

(a) 13ME77 - MECHATRONICS LABORATORY

COURSE OBJECTIVES

To gain knowledge of logical formulation and use it by the application of software and hardware for the controlling of mechanical equipments accurately.

COURSE OUTCOMES

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

CO1 : *Have a firm base of knowledge in areas of mathematics, and physics relevant to mechatronics, and be able to apply and extend this knowledge;*

CO2 : *Integrate mechanical engineering with electronics and intelligent computer control in designing and manufacturing machines, products and processes;*

CO3 : *Function effectively on problem-solving teams and to coordinate and provide leadership for teams, including multidisciplinary teams;*

CO4 : *Acquire fundamental knowledge about interfacing real time data with software for controlling the various processes and equipments.*

LIST OF EXPERIMENTS

1. Study of Mechatronics system design.
2. Introduction to Lab View.
3. Resistor simulation.
4. Capacitor simulation.
5. Simple servo simulation.
6. Temperature control system using Lab View.
7. Design of vehicle speed indicator using Lab View.
8. Measurement of pressure using load cell and Lab View.
9. Color matching using Lab View.
10. Analyzing and logging bio signals.
11. Matlab simulation for mathematical functions.
12. Matlab simulation of four bar mechanism.

TEXT BOOK

Mechatronics laboratory Manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X		X					X
2	X	X	X	X	X			X	X	X	X
3	X	X	X	X		X	X				X
4	X	X		X	X		X	X	X	X	X

(b) 13ME77 - CAD/CAM LABORATORY

COURSE OBJECTIVES

To study the usage of CAD software package, to gain hands-on training on the various commands used and to familiarize with model building and subsequently gain exposure to different analysis and simulation modules.

To develop the programming skills to write computer programs for the given component drawing to be used on a CNC machine for product manufacture and to simulate machining process prior to manufacture.

COURSE OUTCOMES

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

CO1 : *Model components from 2-D drawings using various commands.*

CO2 : *Understand various transformations and manipulations in order to simulate and analyze for its functional performance.*

CO3 : *Convert CAD models on computer into a product machined out on a CNC machine in the real time environment using the latest software.*

LIST OF EXPERIMENTS

1. Basic Function of Pro-E CAD Package - Sketcher Commands - Part Modeling (Basic Level) - Part Modeling (Advanced Level)
2. Assembly and Kinematic Mechanism - Blower - Modeling of Upper Housing - Modeling of Lower Housing - Modeling of Cover - Modeling of Blower - Modeling of Motor and Shaft - Assembly
3. Surface Modeling (ProE/Creo Parametric) .
4. Study of Turn CNC Lathe - Study of XL Mill / CNC Milling - Study of Feed Back Milling
5. Turning Model (Contour, Step, CW, CCW, Taper, Step Turn, Chamfer, Threading and Contouring with Facing, Drilling)
6. Stand alone CNC Lathe Practice - Feedback Milling (Linear Path, Circular Path) - XL Milling Practice. (MasterCAM).

TEXT BOOK

CAD/CAM laboratory Manual, Department of Mechanical Engineering, CIT.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X			X		X	X
2	X	X	X		X		X	X	X		X
3	X	X	X	X	X		X		X	X	X

13ME81 - AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

Automobiles are the principal mode of transport system. Their manufacture and maintenance gives a major scope for employment. Many entrepreneur pass outs go for servicing of automobiles or trading/ manufacturing of auto components. Thus automobile engineering is an important subject to be in the regular curriculum of the mechanical engineers. This course aims to gain exposure to general working principle of automotive vehicles and an overall knowledge in automotive propulsion, transmission and control systems with recent advancements.

COURSE OUTCOMES

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

CO1 : *Gained knowledge in the basic principles of automobile engineering.*

CO2 : *Acquired knowledge in the recent developments and advanced technologies in automotive sector.*

CO3 : *Explain and demonstrate the acquired skills effectively relating to automobile technology.*

CO4 : *Gained Peripheral knowledge in various fields of engineering associated with automobile engineering.*

CO5 : *Address issues related to vehicle pollution, human safety, etc.*

INTRODUCTION

History of Automobiles- classifications - Automobile layout - Scope - Past and present developments, future trends. **(2)**

AUTOMOTIVE ENGINES

Types of engines - engine rating - multi cylinder - Power & Mechanical balance - firing order - rotary engines - stratified charged engines - Lean burn engines - Turbocharged engines- Emission and its control. **(6)**

AUTOMOBILE AUXILIARY SYSTEMS

Carburetors, Electronic fuel injection systems - Mono point and Multipoint types - CRDI, principles of modern electrical systems - Battery, dynamo, alternator, starting motor, lighting and ignition (Conventional and Electronic types) **(7)**

TRANSMISSION SYSTEMS

Clutches - Need - types - Single and Multi plate - diaphragm clutch - over running clutch - Fluid coupling. Gear boxes - Manual and automatic - Epi cyclic and hydromatic transmission, universal joint, propeller shaft, Hotchkiss drive, torque tube drive, differential - Need and types - Construction - Four Wheel drive. **(8)**

STEERING AND SUSPENSION SYSTEMS

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

WHEELS AND BRAKES

Wheels and tires - Construction - Types and Specifications - wear types and causes. Brakes - Need - types - Mechanical, hydraulic and pneumatic - Details of Components, redundancy in brake system, trouble shooting in brake system, power brake- Diagonal Braking system. **(7)**

CURRENT AND FUTURE TRENDS

ABS, EBD and Air-bags - Automobile air conditioning - Automatic climate control - Defogger - Alternative fuels - Hydrogen - Compressed Natural Gas (CNG) - Liquefied Petroleum Gas (LPG), alternative power plants - Electric - Hybrid Vehicle -Fuel Cells-Solar Cars. **(7)**

TOTAL : 45

TEXT BOOKS

1. Sethi H.M., "Automobile Technology", Tata McGraw Hill, 2004.
2. Kirpal Singh., "Automobile Engineering - Vol 1 and 2", Standard Publishers, New Delhi, 2013.

REFERENCE BOOKS

1. Joseph Heitner, "Automotive Mechanics", East West Press, 3rd Edition, 2002.
2. William H.Crouse, "Automotive Mechanics", Tata McGraw Hill, 10th Edition, 2007.
3. Gupta R.B., "Automobile Engineering", SathyaPrakashan Publications, New Delhi, 1993.
4. Newton, Steeds and Garret, "Motor Vehicles", Butterworth Publishers, 13th edition, 2001.
5. James D. Halderman, "Automotive Technology- Principles, Diagnosis, and Service", Fourth edition, Prentice Hall, 2009.
6. Srinivasan S., "Automotive Mechanics", Tata McGraw Hill, Second Edition, 2003.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X	X	X		X	X			X
2	X		X	X	X	X		X	X	X	X
3		X	X	X			X	X	X		X
4	X			X	X	X		X	X	X	X
5		X	X	X	X	X		X		X	

13ME82 - QUANTITY PRODUCTION METHODS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

Appropriate techniques and process is required to manufacture the component economically and be competitive in the market. This requires a clear knowledge on the optimal production quantity to be processed in a given operation. This course imparts knowledge on the different types of production system, the appropriate production techniques for certain standard products based on machining, automation and use of non tradiational machining systems. The course imparts knowledge on the quantity production methods and their applications in the current engineering field.

COURSE OUTCOMES

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

CO1 *: Demonstrate the need for the quantity constraints in manufacturing process.*

CO2 *: Exhibit the knowledge on various standard parts produced in bulk.*

CO3 *: Design the appropriate production technology for a given product*

CO4 *: Exhibit skills of analytical skills in developing the production system.*

INTRODUCTION

Introduction - Engineering production; Aim and objectives, history of progress, definition and requirements. Levels of production; piece, batch, lot, mass and quantity production, mechanization and automation; need, degree and types of automation, Role of automation on industrial production. **(9)**

QUANTITY PRODUCTION METHODS

Classifications and methods - Broad classification of engineering production methods. Major sequential steps in industrial production; performing, semi finishing, treatments finishing and assembly and inspection at different levels. Quantity production methods of common engineering components; metallic rods, bars, plates, sheets, tubes and wire; shafts and spindles. Metallic discs, pulley, rims, clutches and cams; threaded objects; screws, bolt and nuts, and lead screws different types of bearings; gears (teeth); comparison of the methods w.r.t. process, productivity, product quality and economy automobile parts; engine block, piston, connecting rod and crank shaft. Methods of quantity production of cutting tools and tool inserts. Small size products in large volume; pins, clips, needles, metallic caps of bottles, washers, metallic utensils, chain links, paste tubes and coins; Quantity production by spinning, bulging. **(9)**

QUANTITY PRODUCTION APPLICATIONS

Applications of quantity production-Process planning and scheduling for quantity production in single spindle automatic lathe, transfer machines, CNC machine tools, Design and use of jigs and fixtures in machine shops. **(9)**

QUANTITY PRODUCTION MECHANIZATION

Mechanization of quantity production- Group technology; principle and application in quantity production. Inspection and quality control in quantity production. Computers and robotics in quantity production. **(9)**

QUANTITY METHODS FOR NON-TRADITIONAL PROCESSES

Quantity methods for non-traditional processes- Quantity production by non-traditional manufacturing processes. Methods and systems of quantity production of various ceramic and polymer products of common use. **(9)**

TOTAL : 45

TEXT BOOKS

1. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley & Sons, 4th Edition, 2010.
2. Sherif D. El Wakil., "Processes and design for manufacturing", PWS Pub. Co, 2nd Edition, 1998.
3. Kalpakjian S., "Manufacturing engineering and technology", Addison-Wesley Pub. Co, 3rd Edition, 2009.

REFERENCE BOOKS

1. Paul Degarmo E., Black J.T. and Ronald A. Kohser, "Materials and Processes in Manufacturing", 11th Edition, 2012.
2. Ghosh A, & Mallik A.K., "Manufacturing science", East West Press, 2nd Edition, 1999.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X	X	X		X	X			
2		X	X		X	X		X	X		X
3	X	X	X	X		X		X		X	X
4	X	X	X		X		X	X	X	X	

13ME83 - ALTERNATIVE ENERGY RESOURCES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on alternative energy resources, highlights the need for the use of non conventional energy resources, various forms, utilization procedure. The course explains the concept of various forms of renewable energy, by outlining division aspects and utilization of renewable energy sources for both domestics and industrial applications. It also analyse the environmental and cost economics of using renewable energy sources compared to fossil fuels. To gain basic knowledge on the conventional and alternative energy resources availability. To understand different energy conversion technologies for producing mechanical and electrical power.

COURSE OUTCOMES

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

CO1 *: Gain knowledge about the availability of conventional and alternative energy resources.*

CO2 *: Understand the processes of renewable energy utilizations.*

CO3 *: Acquire knowledge in different energy conversion techniques.*

CO4 *: Understand the impact of energy resources on society.*

ENERGY CONSUMPTION PATTERN

Commercial and Non-commercial energy sources - study of global energy availability. Energy consumption pattern in India and growth rate, total energy concept, total energy installations. **(3)**

SOLAR SYSTEMS

Solar Radiation - properties, measurement. Solar Collectors - focusing, non-focusing - solar thermal systems - storage systems - photo voltaic conversion systems- case studies. **(9)**

WIND POWERED SYSTEM

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

BIOENERGY

Bio energy sources - Photosynthesis and origin of biomass - bio chemical and thermo chemical conversion techniques - anaerobic digestion, fermentation - different biogas plants - applications. **(6)**

NUCLEAR PLANTS

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

NON CONVENTIONAL PLANTS

Geothermal energy conversion systems - OTEC - Tidal Power systems - wave energy generators -MHD systems. Thermo electric, thermionic systems, fuel cells. **(9)**

TOTAL : 45

TEXT BOOKS

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

REFERENCE BOOKS

1. Culp, "Principle of Energy Conversion", Tata McGraw Hill, 2005.
2. Magal, "Solar Power Engineering", Tata McGraw Hill, 2005.
3. Ashok V Desai, "Non-Conventional Energy", Wiley Eastern Ltd., New Delhi, 2002.
4. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 1996.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X		X	X	X	X	X	X	
2	X	X	X	X	X		X	X	X	X	X
3	X	X	X	X	X			X		X	X
4	X		X		X	X		X		X	X

13ME86 - ELECTIVE LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVES

To provide scope for performing advanced experiments using the existing facilities at the institute from any two of Design, Thermal and Manufacturing laboratories.

COURSE OUTCOMES

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

CO1 : *Think innovatively to conduct new experiments*

CO2 : *Interpret the data obtained from the experiments and suggest for newer experiments*

CO3 : *Work in groups and exchange ideas and understand the need for interpersonal skills.*

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X				X
2	X	X	X		X		X	X	X	X	X
3	X		X	X		X	X		X	X	

13ME87 - PROJECT WORK

L	T	P	C
0	0	6	6

ASSESSMENT : PROJECT

COURSE OBJECTIVES

The project at the end of the curriculum aims to bring forth the multi facet attributes within the student. It increase, develop and apply mechanical engineering knowledge and work with team members for sharing ideas and knowledge transfer. The student gains project management skills and enhance the technical writing skills, and decided and agree with peers what work moves all toward a goal and to sustain diverse acts with partners to complete a sound project.

COURSE OUTCOMES

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

CO1 : *Effectively demonstrate and practice the fundamental concepts of basic sciences and mechanical engineering concepts and principles in addressing a real time situation autonomously or in a team.*

CO2 : *Enhance the management skills to achieve the project goal by working as a team and also improve technical writing skills.*

CO3 : *Demonstrate the technical skills to provide feasible solutions for real-life problems.*

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X	X		X		X	
2		X		X	X		X		X	X	X
3	X	X	X		X	X		X	X	X	

13MEE01 - RAPID PROTOTYPING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

Opposed to a conventional machining process which takes away excess material from a block of workpiece, in 3-D Rapid Prototyping and Manufacturing (3DRPM) produce parts by building one layer upon another in a horizontal manner. This offers many advantages over machining limitations such as the capability to produce complex and difficult-to-machine models. Jigs and fixtures are also no longer needed. This course will provide a detailed knowledge on different techniques used in Rapid Prototyping, their needs, application, method of operation and the future of Rapid Prototyping system in industrial application, enhance innovative thinking and develop novel products using Rapid Prototyping technique.

COURSE OUTCOMES

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

CO1 : *Have in-depth knowledge about rapid prototyping technology along with recent trends in advanced manufacturing.*

CO2 : *Understand the need and application of RP in product manufacturing.*

CO3 : *Develop innovative components and novel product designs using rapid prototyping technology.*

INTRODUCTION

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

PRODUCT PROTOTYPING

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

VIRTUAL PROTOTYPING, MATERIALS SELECTION & RAPID PROTOTYPING

Using Commercial Software for Virtual Prototyping - Prototyping Materials - Material Selection Methods - Rapid Prototyping Overview -Rapid Prototyping Cycle - Rapid Prototyping Procedure - STL files - Converting STL File from Various CAD Files - Controlling Part Accuracy in STL Format - Slicing the STL File - Case Studies in Design for Assembly. **(10)**

TYPES OF RAPID PROTOTYPING PROCESS

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

APPLICATIONS OF RAPID PROTOTYPING

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

TOTAL : 45

TEXT BOOKS

1. Chua C.K., Leong K.F., and Lim C.S, "Rapid Prototyping: Principles and Applications", World Scientific Publishig Co. Pvt. Ltd., 2010.
2. Cooper G.K, "Rapid Prototyping Technology Selection and Application", Marcel Dekker Inc, USA, 2001.
3. Liou W.F, "Rapid Prototyping and Engineering Applications", A toolbox for prototype development, CRC Press, Taylor & Francis Group LLC, USA, 2008

REFERENCE BOOKS

1. Kai C.C., Lim C.S. and Leong F.K., “Rapid Prototyping: Principles and Applications in Manufacturing”, Wiley Publication, 2008.
2. Rafiq Noorani, “Rapid Prototyping : Principles and Applications”, Wiley, 2006
3. Julia A McDonald, Chris J Ryall, David I Wimpenny, “Rapid Prototyping case book”, Wiley, 2001.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X			X	X
2		X		X		X	X	X	X		X
3	X	X	X	X	X	X		X	X	X	X

13MEE02 - ADVANCED FOUNDRY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course is designed for students to acquire quality knowledge in the area of design and production of cast products. The course is nourished with practical problems and solutions that will enhance the design knowledge of the students. Topics to be covered in the course include: melting practice; casting processes; gating systems; fluidity; risering; solidification of metals/alloys; casting defects; and casting design

COURSE OUTCOMES

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

CO1 : *Realise the given physical problem and develop procedure to manufacturing using casting process.*

CO2 : *Comment on the economics of using casting as the prime manufacturing process.*

CO3 : *Use computer and develop based solutions for design of the moulding process.*

CO4 : *Simplify the problems faced in moulding.*

INTRODUCTION TO FOUNDRY AND PATTERN

Introduction Foundry as a manufacturing centre and types of foundries. Types of patterns - Pattern materials - Pattern allowances - Pattern layout, pattern making. **(9)**

MOULDING AND CORE MAKING

Materials: Ingredients, properties, Moulding methods:- Green sand moulding, dry sand moulding, CO_2 moulding, no bake moulding, shell moulding, Investment casting, permanent moulding, die casting and centrifugal casting, Cold box and Hot box. No bake processes. **(7)**

GATING AND RISERING SYSTEM

Gates and risers -their functions - Types - Design principles, design of gating and risering for steels and cast irons. **(10)**

MELTING FURNACES

Constructional details - Operation of crucible furnaces, Reverberatory furnaces - Cupola, rotary furnace - Core type and coreless type Induction furnaces - Arc furnace (direct and indirect arc furnaces), Resistance furnaces. **(9)**

QUALITY CONTROL AND PRINCIPLES OF MECHANIZATION

Composition control and temperature control. Simple problems in composition control for steels and cast irons, Sand reclamation, moulding machines, foundry layout and mechanization. **(10)**

TOTAL : 45

TEXT BOOKS

1. Heine R W. Loper, C.R. Rosenthal, P.C.,"Principles of Metal Casting",Tata-McGraw Hill Publishing Co Ltd, New Delhi, 2005.
2. Jain P.L., "Principles of Foundry Technology", Tata McGraw Hill Publishing Co Ltd, New Delhi, 2004.

REFERENCE BOOKS

1. Ramana Rao T.V., "Metal Casting: Principles and Practice", New Age International Publishing Co., New Delhi, 2010.
2. Srinivasan N.K.,"Foundry Engineering", Khanna Tech Publications, New Delhi, 1994.
3. ASM Metals Hand Book, Vol. 15, "Casting" ASM International, 10th edition, 2001.
4. Beeley P.R., "Foundry Technology", Blueworth, London, 2001.
5. Albert E. Barrington, "High Vacuum Engineering", Prentice Hall, 1964.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X	X	X	X			X
2	X		X		X		X		X	X	
3	X	X		X		X	X	X			X
4			X		X	X		X	X		X

13MEE03 - ADVANCED WELDING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course is designed for students to acquire quality knowledge in the field of weldments. The course is nourished with practical problems and solutions that will enhance the design knowledge of the students, about the recent welding processes, the weldability of ferrous and non-ferrous metals and alloys, the effects of heat flow in welding, the resulting residual stresses and distortion, good welding design principles and welding automation.

COURSE OUTCOMES

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

CO1 *: Demonstrate the science and technology behind the welding.*

CO2 *: Select suitable welding process and technique for a given material.*

CO3 *: Minimize distortion and residual stresses induced in weldments.*

CO4 *: Evolve better design for both fatigue and static loading conditions.*

CO5 *: Select suitable welding automation for the entire production of engineering components*

SPECIAL WELDING PROCESSES

Introduction to advanced welding processes - Electron beam welding, Fundamentals and types of laser welding including hybrid processes - Laser beam welding, Ultrasonic welding, explosion welding, Electroslag and Electrogas welding, Cold pressure welding, Friction welding, Friction stir welding - Friction stir spot welding - Electromagnetic pulse welding - High velocity projectile impact welding. **(10)**

HEAT FLOW IN WELDING

Metallurgical effects of heat flow in welding - TTT curve - Continuous cooling transformation diagrams - Development of residual stress, methods of relieving or controlling welding residual stress, types and control of distortion, pre-heat and post weld heat treatment. **(8)**

WELDABILITY OF FERROUS AND NON-FERROUS ALLOYS

Weldability of carbon and alloy steels, stainless steels, cast irons, copper and its alloys, aluminium and its alloys, titanium and its alloys, Nickel and its alloys. Testing of weldments. **(10)**

WELDING DESIGN

Typical joints for different welding processes, principles of welding joint design and location of joint within the member, evolving good weld design, welding symbol - Blue print reading, weld design for static and fatigue loading, fracture toughness. **(8)**

AUTOMATION IN WELDING

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

TOTAL : 45

TEXT BOOKS

1. Parmar R.S., "Welding Processes and Technology", Khanna Publishers, 2009.

REFERENCE BOOKS

1. Davis A.C., "Welding", Cambridge University Press, 10th Edition, 1996.
2. Larry, "Welding - Principles and Applications", Delmar Publisher, New York, 4th Edition, 2007.
3. American Welding Society, “Welding Handbook - Welding Processes Part 2”, Vol. 3, AWS, 2004.
4. Zhou Y.N., "Microjoining and Nanojoining", Woodhead publishing, 2008.
5. Steen W., "Laser Material Processing", Springer-Verlag, 1991.
6. Linnert G.E., "Welding Metallurgy", Vol. I and II, 4th Edition, AWS, 1994.
7. Mishra R.S. and Mahoney M.W., "Friction Stir Welding and Processing", ASM, 2007.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X	X			X
2	X		X		X	X		X		X	X
3	X	X		X		X	X		X		X
4	X		X	X		X		X		X	X
5	X	X	X		X	X		X		X	

13MEE04 - DESIGN OF JIGS AND FIXTURES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To improve the productivity, elimination of non productive time in the processes is essential. Different types of production tools such as Jigs, Fixtures, Gauges etc., are employed wherever necessary /possible. A thorough knowledge on the principles, construction and working principle of various locating devices, Jigs, Fixtures and gauges is dealt in this course.

COURSE OUTCOMES

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

CO1 : *Suggest and design appropriate clamping for specified operations.*

CO2 : *Design appropriate locating systems to arrest the possible degrees of freedom exhibited by the component.*

CO3 : *Design appropriate work holding and tool guiding devices for efficient and effective manufacturing.*

INTRODUCTION

Introduction - Jigs and Fixtures - Difference between Jigs and Fixtures - Advantages of Jigs and Fixtures - Functions -Elements of Jigs and Fixtures - Fool Proofing - Degrees of freedom - 12 degrees of freedom -3-2-1 principle of location - Essential features of Jigs and Fixtures- Materials used in Jigs and Fixtures - General Design Principles - Design steps -Common defects in Jig Design. **(9)**

LOCATING AND CLAMPING PRINCIPLES

Locating principles - Basic rules for locating - six point principles. Locating methods and devices - Redundant Location - Standard parts-Principles of clamping - types of mechanical actuation clamps, pneumatic and hydraulic actuation clamping, special clamping operation. **(9)**

ANALYSIS OF CLAMPING FORCES

Clamping force, Clamping force analysis of strap clamp, toggle clamp, cam operated clamp and screw clamp. Tolerance and error analysis - Limit and fits, types of tolerance, Geometric dimensioning- Error analysis, types of error analysis. **(9)**

DRILL JIGS

Drill bushes - design principles, materials for drill bushes, design principles for drill bushings, types of drill bushes, clearance, common defects in jig design, construction of jigs, different types of jigs, Post, Turnover, Channel, latch, box, pot, angular post jigs - Indexing jigs, Air operated drilling jig components, chip control. Design and development of jig for the given component. **(9)**

FIXTURES

Design principles, types of fixtures, General principles of Boring fixtures, types of boring, milling, Lathe, broaching, shaping and grinding fixtures - Assembly, Inspection and Welding fixtures - Modular fixturing systems- Air operated fixtures. Design and development of fixture for given component.

Case studies for practice for jigs and fixtures. Assembly drawings of a simple jig or fixture using computer software AUTOCAD or any other CAD software. **(9)**

TOTAL : 45

TEXT BOOKS

1. Joshi P., "Jigs and Fixture - Design Manual", Mc Graw Hill, 2003.
2. Cyrill Donoldson V.C. and Others, "Tool Design", 4th Edition, Tata McGraw Hill, 2012
3. Kempster, "Introduction to Tool Design and Jigs and Fixtures", 2013

REFERENCE BOOKS

1. ASTME, "Hand book of Fixture design"
2. Goroshkin A.K., "Jigs and Fixtures Handbook", MIR Publishers, Moscow
3. Joshi, "Jigs and Fixtures", Tata McGraw-Hill Education, 2001.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X			X	X	X	X
2	X	X		X	X		X	X		X	
3	X	X		X	X	X			X	X	X

13MEE05 - MECHANICAL HANDLING SYSTEMS AND EQUIPMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

The movement of materials from one processing area to another and from department to department necessitates the use of much personnel and equipment and the handling of treatment tonnages of materials. This course provides a solid foundation in basic material handling systems and fundamental aspects of mechanical engineering.

COURSE OUTCOMES

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

CO1 : *Apply the principles learned for the analysis of mathematics and science to solve engineering problems involving movement of bulk and individual material systems.*

CO2 : *Design efficient system to minimize the energy utilization.*

CO3 : *Design as well as to analyze, and interpret data, with specific reference to design and development of newer material handling systems.*

INTRODUCTION

Elements of Material Handling System-Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipment. **(7)**

SELECTION & ANALYSIS

Selection of Material Handling Equipment-Factors affecting selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials. **(8)**

DESIGN OF HOISTS & CRANES

Design of Mechanical Handling Equipment- Design of Hoists, Drives for hoisting, components, and hoisting mechanisms; rail travelling components and mechanisms; hoisting gear operation during transient motion; selecting the motor rating and determining breaking torque for hoisting mechanisms. Design of Cranes, Hand-propelled and electrically driven E.O.T. overhead Travelling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead travelling cranes; Stability of stationary, rotary and travelling rotary cranes. **(8)**

DESIGN OF LOAD LIFTING ATTACHMENTS

Load chains and types of ropes used in Material Handling System; Forged, Standard and Ramshorn Hooks; Crane Grabs and Clamps; Grab Buckets; Electromagnet; Design consideration for conveyor belts; Application of attachments. **(7)**

STUDY OF SYSTEMS AND EQUIPMENT USED FOR MATERIAL STORAGE

Objectives of storage; Bulk material handling; Gravity flow of solids through slides and chutes; Storage in bins and hoppers; Belt conveyors; Bucket-elevators; Screw conveyors; Vibratory Conveyors; Cabin conveyors; Mobile racks etc. **(7)**

MATERIAL HANDLING / WAREHOUSE AUTOMATION AND SAFETY CONSIDERATIONS

Storage and warehouse planning and design; computerized warehouse planning; Need, Factors and Indicators for consideration in warehouse automation; which function, when and How to automate; Levels and Means of Mechanizations. Safety and design; Safety regulations and discipline. **(8)**

TOTAL : 45

TEXT BOOKS

1. James M. Apple, "Material Handling System Design", John-Willey and Sons Publication, New York.
2. John R. Immer, "Material Handling", McGraw Hill Co. Ltd., New York.
3. Colin Hardi, "Material Handling in Machine Shops", Machinery Publication Co. Ltd., London.

REFERENCE BOOKS

1. Nexandrn M.P., "Material Handling Equipment", MIR Publication, Moscow.
2. Cock C.R. and Mason J., "Bulk Solid Handling", Leonard Hill Publication Co. Ltd., U.S.A.
3. Spivakovsy A.O. and Dyachkov. V.K., "Conveying Machines", Volumes I and II, MIR Publishers.
4. Kulwiac R. A., "Material Handling Hand Book", JohnWilly Publication, New York.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X		X		X	X	X	X	X
2	X		X		X	X	X	X		X	X
3		X	X	X	X			X	X		X

13MEE06 - NON-TRADITIONAL MACHINING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on non traditional machining process will provide an insight to the students on different techniques of material removal process using on or combination of more than one of mechanical energy, electrical energy, thermal energy, light and other non traditional methods. The course aims to provide a basic knowledge on the processes, analytical, limitations of Newer Machining, LBM and other allied processes, along with micro and nano machining processes.

COURSE OUTCOMES

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

CO1 *: Familiarize about the impact of new technologies in the machining industry.*

CO2 *: Understand the latest applications to micro-manufacturing in the industry.*

CO3 *: Use and apply the non-traditional machining techniques for in the industries.*

CO4 *: Produce parts that will meet the given specifications*

INTRODUCTION & MECHANICAL MACHINING PROCESS

Introduction - Classification - process economy - Mechanical machining - Types - Ultrasonic machining (USM) - Abrasive Jet Machining (AJM) - Abrasive Flow Machining (AFM) - Water Jet Machining (WJM) - Operating principle - Process parameters - Applications - Limitations. **(7)**

ELECTRO - CHEMICAL PROCESSES

Electro chemical machining - Chemical material removal - Types - Electro chemical machining (ECM) - Electro chemical drilling (ECD) - Electro chemical grinding (ECG) - Electro chemical honing (ECH) - Shaped tube electrolytic machining - Operating principle - Process parameters - Applications - Limitations. **(9)**

THERMO ELECTRICAL PROCESSES

Thermo electrical machining - Types - Electrical discharge machining (EDM) - Electrical discharge wire cutting (EDWC) - Electron beam machining (EBM) - Ion Beam Machining (IBM) - Plasma Arc Machining (PAM) - Operating principle - Process parameters - Applications - Limitations. **(9)**

LASER MACHINING PROCESS

Laser materials processing - Laser types - Processes - Laser beam machining (LBM) - Laser cutting (LC) - Laser drilling (LD) - Laser marking and engraving (LM) - Laser micromachining (LMM)-Laser engineered net shaping (LENS) - Applications - Limitations. **(9)**

MICRO ELECTRO MECHANICAL SYSTEMS & NANO TECHNOLOGY

Introduction to silicon processing - wafer cleaning - oxidation - photolithography - electron beam and X-ray lithography - thin film deposition - sputtering - chemical vapour deposition - electro plating - Etching process-Wet etching - isotropic etching - anisotropic etching - dry etching. Nano Technology - nano-

grating system - nano-lithography - fabrication of CCDS - nano processing of materials for super high density ICs - nano-mechanical parts -Case studies. **(11)**

TOTAL : 45

TEXT BOOKS

1. Vijay K. Jain, "Advanced Machining Processes", Allied Publications Private Limited, 2002.
2. Pandey P.C. and Shan H.S., "Modern Machining processes" Tata McGraw-Hill, New Delhi (2007).
3. Nano Tanigudi, "Nanotechnology", Oxford University Press, New York, 2003.
4. Murthy R.L., "Precision Engineering in Manufacturing", New Age International Publishers, 1996.

REFERENCE BOOKS

1. Carl Somme R, "Non-traditional Machining Handbook", Advance Publishing Inc., 2000.
2. Steen W.M. and Watkins K., "Laser Materials Processing", Springer London Ltd, 2003.
3. Groover M.P., "Fundamentals of modern manufacturing processes - Materials, Processes and Systems", 3rd Edition, John Wiley and Sons Inc., 2007.
4. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, (1998).
5. 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.
6. Hassan Abdel and Gaward El-Hofy, "Advanced Machining Processes", McGraw Hill Publications, 2005.
7. Mark J. Madou, "Fundamentals of Micro Fabrication", CRC Press, 2002.
8. Abdel H. and El-Hofy G., "Advanced Machining Processes", McGraw-Hill, USA, 2005.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X			X		X		X	X		X
2		X	X	X	X	X		X	X	X	
3	X	X	X		X		X		X	X	X
4	X	X	X	X	X	X		X	X	X	X

13MEE07 - NON-DESTRUCTIVE EVALUATION AND IMAGING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

Overview the concepts, principles, and methods employed for Non Destructive Evaluation (NDE) of structures and materials. While emphasis is on inspection methods employed to ensure structural integrity of aerospace vehicles, course content has application to a broad class of high performance structures. Major NDE techniques covered include X-rays, ultrasonics, eddy currents, penetrants, magnetic flux, and visual/optical methods. Further topics such as damage-tolerant design, retirement-for-cause, factors affecting NDE reliability, and structural "aging" are discussed in the context of NDE engineering

COURSE OUTCOMES

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

CO1 *: Gain knowledge on non-destructive evaluation and imaging principles and to apply for practical solutions.*

CO2 *: Conduct experiments as well as to analyse data.*

CO3 *: Identify, formulate and solve problems encountered in the practice.*

CO4 *: Understand the basic principles of various NDT methods.*

CO5 *: Understand applications, limitations and techniques of various NDT methods.*

CO6 *: Study codes, standards and specifications related to non-destructive testing technology.*

FUNDAMENTALS NON-DESTRUCTIVE EVALUATION & IMAGING.

Introduction -Modes of failure - Types of fractures - Fundamentals of Visual Testing -Vision, lighting, material attributes environmental factors, Visual perception, direct and indirect methods. **(5)**

LIQUID-PENETRANT AND MAGNETIC PARTICLE INSPECTION TESTING

Principles - types and properties of liquid penetrants - developers- advantages and limitations of various methods - Preparation of test materials - Application of penetrants to parts, removal of surface penetrants, post cleaning - selection of penetrant method - solvent removable, water washable.

Theory of magnetism - ferromagnetic, Paramagnetic materials -characteristics of magnetic fields - magnetization by means of direct and alternating current - surface strength characteristics - Depth of penetration factors, Direct pulsating current typical fields, advantages - Circular magnetization techniques, field around a strength conductors, right hand rule field - Prods technique, current. **(10)**

RADIOGRAPHIC TESTING AND RADIATION SAFETY

Geometric exposure principles-Influence coefficients -Radio isotopic sources - types and characteristics- Production and processing of radioisotopes - radiographic cameras - X-ray sources generation and properties- industrial X-ray tubes - target materials and characteristics

Film Radiography: X-ray film - structure and types for industrial radiography -sensitometric properties - use of film, characteristic curves (H & D curve) - latent image formation on film - X-ray and gamma ray exposure charts.

Special Radiographic Techniques: Principles and applications of Fluoroscopy/Real-time radioscopy - advantages and limitations - recent advances, intensifier tubes, vidicon tubes. **(10)**

ULTRASONIC INSPECTION

Principles of Acoustics: Nature of sound waves, wave propagation - modes of sound wavegeneration - Various methods of ultrasonic wave generation - Ultrasonic Inspection Methods, Equipment/Materials: Principle of pulse echo method, through transmission method, resonance method - Advantages, limitations - contact testing,immersion testing, couplants - Data presentation A, B and C scan displays, comparison of contact and immersion method. Recent advances in ultrasonic testing, Ultrasonic imaging, Synthetic Aperture FocusingTechniques (SAFT), Time of Flight Diffraction (TOFD), Signal Analysis, Artificial Intelligence, Neural Network, Fuzzy logic, Guided waves ultrasonic testing. **(10)**

THERMOGRAPHY

Principles of Thermography - Contact and non-contact inspection methods - Heat sensitivepaints - Heat sensitive papers - thermally quenched phosphors liquid crystals - techniques for applying liquid crystals - calibration and sensitivity - other temperature sensitive coatings -non contact thermography inspection - Advantages and limitations - Infrared radiation and infrared detectors, Instrumentations and methods, applications. Introduction to advanced Non-destructive Evaluation techniques - Acoustic emission inspection, Leak Testing. **(10)**

TOTAL : 45

TEXT BOOKS

1. Peter J. Shull, "Non-destructive Evaluation: Theory, Techniques, and Applications", CRC Press, 2002.
2. Chuck Hellier, "Handbook of Nondestructive Evaluation”, Second Edition, McGraw Hill Professional, 2012.

REFERENCE BOOKS

1. Paul E. Mix., "Introduction to Nondestructive Testing: A Training Guide”, 2nd Edition, John Wiley & Sons, Inc., 2005.
2. Miller, Ronnie and Paul Mclntire, "Non-Destructive Testing Handbook; Acoustic Emission Testing, VoL-5, 2ed, Columbus, OH: American Society for Non-DestructiveTesting, 1987.
3. American Society for Metals, “Non-Destructive Inspection and Quality Control: Metalshand Book, Vol-11”, 8th Ed, Metals park Oh, 1976.
4. “Non-Destructive Testing Hand Book: Radiography and Radiation Testing: VoI. 3”, 2nd ed, Columbus, OH, American Society for Non-Destructive Testing, 1985.
5. “Non - Destructive Evaluation and Quality control”, ASM Hand book, Vol. 17.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X				X	X	X	X	X		
2		X	X	X		X		X	X	X	
3		X	X		X		X	X	X		
4	X		X	X	X	X	X	X	X		
5	X		X	X	X					X	X
6	X	X	X		X		X		X		

13MEE08 - ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

Robots are devices, which have been used to assist humans in various tasks. Majority of robots have been used in manufacturing, a recent trend has seen robots used in a variety of applications including space and underwater exploration, medicine and a wide range of service industries. The discipline of robotics embraces the design and operation of these devices and their integration with other systems in the work environment.

This course produces students who can use their multidisciplinary skills to meet growing demand from an industry that is pushing the limits of technology by exploiting the growing convergence of these fields. The course aims to provide knowledge on fundamentals of robots, robot programming, and its vision system and apply to demonstrate their knowledge in real time application

COURSE OUTCOMES

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

CO1 : *Demonstrate the concepts of robotic principles and various robot configurations.*

CO2 : *Develop solutions for the robot position and orientation for given application.*

CO3 : *Identify the appropriate configuration for the application.*

CO4 : *Design intelligence systems incorporating real time data capturing using vision systems.*

CO5 : *Understand robotic programming.*

CO6 : *Develop simple robotic systems.*

INTRODUCTION TO ROBOTS

Fundamental concepts of robotics, robot configurations, robots in automation, specification of robots, robot terminologies - volume, degrees of freedom, singularity, redundancy, resolution, repeatability and accuracy of the manipulator, Manipulators - Driver mechanisms, hydraulic, electric, pneumatic drives, End Effectors - mechanical grippers, types of gripper mechanism, vacuum grippers, magnetic grippers, flexible grippers. **(9)**

KINEMATICS OF ROBOT MANIPULATORS

Homogeneous representation of objects, robot manipulator joint co-ordinate system, Euler angles and Euler transformations, Denavit-Hartenburg (D-H) representations, direct kinematics in robotics, inverse kinematic solutions, geometrical approach in inverse kinematics, jacobian of transformation in robotic manipulation. **(9)**

DYNAMICS OF ROBOT MANIPULATORS

Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion, trajectory planning, Examples of a planar 2R and four-bar mechanism, Recursive dynamics, Commercially available multi-body simulation software (ADAMS) and Computer algebra software Maple. **(11)**

ROBOT VISION SYSTEM

TV cameras - illumination techniques -fundamentals of image processing visual data acquisition - image enhancement - image segmentation - image extraction and recognition- object and model matching - image extraction. Typical vision systems. **(9)**

ROBOT PROGRAMMING

Robot programming languages-characteristics of robot-level languages- characteristics of task level languages, simulation languages. Teaching, offline robot programming - sample programs, path planning, obstacle avoidance, robot programming using MATLAB software. **(7)**

TOTAL : 45

TEXT BOOKS

1. King Sun Fu, Gonzales R.C., Lee C.S.G., "Robotic control, sensing, vision and intelligence", McGraw Hill International editions, 2006.
2. Mikell P. Groover, "Industrial Robotics - Technology, Programming and Applications", McGraw Hill, 1986.

REFERENCE BOOKS

1. King Sun Fu, Gonzalez R.C., "Robotics", McGraw Hill, 1987.
2. Mohsen Shahinpoor, "A Robot Engineering - Text book", Harper & Royal Publications, Newyork, 1987.
3. L'ttole F., Kauffmann J.M., Pierre Andre and Taillard J.P., "Robot components and systems Volume IV", Prentice Hall, 1983 edition.
4. Nagy F.N., Andras Siegler, "Engineering foundations of Robotics", Prentice Hall India, New Delhi, 1987
5. Richard D. Klafter, Thomas Achmielewski and Mickael Negin, "Robotic Engineering - An integrated Approach", Prentice Hall India, New Delhi, 2001.
6. Reza N. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", (2nd Edition)

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X		X		X		X	X	X	
2	X		X		X		X	X	X		X
3	X	X		X		X	X	X	X		X
4		X	X	X	X		X	X		X	
5	X				X	X	X		X		
6	X	X	X	X		X	X	X		X	X

13MEE09 - MACHINE TOOL DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

Design of machine tools involves the consideration of both static and dynamic design of the system for a given application. The design process consist of design and selection of appropriate power transmission system, rigid structure for both stable and reliable system. This course aims to provide knowledge on functions, materials and design principles of machine tool structures, guide ways, spindle and supports. It also provide the basic concepts and design guide lines of machine tools and enable the student to be familiar with solving problems in design modification of the different machine tools.

COURSE OUTCOMES

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

CO1 : *Provide appropriate solution for design and development of machine tools for specific applications.*

CO2 : *Understand functions and design principles of machine tool structures and different types of guide ways.*

CO3 : *Design machine tool structures and different types of guide ways.*

CO4 : *Design and make selections on spindles and power screws.*

STATIC AND DYNAMIC STIFFNESS, FORCE ANALYSIS

Static stiffness and compliance - Role of Static & Dynamic Stiffness in the design of elements of machine tools, Factors affecting stiffness of machine tool structures & methods of improving it - deformation caused by weight, Forces - deformation caused by cutting forces - forced vibrations, self-excited vibrations, Force distribution in different parts of Lathe, Drilling machine, Milling machine. **(9)**

DESIGN OF STRUCTURES

Function & Requirement of Machine Tool Structure, Design Criteria from Strength & Stiffness considerations - Beds, columns and housing for maximum strength and rigidity - cast and welded construction - CNC machine tools - structure - main drive and feed drive - ball screws - automatic tool changers- chip conveyors- tool magazines - tool turrets. **(9)**

DESIGN OF GUIDE WAYS

Function & Types of Guide ways, Types of Slide ways & Antifriction Ways, Selection of Materials, Methods of adjusting Clearance, Selection of materials - integrated and attached ways - hydro-static guide ways, aero-static guide ways - antifriction guide ways - design of friction guide ways - plastic inserted guide ways and LM guide ways. **(9)**

DESIGN OF SPINDLES AND DRIVES

Function & Design requirements - standards - selection of spindle bearings - materials for spindles - Design of Spindle for Bending Stiffness: Deflection of Spindle Axis due to bending, due to Compliance of Spindle Supports, due to Compliance of the Tapered Joint. Optimum Spacing between Spindle Supports.

Permissible Deflection & Design for stiffness: Additional Check for Strength like Additional Supports, Location of Bearings and Drive elements, balancing - design consideration of Electrical, Mechanical and Hydraulic drives in machine tools. **(9)**

DESIGN OF POWER SCREWS

Design of Sliding friction Power Screw for Wear Resistance, Strength, Stiffness, & Buckling Stability. Design of Rolling friction Power Screw for Strength under static loading, Strength under cyclic loading, & Stiffness. **(9)**

TOTAL : 45

TEXT BOOKS

1. Mehta N. K., "Machine Tool Design and Numerical control", Tata McGraw Hill, 2012.
2. Pal D.K., Basu S. K., "Design of Machine Tool", 4th Edition. Oxford IBH, 2005.

REFERENCE BOOKS

1. Bhattacharya and Sen S. G., "Principles of Machine Tool", New central book agency Calcutta, 2006.
2. Acherkan N. S., "Machine Tool", Vol. I, II, III and IV, MIR publications.
3. Koenigsberger F., "Design Principles of Metal Cutting Machine Tools", The Macmillan Company New York, 1964.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X			X	X	X	X	X	X		X
2	X	X	X	X	X	X	X		X	X	
3		X	X	X	X		X	X	X		X
4	X	X	X	X		X		X		X	X

13MEE10 - FLUID POWER CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

Study and development of Automation and power transmission and controls systems using fluid as the prime media is called as fluidics. This course aims to provide basic knowledge about the working principle of various hydraulic and pneumatic components used for different industrial applications, understand hydraulic and pneumatic circuits for different applications and to gain hands-on experience in designing, analyzing and implementing control systems for real and physical systems.

COURSE OUTCOMES

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

CO1 *: Design and control simple automation systems using fluidics.*

CO2 *: Carry out design, selection and enhance existing automated system using fluidics.*

CO3 *: Demonstrate the importance of using electro mechanical systems in automation.*

CO4 *: Analysis and design of hydraulic circuits and some safety precautions in such circuits.*

FLUID POWER SYSTEMS AND FUNDAMENTALS

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids - General types of fluids - Fluid power symbols. Basics of Hydraulics laws. **(3)**

FLUID POWER DRIVES

Sources of Hydraulic Power: Pumping theory - Pump classification - Gear pump, Vane Pump, piston pump, construction and working of pumps - pump performance - Variable displacement pumps. Hydraulic motors - principle of working, calculation of discharge, power and efficiency.

Fluid Power Actuators: Linear hydraulic actuators - Types of hydraulic cylinders - Single acting, Double acting special cylinders - tandem - Rodless - Telescopic. Cushioning mechanism. Rotary actuators. **(8)**

FLUID POWER ELEMENTS

Construction of Control Components : Director control valve - 3/2 way valve - 4/2 way valve - Shuttle valve - check valve - pressure control valve - pressure reducing valve, sequence valve, Flow control valve - Fixed and adjustable, electrical control solenoid valves, Relays.

Ladder diagram Accumulators and Intensifiers: Types of accumulators - Accumulators circuits, sizing of accumulators, intensifier - Applications of Intensifier - Intensifier circuit. **(9)**

BASIC HYDRAULIC CIRCUITS

Design of Hydraulic circuits - speed control, sequencing circuits, regenerative circuits, unloading circuits. Design and application of hydraulic circuits of machine tool, press, Mobile hydraulic and other industrial applications. **(8)**

PNEUMATIC SYSTEMS AND COMPONENTS

Pneumatic Components: Properties of air - Compressors - Filter, Regulator, Lubricator Unit - Pneumatic system, pneumatic components - pressure - flow - direction controls valves, Air control valves, Quick exhaust valves, pneumatic actuators. **(3)**

PNEUMATIC CIRCUITS DESIGN

Design of pneumatic circuits for automation, selection and specification of circuit components, sequencing circuits, cascade, and karnaugh - Veitch map method - Regenerative, speed control, synchronizing circuits. **(8)**

ELECTRO PNEUMATICS AND PLC CIRCUITS

Use of electrical timers, switches, solenoid, relays, proximity sensors etc. electro pneumatic sequencing Ladder diagram - PLC - elements, functions and selection - PLC programming - Ladder and different programming methods - Sequencing circuits. **(6)**

TOTAL : 45

TEXT BOOKS

1. Anthony Esposito, "Fluid power with applications", 6th edition, Pearson education, 2003.
2. Andrew Parr, "Hydraulics and Pneumatics", Jaico Publishing House, 2004.
3. Majumdar S.R., "Oil Hydraulics", Tata McGraw-Hill, 2000.

REFERENCE BOOKS

1. Harry L. Stevart D.B., "Practical guide to fluid power", Taraoeala sons and Port Ltd. Broadey,1976.
2. Rexroth - hydraulic training manual.
3. Majumdar, "Pneumatic system: Principles and Maintenance", Tata McGraw Hill, 2004.
4. John Watton., "Fundamentals of Fluid Power Control", 1st Ed, Cambridge University Press, 2009.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X			X		X	X	X		X	
2	X	X	X	X		X	X	X	X	X	X
3	X	X	X		X		X	X	X	X	X
4	X	X	X	X		X	X	X	X	X	

13MEE11 - ADVANCED FLUID MECHANICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To extend the depth of knowledge in Fluid Mechanics further, the course "Advanced Fluid Mechanics" has been designed and framed to emphasize advanced theories and mathematical formulation of various flow problems.

COURSE OUTCOMES

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

CO1 *: Understand the given physical problem and develop mathematical models.*

CO2 *: Compute the exact solutions of Navier-Stokes equations of flow problems.*

CO3 *: Calculate the potential flows and stability theory in fluid flows.*

CO4 *: Derive the governing equations of laminar and turbulent flow systems.*

CO5 *: Understand the boundary layer concepts*

FUNDAMENTALS AND GOVERNING EQUATIONS OF FLUID MOTION

Definition and properties of Fluids, Fluid as continuum, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics. Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler's equation, Bernoulli's Equation. **(6)**

EXACT SOLUTIONS OF NAVIER-STOKES EQUATIONS

Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections, Unsteady flows,Creeping flows. **(8)**

POTENTIAL FLOWS

Revisit of fluid kinematics, Stream and Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag. **(8)**

LAMINAR BOUNDARY LAYERS

Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Approximate Methods, Flow separation, Entry flow into a duct. **(8)**

ELEMENTS OF STABILITY THEORY

Concept of small-disturbance stability, Orr-Sommerfeld equation, Inviscid stability theory, Boundary layer stability, thermal instability, transition to turbulence. **(7)**

TURBULENT FLOW

Introduction, Fluctuations and time-averaging, General equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Turbulent pipe flow, Prandtl mixing hypothesis, Turbulence modeling, Free turbulent flows. **(8)**

TOTAL : 45

TEXT BOOKS

1. Frank M. White, "Fluid Mechanics", Tata McGraw-Hill, Singapore, Sixth edition, 2008.
2. Muralidhar K. and Biswas G., "Advanced Engineering Fluid Mechanics", Second Edition, Narosa, 2005.

REFERENCE BOOKS

1. Batchelor G.K., "An Introduction to Fluid Dynamics", Cambridge University Press, 1983.
2. Robert Fox W., Alan McDonald T., "Introduction to Fluid Mechanics", Fourth Edition, John Wiley & Sons, 1995.
3. Frank M. White, "Viscous Fluid Flow", Third Edition, McGraw-Hill Series of Mechanical Engineering, 2006.
4. John D. Anderson Jr., "Modern Compressible Flow with Historical Perspective", McGraw-Hill, 1990.
5. Schlichting H., "Boundary Layer Theory", Springer Verlag, 2000.
6. Tennekes H. and Lumley J.L., "A First Course in Turbulence", The MIT press, 1972.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X		X	X	X		X	X
2	X	X	X		X	X	X	X	X	X	X
3	X	X	X	X	X		X	X		X	X
4	X	X	X	X	X	X		X	X	X	X
5	X	X	X		X		X		X	X	X

13MEE12 - REFRIGERATION AND AIR CONDITIONING

(Use of approved Psychrometric Chart is permitted)

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To understand various thermodynamic cycles used in refrigeration and air conditioning systems, aspects related to selection of refrigerants, cooling systems and duct design for comfort air conditioning.

COURSE OUTCOMES

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

CO1 : *Perform basic calculations related to the performance of various refrigeration's cycles and air conditioning processes.*

CO2 : *Know about the different types of refrigeration system.*

CO3 : *Acquire basic knowledge of psychrometry.*

CO4 : *Know about different types of compressors and condensers and expansion devices used in refrigeration system .*

AIR CYCLE REFRIGERATION

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

REFRIGERANT SELECTION

Properties, Eco - friendly refrigerants, Selection of Refrigerants. **(2)**

VAPOUR COMPRESSION REFRIGERATION SYSTEM

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

BALANCING OF COMPONENTS

Condensers - Air cooled, water cooled and evaporative condensers. Evaporator - flooded, dry expansion, shell and tube and double pipe. Compressors - reciprocating, rotary and centrifugal types. Expansion devices - capillary and TEV. **(8)**

VAPOUR ABSORPTION SYSTEMS

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

AIR CONDITIONING

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

AIR CONDITIONING SYSTEMS

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

TOTAL : 45

TEXT BOOKS

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

REFERENCE BOOKS

1. Arora C.P., "Refrigeration and Air Conditioning". Tata MC Graw Hill Publishing Company Ltd., New Delhi, 2007.
2. Roy J. Dossat, "Principles of Refrigeration", Prentice Hall of India Pvt. Ltd., 2005.
3. Thipse S.S., "Refrigeration and Air Conditioning", Jaico Publishing House, 2006.
4. Stoecker W.F. and Jones J.W., "Refrigeration & Air Conditioning", McGraw Hill Book Company, 1985

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X	X	X		X
2	X		X	X	X	X	X	X	X	X	X
3	X	X	X		X			X	X	X	
4	X		X	X	X	X	X	X	X	X	X

13MEE13 - CRYOGENICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To learn cryogenic engineering which involves the design and development of system and components which produce, maintain and utilize low temperature well below -150^{0}C.

COURSE OUTCOMES

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

CO1 *: Have the necessary skills required to model and solve problems related to design and analysis of equipments and cycles used in the cryogenic engineering.*

CO2 *: Gain confidence in seeking employment in cryogenic industry.*

GAS LIQUEFACTION SYSTEM

System performance parameters - ideal system, liquefaction systems - simple linde - hampson, Claude systems - systems for neon, hydrogen and helium. **(9)**

CRYOGENIC REFRIGERATION SYSTEM

Claude refrigerator - Philips refrigerator, Solvay, Gifford-Mc Mahon refrigerators - magnetic cooling - magnetic refrigerators systems. **(9)**

SEPARATION AND PURIFICATION SYSTEMS

Theoretical plate calculations of air columns - air separation systems - Linde double column systems - Argon, Neon, Hydrogen and Helium separation systems - Gas purification methods. **(9)**

MEASUREMENT SYSTEMS

Temperature, pressure, flow rate, fluid quality, liquid level measurement systems. **(9)**

STORAGE AND APPLICATIONS

Cryogenic fluid storage systems - vacuum technology - applications of cryogenics. **(9)**

TOTAL : 45

TEXT BOOKS

1. Randal F. Barron, "Cryogenic Systems", Oxford University Press, 1985.
2. Thomas M. Flynn, "Cryogenic Engineering", 2nd Edition, Taylor and Francis, 2005.

REFERENCE BOOKS

1. Mamata Mukhopadhyay, "Fundamentals of Cryogenic Engineering", Prentice Hall of India, 2010.
2. Peter Kittel, "Advances in Cryogenic Engineering", Plenum Press, 1998.

3. Guglielmo Ventura and Lara Risegari, "The art of Cryogenics - Low Temperature Experimental Techniques", Elsevier, 2008.

4. Guy K. White, "Experimental Techniques in Low Temperature Physics", Claredon Press, Oxford, 1987.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X		X	X	X	X	X	
2	X	X	X	X	X	X	X		X	X	X

13MEE14 - ADVANCED THERMODYNAMICS

(Use of Property Tables is permitted)

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To gain a thorough background into thermodynamic property relationships, Laws of Thermodynamics, thermodynamics of multi-component systems and effectively use thermodynamics in the practice of engineering.

COURSE OUTCOMES

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

CO1 : *Have the necessary skills required to be able to analyze thermodynamic processes undergone by multi-component mixtures of ideal gases or real gases*

CO2 : *Gain confidence to undertake advanced courses in chemical thermodynamics*

CO3 : *Acquire knowledge useful to undertake advanced courses such as Combustion in IC Engines, Boilers.*

THERMODYNAMIC PROPERTY RELATIONS

Fundamental postulate of thermodynamics, Fundamental equations of thermodynamics for simple compressible systems, Maxwell relations, Relations for c_p and c_v, Relationships for calculating changes in internal energy, enthalpy and entropy, Joule-Thompson coefficient. **(9)**

REAL GAS BEHAVIOR

Real gas equations of state (EOS) e.g. Van der Waals, Redlich-Kwong EOS, Determination of EOS model constants from critical point data, Property relationships for real gases, Ideal gas vs. real gas mixtures, Dalton and Amagat models, Mixture rules for real gas mixtures, Entropy of mixing. **(9)**

MULTI-COMPONENT SYSTEMS

Chemical work, Fundamental equations of thermodynamics for multi-component systems, Maxwell relations, Chemical work and chemical potential, Partial molar properties, Gibbs-Duhem equation. **(9)**

AVAILABILITY AND EXERGY

Reversible work, Irreversibility, Availability functions for closed and open systems, Degradation of exergy, Second law efficiency, Applications to various thermodynamic processes. **(9)**

COMBUSTION

Combustion process, Enthalpy of formation, First-law analysis of reacting systems, Enthalpy and internal energy of combustion, Heat of reaction, Chemical Equilibrium, Adiabatic flame temperature, Third law of thermodynamics and absolute entropy, Second law analysis of reacting systems. **(9)**

TOTAL : 45

TEXT BOOKS

1. Nag P.K., "Engineering Thermodynamics", 3rd Ed., Tata McGraw-Hill, 2005.
2. Claus Borgnakke, Richard E. Sonntag, "Fundamentals of Thermodynamics", 7th Ed., International Student Version, Wiley, 2009.

REFERENCE BOOKS

1. Jones J. B., Dugan R. E., "Engineering Thermodynamics", Indian Edition, PHI Learning Private Limited, 1996.
2. Michale Graetzel & Pierre Infelta, "The Bases of Chemical Thermodynamics", Overseas Ed., Overseas Press India Pvt. Ltd., 2006.
3. Dhar P. L., "Engineering Thermodynamics - A Generalised Approach", Elsevier, New Delhi, 2008.
4. Kenneth Wark, "Advanced Thermodynamics for Engineers", McGraw-Hill, 1994.
5. Dittman R.H., Zemansky M.W., "Heat and Thermodynamics", 7th ed., Tata McGraw-Hill, 2007.
6. Bejan A., “Advanced Engineering Thermodynamics”, John Wiley, 1988.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X		X		X	X	X
2	X	X	X	X	X	X			X		X
3		X		X	X		X	X	X	X	X

13MEE15 - COMBUSTION AND INTERNAL COMBUSTION ENGINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To understand fundamental aspects of combustion which includes thermodynamics, chemical kinetics, types of flames and elaborate the differences between ideal and actual cycles for IC Engines. Understanding and Develop a simplified model for combustion inside an engine

COURSE OUTCOMES

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

CO1 : *Gain knowledge of the thermodynamic and chemical aspects of combustion and the governing equations for the same*

CO2 : *Distinguish between different types of flames*

CO3 : *Understand the difference between air standard cycles and actual cycles, know the parameters causing the difference, and also be able to quantify the same*

CO4 : *Develop simplified models of combustion for I.C. engines*

CO5 : *Function effectively on problem solving-teams to coordinate and provide leadership for teams including multi-disciplinary teams*

CO6 : *Construct, explain and present indicator diagrams for IC Engines*

THERMODYNAMICS OF COMBUSTION, CHEMICAL KINEMATICS AND REVIEW OF TRANSPORT EQUATIONS

Properties of mixtures - Combustion stoichiometry - Heating values - Adiabatic flame temperature - Nature of combustion chemistry - Elementary reaction rate - Simplified models of combustion chemistry, Review of mass transfer - Conservation equations of mass, species, momentum and energy - Normalized form of conservation equations - Transport properties. **(12)**

PREMIXED FLAMES AND DIFFUSION FLAMES

Physical processes - Flammability limits and flame quenching - Minimum energy for sustained ignition and flame propagation - turbulent premixed flames - Structure of non-premixed laminar free jet flames - Burke-Schumann jet diffusion flame - Turbulent jet flames - Condensed fuel fires. **(9)**

DROPLET EVAPORATION AND COMBUSTION

Droplet vaporization in convective Flow - Droplet combustion - Initial heating of a droplet - Droplet diffusion **(6)**

FUEL-AIR CYCLE AND ACTUAL CYCLES

Fuel air cycle - Variation of specific heat - Dissociation and chemical equilibrium loss - Comparison of p-v diagram - thermal efficiency and fuel consumption - effect of variables - Actual cycle - Heat loss factor - Time loss factor - Exhaust blow-down. **(9)**

COMBUSTION IN I.C. ENGINES

Auto-ignition and effect of pressure on auto-ignition - Piloted ignition, Normal and abnormal combustion in SI engines - Octane rating - Gasoline direct injection - Normal and abnormal combustion in CI engines - Cetane rating - Homogeneous charge compression ignition engine - Simplified two-zone model of engine combustion. **(9)**

TOTAL : 45

TEXT BOOKS

1. McAllister S., Jyh Yuan Chen and Fernandez-Pello A.C., "Fundamentals of Combustion Processes", Springer, New York, 2013.
2. Heywood J.B., "Internal Combustion Engines Fundamentals", 2nd Edition, McGraw Hill, 1989

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REFERENCE BOOKS

1. Williams F.A., "Combustion Theory - The Fundamental Theory of Chemically Reacting Flows", 2nd Edition, The Benjamin-Cummings Publishing Company, 1985.
2. Turns S.R., "An Introduction to Combustion - Concepts and Applications", 3rd Edition, McGraw Hill, 2011.
3. El-Mahallawy F. and Habik S.E., "Fundamentals and Technology of Combustion", Elsevier Science, 2002.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X	X	X		X	X	X	X	X
2		X	X		X	X	X				
3		X	X	X	X	X		X	X	X	X
4	X		X	X	X	X	X	X		X	
5		X		X			X	X	X	X	X
6		X	X		X	X		X		X	X

13MEE16 - ENERGY CONSERVATION AND WASTE HEAT RECOVERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study the principles of different kinds of energy conservation methods and to introduce basic knowledge in waste heat recovery.

COURSE OUTCOMES

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

CO1 *: Understand the importance and need for energy conservation*

CO2 *: Gain knowledge on different instruments used for energy conservation*

CO3 *: Know the various methods adopted for energy conservation*

CO4 *: Understand the various energy conservation possibilities in thermal and electrical systems*

CO5 *: Know the importance of waste heat recovery systems.*

INTRODUCTION

Energy Scenario - Basics of Energy and its various forms. Energy Resources Availability in India. Energy consumption pattern. Energy conservation and energy efficiency - needs and advantages. Energy auditing - types, methodologies, barriers. Role of energy manager. **(7)**

INSTRUMENTS FOR ENERGY AUDITING

Instrument characteristics - sensitivity, readability, accuracy, precision and hystersis. Error and calibration. Measurement of flow, velocity, pressure, temperature, speed, Lux, power and humidity. Analysis of stack, water quality, power and fuel quality. **(9)**

ENERGY CONSERVATION IN THERMAL SYSTEMS

Energy Efficiency in Thermal Utilities - Fuels and Combustion - Boilers - Thermic Fluid Heaters - Steam Systems - Furnaces - Insulation and Refractory - FBC Boilers - Thermal Storage. **(10)**

ENERGY CONSERVATION IN ELECTRICAL SYSTEMS

Energy Efficiency in Electrical Utilities - Electric Motors - Compressed Air System - HVAC and Refrigeration System - Fans and Blowers - Pumps and Pumping System - CoolingTower. **(10)**

WASTE HEAT RECOVERY SYSTEMS

Introduction - Principles of Thermodynamics and Second Law - sources of waste heat recovery.

Waste heat recovery systems - Design Considerations - fluidized bed heat exchangers - heat pipe exchangers - plate heat exchangers - heat pumps - thermic fluid heaters - selection of waste heat recovery technologies. **(9)**

TOTAL : 45

TEXT BOOKS

1. Chakrabarti, Amlan, “Energy Engineering And Management”, PHI Learning Private Limited, (2013).
2. Sengupta Subrata, Lee SS EDS, “Waste Heat Utilization and Management”, Hemisphere, Washington, 1983

REFERENCE BOOKS

1. Rajan G.G., “Energy Efficiency Optimization”, Productivity & Quality Pub.p.ltd, 2010.
2. Meenu Agrawal, “Energy Conservation & Energy Security in India”, Kunal Books (publishers & Dist.), 2013.
3. Smith C.B., “Energy Management Principles”, Pergamon Press, NewYork, 1981.
4. “Handbook of energy audits”, 9th edition, Thumann, Albert, (2013).
5. Institute of Fuel, London, “Waste Heat Recovery”, Chapman and Hall Publishers, London, 1963.
6. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com).

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1		X	X	X	X	X	X	X	X	X	X
2		X	X	X		X	X	X	X		X
3	X	X	X	X	X	X		X	X	X	X
4			X		X	X	X	X	X	X	
5		X	X	X	X	X		X	X	X	X

13MEE17 - COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To gain an introduction to computational fluid dynamics analysis techniques for under-graduate students of mechanical engineering.

COURSE OUTCOMES

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

CO1 : *Acquire necessary skills required to model and solve simple multi-dimensional fluid flow and heat transfer problems.*

CO2 : *Gain exposure to CFD analysis using commercial software packages*

CONSERVATION LAWS OF FLUID MOTION AND HEAT TRANSFER

Introduction - Governing equations of fluid flow and heat transfer - Navier-Stokes (N-S) equations for a Newtonian fluid **(9)**

IRROTATIONAL FLOWS AND LAMINAR BOUNDARY LAYERS

Introduction - Potential functions and stream functions - Numerical treatment of steady irrotational flows in two dimensions - Simple two-dimensional laminar flows - Boundary layer over a flat plate - Blasius solution - Numerical treatment of ordinary differential equations related to Blasius solution. **(9)**

NUMERICAL HEAT TRANSFER - FINITE VOLUME METHOD

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

NUMERICAL TREATMENT OF FLUID FLOW - FINITE VOLUME METHOD

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

TURBULENT FLOWS

Introduction - Reynolds Averaged N-S equations for turbulent flows - Eddy viscosity concept - Mixing length models - Brief overview of turbulence kinetic energy and dissipation (k-e) models - Brief overview of advanced turbulent flow models. **(9)**

TOTAL : 45

TEXT BOOKS

1. Ghoshdastidar P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill, New Delhi, 1999.

2. Versteeg H.K. and Malalasekara W., "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Pearson Education, 2nd Edition, England, 2007.

REFERENCE BOOKS

1. Muralidhar K., Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
2. Niyogi P., Chakrabarthy S.K., Laha M.K., "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.
3. Chung T.J., "Computational Fluid Dynamics", Cambridge Univ. Press, New York, 2002.
4. Anil W. Date., "Introduction to Computational Fluid Dynamics", Cambridge Press, UK, 2005.
5. Titus Petrila and Damian Trif., "Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics", Springer, Boston, 2005.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X	X	X		X		X
2	X	X	X	X		X	X	X	X	X	X

13MEE18 - DESIGN OF HEAT EXCHANGERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study a range of relevant topics including the main considerations for equipment selection and design, and different methods of analysis for performance and sizing. Understanding and design specification of heat exchangers by solving practical problems using a synthesis of other mechanical engineering subjects such as thermodynamics, heat transfer, and fluid mechanics and multi-phase flows

COURSE OUTCOMES

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

CO1 : *Apply knowledge of mathematics, science, and engineering principles relevant to area of fluid/ thermal science*

CO2 : *Select and apply appropriate models for simulations of the real world and analyzes output of models/simulations to provide information for design decisions.*

CO3 : *Perform feasibility analysis and use results to choose candidate solutions and evaluate quality of solutions to select the best ones.*

CO4 : *Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, and sustainability*

CO5 : *Select the proper model to solve problems by using modern software packages, employed as standard tools in the industrial and developmental environment.*

INTRODUCTION

Classification of Heat Exchangers - Heat Transfer Mechanisms - Flow Arrangements - Applications - Selection of Heat Exchangers. **(3)**

ANALYSIS OF HEAT EXCHANGER

Introduction - Arrangement of flow paths in Heat Exchangers - Overall heat transfer co-efficient - LMTD and NTU Method for heat exchanger analysis - Heat exchanger design methodology - Variable overall heat Transfer co-efficient - Heat exchanger design calculation. **(8)**

FORCED CONVECTION CORRELATIONS FOR SINGLE-PHASE HEAT EXCHANGERS

Introduction - Hydro dynamically developed & Thermally developing laminar flow in smooth circular ducts - Effect of variable physical properties - laminar flow of liquids and gases in ducts -Turbulent forced convection - Turbulent flow in smooth straight non-circular ducts - Turbulent flow liquid and gases in ducts. **(8)**

SHELL AND TUBE HEAT EXCHANGERS

Introduction - Basic components - Basic design procedure of a heat exchanger - Preliminary estimation of unit size -Rating of the preliminary design - Shell and tube - Side heat transfer, pressure drop, heat transfer coefficient - Bell-Delaware method - Design of heat exchanger subject to fouling. **(8)**

HEAT EXCHANGER PRESSURE DROP AND PUMPING POWER

Introduction - Tube-side pressure drop - Circular cross-section tubes - Non circular cross-sectional ducts - Pressure drop in tube bundles in cross flow - Pressure drop in helical and spiral coils - Pressure drop in bends and fittings - Pressure drop for abrupt contraction, expansion, and momentum change - pumping power. **(9)**

HEAT EXCHANGERS WITH TWO-PHASE FLOW

Introduction - Characteristic of multiphase flow - Classification of two-phase flow - Evaporator - Condensers - Flow pattern maps for vertical and horizontal in-tube and shell side flows - Thome's flow pattern - Void fraction - dryness fraction. **(9)**

TOTAL : 45

TEXT BOOKS

1. Sadik Kakaç, Hongtan Liu, Anchasa Pramuanjaroenkij, “Heat Exchangers: Selection, Rating, and Thermal Design.” CRC Press, 2012.
2. Ramesh K., Shah and Dusan P. Sekulic, "Fundamental of Heat Exchangers Design”, John Wiley & Sons, Inc., 2003.

REFERENCE BOOKS

1. Arthur P. Frass, "Heat Exchanger Design", Second Edition, John Wiley & Sons, New York, 1996.
2. Taborek T., Hewitt G.F. and Afgan N., "Heat Exchangers ", Theory and Practice, McGraw Hill Book Co., 1980.
3. Walker, "Industrial Heat Exchangers - A Basic Guide”, McGraw Hill Book Co., 1980.
4. Holger Martin, "Heat Exchangers", Hemisphere Publishing Corporation, London, 1992.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X	X			X	X	
2		X	X	X	X		X	X		X	X
3	X	X	X	X	X	X	X	X	X	X	
4		X	X	X	X	X	X		X	X	X
5	X	X				X	X	X			X

13MEE19 - SOLAR ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To learn the fundamentals of solar energy , available solar energy to the local and national needs, solar engineering applications, emerging technologies, understanding the interdisciplinary approach for designing stand-alone PV systems, predicting performance with different systems, implementing design with cost analysis.To learn how to advance the current technology of the solar energy systems for making the process

To be able to serve industries or academia involved in sustainable energy engineering.

COURSE OUTCOMES

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

CO1 : *Understand the available solar energy and the current solar energy conversion and utilization processes*

CO2 : *Acquire a working knowledge of semiconductor physics, photovoltaic engineering and solar cell applications*

CO3 : *Analyze issues related to renewable solar energy*

CO4 : *Use the knowledge gained to design solar energy collectors and assess their performance during operation*

INTRODUCTION TO SOLAR ENERGY

Introduction, overview of applications - calculation of solar constant, terminology related to solar radiation, definition and calculation of solar times, definition and calculation of all solar angles and related earth angles. **(4)**

PHOTOVOLTAICS

Fundamentals of solar cells: types of solar cells, semiconducting materials, band gap theory, absorption of photons, excitons and photoemission of electrons, band engineering; Solar cell properties and design; p-n junction photodiodes, depletion region, electrostatic field across the depletion layer, electron and holes transports, device physics, charge carrier generation, recombination and other losses, I-V characteristics, output power. **(9)**

SOLAR CELL

Solar Cell Applications - Solar cell manufacturing processes: material resources, chemistry, and environmental impacts; low cost manufacturing processes - Thin film solar cells - Single crystal, polycrystalline and amorphous silicon solar cells, cadmium telluride thin-film solar cells, conversion efficiency. **(6)**

SOLAR CALCULATION AND SOLAR COLLECTORS

Calculation of extra-terrestrial irradiation on a horizontal surface on a hourly and daily basis, relationship between radiation on titled and horizontal surfaces, effect of atmosphere on solar radiation, Hottel's

estimation of clear sky radiation, types and classification of solar collectors, terminology related to non-concentrating collectors, efficiency of a solar collector. **(4)**

THERMAL MODELLING OF NON- CONCENTRATING COLLECTORS

Modeling of heat transfer processes in flat plate collector, formula for effective transmittance-absorptance product, estimation of top, bottom and overall heat loss coefficient using resistance network method, collector stagnation temperature, temperature distribution between tubes and along tubes, collector efficiency factor F, collector heat removal factor FR, collector heat exchanger modeling and combined efficiency factor FR. **(10)**

SOLAR THERMAL CONVERSION

Overview of active and passive heating - Calculation of space and water heating loads, degree-days, F-chart method for air and liquid based system. Low, medium and high temperature collectors, Heat storage, storage media, steam accumulator, other storage systems, heat exchangers and applications of stored energy. **(6)**

THERMO- ELECTRIC SYSTEMS

Thermoelectricity, Peltier effect, Seebeck effect; thermoelectric materials, Bismuth telluride, automotive thermoelectric generators, radioisotope thermoelectric generator; thermoelectric power generators, thermoelectric refrigerators and heat pumps. **(6)**

TOTAL : 45

TEXT BOOKS

1. Yogi Goswami D., Taylor and Francis, " Principles of Solar Engineering ", 2000, ISBN 10: 1-56032-714-6.
2. Garg H.P., Prakash J., "Solar Energy Fundamentals & Applications", Tata McGraw Hill, New Delhi, 1997.

REFERENCE BOOKS

1. Stuart Wenham, Martin Green, and Muriel Watt, Earthscan, "Applied Photovoltaics", 2007, ISBN 1-84407-407-3
2. Lasnier F. and Ang T. G., "Photovoltaic Engineering Handbook", IOP Publishing UK (Adam Hilger USA) 1990, ISBN 0-85274-311-4
3. Sze S. M., New York, NY: Wiley, "Semiconductor Devices, Physics, and Technology", Second Edition, 2001, ISBN: 0471874248
4. Martin A. Green, "Solar Cells: Operating Principles, Technology and system Applications" Published by the University of New South Wales, 1998, ISBN 0 85823 580 3
5. Sukhatme S. P., "Solar Energy", Tata McGraw Hill, New Delhi, 1999.
6. Duffie J. A. and Beekman W.A., " Solar Engineering of Thermal Processes", John Wiley and Sons, New York, 2005.

7. Tiwari G.N.,Suneja S., "Solar Thermal Engineering System", Narosa Publishing House, New Delhi, 1997.
8. Bhattachariya T., "Terrestial solar Photovoltaic", Narosa Publishers, New Delhi, 2008.
9. Rauschenbach H.S., "Solar Cell Array Design Hand Book", Van Nostrand Reinfold Company, New York, 1980.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X	X		X	X	X	
2		X	X	X		X	X		X		X
3	X	X	X	X	X	X		X		X	
4	X	X		X	X	X	X	X		X	X

13MEE20 - MANAGEMENT OF INVENTORY CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study the concepts, principles, problems, and procedures in inventory management on the formulation of models for inventory management, and to gain a deeper understanding on the crucial role of inventory and materials management in the efficiency, competitiveness, and profitability of a business organization.

COURSE OUTCOMES

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

CO1 : *Interact dynamically among different elements of production and distribution system.*

CO2 : *Develop aggregate production plans and detailed schedules through simple policies using both deterministic and stochastic models.*

CO3 : *Optimize the use of resources which include: people, plant, equipment, tools, inventory, premises and information systems.*

CO4 : *Understand how inventory management is applied to the entire spectrum of a supply chain*

INVENTORY MANAGEMENT

Inventory - Need of Inventory - Costs associated with Inventory - Types of Inventory - Basic EOQ Model - EOQ with discounts - Determining Safety Stock Levels - Objectives and Importance of the inventory management function in reference to Profitability, Strategy, customer satisfaction and Competitive Advantage. **(10)**

INVENTORY CONTROL TECHNIQUES

Inventory classification and its use in controlling inventory, Setup time and inventory control, safety stock determination considering service level. Strategies to increase Inventory Turns, Reduce throughput time, Reduce work in progress, reduce inventory level in service and manufacturing organizations. **(7)**

INVENTORY MODELS

Inventory Models: deterministic and stochastic models, Determination of EOQ under various conditions of Demand and Lead-Time Analysis.

Inventory models - Fixed Order Versus Fixed Interval systems - Developing Special Quantity Discount Models - Inventory Model for Manufactured Items - Economic Lot Size when Stock Replenishment is instantaneous. Production Lot Size Model - Planned Shortage Model - Review Systems - Single-period Inventory Model. **(10)**

STORES MANAGEMENT

Store Objectives, Receiving Procedures and Control, Identification of Materials, Stores system and Procedures Classification and Codification, Standardisation, Storing of Materials, Stores Location and Layout, Preservation, Issue Control, Stores Documentation. Stock Valuation Methods and Stock Verification. **(9)**

MATERIAL HANDLING

Choice of Equipments, Evaluation of Material Handling, Cost Reduction Methods.

Traffic: Transportation cost, Shipping terms, Mode of transportation, Loss and damage of Freight Demurrage, Transportation Strategy and Cost Reduction.

Waste management: Sources of Surplus, Disposal of Surplus, Buying Surplus Material. **(9)**

TOTAL : 45

TEXT BOOKS

1. Zipkin P.H., "Foundations of Inventory Management", Irwin/McGraw-Hill, 2004.
2. Donald waters, "Inventory Control and Management", John Wiley & Sons Ltd., 2003.
3. Sven Axsater, "Inventory Control", Springer Science & Business Media, 2006.

REFERENCE BOOKS

1. Porteus E. L., "Foundations of Stochastic Inventory Theory", Stanford Univ. Press, 2002.
2. Chandrabose D., "Inventory Management", Prentice hall of India Pvt. Ltd., 2006.
3. Mercado E.D.C., " Hands on Inventory Management", Auerbach Publications, 2008.
4. Max Muller, "Essentials of Inventory Management", Amacon, 2003.
5. John W. Toomy, "Inventory Management", Kluwer Academic Publishers, 2000.
6. Narayan P. & Jaya Subramanian, "Inventory Management-Principles and Practices", Excel Books, 2008.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X		X		X	X			X	
2	X	X	X	X	X		X	X	X		X
3		X	X		X	X	X	X		X	X
4	X	X	X	X	X		X	X	X	X	X

13MEE21 - WORK SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study the tools to measure the work content in and design, jobs, tasks, workstations, work environment, and work systems. The course also describes that motion and time study is vital for service industries as well as manufacturing.

COURSE OUTCOMES

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

CO1 : *Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.*

CO2 : *Develop, implement and improve systems that include people, materials, information, equipment, and energy.*

CO3 : *Develop equipment's and devices by considering ergonomic factors.*

PRODUCTIVITY

Definition - Reasons for low productivity - Methods to improve productivity - Concept of work study and productivity - Possibility guides - Methods study - Scope of motion and time study - Productivity measurement - Productivity models - Kurosawa structural approach, Lawlor's approach, Gold's approach, Quick Productivity Appraisal approach (QPA), Inter-firm comparison (IFC) - Work methods design. **(9)**

METHOD STUDY

Total work content, Developing methods - Process analysis - Process charts, Process flow charts - Multiple activity charts - Man and machine chart - Two handed process chart - String diagram - Travel chart - Cycle graph - Chrono-cycle graph - Therbligs - Micro motion and memo motion study - Simo chart - Principles of motion economy - Development and installation of new method. **(9)**

WORK MEASUREMENT AND ITS METHODS

Work sampling - Various techniques of work - Measurement of work - Stopwatch time study & its procedure - Job selection - Equipment and forms used for time study - Rating, methods of rating, allowances and their types - Determining time standards from standard data and formulae - Predetermined motion time standards - Work factor system - Methods time measurement, Analytical Estimation. **(9)**

APPLIED WORK MEASUREMENT

Measuring work by physiological methods - Heart rate measurement - Measuring oxygen consumption- Establishing time standards by physiology methods - Methods time measurement (MTM) and its application to production and maintenance - Organization and methods (O&M) - Wage incentive plans. **(9)**

ERGONOMICS

Motion economy- Ergonomics practices - Human factors Engineering - Human performance in physical work under heat, cold, illumination, vibration, noise, pollution, static and dynamic conditions, human body

measurement - Layout of equipment - Seat design - Design of controls and compatibility - Environmental control - Vision and design of displays. Design of work space, chair table. **(9)**

TOTAL : 45

TEXT BOOKS

1. Groover M. P., "Work Systems and the Methods, Measurement, and Management of Work", New Jersey: Pearson Education Inc, 2007.
2. Niebel B. and Freivalds A.,"Methods, Standards and Work Design", 12th Edition, Boston: McGraw-Hill, 2013.

REFERENCE BOOKS

1. Barnes R.M., "Motion and Time Study", John Wiley and sons, 2002.
2. Bridger R.S., "Introduction to Ergonomics", McGraw Hill, 1995.
3. “Introduction to work study” ILO, 3rd edition, Oxford & IBH publishing, 2001.
4. Konz S. and Johnson S., "Work Design: Industrial Ergonomics", 5th Edition, Holcomb Hathaway, 2000.
5. Marvin E., Mundel. And David L. "Motion & Time Study: Improving Productivity", Pearson Education, 2000.
6. Prem Vrat, "Productivity Management - A systems approach", Narosa publishing, 1998.
7. Sanders Mark S. and McCormick Ernert J., "Human Factors in Engineering and Design", McGraw-Hill Inc., 1993.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X		X	X	X	X	X	X	X
2	X	X	X	X	X	X	X	X	X	X	X
3	X	X	X		X	X	X	X	X	X	X

13MEE22 - SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on supply chain management aims to provide a basic and a deeper understanding about supply chain management and the role of supply chain in an industry for meeting end user needs. The students are expected to acquire a detailed knowledge on product and the process management involved, and gain an insight in supply chain management in industrial perspective.

COURSE OUTCOMES

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

CO1 : *Have a deeper understanding on the manufacturing and management process involved in a product.*

CO2 : *Have a complete end-end understanding in developing products and the possible engineering and technological applications.*

CO3 : *Know the applications that could be incorporated from design to marketing the end-product.*

CO4 : *Build and manage a competitive supply chain using strategies, models, techniques and information technology.*

INTRODUCTION

Supply Chain, Objectives & Stages, power of SCM - Process views of a supply chain - Strategic planning, Achieving a strategic fit in a supply chain and factors affecting the strategic fit - Value chain, supply chain flow lines - Understanding a product, Product life cycle, Fishers classification of products - Effective and efficient supply chain - case studies on products. **(9)**

SUPPLY CHAIN PROCESS

Forecasting in supply chain, forecast error distribution order quantity and reorder point characteristics & components of forecasting - time series methods of forecasting, Demand Management in MPC - MTS - ATO - MTO.

Inventory, role of cycle inventory, economies of scale to exploit fixed costs, Economies of scale to exploit quantity discounts, Short term discounting and trade promotions Managing multi-echelon cycle inventory - Bullwhip effect - Product substitution, Postponement. **(9)**

PRODUCT PROCUREMENT & TRASPORTATION

Procurement process, EOQ - Sourcing in a supply chain - deciding factors for in-house or outsourcing - Supplier selection - auctions and negotiations, risk management in sourcing Freight management, Transportation networks, Milk run, Cross Docking, tailored transportation, 3PL - 4 PL, Risk management in transportation. **(9)**

DESIGNING A SUPPLY CHAIN

Supply chain drivers - Supply chain performance measures - SCOR Model - Network design in a supply chain, factors influencing design, Framework for network design network, models for facility location and

capacity allocation - Uncertainty in network design - Discounted cash flow analysis, Decision trees in evaluating network design - Distribution, factors influencing distribution, design options for a distribution network. **(9)**

IT IN SUPPLY CHAIN

Lean Supply Chain, agile supply chain, Dynamic supply chain design, Impact of technology on SCM, Key trends in SCM, IT in supply chain coordination, IT in supply chain design - MRP, ERP, CRM, ISCM - Performance metrics .Discussion on supply chain adopted by primary industrial sectors and case studies. **(9)**

TOTAL : 45

TEXT BOOK

1. Ayers J., “Hand Book of Supply Chain Management”, The St. Lencie Press/ APICS Series on Resource Management, 2000.

REFERENCE BOOKS

1. Burt N.D., Dobler. W.D. and Starling L.S., World Class Supply Chain Management, The Key to Supply Chain Management”, Tata McGraw Hill Publishing Company Limited, 2005.
2. Chopra S., Meindl P. and Kalra, D.V., “Supply Chain Management, Strategy, Planning and Operation”, Pearson Education, Inc., 2008
3. Fredendall D.L. and Hill E., “Basics of Supply Chain Management”, The St. Lucie Press / APICS Series on Resource Management, 2001.
4. Monczka R., Trent R. and Handfield R., “Purchasing and Supply Chain Management”, 3rd edition, Thompson Learning Inc., 2007.
5. Sople V.V, “Supply Chain Management”, Pearson Education, 2012
6. Vollmann T.E., Berry L.W., Whybark D.C. and Jacobs, R.F., “Manufacturing Planning and Control for Supply Chain Management”, Tata McGraw Hill Publishing Company Limited, 2008.
7. Wild T., “Best Practice in Inventory Management”, Butterworth - Heinmann, Elsevier Science Ltd., 2002.

ADDITIONAL READING

1. European Journal of Innovation Management
2. Logistics Information Management an International Journal
3. Supply Chain Management an International Journal
4. Sethi P.S., Yan H. and Zhang H., “Inventory and Supply Chain Management with Forecast Updates”, Springer International Series, 2006.
5. Mohantry P.R. and Deshmukh G.S., “Supply Chain Management, Theories and Practices”, Published by Biztantra Innovations in Management, 2005.
6. Kulkarani S and Sharma A., “Supply Chain Management”, Tata McGraw Hill Publishing Company Limited, 2008.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X		X		X	X		X
2	X	X	X		X	X	X	X		X	
3		X	X	X	X	X		X	X		X
4	X	X	X	X		X	X	X		X	

13MEE23 - ADVANCED OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on advanced operation research, provides an detailed analysis on class of problems, which requires special methods to determine the optimal solution. Special techniques for Optimizing linear programming problems, integer programming, goal programming dynamic programming and networking problems are discussed

COURSE OUTCOMES

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

CO1 *: Understand techniques and develop skills on modern tools used in optimization.*

CO2 *: Apply current knowledge and adapt to emerging applications in engineering and technology.*

CO3 *: Conduct experiments and analyze and interpret experimental results to improve processes.*

LINEAR PROGRAMMING

Problem formulation, graphical solution, simplex method, big M method, two phase method, dual simplex method, duality theory, sensitivity analysis. **(12)**

INTEGER PROGRAMMING

The branch and bound technique and Gomory's cutting plane method. **(10)**

NETWORK ANALYSIS

Shortest route problem, minimal spanning tree problem and maximum flow problem. **(11)**

GOAL PROGRAMMING AND DETERMINISTIC DYNAMIC PROGRAMMING

Goal programming formulation and simplex method for solving goal programming. Cargo loading model, reliability improvement model and single machine scheduling model. **(12)**

TOTAL: 45

TEXT BOOKS

1. Hamdy A. Taha, "Operations research", Pearson, 2010.
2. Rao S.S., "Optimisation Theory and Applications", Wiley Eastern Ltd., New Delhi, 2009.

REFERENCE BOOKS

1. Frederick S. Hillier, Gerald J. Lieberman, "Introduction to operations research", Mc Graw Hill, 7th edition, 2001.
2. Ravindran, Phillips, Solberg, "Operations research principles and practice", Wiley & Sons, 1987.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X	X	X		X
2		X	X	X	X	X	X		X	X	
3	X	X	X	X	X		X	X	X	X	X

13MEE24 - MECHANICAL VIBRATIONS AND CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To gain fundamental knowledge on vibration analysis for both single and multi-degree-of-freedom systems, and also the use of solution methods in the analysis of complex problems.

COURSE OUTCOMES

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

CO1 *: Analyse a given physical problem and develop a simple mathematical model.*

CO2 *: Compute natural frequencies and critical speeds of a given system.*

CO3 *: Simplify non-linear vibratory systems in order to analyse as linear problems.*

CO4 *: Determine overall response of a vibratory system based on initial conditions.*

CO5 *: Apply vibration control mechanisms in real-world problems.*

FUNDAMENTALS OF VIBRATION

Introduction - Sources of vibration - Mathematical models - Displacement, velocity and acceleration - Single degree of freedom systems - Vibration isolation.Vibrometers and accelerometers - Response to arbitrary and non- harmonic Excitations - Transient Vibration - Impulse loads. **(9)**

TWO DEGREE OF FREEDOM SYSTEM

Introduction - Undamped and damped free vibrations - Forced Vibration with Harmonic Excitation System - Coordinate Couplings and Principal Coordinates. **(7)**

MULTI-DEGREES OF FREEDOM SYSTEM AND CONTINUOUS SYSTEM

Multi Degrees of freedom system - Influence coefficients - Natural frequencies and mode shapes - Modal analysis of undamped, damped and forced vibrations - Matrix inversion method - Continuous System: Vibration of String, longitudinal vibration of bars and torsional vibration of circular shafts. **(10)**

MULTI-DEGREES OF FREEDOM SYSTEM AND NUMERICAL METHODS

Approximate Methods - Rayleigh's method, Dunkerley method, Stodola's method, Rayleigh-Ritz method, Method of matrix iterations and Holzer Methods - Natural frequencies for multi-rotor system - geared systems. **(9)**

VIBRATION CONTROL

Specification of Vibration Limits - Vibration severity standards - Vibration as condition Monitoring tool - Vibration Isolation methods - Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber - Damped Vibration absorbers-Static and Dynamic Balancing - Balancing machines - Field balancing - Vibration Control by Design Modification - Active Vibration Control. **(10)**

TOTAL : 45

TEXT BOOKS

1. Rao S.S., "Mechanical Vibrations", 5th Edition, Prentice Hall, 2010.
2. Grover G.K., "Mechanical Vibrations", New Chand and Brothers, Roorkey, 1996.

REFERENCE BOOKS

1. Thomson W., "Theory of Vibration with Applications", CRC Press, 1996.
2. Ashok Kumar Mallik, "Principles of Vibration control", Affiliated East-West Press (P) Ltd., New Delhi Press, 1990.
3. Lewis H. Bell, "Industrial Noise Control Fundamentals and Applications", Marcel Dekkev Incl., New York, 1982.
4. Seto, "Mechanical Vibrations ", Schaum's Outline Series, McGraw Hill Book Company, New Delhi, 1990.
5. Ambekar A.G., "Mechanical Vibrations and Noise Engineering", PHI Learning Pvt. Ltd., 2006.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X	X	X	X		X	X
2	X	X	X	X	X	X		X			X
3	X	X	X		X	X	X		X	X	X
4	X	X	X	X	X		X	X			X
5	X	X	X		X	X		X	X		X

13MEE25 - COMPOSITE MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study the fundamentals of composite materials, properties of fibers and matrix materials, the manufacturing processes used in commercial composites and the concept of tailored design philosophy. To gain knowledge on applications and selection of different composites in consideration of the properties and characteristics. To understand simple stresses, strains and deformation and their relations in composite materials

COURSE OUTCOMES

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

CO1 *: Select the most appropriate manufacturing process for fabricating composite components*

CO2 *: Design composite materials for specific applications*

CO3 *: Describe the properties of different types of composite materials*

CO4 *: Demonstrate the understanding of different materials (fibers, resins) used in composites*

CO5 *: Appreciate current and emerging applications of composites*

INTRODUCTION

Definition of composite materials- General characteristics - need for composites - classification based on Matrix - Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), classification based on reinforcement - Particulate composites, Fiber reinforced composites, Laminar composites - types of fibers - Smart materials - types and characteristics - Material selection process - Applications related to Aerospace, Automobile, medical, Bridge and other Civil Engineering Structures. **(8)**

POLYMER MATRIX COMPOSITES

Functions and properties of matrix resins - Thermosetting and thermoplastic resins - Role and selection of reinforcement materials, properties of fibers, types of fibers. PMC processes - Hand layup process, Bag molding process, Compression molding, reaction injection molding, Resin transfer molding, Pultrusion, Filament winding, Injection molding process. Fiber reinforced plastics, Glass fiber reinforced plastics. **(8)**

METAL MATRIX COMPOSITES

Types of Metal matrix composites - Characteristics - Advantages and Limitations of MMC- Effect of reinforcement - volume fraction - rule of mixtures - Processing of MMC - vacuum hot pressing, Powder metallurgy process, liquid metal infiltration, compocasting, squeeze casting. **(7)**

CERAMIC MATRIX COMPOSITES

Ceramic matrix materials - properties - advantages - limitations - Processing - Hot pressing, liquid infiltration technique, Lanxide process, insitu chemical reaction techniques - Interface in CMCs - Applications. **(7)**

GEOMETRICAL ASPECTS AND ANALYSIS

Characteristics of fiber filled lamina - Volume fraction and weight fraction - Woven roving, in-plane random fibers - Fiber length and fiber orientation distribution - Voids - Fiber orientation during flow. Failure theories - Laminate design consideration - Stress Analysis of Laminated composites Beams, Plates and Shells - Vibration and Stability Analysis - Reliability of Composites - Finite Element Method of Analysis - Analysis of Sandwich Structures. **(8)**

FATIGUE AND CREEP IN COMPOSITE MATERIALS

Fatigue - S-N curves - Fatigue behaviors of CMCs - Fatigue of particle and whisker reinforced composites - Hybrid composites - Thermal fatigue - Creep. **(7)**

TOTAL : 45

TEXT BOOKS

1. Mallick P.K., "Fiber-Reinforced Composites: Materials, Manufacturing and Design", CRC Press, 2013.
2. Agarwal B.D., and Broutman L.J. and Chandrashekhara, "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 2006.

REFERENCE BOOKS

1. Krishnan K. Chawla, "Composite Materials Science and Engineering", Springer, 2012.
2. Mathews F.L. and Rawlings R.D., "Composite Materials: Engineering and Science", CRC Press and Woodhead Publishing Limited, 2002.
3. Hull D., "An Introduction to Composite Materials", Cambridge University Press, 2nd Edition, 2003.
4. “Handbook of Composites” - American Society of Metals, 1990.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X		X	X	X		X	X
2	X	X	X	X	X	X	X	X	X	X	X
3	X	X	X	X	X		X		X	X	X
4	X		X	X			X	X		X	X
5		X	X		X	X	X		X	X	X

13MEE26 - ADVANCED BIOMATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To gain knowledge on use of synthetics in different biomedical applications and To understand the mechanical behavior of a various of tissues

COURSE OUTCOMES

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

CO1 : *Understand the relationship between the structure of a material and its behavior as a basis for materials selection in biomedical applications.*

CO2 : *Know about structure, function and mechanical behaviour of natural tissues.*

CO3 : *Describe appropriate techniques for determination of the mechanical behavior of biomedical materials*

FUNDAMENTALS OF BIOMATERIALS AND BIOCOMPATIBILITY

Overview - Introduction - definitions and their Implications - Biomaterial - Biocompatibility - Host response - Cell-Material Interactions - Experimental Evaluation of Biocompatibility - In vitro Tests - In vivo Tests - Steps for characterizations of biomaterials - Broad overview of Fundamentals. **(7)**

MATERIALS FOR ORTHOPEDIC APPLICATIONS

Overview- Introduction - Structure and Properties of Hard Tissues - Processing and Properties of Bioceramics and Bioceramic Composites - Calcium Phosphate Based Biomaterials - Hydroxyapatite-Ceramic Composites - Glass-Ceramics Based Biomaterials - Mica Based Glass Ceramics - Other Bioglass-Ceramics - Bioinert Ceramics - Polymeric Biomaterials - Polymer-Polymer Composites - Polymer-Ceramic Composites - HDPE-Hap-Al2O3 Hybrid Composites - Metals and Alloys in Biomedical Applications - Issues Limiting Performance of Metallic Biomaterials - Wear of Implants - Corrosion of Metallic Implants - Ti-Based Alloys - Co-Cr-Mo, Ni or Ta-Based Alloys - Other Non-Ferrous Metals and Their Alloys - Coating on Metals. **(12)**

TITANIUM DENTAL IMPLANT SYSTEMS

Overview - Introduction - Requirements for Successful Implant Systems - Biological Compatibility - Mechanical Compatibility - Morphological Compatibility - Osseo integration and Bone/Implant Interface - Integrated Implant System. **(7)**

PROCESSING OF BIOMATERIALS

Overview - Introduction - Processing of Biomaterials - Metals - Ceramics - Polymers - Biocomposites - Sterilization - Processing for Scale - Micro/Nano Surface Modification - Micro/Nano Fabrication-Tensile testing, microscopy (SEM,AFM)evaluation. **(7)**

BIOMATERIAL APPLICATIONS

Overview - Introduction - Applications in Medicine, Biology, and Artificial Organs - Cardiovascular Medical Devices - Extracorporeal Artificial Organs - Orthopedic Implants - Dental Implantation - Bioadhesive -

Opthalmologic Applications - Cochlear Prosthesis - Drug Delivery - Tissue Engineering - 2-D and 3-D tissue engineering applications and their mechanical characterization -Array Technologies and Specific Medical Applications. **(12)**

TOTAL : 45

REFERENCE BOOKS

1. Joon. B. Park and Joseph D. Bronzino, “Bio Materials - Principles and Applications”, CRC press, 2010.
2. Park J. B. and Lakes R.S., “Bio Materials - An Introduction”, Plenum Press, New York, 2009.
3. Bikramjit Basu, Ashok Kumar and Katti S., “Advanced Biomaterials - Fundamentals, Processing and Applications”, John Wiley & Sons, INC, Publication, 2009.
4. Dee KC, Puleo and DA, Bizios R, “An Introduction to Tissue-Biomaterial Interactions”, John Wiley & Sons, 2007.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X	X	X		X	X	X
2	X	X	X		X			X	X		X
3	X	X	X	X	X	X	X		X		X

13MEE27 - ADVANCED STRENGTH OF MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To extend the knowledge gained in the course strength of materials to solve boundary value problems using continuum mechanics.

COURSE OUTCOMES

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

CO1 *: Become familiar with the basics of continuum mechanics.*

CO2 *: Apply simplifying assumptions to make a complex structure analyzable.*

CO3 *: Understand the response of solids to applied forces in three dimensions.*

INTRODUCTION AND MATHEMATICAL PRELIMINARIES

Review of basic concepts and equations in mechanics, Classification of materials, Outline of general techniques to solve boundary value problems. Indicial notation, Introduction to tensors, Representation of tensors, Gradient and related operators, Divergence theorem. **(7)**

KINEMATICS

Motion field, Displacement field, Deformation gradient, Transformation of curves, surfaces and volumes, strain measures, linearized strain measures, Principal strains and principal directions, Transformation of strain components with changes in coordinate basis, Compatibility conditions for linearized strain. **(7)**

TRACTION AND STRESSES

Concept of traction, Cauchy's stress theorem, Postulate of Cauchy stress tensor, Traction on arbitrary planes, Extreme normal and shear traction, Octahedral shear stress, Other stress measures - Engineering stress. **(7)**

EQUILIBRIUM AND CONSTITUTIVE EQUATIONS

Derive equilibrium equations in Cartesian and cylindrical polar coordinates. Restrictions on constitutive relations, General relationship between Cauchy stress and Cauchy Green strain for isotropic materials, General Hooke's law and its reduction for isotropic and orthotropic materials. **(8)**

BOUNDARY VALUE PROBLEMS

Displacement method, Stress method, Airy's stress functions for plane stress and strain problems, Uniaxial Tension, Thick-walled annular cylinder subjected to uniform boundary pressure, Infinite medium with a stress-free hole under far field tension loading. **(8)**

BENDING OF PRISMATIC STRAIGHT BEAMS

Pure bending, bending due to uniform transverse loading and bending due to transverse sinusoidal loadIng of a beam, Asymmetrical bending of straight beams, Shear center, Shear stresses in thin walled open sections. **(8)**

TOTAL : 45

REFERENCE BOOKS

1. Srinath L.S., "Advanced Mechanics of Solids", Tata McGraw Hill, 2007.
2. Ragab A.R. and Bayoumi S.E., "Engineering Solid Mechanics: Fundamentals and Applications", CRC Press, 1999.
3. Sadd M.H., "Elasticity: Theory, Applications and Numerics", Academic Press, 2006.
4. Atkin R.J. and Fox N., "An Introduction to The Theory of Elasticity", Longman, New York, 1980.
5. Holzapfel G.A., "Nonlinear Solid Mechanics", Wiley, New York, 2001.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X		X	X		X			X		X
2	X	X	X	X	X		X	X		X	X
3	X	X	X	X	X	X	X				X

13MEE28 - PROCESS DYNAMICS AND ADAPTIVE CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study various advanced theories in process control, different types of controllers, control strategies in real time systems and z- transforms for digital signal processing. To gain knowledge to model, conduct dynamic study and control real process in chemical industry and also about distributed control systems and digital control.

COURSE OUTCOMES

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

CO1 : *Know the application of different computer process control systems.*

CO2 : *Be conversant with application of different digital controllers and their designs to suitable processes with or without time delay systems.*

CO3 : *Understand the advanced control concepts, system identification and process modeling.*

REVIEW OF SYSTEMS

Basic equation - Integral and instantaneous balances - Material and Energy balances - General form of dynamic models. Linearization of nonlinear systems in state space form - Response of lead-lag modules - Self-regulating system - transfer function analysis of higher order systems. **(6)**

SECOND ORDER SYSTEMS

A second order system - Pole-Zero cancellation - Systems in series - Blocks in parallel - linear boundary value problems - Parameter estimation of discrete linear systems. Phase plane analysis - generalization of phase plane behavior - nonlinear systems - Introduction to nonlinear dynamics - bifurcation behavior of systems **(9)**

APPLICATIONS

Stirred tank heaters, Absorption-isothermal, continuous stirred tank chemical reactors, Biochemical reactors - adiabatic continuous stirred tank reactor - ideal binary distillation columns. **(6)**

LINEAR DYNAMIC SYSTEM IDENTIFICATION

System Identification: Introduction, dynamic systems, models, system identification procedure. Simulation and Prediction. Non-parametric time and frequency domain methods. Linear dynamic system Identification: Overview, excitation signals, general model structure, time series models, models with output feedback, models without output feedback. Convergence and consistency. **(9)**

ADAPTIVE CONTROL

Parameter estimation methods, minimizing prediction errors, linear regressions and Least squares method, Instrumental - variable method, prediction error method. Recursive algorithms.Closed-loop Identification. Adaptive Control: Close loop and open loop adaptive control. Self-tuning controller. Auto tuning for PID controllers: Relay feedback, pattern recognition, and correlation technique. **(9)**

ADAPTIVE ADVANCED CONTROL

Adaptive Smith predictor control: Auto-tuning and self-tuning Smith predictor. Adaptive advanced control: Pole placement control, minimum variance control, generalized predictive control. **(6)**

TOTAL : 45

TEXT BOOKS

1. Bequette B.W., "Process Dynamics - Modeling, Analysis and Simulation", PHIPE, New Delhi, 1998.
2. Stephanopoulos G., "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall of India (P) Ltd., New Delhi, 2009.

REFERENCE BOOKS

1. Shinsky F.G., "Process Control Systems: Application, Design and Adjustment", 3rd Edition, McGraw Hill Book Co., New York, 1988.
2. Nelles O., "Nonlinear System Identification", Springer Verlag, Berlin, 2011.
3. Ljung L., “System Identification: Theory for The User”, Prentice Hall, Englewood Cliffs, 1999.
4. Astrom K., “Adaptive Control”, Second Edition, Pearson Education Asia Pvt. Ltd., 2002.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X		X		X
2	X	X	X	X	X	X	X	X	X	X	X
3	X	X	X	X	X	X	X		X	X	X

13MEE29 - EXPERIMENTAL STRESS ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To gain the basic knowledge of experimental stress analysis that includes exhaustive treatment of most versatile techniques like photoelasticity and strain gauges. To study the fundamental aspects of different experimental techniques such as Moiré, Brittle coating, and Holography.

COURSE OUTCOMES

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

CO1 : *Appreciate the fundamentals of theory of elasticity to conduct experiments.*

CO2 : *Understand the principles and techniques of photo elastic measurements.*

CO3 : *Apply the principles and techniques of strain gauge measurement.*

CO4 : *Use the principles and techniques of Moiré analysis, Brittle coating analysis, and Holographic interferometry.*

INTRODUCTION

Introduction: Principal stresses and strains - Three dimensional stresses - strain relationships -Plane stress and Plane strain conditions. Strain gauges - Types - Mechanical, Optical and Electrical strain gauges - Electrical resistance strain gauges - Gauge factor - Strain gauge circuitry - Temperature compensation - Bridge balancing and calibration of D.C and A.C bridges. **(12)**

APPLICATION OF STRAIN GAUGES

Application of strain gauges: Transverse sensitivity - Selection and mounting of strain gauges - Strain gauge rosettes - Analysis of strain gauge data and stress calculations -Recording equipments for static and dynamic strains - Strain gauge transducers - Introduction to semiconductor strain gauges - Residual stresses - Beneficial and harmful effects - Principle of residual stress measurement methods. **(11)**

PHOTO ELASTICITY

Photo elasticity: Theory of photo elasticity - Stress-optic law - Plain Polaris cope and Circular Polaris cope - Isoclinic and Isochromatic fringes - Partial fringe value and compensation techniques - Tardy's Method. Photo elastic model materials and their desired properties - use of photo elastic coatings. Applications of Photoelasicity for two dimensional models - Separation of Principal stresses - Scaling models to prototype. Introduction to 3D Photo elasticity. **(11)**

OTHER STRESS ANALYSIS TECHNIQUE

Other Stress analysis techniques: Moiré fringe method and Brittle coating technique for stress analysis. Introduction to Holography in stress analysis. Non-destructive testing - Types - Dye penetrate methods, Radiography, X-ray and Gamma ray -X-ray fluoroscopy - Penetrameter - Magnetic particle method. Introduction to lasers in NDT - Ultrasonic flaw detection. **(11)**

TOTAL : 45

TEXT BOOKS

1. Dalley and Riley, "Experimental Stress Analysis", McGraw Hill, 1991.
2. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1993.

REFERENCE BOOKS

1. Dove and Adams, "Experimental Stress Analysis and Motion Measurement", Prentice Hall, 1965.
2. Hetenyi, "Handbook of Experimental Stress Analysis", John Wiley, 1966.
3. Perry and Lissener, "Strain Gauge Primer", McGraw Hill, 1962.
4. McGonnagle W.J., "Non-Destructive Testing", McGraw Hill, 1961.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X			X	X		X
2	X	X	X	X	X	X		X	X	X	X
3	X	X	X	X	X		X		X		X
4	X	X	X	X		X	X	X	X	X	X

13MEE30 - SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To study the challenges of implementing sustainability in a variety of contexts from the perspectives of climate change, energy use, natural resource use, and ecosystems/land use.

COURSE OUTCOMES

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

CO1 : *Appreciate the scale of the global challenges in energy production and control of climate change, and the importance of identifying, quantifying and pursuing the developments which will have significant impact.*

CO2 : *Understand a range of opportunities to reduce energy consumption and to implement lower carbon technologies, in different sectors of engineering, in both developed and developing economies.*

CO3 : *Perform a technical investigation into an aspect of Sustainable Engineering of their own choice.*

INTRODUCTION

The concept of environmental sustainability, Examples of non-sustainability and sustainability. The special role of engineers in helping society transition to a more sustainable state. Definitions, principles, and indicators of sustainability. Overall criteria for development that is sustainable. Indicator studies. **(12)**

THE RISE OF SUSTAINABILITY

Historical perspectives in Europe and in the US. Modern debates: Sustainability extremists, Environmentalists, Traditional Engineers, and Anti-sustainability extremists. "Tragedy of the commons" and the ethics of sustainability. Models for achieving sustainable industries. **(12)**

POPULATION GROWTH ON A FINITE EARTH

Population models, Food production, Water resources, Urban sprawl. **(9)**

NON-RENEWABLE RESOURCES

Fossil fuels - Formation of fossil fuels: oil, natural gas, coal. Modeling of oil reserves. Metals - Material flow analysis, Environmental effects of mining and processing metals, Time-to-depletion. **(12)**

TOTAL : 45

TEXT BOOK

1. Robinson J., “Squaring the circle? Some thoughts on the idea of sustainable development”, Ecological Economics 48(4): 369-384, 2004.

REFERENCE BOOKS

1. Hjorth P. and Bagheri A., “Navigating Towards Sustainable Development: A System Dynamics Approach”, Futures 38: 74-92, 2006.
2. Douthwaite B., “Enabling Innovation. A Practical Guide to Understanding and Fostering Innovation”, London, Zed Books, 2002.
3. http://www.sustainability.com/developing-value/definitions.asp

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1			X	X		X	X	X		X	
2	X	X	X		X	X		X	X		X
3	X	X	X	X	X	X	X	X			X

13MEE31 - FATIGUE, CREEP AND FRACTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To gain in-depth knowledge related to material deformation mechanisms, fracture mechanics, stress-based fatigue and creep failures

COURSE OUTCOMES

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

CO1 : *Acquire fundamental understanding of fracture mechanics, creep, and fatigue*

CO2 : *Understand the basics of corrosion and environmentally-assisted cracking*

CO3 : *Use the techniques used to perform failure analysis*

CO4 : *Become familiar with macro-fractographic and micro-fractographic analysis of failures*

FUNDAMENTALS OF FATIGUE

Types of fatigue, Fatigue test, endurance limit, S-N diagram; Factors influencing fatigue strength; Influence of stress concentration on fatigue test; Fretting corrosion; Effect of environment - corrosion fatigue; Increased fatigue life due to surface protection. **(5)**

FATIGUE ANALYSIS

Low cycle fatigue, Coffin-Manson law, Cyclic work hardening and softening. Micro structural models of crack initiation. Stage I, II and III crack growth. The empirical laws of fatigue failure. High cycle-low strain fatigue, Basquin's law, Goodman, Soderberg and Gerber mean stress corrections, Miner's law of damage summation. **(7)**

CREEP

Mechanics of creep, inter-granular, trans-granular creep, Creep test, Creep strain rate-time curves, Deformation mechanism map; High temperature properties of materials; Long time creep-stress-time relations; Creep contribution to the fracture mechanism; DVM, DVL German-standard, Hatifield time yield test. **(10)**

FUNDAMENTALS OF FRACTURE

Fracture behaviour of metals and alloys. The ductile/brittle transition temperatures for notched and un-notched components, Ductile rupture as a failure mechanism, Fracture at elevated temperature. **(5)**

STRESS INTENSITY FACTORS AND FRACTURE MECHANICS

Early concepts of stress concentrators and flaws, Ingles solution to stress round elliptical hole-implications of results. Stress intensity factor for a crack. Westergaard's solution for crack tip stresses. Stresses and displacement in Cartesian and polar coordinates, Linear Elastic Fracture Mechanics. Typical values of fracture toughness, Different modes of crack opening. Superposition of crack tip stress fields, Direction of crack growth under mixed mode loadings. Crack tip plasticity. **(10)**

ELASTIC/PLASTIC FRACTURE MECHANICS

Elastic/plastic fracture mechanics: The crack opening displacement and J-integral approaches, R-curve analysis Testing procedures, Measurement of these parameters, RAD, Fail sage and safe life design approaches, Practical applications. Advanced topics in EOFM. **(8)**

TOTAL : 45

TEXT BOOKS

1. Broek D., "Elementary Engineering Fracture Mechanics ", Kluwer Academic Publishers, Dordrecht, 1986.
2. Barsom J.M. and Rolfe S.T., "Fracture and Fatigue Control in Structures ", Prentice-Hall, Englewood Cliffs, NJ, 1987.

REFERENCE BOOKS

1. Anderson T.L., "Fracture Mechanics - Fundamentals and Applications ", CRC Press, Boca Raton, Florida, 1986.
2. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw Hill, New Delhi, 2009.
3. Simha K. R.Y., "Fracture Mechanics for Modern Engineering Design", Universities Press (India) Limited, 2001.
4. Charlie R. Brooks and Ashok Choudhury, "Failure Analysis of Engineering Materials," McGraw-Hill, 2002.
5. Josef Betten, "Creep Mechanics", Springer, 2008.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X	X	X		X
2	X	X	X		X		X	X	X	X	X
3	X	X	X	X	X	X	X	X			X
4		X		X	X		X		X	X	X

13MEE32 - TRIBOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To gain an overview of design of fluid containment systems like seals and gasket, lubrication of surfaces in relative motion to achieve reduced friction and wear.

COURSE OUTCOMES

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

CO1 : *Know the influence of structure of the bearing and the nature of fluid flow on the loads that can be supported.*

CO2 : *Understand the modeling of elasto-hydrodynamic lubrication as infinite and finite structures.*

INTRODUCTION

Fundamentals of tribology, History of tribology, Interdisciplinary Approach, Economic Benefits. **(6)**

FRICTION

Causes of Friction, Adhesion Theory, Abrasive Theory, Junction Growth Theory, Laws of Rolling Friction, Friction Instability. **(8)**

WEAR

Wear Mechanisms, Adhesive Wear, Abrasive Wear, Corrosive Wear, Fretting Wear, Wear Analysis. **(8)**

LUBRICATION AND LUBRICANTS

Importance of Lubrication, Boundary Lubrication, Mixed Lubrication, Full Fluid Film Lubrication, Hydrodynamic, Elasto hydrodynamic lubrications, Types and Properties of Lubricants, Lubricants Additives. **(9)**

FLUID FILM LUBRICATION

Fluid mechanics concepts, Equations of Continuity and Motion, Generalised Reynolds Equation with Compressible and Incompressible Lubricants. **(8)**

APPLICATION OF TRIBOLOGY

Introduction, Rolling Contact Bearings, Gears Journal Bearings - Finite Bearings. **(6)**

TOTAL : 45

TEXT BOOK

1. Ludema K.C., “Friction, Wear, Lubrication: A Textbook in Tribology", CRC Press, 2010.

REFERENCE BOOKS

1. Dowson D., "History of Tribology", Longman London, 1979.
2. Stachowiak G.W. and Batchelor A.W., "Engineering Tribology", Third Edition, Elsevier Inc., 2005.
3. Shigley J.E., Mischke C.R., "Mechanical Engineering Design", Tata McGraw - Hill Publishing Company Limited, 2003.
4. Hamrock B.J., Jacobson B.O. and Schmid S.R., "Fundamentals of Machine Elements", McGraw-Hill Inc., 1998.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X		X	X	X		
2	X	X	X	X	X	X		X		X	X

13MEE33 - MICRO AND SMART SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

This course on micro and smart systems aims to provide gain an overview of micro and smart systems technologies and also an understanding of the applications and issues involved.

COURSE OUTCOMES

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

CO1 *: Use the concepts of mechanics of solids and design, as they pertain to micro and smart systems.*

CO2 *: Acquire a comprehensive description of micro-fabrication*

INTRODUCTION

Glimpses of Microsystems, scaling effects, Smart materials and systems: an overview. Microsensors - some examples, Microactuators - some examples, Microsystems - some examples. Examples of smart systems: structural health monitoring and vibration control. **(9)**

MICROFABRICATION PROCESSES

Structure of silicon and other materials, Silicon wafer processing; Thin-film deposition, Lithography, wet etching and dry etching, Bulk micromachining and Surface micromachining, Wafer-bonding; LIGA and other moulding techniques, Soft lithography and polymer processing, Thick-film processing; Low temperature co-fired ceramic processing, Smart material processing. **(10)**

MECHANICS OF SOLIDS

Stresses and deformation: bars and beams, Microdevice suspensions: lumped modelling, Residual stress and stress gradients, Poisson effect; Anticlastic curvature; examples of micromechanical structures, Thermal loading; bimorph effect, Dealing with large displacements; in-plane and 3D elasticity equations, Vibrations of bars and beams, Gyroscopic effect Frequency response; damping; quality factor, Basic micro-flows for damping calculation. **(10)**

FINITE ELEMENT METHOD

Types of numerical methods for solving partial differential equations. Variational principles Weak form, shape functions, iso-parametric formulation and numerical integration, Implementation of finite element method, FEM for piezoelectrics. **(6)**

ELECTRONICS AND PACKAGING

Semiconductor devices: basics, OpAmps and OpAmp circuits, Signal conditioning for microsystems devices, Control and microsystems, Vibration control of a beam, Integration of microsystems and microelectronics, Packaging of Microsystems, Reliability, Case-studies. **(10)**

TOTAL : 45

REFERENCE BOOKS

1. Senturia S.D., "Microsystem Design", Kluwer Academic Publishers, 2001.
2. Tai-Ran Hsu, "MEMS & Microsystems Design and Manufacture", McGraw Hill, 2002.
3. Varadan V.K., Vinoy K.J. and Gopalakrishnan S., "Smart Material Systems and MEMS: Design and Development Methodologies", Wiley, 2006.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	X	X	X	X	X	X	X	X		X	X
2	X	X	X	X	X		X		X	X	

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE - 641 014, TAMILNADU, INDIA

GOLDEN JUBILEE

(1956 - 2006)

Department of Mechanical Engineering

B.E. MECHANICAL ENGINEERING

Curriculum and Syllabi

THIRD TO EIGHTH SEMESTER

(For the students admitted during 2013-2014 onwards)

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