COIMBATORE INSTITUTE OF TECHNOLOGY

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

COIMBATORE - 641 014, TAMILNADU, INDIA

DIAMOND JUBILEE

(1956 - 2016)

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF MECHANICAL ENGINEERING

Curriculum and Syllabi

Under Choice Based Credit System

(For the students admitted during 2015 - 2016 and onwards)

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DEPARTMENT OF MECHANICAL ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

VISION AND MISSION OF THE INSTITUTE

VISION

The Institute strives to inculcate a sound knowledge in Engineering along with realized 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

COIMBATORE INSTITUTE OF TECHNOLOGY

VISION, MISSION AND PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) FOR BACHELOR OF MECHANICAL ENGINEERING

The Vision of the Department of Mechanical Engineering is :

To become one of the best mechanical engineering departments in the country within the next decade, in preparing engineers capable of working innovatively and creatively towards a better world.

The Mission of the Department of Mechanical Engineering is :

- Impart sound knowledge through effective teaching-learning methods.
- Prepare students to address current and impending challenges facing the country.
- Create and nurture an environment for fostering innovation and research.

DEPARTMENT OF MECHANICAL ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The student will :

PEO 1 Acquire fundamental knowledge and expertise necessary for successful professional practice in mechanical engineering and allied fields, and for higher studies.

PEO 2 Attain and demonstrate essential technical skills to identify, analyze and solve complex problems and design issues in mechanical engineering.

PEO 3 Possess a professional attitude as an individual or a team member with consideration for societal, ethical and environmental factors, and display motivation for life-long learning.

DEPARTMENT OF MECHANICAL ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

PROGRAMME OUTCOMES (POs)
FOR
BACHELOR OF MECHANICAL ENGINEERING

The students will be able to :

Sl. No.	Program Outcomes
1	Demonstrate knowledge of fundamental mathematics, science, and mechanical engineering principles and apply these to solve complex problems.
2	Identify, formulate and analyze complex problems related to mechanical engineering and allied fields.
3	Visualize and design mechanical components, systems or processes that meet desired objectives with proper consideration for public health and safety.
4	Investigate complex mechanical engineering problems through proper formulation, simulation and experimentation.
5	Apply techniques, skills, and modern engineering tools and software necessary to address complex mechanical engineering problems.
6	Relate knowledge based on codes and standards to professional mechanical engineering practice.
7	Identify the impact of solutions to mechanical engineering problems for sustainable development, with consideration for environment and society.
8	Adopt and apply ethical principles to professional mechanical engineering practice.
9	Contribute effectively as an individual and as a member or as a leader in multi-disciplinary teams to achieve desired goals.
10	Demonstrate effective oral and written communication skills through presentations and technical reports to peers and society at large on issues pertaining to mechanical engineering.
11	Execute and manage projects using engineering and financial management principles.
12	Adapt independently to technological changes by engaging in life-long learning.

COIMBATORE INSTITUTE OF TECHNOLOGY

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DEPARTMENT OF MECHANICAL ENGINEERING

(III TO VIII SEMESTER)

SUBJECT OF STUDY

III SEMESTER

Course Code	Course Name	Category	L	T	P	C
15CEM31	Complex Variables, Fourier Transforms and Partial Differential Equations	BS	2	2	0	3
15ME31	Fluid Mechanics and Machinery	ES	2	2	0	3
15ME32	Electrical Machines and Drives	ES	3	0	0	3
15ME33	Statics and Dynamics	ES	2	2	0	3
15ME34	Materials and Metallurgy	PC	3	0	0	3
15ME35	Applied Thermodynamics	PC	2	2	0	3
15HSS01	Science of Creativity and Professional Ethics	EEC	1	0	0	1
15ME36	Fluid Mechanics and Machinery Laboratory and Electrical Machines and Drives Laboratory	ES	0	0	4	2
15ME37	Materials and Metallurgy Laboratory and Applied Thermodynamics Laboratory	PC	0	0	4	2
15ME38	Computer Graphics Practice	PC	0	0	2	1
	TOTAL CREDITS					**24**

IV SEMESTER

Course Code	Course Name	Category	L	T	P	C
15CMM41	Numerical Methods, Random Variables, Sampling Theory and Z - Transforms	BS	2	2	0	3
15ME41	Strength of Materials	ES	2	2	0	3
15ME42	Embedded Processor Architecture and Programming	ES	3	0	0	3
15ME43	Mechanisms and Machines	PC	2	2	0	3
15ME44	Manufacturing Science and Technology	PC	2	2	0	3
15ME45	Gas Dynamics and Propulsion Systems	PC	2	2	0	3
15ME46	Strength of Materials Laboratory, Embedded	ES	0	0	4	2
	Processor Architecture and Programming Laboratory					
15ME47	Mechanisms and Machines Laboratory	PC	0	0	2	1
15ME48	Advanced Computer Graphics Practice	PC	0	0	2	1
15EEC01	Employability Skills	EEC	0	2	0	1
	TOTAL CREDITS					**23**

V SEMESTER

Course Code	Course Name	Category	L	T	P	C
15ME51	Heat and Mass Transfer	PC	2	2	0	3
15ME52	Machining Technology and Surface Engineering	PC	3	0	0	3
15ME53	Design of Machine Elements	PC	2	2	0	3
15ME54	Metrology and Quality Control	PC	3	0	0	3
15ME	Elective - I	PE	3	0	0	3
15ME	Elective - II	PE / OE	3	0	0	3
15ME55	Design and Machine Drawing Practice	PC	0	0	4	2
15ME56	Machine Shop Practice and Foundry and Welding Laboratory	PC	0	0	4	2
15ME68	Mini Project	EEC	0	0	2	0
	TOTAL CREDITS					**22**

VI SEMESTER

Course Code	Course Name	Category	L	T	P	C
15ME61	Computer Aided Design and Manufacturing	PC	3	0	0	3
15ME62	Engineering Optimization	PC	2	2	0	3
15ME63	Automobile Engineering	EEC	3	0	0	3
15ME64	Engineering Economics and Management	HS	3	0	0	3
15ME65	Design of Transmission Systems	PC	2	2	0	3
15ME	Elective - III	PE	3	0	0	3
15ME66	Special Machines Laboratory and CAD/CAM Laboratory	PC	0	0	4	2
15ME67	Metrology Laboratory and Heat Transfer Laboratory	PC	0	0	4	2
15ME68	Mini Project	EEC	0	0	2	2
	TOTAL CREDITS					**24**

VII SEMESTER

Course Code	Course Name	Category	L	T	P	C
15ME71	Finite Element Analysis	PC	2	2	0	3
15ME72	Operations Research	PC	2	2	0	3
15ME73	Control Theory and Mechatronics	EEC	2	2	0	3
15ME	Elective - IV	PE	3	0	0	3
15ME74	Production and Operations Management	PC	3	0	0	3
15ME75	Alternate Energy Resources	EEC	3	0	0	3
15ME76	Control Theory and Mechatronics Laboratory	EEC	0	0	2	1
15ME81	Project Work	EEC	0	0	6	0
	TOTAL CREDITS					**19**

VIII SEMESTER

Course Code	Course Name	Category	L	T	P	C
15ME	Elective - V	PE	3	0	0	3
15ME	Elective - VI	PE / OE	3	0	0	3
15ME	Elective - VII	PE	3	0	0	3
15ME	Elective - VIII	PE	3	0	0	3
15ME	Elective - IX	PE / OE	3	0	0	3
15ME81	Project Work	EEC	0	0	6	6
	TOTAL CREDITS					**21**

PROFESSIONAL ELECTIVES

DESIGN AND ANALYSIS - STREAM

Course Code	Course Name	Category	L	T	P	C
	III YEAR					
15MEE01	Design of Jigs and Fixtures	PE	2	2	0	3
15MEE02	Advanced Strength of Materials	PE	2	2	0	3
15MEE03	Mechanical Behavior of Materials	PE	2	2	0	3
	IV YEAR					
15MEE04	Machine Tool Design	PE	2	2	0	3
15MEE05	Mechanical Vibrations and Control	PE	2	2	0	3
15MEE06	Tribology	PE	3	0	0	3
15MEE07	Experimental Stress Analysis	PE	2	2	0	3
15MEE08	Fluid Power Control Systems	PE	3	0	0	3
15MEE09	Design for Manufacture and Assembly	PE	3	0	0	3
15MEE10	Design and Analysis of Experiments	PE	3	0	0	3

MANUFACTURING AND MATERIALS - STREAM

Course Code	Course Name	Category	L	T	P	C
	III YEAR					
15MEE11	Rapid Prototyping	PE	3	0	0	3
15MEE12	Non-Traditional Machining	PE	3	0	0	3
15MEE13	Non-Destructive Evaluation and Imaging	PE	3	0	0	3
	IV YEAR					
15MEE14	Advanced Foundry Technology	PE	3	0	0	3
15MEE15	Advanced Welding Technology	PE	3	0	0	3
15MEE16	Composite Materials	PE	3	0	0	3
15MEE17	Engineering Polymers, Composites and allied Manufacturing processes	PE	3	0	0	3
15MEE18	Industrial Robotics	PE	3	0	0	3
15MEE19	Bio Materials	PE	3	0	0	3

INDUSTRY AND MANAGEMENT - STREAM

Course Code	Course Name	Category	L	T	P	C
	III YEAR					
15MEE20	Work System Design	PE	3	0	0	3
15MEE21	Total Quality Management	PE	3	0	0	3
15MEE22	Plant Layout and Material Handling	PE	3	0	0	3
	IV YEAR					
15MEE23	Business Process Reengineering	PE	3	0	0	3
15MEE24	Project Management	PE	3	0	0	3
15MEE25	Quantity Production Methods	PE	3	0	0	3
15MEE26	Production Planning and Control	PE	2	2	0	3
15MEE27	Lean and Agile Manufacturing	PE	3	0	0	3
15MEE28	Manufacturing Planning and Cost Estimation	PE	3	0	0	3
15MEE29	Manufacturing Systems Management	PE	3	0	0	3

THERMAL AND FLUID - STREAM

Course Code	Course Name	Category	L	T	P	C
	III YEAR					
15MEE30	Advanced Fluid Mechanics	PE	2	2	0	3
15MEE31	Refrigeration and Air Conditioning	PE	2	2	0	3
15MEE32	Advanced Thermodynamics	PE	2	2	0	3
	IV YEAR					
15MEE33	Cryogenics	PE	3	0	0	3
15MEE34	Combustion and Internal Combustion Engines	PE	3	0	0	3
15MEE35	Energy Conservation and Waste Heat Recovery	PE	3	0	0	3
15MEE36	Design of Heat Exchangers	PE	2	2	0	3
15MEE37	Turbo Machinery	PE	2	2	0	3
15MEE38	Computational Fluid Dynamics	PE	2	2	0	3
15MEE39	Power Plant Engineering	PE	3	0	0	3
15MEE40	Solar Energy Technology	PE	3	0	0	3

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LIST OF OPEN ELECTIVES

DEPARTMENT OF CIVIL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15CEE35	Disaster Management	3	0	0	3	All Branches
15CEE36	Renewable Energy Resources	3	0	0	3	All Branches
15CEE38	Environmental Impact Assessment	3	0	0	3	All Branches
15CEE39	Solid and Hazardous Waste Management	3	0	0	3	All Branches
15CEE40	Principles of Sustainable Development	3	0	0	3	All Branches
15CEE41	Safety Engineering in Building	3	0	0	3	All Branches

DEPARTMENT OF MECHANICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15MEOE01	Robotics	3	0	0	3	All Branches
15MEOE02	Low Cost Automation	3	0	0	3	All Branches
15MEOE03	Adaptive Control and Process Dynamics	3	0	0	3	All Branches
15MEOE04	Project Planning and Management	3	0	0	3	All Branches
15MEOE05	Supply Chain Management	3	0	0	3	All Branches
15MEOE06	Resource Management Techniques	2	2	0	3	All Branches
15MEOE07	Sustainable Development	3	0	0	3	All Branches
15MEOE08	Processing and Applications of Biomaterials	3	0	0	3	All except CSE & IT
15MEOE09	Numerical Simulation of Fluid Flow	3	0	0	3	All Circuit Branches
15MEOE10	Solar Energy Utilisation	3	0	0	3	Civil & Chemical

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15EEOE01	Energy Auditing	3	0	0	3	ECE, Mech, Chemical, Civil
15EEOE02	Solar and Wind Energy Systems	3	0	0	3	ECE, Mech, Chemical
15EEOE03	Hybrid Smart Vehicles	3	0	0	3	All Branches except Civil, Chemical
15EEE07	Electrical Safety	3	0	0	3	All Branches
15EEE14	Energy Efficient Lighting System	3	0	0	3	All Branches

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15ECOE01	Consumer Electronics	3	0	0	3	Civil & Mech
15ECOE02	Arm System Architecture	3	0	0	3	CSE & IT
15ECOE03	Broadband Communication	3	0	0	3	Mech, EEE, CSE & IT
15ECOE04	Robotics for Industrial Applications	3	0	0	3	Mech, CSE & IT
15ECOE05	Signal Processing and its Applications	3	0	0	3	Chemical, Mech & CSE

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15CSOE01	Fundamentals of Software Engineering	3	0	0	3	EEE, ECE, Mech, Chemical & Civil
15CSOE02	Introduction to Data Warehousing and Data Mining	3	0	0	3	EEE, ECE, Mech, Chemical & Civil
15CSOE03	Introduction to Embedded Systems	3	0	0	3	Mech, Chemical & Civil
15CSOE04	Internet Programming	3	0	0	3	EEE, ECE, Mech, Chemical & Civil
15CSOE05	Customer Relationship Management Essentials	3	0	0	3	IT, EEE, ECE, Mech, Chemical & Civil
15CSOE06	E-commerce	3	0	0	3	IT, EEE, ECE, Mech, Chemical & Civil

DEPARTMENT OF INFORMATION TECHNOLOGY

Course Code	Course Name	L	T	P	C	Eligible Branches
15ITOE01	Digital Computer Basics	3	0	0	3	Mech, Civil & Chem
15ITOE02	Programming in Java	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
15ITOE03	Fundamentals of Database Systems	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
15ITOE04	Cloud Computing Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
15ITOE05	Information Security Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
15ITOE06	Introduction to Human Computer Interaction	3	0	0	3	CSE, EEE, ECE, Mech, Civil & Chemical
15ITOE07	Enterprise Resource Planning Concepts	3	0	0	3	CSE, EEE, ECE, Mech, Civil & Chemical

DEPARTMENT OF CHEMICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15CHOE01	Industrial Safety Engineering	3	0	0	3	All Branches
15CHOE02	Risk Analysis and Hazop	3	0	0	3	All Branches
15CHOE03	Green Technology	3	0	0	3	All Branches
15CHOE04	Corrosion Science and Engineering	3	0	0	3	All Branches
15CHOE05	Introduction to Chemical Engineering	3	0	0	3	All Branches

DEPARTMENT OF MATHEMATICS

Course Code	Course Name	L	T	P	C	Eligible Branches
15MOE01	Graph Theory & Its Applications	3	0	0	3	All Branches
15MOE02	Methods of Applied Mathematics	3	0	0	3	All Branches
15MOE03	Linear & Non-Linear Programming	3	0	0	3	All Branches
15MOE04	Probability & Random Processes	3	0	0	3	All Branches

DEPARTMENT OF PHYSICS

Course Code	Course Name	L	T	P	C	Eligible Branches
15POE01	Introduction to Nanoscience and Nanotechnology	3	0	0	3	Civil, Mech, EEE, ECE, CSE & Chemical
15POE02	Physics and Technology of Thin Films	3	0	0	3	Mech, EEE, ECE & Chemical
15POE03	Solar Cells : Fundamentals and Materials	3	0	0	3	EEE, ECE & Chemical
15POE04	Advanced Material Processing Technologies	3	0	0	3	Mech & Chemical

DEPARTMENT OF CHEMISTRY

Course Code	Course Name	L	T	P	C	Eligible Branches
15COE01	Medical Nano Technology	3	0	0	3	Chemical
15COE02	Advanced Drug Delivery System	3	0	0	3	Chemical
15COE03	Biosensors	3	0	0	3	Chemical, ECE & EEE
15COE04	Nanocomposites	3	0	0	3	Mech, Chemical & Civil
15COE05	Biorefinery	3	0	0	3	Mech & Chemical

DEPARTMENT OF HUMANITIES

Course Code	Course Name	L	T	P	C	Eligible Branches
15HOE01	Principles of Management	3	0	0	3	All Branches
15HOE02	Current Trends in Indian Economy	3	0	0	3	All Branches
15HOE03	Monetary Economics	3	0	0	3	All Branches
15HOE04	Accounting for Managerial Decisions	3	0	0	3	All Branches
15HOE05	Entrepreneurship Development	3	0	0	3	All Branches
15HOE06	Employability Skills	3	0	0	3	All Branches
15HOE07	English for Academic Purposes	3	0	0	3	All Branches
15HOE08	English for Competitive Exams	3	0	0	3	All Branches
15HOE09	Life and Literature	3	0	0	3	All Branches

15CEM31 - COMPLEX VARIABLES, FOURIER TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Apply complex variable concepts to solve mechanical engineering problems.*

CO2 *: Employ partial differential equation and Fourier transforms ideas in modeling, analyzing and solving mechanical engineering problems.*

CO3 *: Solve problems related to 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 and simple problems. **(6+6)**

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 semi-circular contours. **(6+6)**

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. **(6+6)**

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. **(6+6)**

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. **(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Srimanta Pal and Subodh C. Bhunia, "Engineering Mathematics", Oxford University Press India, 1st Edition, 2015.*
2. *E.Rukmangadachari, "Engineering Mathematics Vol II & Vol III", Pearson Education, 1st Edition.*
3. *VeerarajanT.,"Engineering Mathematics", For Semester I & II, 3rd Edition, Tata McGraw-Hill Publishing company Ltd., 2012.*
4. *Veerarajan .T, "Engineering Mathematics", (for Semester III), 3rd Edition, Tata McGraw-Hill Publishing Company Ltd, 2008.*

REFERENCES

1. *Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons (Asia) Private Limited, 2008.*
2. *Grewal, B.S., "Higher Engineering Mathematics", 40th Edition, Khanna Publishers, 2007.*
3. *Free ebook : Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons (Asia) Private Limited., 2008- http://www-elec.inaoep.mx/~jmram/Kreyzig-ECS-DIF1.pdf*
4. *http://nptel.ac.in/courses/111105035/*

15ME31 - FLUID MECHANICS AND MACHINERY

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Use basic fluid properties and employ principles of manometry to compute pressure differences and make pressure measurements.*

CO2 : *Calculate hydro-static forces on a given plane or curved surfaces fully submerged in a known fluid.*

CO3 : *Deduce relationships for static and dynamic behaviour of fluids using Buckingham method of dimensional analysis and perform model analysis for hydraulic phenomena.*

CO4 : *Differentiate between laminar and turbulent flows and develop shear-stress pressure gradient relationship for laminar flow between parallel plates and through circular tubes.*

CO5 : *Choose appropriate hydraulic turbine and estimate its geometric dimensions by using velocity triangles for a given performance requirement or vice-versa. Calculate head and efficiency for centrifugal pumps using velocity triangles.*

CO6 : *Calculate discharge and efficiency of reciprocating pumps*

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. **(6+6)**

FLUID FLOW CONCEPTS

Fluid kinematics - flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation. Fluid dynamics - Euler's equation of motion - Bernoulli's equation, applications - venturi meter, orifice meter, Pitot tube. **(6+6)**

DIMENSIONAL ANALYSIS AND MODEL STUDIES

Dimensional analysis - Buckingham's Pi theorem - applications - similarity laws and models. **(4+4)**

LAMINAR AND TURBULENT FLOW CONCEPTS

Incompressible fluid flow - viscous flow - Navier-Stokes equation - Shear stress, pressure gradient relationship - laminar flow between parallel plates - laminar flow through circular tubes (Hagen - Poiseulle's equation). **(5+5)**

HYDRAULIC TURBINES

Introduction to impulse-momentum principle, moment of momentum equation, Hydraulic turbines - classification - Pelton, Francis and Kaplan turbines - Velocity triangles - simple problems - determining geometric dimensions - specific speed - unit quantities. **(5+5)**

HYDRAULIC PUMPS

Centrifugal pumps - velocity triangle - performance calculations. Positive Displacement pump - working principle - air vessel. **(4+4)**

TOTAL : 60

TEXT BOOKS

1. *Som S.K., Biswas G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2nd Edition, 2008.*
2. *Modi P.N, & Seth S.M., "Hydraulics, Fluid Mechanics & Hydraulic Machinery", Metropolitan Book Company, New Delhi, 2013.*

REFERENCES

1. *Bansal R.K., "A Textbook of Fluid Mechanics and Hydraulic Machines", 9th Edition, Laxmi Publications, 2005.*
2. *Kumar K.L., "Engineering Fluid Mechanics", 6th Edition, S. Chand Ltd., 2008.*
3. *Ramamrutham S, "Fluid Mechanics, Hydraulics & Fluid Machinery", M/s.Dhanpat Rai & Sons, New Delhi, 1998.*
4. *Arora K.R., "Fluid Mechanics, Hydraulics and Hydraulic Machines", Standard Publishers & Distributors, 1998.*
5. *NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video sources on fluid mechanics.*

15ME32 - ELECTRICAL MACHINES AND DRIVES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Analyze the characteristics of AC single and three phase motors, load dynamics and performance parameters of DC and AC drives for different applications.*

CO2 : *Adjust the drive parameters to match the joint characteristics of the motor with load.*

CO3 : *According to industrial and environmental standards and also develop the control schemes for any electric drive.*

CO4 : *Apply suitable speed control technique for DC motors, AC induction and synchronous motors by using solid state controllers in DC and AC drives.*

CO5 : *Describe the concept and application of special electrical machines with modern electric drives.*

THREE PHASE MACHINES

Alternator - construction, working principle, EMF equation. Three phase Induction Motors - Construction - Types: Squirrel cage and Slip ring, comparison, applications - Slip/Speed - Torque characteristics - Stator and Rotor side speed Control Methods. **(9)**

SPECIAL ELECTRICAL MACHINES

Working principle, characteristics, speed control and application of - Capacitor start induction motor - Servo Motors - Synchros - Stepper Motor - Universal Motor. **(9)**

ELECTRIC DRIVES

Electric drive System - advantage and comparison - Classification - Factors affecting the choice of drive: Different classes of duty cycle of motors, Load inertia and Environment conditions. **(9)**

DC and AC DRIVES

DC drive: Introduction - Control Strategies - Single phase and three phase fully controlled converter fed DC drives - Chopper Fed DC drives (separately excited): single, two and four quadrant chopper. AC drive: Introduction - Control Strategies - Stator Control: Variable frequency drives (V/F control) for three phase induction motor speed control. Rotor Control: Rotor Resistance Control, Applications. **(9)**

APPLICATIONS

Selection of Motor and Drive System for Industrial Applications: Cranes and Electric Traction, Centrifugal Pumps, Air compressors, Paper and Pulp Industry, Textile Industry, Steel Industry. **(9)**

TOTAL : 45

TEXT BOOKS

1. *B.L Theraja and A.K Theraja, "A Text Book of Electrical Technology", Vol.2, S. Chand Publications (P) Ltd., New Delhi, 2014.*
2. *Vedham Subramanyam, "Electric Drives Concept and Applications", 2nd Edition, Tata McGraw-Hill Publishing Company, 2010.*
3. *S.K. Pillai, "A First Course on Electrical Drives", 2nd Edition, New Age International Publishers, 2004.*

REFERENCES

1. *I.J. Nagrath and D.P. Kothari, "Electrical Machines", 3rd Edition, Tata McGraw-Hill Publishing Company, 2010.*
2. *G.K Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2007.*
3. *B.K. Bose, "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2006.*

15ME33 - STATICS AND DYNAMICS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Calculate forces and moments acting on two dimensional and three dimensional bodies in static equilibrium by constructing free body diagram.*

CO2 *: Analyze plane trusses having different types of supports (simple, fixed, pinned and roller) and determine forces in each members..*

CO3 *: Construct free body diagrams to determine frictional force in wedges, square thread, journal and thrust bearing, clutches, flat and V belts, and brake drums.*

CO4 *: Calculate and locate centroid, center of gravity, moments of inertia and radius of gyration of different geometries about an axis.*

CO5 *: Determine the virtual displacements and forces of systems in equilibrium using principle of virtual work.*

CO6 *: Apply equations of motion to particles and rigid bodies to calculate displacement, velocity and acceleration.*

VECTOR ALGEBRA

Force, Couple, Moment, Varignon's Theorem, Resultant of concurrent and non-concurrent coplanar forces, free body diagram, Equilibrium of systems in 2D & 3D. **(4+4)**

TRUSS ANALYSIS

Types of trusses - Loads - Supports, Assumptions - Analysis, Method of joints and sections. **(4+4)**

FRICTION

Laws of Friction - Angle of friction, Friction in wedges, Square thread, Journal and thrust bearing, Clutches, Belt - flat and 'V' - belt, Brake drums. **(4+4)**

DISTRIBUTED FORCES: MOMENT OF INERTIA

Centroid, Center of gravity and Moment of inertia - first moment of mass and area. Second moment of mass and area, Radius of gyration, Transfer of axes, Parallel and perpendicular axis theorem, Composite bodies. **(5+5)**

METHOD OF VIRTUAL WORK

Virtual Displacement, Principle of virtual work, Applications of virtual work principle to machines, Mechanical efficiency, Work done by force/couple, Potential energy - Stability of equilibrium. **(4+4)**

KINEMATICS OF PARTICLES

Rectilinear and curvilinear motion in rectangular co-ordinates, Relative and constrained motion. Plane kinematics of rigid bodies - rotational motion. Relative Velocity, instantaneous center of rotation. Relative acceleration, rotating reference frames. **(4+4)**

KINETICS 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. Newton's second law of motion, D'Alembert's principle. Work - kinetic energy, power, potential energy. Impulse - momentum (linear, angular), Impact (Direct and oblique), combination problems. **(5+5)**

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", Wiley, 7th Edition, 2012.*
3. *Meriam J.L., Kraige L.G., "Engineering Mechanics: Dynamics", Wiley, 7th Edition, 2012.*

REFERENCES

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. *Rajasekaran S., Sankarasubramanian G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Private Ltd., 2010.*
4. *McLean, "Engineering Mechanics", Schaum Series, McGraw-Hill, 6th Edition, 2010.*
5. *S. S. Bhavikatti, "Engineering Mechanics", 4th Edition, New Age International Publishers, 2012.*
6. *www.nptel.iitm.ac.in/syllabus/syllabus.php?subjectId=112103108.*

15ME34 - MATERIALS AND METALLURGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Analyze crystalline defects in metals and its influence on strengthening mechanism for the enhancement of mechanical properties. Calculate AFS grain size number using ASTM standards.*

CO2 : *Construct binary phase diagrams to analyze the solidification of ferrous and nonferrous alloys and estimate amount of phases at different temperatures and compositions.*

CO3 : *Choose and develop the required heat treatment and case hardening technique for enhancing the mechanical properties of the specified carbon steels and alloy steels components. Evaluate appropriate alloying elements for ferrous alloy to improve the mechanical properties according to application.*

CO4 : *Compare the properties and applications of nonmetallic materials and select for the specified engineering applications. Describe the procedure for powder metallurgy process and recognize its significance.*

CO5 : *Apply the procedure and estimate mechanical, fatigue and creep properties for the given data of the material.*

CRYSTAL IMPERFECTIONS

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. **(7)**

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. **(7)**

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. **(7)**

Ferrous and nonferrous 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. **(8)**

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. **(9)**

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 test. **(7)**

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, 2013.*

REFERENCES

1. *Lakhtin Y., Weinstein N., "Engineering Physical Metallurgy", University Press of the Pacific, 2000.*
2. *Raghavan V., "Physical Metallurgy", Prentice Hall of India Pvt. Ltd., New Delhi, 2nd Edition 23rd Reprint 2012.*
3. *Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice - Hall of India, 2010*
4. *NPTEL courses, http://www.nptel.iitm.ac.in/courses.php: related web and video resources under Mechanical Engineering & Metallurgy and Material Science categories.*

15ME35 - APPLIED THERMODYNAMICS

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

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Determine thermodynamic state points in an Otto or Diesel cycle, using air-standard assumptions, to calculate the performance parameters of two-stroke and four-stroke engines under specified operating conditions.*

CO2 *: (i) Compare the performance of single-stage and multi-stage compressors (isothermal compression) of specified clearance, with and without inter-cooling; (ii) Calculate the power requirements for a specified free air delivery and pressure ratio.*

CO3 *: Analyze the performance of ideal and non-ideal gas turbine cycles with one or more of the following modifications: regeneration, inter-cooling, and reheating, for specified operating conditions.*

CO4 *: (i) Analyze and compare the performance of an ideal and a non-ideal Rankine cycle and its modifications (regeneration, reheat, or a combination of reheat and regeneration) using steam tables or Mollier chart. (ii) Analyze steam flow through nozzles*

CO5 *: Estimate the performance of a refrigeration system for specified cooling requirements and operating conditions using Refrigerant property tables and charts.*

CO6 *: Use psychrometric chart or psychrometric relations to estimate changes in enthalpy and humidity during sensible heating, cooling, humidification and dehumidification processes, for specified air-conditioning requirements.*

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. **(6+6)**

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. **(6+6)**

GAS TURBINES

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. **(5+5)**

STEAM TURBINE, BOILERS and NOZZLES

Ideal Rankine cycle - externally irreversible Rankine cycle - superheat - reheat - regeneration - internally irreversible Rankine cycle. 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. **(7+7)**

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. 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. **(6+6)**

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.*

REFERENCES

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", Dhanpat Rai and Sons, 2004.*
5. *Ballaney P. L., "Thermal Engineering", Khanna Publishers, 24th Edition, 2003.*

15HSS01 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Describe the principles of karma yoga and functioning of mind and consciousness.*

CO2 *: Hypothesize the evolution of Universe and living beings in a global and societal context*

CO3 *: Infer the principles of Yoga to practice it and know the value of health.*

CO4 *: Interpret the philosophy of introspection procedures for better living*

CO5 *: Assess, take personal responsibility and follow professional ethics for sustained growth in career and life*

LIFE FORCE, MIND AND CONCIOUSNESS

Science of creativity and Personality Development - objectives - Principles of Karma Yoga - Duty Consciousness - Communism and Capitalism - Law of Nature - Life Force - Origin - Potentiality of the Life Force - Premordial State - Wave Theory - Consciousness - Pancha Thanmatras - Secret of Revelations - Mind - Bio-magnetism physical transformation of biomagnetism. **(6)**

EVOLUTION OF THE UNIVERSE AND LIVING BEINGS

Evolution of the Universe: Creation Theory - Evolution Theory - Theory of Permanence - Theory of Mithya - Evolution of Living Beings: Absolute Space and Force - Plants Experience Pain - Two Eyes and Two Ears - Seven Constituent Layers in the Body. **(5)**

YOGA AND ITS BENEFITS

Simple and Safe Yoga - Upa Yoga Practices: Yoga for Peace - Yoga for Health - Yoga for Joy - Yoga for Love - Yoga for Well-being - Yoga for Success. Physical Exercise - Meditation - Seven Centers of Meditation - Benefits - Effect of Good Vibrations - Cause and Effect System - Food and Health. **(8)**

INTROSPECTION

Attachment, Detachment and Moderation in Enjoyment - Imaginary Expectations - Harmony in Life: Self, Family, Society and Nature - Introspection: Analysis of Thought, Moralization of Desire, Neutralization of Anger, Eradication of Worries and Self Realization. **(5)**

HUMAN VALUES

Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Virtues - Respect for Others - Living Peacefully - Caring - Sharing - Honesty - Courage - Valuing Time - Co-operation - Commitment - Empathy - Self Confidence - Challenges in Work Place - Impact of cyberspace on individuals. **(6)**

TOTAL : 30

TEXT BOOKS

1. *Yogiraj Vethathri Maharishi, "Karma Yoga - The Holistic Unity", Vethathri Publications, 4th Edition, 2009. (Life Force, Mind and Conciousness, Evolution of the Universe and Living Beings, Yoga and Introspection)*
2. *R.S.Naagarazan, "A Textbook on Professional Ethics and Human Values", New Age International Publishers, New Delhi, 2011 (Human Values)*

REFERENCES

1. *Sadhguru, "Body the Greatest Gadget and Mind is your Business", Diamond Pocket Books Pvt. Ltd, Isha Foundations, 2013.*

2. *Swami Vivekananda and Swami Nikhilananda, "Karma Yoga and Bhakti Yoga", 2nd Edition, Ramakrishna Vivekananda Publications, 2008.*
3. *Henry Dreyfuss, "The Measure of Man and Woman: Human Factors in Design", John Wiley and Sons Publications, 2012.*
4. *Mike W. Martin and Roland Schinzinger,"Ethics in Engineering", 4th Edition McGraw Hill, NewYork, 2005.*
5. *M. Govindarajan, S. Natarajan, V.S. Senthilkumar, "Engineering Ethics", 1st Edition, Prentice Hall of India, 2009.*

15ME36 - FLUID MECHANICS AND MACHINERY LABORATORY AND ELECTRICAL MACHINES AND DRIVES LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

FLUID MECHANICS AND MACHINERY LABORATORY

COURSE OUTCOME

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

CO1 *: Determine the coefficient of discharge of flow measurement devices - venturimeter, orifice meter, notches and mouthpiece using Bernoulli's equation.*

CO2 *: Experimentally estimate major and minor losses in pipelines*

CO3 *: Prove Bernoulli's theorem experimentally.*

CO4 *: Experiment on centrifugal pump, reciprocating pump, jet pump and submersible pump to evaluate their performances.*

CO5 *: Experiment on Pelton wheel and Francis turbine to evaluate their performances.*

CO6 *: Summarize experimentation, analyze results and deduce conclusions. Synthesize reports of experiments in accordance with standards.*

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 & submersible pump, Pelton wheel, Francis turbine

REFERENCE

1. Fluid mechanics laboratory Manual, Department of Civil Engineering, CIT, 2015.

ELECTRICAL MACHINES AND DRIVES LABORATORY

COURSE OUTCOME

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

CO1 *: Select a drive for a particular application based on power rating and characteristics of the application.*

CO2 *: Experimentally determine the braking characteristics of DC shunt motor and Induction motor.*

CO3 *: Demonstrate the converter topologies, inverter topologies control principles and modern tools used in DC drives, AC drives and special electric drives*

CO4 *: Demonstrate the speed control of DC motors by using converters and chopper fed drive and also to demonstrate the speed control of AC motors by using inverter fed AC drive*

CO5 *: Realize the drive based energy saving technique through experimental verification and to perform the speed control techniques for special electric machines by using drive.*

LIST OF EXPERIMENTS

1. OCC Characteristics of DC shunt Generator
2. Load test on DC shunt Motor.
3. Load test on Single phase two winding transformer.

4. Load test on single phase Capacitor start IM.
5. Load test on three phase squirrel cage IM.
6. Load test on single phase Alternator.
7. AC voltage controller for fan motor speed control.
8. DC and AC servo motor position control system.
9. Stepper Motor control system.
10. Speed control of DC motor using DC drive.
11. Speed control of three phase induction motor using AC drive.

REFERENCE

1. Electrical Drives and Controls laboratory manual, Department of Electrical Engineering, CIT, 2015.

15ME37 - MATERIALS AND METALLURGY LABORATORY AND APPLIED THERMODYNAMICS LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

MATERIALS AND METALLURGY LABORATORY

COURSE OUTCOME

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

CO1 *: Prepare specimen via dry polishing, wet polishing and etching, and use microscope for identifyingferrous and non-ferrous alloys.*

CO2 *: Evaluate properties of aluminum using Jominy end test.*

CO3 *: Identify the surface and sub surface defects in a given material usingNondestructive testing.*

LIST OF EXPERIMENTS

1. Study of metallurgical microscope
2. Specimen preparation
3. Microstructure of cast iron after etching
4. Microstructure of carbon steel
5. Microstructure of tool steels and stainless steel
6. Microstructure of non-ferrous (Aluminum and Copper) alloys
7. Non-destructive testing - liquid penetrant testing and magnetic particle testing
8. Jominy end quench test (Hardenability of Aluminium alloy)
9. Study of squeeze casting and FESEM
10. Find the hardness of the various treated and untreated steels

REFERENCE

1. Materials and Metallurgy Laboratory Manual, Department of Mechanical Engineering, CIT, 2015.

APPLIED THERMODYNAMICS LABORATORY

COURSE OUTCOME

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

CO1 *: Sketch port-timing diagram and valve-timing diagram using a laboratory model of two-stroke and four-stroke engine and compare the same with the idealized diagrams.*

CO2 *: Operate a petrol or diesel engine manually to estimate its performance parameters; generate a heat balance sheet and conduct Morse test on a multi-cylinder engine.*

CO3 *: Estimate properties of fuels and lubricants such as viscosity, flash point and fire point using Redwood Viscometer, and open and closed cup apparatus, respectively, and determine their limits of applicability.*

CO4 *: Identify operating conditions and determine the performance of a given vapour compression refrigeration system using refrigerant property tables and charts.*

CO5 *: Independently prepare laboratory reports as per standard format for a given experiment.*

LIST OF EXPERIMENTS

1. Port timing diagram of two-stroke engine.
2. Valve timing diagram of four-stroke engine.
3. Performance test on four stroke single-cylinder diesel engine.

4. Heat balance test on four stroke single-cylinder diesel engine.
5. Determination of volumetric efficiency of reciprocating air compressor.
6. Calibration of pressure gauge and vacuum gauge.
7. Flash and fire point - open and closed cup.
8. Economic speed test on multi-cylinder petrol engine.
9. Morse test on multi-cylinder petrol engine
10. Viscosity of lubricating oil - Redwood viscometer.
11. Performance test on vapor compression refrigeration system.

REFERENCE

1. Thermal Engineering Laboratory Manual, Department of Mechanical Engineering, CIT, 2015.

15ME38 - COMPUTER GRAPHICS PRACTICE

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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

CO1 *: Create drafting practices using basic commands to draw the component*

CO2 *: Construct and edit models using commands (object controlling commands, hatching and blocks) in drafting*

CO3 *: Specify text, use commands for geometric dimensioning and system variables for the mechanical drawing*

CO4 *: Develop the orthographic projections of mechanical components*

CO5 *: Create isometric drawings and use advanced drawing commands, script files and plotting commands for creation of mechanical components*

LIST OF EXPERIMENTS

1. Introduction to AutoCAD
2. Drafting practice using basic commands.
3. Practice to use, edit and modify 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.

REFERENCES

1. *CIT, "VRET Training Centre Manual, AutoCAD Level-I", (Preliminary Level).*
2. *Prof. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers", Dream Tech Press, 2016.*
3. *George Omura, "Mastering AutoCAD 2015 and AutoCAD LT 2015", Wiley India Pvt. Ltd.*

15CMM41 - NUMERICAL METHODS, RANDOM VARIABLES, SAMPLING THEORY AND Z-TRANSFORMS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

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

CO2 *: Illustrate statistical ideas to study and analyze the behavior of the developed system.*

CO3 *: Analyze and solve problems using sampling theory and Z-transforms.*

NUMERICAL METHODS

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. **(6+6)**

Finite difference approximations - solution of PDE - Laplace equation - Liebmann's iteration process - Poisson equation - parabolic equations - Bender Schmidt and Crank - Nicholson methods - Hyperbolic equation. **(6+6)**

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. **(6+6)**

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. **(6+6)**

Z-TRANSFORMS

Definition and properties - inverse Z transforms - initial and final value theorems - convolution - solution of difference equations with constant coefficients. **(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Kandasamy P., Thilagavathy P., Gunavathy P., "Numerical methods", S Chand and Company, 2013.*
2. *Kandasamy P., Thilagavathy P., Gunavathy P., "Probability Statistics and Random Process", S Chand and Company, 2008.*
3. *Veerarajan T., "Engineering Mathematics, for Semester-III Transforms and Partial Differential Equations", Tata McGraw-Hill publishing company Ltd, 5th Edition, 2012.*
4. *Veerarajan T., "Probability Statistics and Random Process", 3rd Edition, McGraw-Hill Education Private Limited, New Delhi, 2013.*

REFERENCES

1. *Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt. Ltd., 2011.*
2. *Grewal. B. S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, 2015.*
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., Engle wood Cliffs, New Jercy, 2003.*
6. *Venkataraman. M. K., "Numerical Methods in Science and Engineering", 5th Edition, National Publishing Company, 2008.*

15ME41 - STRENGTH OF MATERIALS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Compute simple stress and strain, thermal stresses*

CO2 *: Compute principal stresses and strain for two dimensional stress system, strain energy due to suddenly applied load and impact load*

CO3 *: Practice shear force and bending moment computations and construct shear force and bending moment diagrams for determinate beams*

CO4 *: Compute stresses related to bending, shear and torsion*

CO5 *: Compute stresses in thin and thick cylinders*

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. **(5+5)**

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. **(4+4)**

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. **(5+5)**

SLOPE AND DEFLECTION

Relationship between moment, slope and deflection, moment area method, Macaulay's method and to calculate slope and deflection for determinant beams. **(4+4)**

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. **(4+4)**

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. **(4+4)**

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. **(4+4)**

TOTAL : 60

TEXT BOOKS

1. *Singh J. P., "A Text Book of Mechanics of Solids", Khanna Publishers, New Delhi, 2009.*
2. *Rajput R. K., "Strength of Materials", S. Chand & Company Ltd, New Delhi, 2007.*

REFERENCES

1. *Pytel A. H. and Singer F. L., "Strength of Materials", 4th Edition, Harper Collins, New Delhi, 1987.*
2. *Beer P. F. and Johnston (Jr.) E. R., "Mechanics of Materials", SI version, McGraw Hill, NY, 2001.*
3. *Popov E. P., "Engineering Mechanics of Solids", SI version 2nd Edition, Prentice Hall, New Delhi, 2003.*
4. *Timoshenko S. P. and Young D. H., "Elements of Strength of Materials", 5th Edition, East West Press, New Delhi, 1984.*
5. *Shames I. H., Pitarresi, J. M., "Introduction to Solid Mechanics", 3rd Edition, Prentice-Hall, NJ, 2000.*
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.*

15ME42 - EMBEDDED PROCESSOR ARCHITECTURE AND PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Distinguish between RISC and CISC processors.*

CO2 *: Use the programmers model and outline the architecture of ARM processor.*

CO3 *: Choose the ARM instructions for performing data transfer, data processing and control operations.*

CO4 *: Develop assembly language programs for the arithmetic and data acquisition applications.*

CO5 *: Write the assembly language program to control the speed of dc motor and stepper motor.*

INTRODUCTION

Introduction to CPU: ALU and control unit - instruction set design - Complex Instruction Set Computer (CISC) -Reduced Instruction Set Computer (RISC) architecture - advantages and 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", Pearson Education Limited, 2014.*
2. *Andrew Sloss, "ARM System Developer's Guide", Morgan Kaufmann Publishers, 2005.*

REFERENCES

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, ZvonkoVranesic and SafwatZaky "Computer Organization and Embedded Systems", McGraw Hill, 2002.*
5. *ARM Architecture reference manual, 2005.*

15ME43 - MECHANISMS AND MACHINES

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Design mechanisms to accomplish a specified task (translation, rotation, force transmission, pick and place), taking into consideration the principles of kinematics and dynamics.*

CO2 *: Select the right type of cam and follower to achieve a required motion, draw cam profiles, analyze velocities and accelerations of cam-followers.*

CO3 *: Analytically calculate number of teeth, length of contact, path of contact, interference, for gears and gear trains using specified inputs (power, torque, speed of rotation, gear ratio etc.).*

CO4 *: Determine the unbalance in rotating and reciprocating masses (wheels, engines) under static and dynamic conditions, and devise means to reduce the unbalance.*

CO5 *: Apply the theory of a gyroscope to predict the effect of gyroscopic couple on moving bodies (airplanes, ships, automobiles).*

CO6 *: Identify the degree of freedom of mechanically vibrating systems (shock absorbers, spring masss systems,torsional systems,bending vibrations) and use the laws of motion to analyze and control the vibrations in such systems.*

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. **(4+4)**

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. **(4+4)**

DYNAMICS OF MECHANISM

Dynamic analysis - static force analysis - dynamically equivalent two mass systems - center of percussion. Dynamic analysis of planar mechanism - four bar & slider-crank mechanisms (using AutoCAD). Analytical expression of slider crank mechanism - piston effort, crank effort, pin effort. **(4+4)**

CAM ANALYSIS

Cams - classification - analytical treatments of followers with uniform motion, parabolic motion, SHM and cycloidal motion, pressure angle - parameters affecting pressure angle. **(3+3)**

ANALYSIS OF GEARS

Gears - nomenclature - law of gearing - length and arc of contact, involutes and cycloidal profile, interference. Helical, spiral and worm gears, simple, compound and epicyclic gear trains - analysis. **(4+4)**

DYNAMIC ANALYSIS OF REVOLVING AND RECIPROCATING SYSTEMS

Balancing - static and dynamic balancing. Balancing of revolving and reciprocating masses in single and multi-cylinder engines. **(3+3)**

GYROSCOPES

Gyroscopes - basic concepts gyroscopic law, effect of gyroscopic couple on automobiles, ships, aircrafts. **(3+3)**

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. **(5+5)**

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

TOTAL : 60

TEXT BOOKS

1. *Ashok Ambekar, "Mechanisms and Machine Theory", Prentice Hall, 2014.*
2. *Rao J. S and Gupta K, "Introductory Course on Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd., New Delhi, 2013.*

REFERENCES

1. *Thomas Bevan, "Theory of Machines", CBI Publishers, 2009.*
2. *Amitabha Ghosh and Asokkumar Mallik, "Theory of Mechanism and Machines", 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 edition, 1998.*
5. *Rattan S. S, "Theory of Machines", McGraw-Hill, 2012.*
6. *V. P. Singh, "Theory of Machines", Dhanpat Rai & Co, 2011.*
7. *NPTEL courses: http://nptel.iitm.ac.in/courses.php, related web and video resources on Kinematics of Machines and Dynamics of Machines.*

15ME44 - MANUFACTURING SCIENCE AND TECHNOLOGY

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Prepare a pattern, riser, and gating system to produce grey cast iron castings using sand molds. Assess solidification process in steel castings in terms of pouring times and cooling times, and predict directional solidification and grain growth during cooling.*

CO2 *: Compute blanking forces, design punches and dies, and develop process plans for making sheet metal products.*

CO3 *: Calculate forging forces for cold and hot working conditions of ferrous and non ferrous metals under sliding and sticking friction.*

CO4 *: Calculate stresses and strains produced in cold rolled ingots, bars, plates and sheets in rolling mills using theories of sliding and sticking friction.*

CO5 *: Assess the suitability of using SMAW, GMAW, GTAW, SAW to weld ferrous alloys, and examine the effect of residual stresses and distortion.*

METAL CASTING

Casting process - introduction, steps involved, types, advantages, limitations and applications of casting process. Pattern - design, types, allowances for pattern, pattern materials. Molding sand preparation, types, composition, properties & testing; core - making, core print; melting practice and furnace; gating design, types, gating ratio - aspiration effect; riser design and placements, directional solidification - Metallurgical aspects of Casting - casting defects - problems. **(7+7)**

METAL FORMING

Sheet metal forming - Basic principles, applications and operations - shearing, parting, notching, punching, blanking, piercing and bending. Types of press and dies. Analysis of Sheet metal forming - punch and die clearance - Bending & spring-back-blank holding force - Cup drawing, deep drawing- drawing force, coining and embossing. Other forming processes - principles, methods, essential requirements and applications of spinning. **(7+7)**

Metallurgical aspects of metal forming; Elastic & plastic deformation, yield criteria (Mises' and Tresca's). Hot, warm and cold working processes: forging - operations, types, forging dies; types, materials, Analysis for load estimation with sliding friction, sticking friction and mixed condition for slab and disc (equilibrium equation method), forging force calculations - forging defects. Rolling: introduction - types, characteristics and applications, Analysis of rolling - effect of friction - maximum draft - neutral point - forces in rolling and rolling defects; extrusion and wire drawing - principles and requirements, classification, methods and applications. Analysis of extrusion - effect of friction - shape factor - extrusion and drawing force, optimal reduction in cross sectional area - problems. **(8+8)**

METAL JOINING

Mechanical joining - temporary, semi-permanent and permanent - welding, brazing and soldering, adhesive bonding, fusion welding - introduction, basic principle, classifications, characteristics and applications - chemical, gas welding, thermit welding. Electrical arc welding - emission and ionization of arc - characteristics of power sources, thermal and metallurgical aspects of welding - peak temperature - SMAW, GMAW, GTAW, SAW; induction welding; plasma arc welding; Resistance welding, design and types. Laser beam welding and electron beam welding; solid state welding: - principles, methods, requirements and applications; welding defects, causes and remedy; Residual stresses and distortion in welding - effects and types. Effect of heat distribution. Science in adhesive bonding. **(8+8)**

TOTAL : 60

TEXT BOOKS

1. *Rao P. N, "Manufacturing Technology", vol. 1, 4th Edition, Tata McGraw-Hill, 2013.*
2. *Amitabha Ghosh and Asok Kumar Mallik, "Manufacturing Sciences", 2nd Edition, East - West Press Pvt. Ltd., 2010.*

REFERENCES

1. *Khan M. I. and SerajulHaque, "Manufacturing Sciences", PHI Learning Pvt. Ltd., 2011.*
2. *Serope Kalpakjian, and Steven R. Schmid, "Manufacturing Processes for Engineering Materials", 5th Edition, Pearson Education, 2009.*
3. *Roy A. Lindberg, "Processes and Materials of Manufacture", 4th Edition, PHI Learning, 2008.*
4. *Timings R. L. and Wilkinson S. P., "Manufacturing Technology: Vol. 1", 2nd Edition, Longman, 1998.*
5. *Prashant P. Date, "Introduction to Manufacturing Technologies: Principles & Practice", Jaico Publishing House, 2010.*

15ME45 - GAS DYNAMICS AND PROPULSION SYSTEMS

(Use of approved gas tables is permitted)

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Derive and apply equations for one-dimensional compressible flow from integral forms of the governing equations for inviscid fluid flow*

CO2 *: Determine geometric design parameters required to accelerate or decelerate an isentropic flow for a given type of nozzle or diffuser, operating under specified conditions*

CO3 *: Analytically estimate the length of a one-dimensional constant area duct to achieve desired changes in properties via the effects of friction and heat transfer*

CO4 *: Analytically evaluate changes in physical properties when a normal shock occurs in one-dimensional constant area or variable area ducts*

CO5 *: Analyze flow through different components of aircraft propulsion systems (diffuser, compressor, combustion chamber, turbine and nozzle) using principles of thermodynamics*

FUNDAMENTALS OF COMPRESSIBLE FLOW

Basics of Thermodynamics - First law, Second law and Entropy. Basics of Fluid Mechanics - Properties and types of fluids, Compressibility. Integral forms of conservation equation for inviscid flows - control volume approach. **(5+5)**

ONE DIMENSIONAL FLOW - ISENTROPIC

One dimensional flow equations - Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles. **(6+6)**

FLOW THROUGH CONSTANT AREA DUCT

One-dimensional flow with heat addition (Rayleigh flow) - analysis and working equations for perfect gas - thermal chocking - reference state and Rayleigh table. One-dimensional flow with friction (Fanno flow) - analysis and working relations for perfect gas - limiting point - friction chocking - reference state and Fanno table. **(6+6)**

NORMAL SHOCK WAVES

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

PROPULSION SYSTEMS

Aircraft propulsion - Jet engines - energy flow, study of turbojet engine components - diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines - thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet engine. Rocket propulsion - rocket engines thrust equation - effective jet velocity specific impulse - rocket engine performance, solid and liquid propellants, comparison of different propulsion systems. **(7+7)**

TOTAL : 60

TEXT BOOKS

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

REFERENCES

1. *Robert D. Zucker, Oscar Biblarz, "Fundamentals of Gas Dynamics", Wiley India Pvt. Ltd., 2nd 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, 5th Edition, 2003.*
4. *Philip Hill, Carl Peterson, "Mechanics and Thermodynamics of Propulsion", Pearson Education, 2nd Edition, 2011.*
5. *Babu V., "Fundamentals of Gas Dynamics", John Wiley & Sons, 2015.*
6. *Oosthuizen P. H. and Carscallen W.E., "Compressible Fluid Flow", McGraw Hill, 1997.*

15ME46 - STRENGTH OF MATERIALS LABORATORY AND EMBEDDED PROCESSOR ARCHITECTURE AND PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

STRENGTH OF MATERIALS LABORATORY

COURSE OUTCOME

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

CO1 *: Assess the strength properties of mild steel rod and brick*

CO2 *: Assess the hardness number of various materials*

CO3 *: Assess the impact load on given metal.*

CO4 *: Calculate the deflection of wood and springs.*

CO5 *: Assess the flexural strength in beams*

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.

REFERENCES

1. *Strength of Materials Laboratory Manual, Department of Civil Engineering, CIT, 2015.*
2. *Rajput R.K, "Strength of Materials", S.K. Kataria and Sons, New Delhi, 2007.*
3. *I.S: 3495 Part I to IV - 1976, "Methods of Test for Burnt Clay Building Bricks", Bureau of Indian Standards, New Delhi.*

EMBEDDED PROCESSOR ARCHITECTURE AND PROGRAMMING LABORATORY

COURSE OUTCOME

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

CO1 *: Develop simple programs for ARM Processor*

CO2 *: Analyze the input and output modules working through ARM development platform*

CO3 *: Experiment with display devices- LED &LCD using ARM Processor*

CO4 *: Test the stepper motor setup for different step angle rotation using ARM processor*

CO5 *: Develop programs for interfacing various devices with ARM Processor*

LIST OF EXPERIMENTS WITH ARM PROCESSOR

1. LED interfacing
2. 7 Segment LED Interfacing

3. Keypad 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. DC Motor interfacing

REFERENCES

1. *Embedded processor architecture and programming laboratory Manual, Department of Electrical Engineering, CIT, 2015*
2. *Jonathan W. Valvano, "Introduction to ARM Cortex - M Microcontrollers", 4th edition, 2013.*
3. *Joseph Yiu, "A Definitive guide to the ARM Cortex-M0", Newnes, 2011.*

15ME47 - MECHANISMS AND MACHINES LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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

CO1 *: Design mechanisms to accomplish a specified task (translation, rotation, force transmission, pick and place), taking into consideration the principles of kinematics and dynamics using graphical-based and text-based programming environments of matrix laboratory.*

CO2 *: Calculate gyroscopic couple and prove the effect of gyroscopic couple on a rotating mass for different speeds using motorized gyroscopic apparatus.*

CO3 *: Determine the whirling speed for different diameter of shafts, attached to fixed and free end bearings.*

CO4 *: Determine the jump phenomenon in various types of cams and followers and compare its displacement plots.*

CO5 *: Compare various types of governors and can also determine sensitiveness, power, effort and controlling force at given speed for each governors.*

CO6 *: Determine radius of gyration for pendulums, bi-filar and tri-filar suspensions and calculate the time taken to complete certain oscillations.*

LIST OF EXPERIMENTS

1. Modelling the positions of joints in a four bar mechanism using MATLAB.
2. Kinematic and Dynamic analysis of a four bar mechanism using MATLAB.
3. Modelling the positions of joints in a slider crank mechanism using MATLAB.
4. Kinematic and Dynamic analysis of a slider crank mechanism using MATLAB.
5. Study of gyroscopic couple using motorized gyroscope apparatus.
6. Finding the whirling speed of a shaft using whirling of shafts demonstrator.
7. 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 forced damped vibrations of a simply supported beam
8. Experiment on different types of cam and followers.
9. Finding the controlling force at a given speed, sensitiveness at given limits of lift and governor effort and power of various type of governors.
10. Study of helical gear, worm gear, epi-cyclic gear, four bar mechanism and Scotch yoke mechanism.

REFERENCES

1. *Mechanisms and Machines Laboratory manual, Department of Mechanical Engineering, CIT, 2015.*
2. *Rudra Pratap, "Getting started with MATLAB", Oxford University Press, 2010.*
3. *Dan B. Marghitu, "Mechanism and Robot Analysis with MATLAB", Springer-verlag London limited, 2010.*
4. *Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, "A Guide to MATLAB: For Beginners and Experienced Users", Cambridge University Press, 2014.*
5. *Javier E. Hasbun, "Classical Mechanics with MATLAB Applications", Jones and Bartlett Publishers, 2010.*

15ME48 - ADVANCED COMPUTER GRAPHICS PRACTICE

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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

CO1 *: Construct the Surface Modeling and the User Coordinate System for a given component*

CO2 *: Practice Viewports, Model space, Paper space and Layouts*

CO3 *: Develop Blocks Attributes and External Reference for the mechanical component*

CO4 *: Develop Menus, Macros and Advanced Rendering and Animation*

CO5 *: Design the solid and surface modeling of mechanical components using AUTOCAD commands*

LIST OF 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

REFERENCES

1. *CIT, "VRET Training Centre Manual", AutoCAD Level-II (Intermediate Level).*
2. *Prof. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers", Dream Tech Press, 2016.*
3. *George Omura, "Mastering AutoCAD 2015 and AutoCAD LT 2015", Wiley India Pvt. Ltd.*

15EEC01 - EMPLOYABILITY SKILLS

L	T	P	C
0	2	0	1

ASSESSMENT : : PRACTICAL

COURSE OUTCOME

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

CO1 *: Apply goal setting guidelines to prepare short and long term goals with time management techniques.*

CO2 *: Demonstrate self-introduction and develop discussion on a specific topic in the interview process.*

CO3 *: Use wide range of vocabulary in speaking for effective communication and develop resume and covering letter for applying jobs online.*

CO4 *: Recognize different leadership styles and qualities for problem solving and ability to integrate others to work towards common goals.*

GOAL SETTING AND TIME MANAGEMENT

Goal Setting - Immediate, Short Term and Long Term Goals - Smart Goals - Strategies to Achieve Goals - Confidence Building, Self-esteem, Motivation - Time Management - Identifying Time Wasters - Time Management Skills. **(6)**

SPEAKING

Ice-breakers - Self introduction - Role Play - Debate - Group Discussion: Purpose - Group Behavior - Analyzing Performance. Job Interviews: Identifying Job Openings - Interview Process - Types of Questions - Mock Interviews - Professional Grooming. **(7)**

READING AND WRITING

Reading Comprehension - Speed Reading Necessary for Reading Letters and Files - Vocabulary Development - Preparing Job Applications - Writing Covering Letter and Résumé - Applying for Jobs Online - Creative Writing - Article Writing - Book Review. **(6)**

LISTENING

Listening to - Conversations, Long Speeches, Narrations, Descriptions, Famous Speeches. **(5)**

LEADERSHIP AND TEAM MANAGEMENT

Qualities of a Good Leader - Leadership Styles - Decision Making - Problem Solving - Etiquettes - Email, Professional, Dining & Telephone - Team Building - Team Work - Delegation. **(6)**

TOTAL : 30

REFERENCES

1. *ArunaKoneru, "Professional Communication", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.*
2. *Jones, Leo and Richard Alexander, "New International Business English", Cambridge University Press, 2003.*
3. *Corneilssen, Joep, "How to Prepare for Group Discussion and Interview", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2009.*

15ME51 - HEAT AND MASS TRANSFER

(Use of Heat and Mass Transfer Data Book is permitted)

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Identify, formulate and solve heat transfer engineering problems. Apply suitable model for a physical system, principles of heat transfer mechanism, thermodynamics, fluid mechanics, and materials to obtain a solution that satisfies the constrain; Deduce and estimate heat transfer rate for one dimensional steady, unsteady state heat transfer problems with relevant boundary and initial conditions.*

CO2 : *Derive the fundamental among relationships between fluid flow, convection heat transfer and choose empirical correlations for both forced and free convection to determine values for the convection heat transfer coefficient. Calculate heat transfer rates using the coefficients.*

CO3 : *Show the physical nature of thermal radiation and its interaction with matter and able to calculate radiation heat exchange between two or more surfaces.*

CO4 : *Outline the theory of pool boiling, flow boiling and laminar and turbulent film condensation.*

CO5 : *Perform Heat transfer analysis using LMTD NTU method depending on the nature and of problem and available data and to perform thermal analysis of various types of heat exchangers. Calculate mass transfer and heat transfer by using empirical correlations.*

MODES OF HEAT TRANSFER

Introduction - Various modes of heat transfer - Laws of Fourier, Newton and Stefan Boltzmann, Combined modes of heat transfer, and overall heat transfer coefficient. **(2)**

STEADY HEAT CONDUCTION IN ONE DIMENSION

General Heat Conduction Equation - One dimensional heat flow through Composite slabs, Cylinder and Spheres (with and without heat generation) - Effect of Variable thermal Conductivity - Insulation - Critical thickness. **(15)**

FINS AND UNSTEADY HEAT CONDUCTION

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 and Grober Charts. **(15)**

CONVECTION

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

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

Free Convection:-Vertical surfaces - Horizontal surfaces - heat transfer coefficient - heat transfer 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. **(6)**

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. **(3)**

HEAT EXCHANGERS

Classification of Heat exchangers - Logarithmic Mean Temperature Difference - Parallel, Counter and Cross flow, Multi passes flow - fouling factor. Effectiveness - NTU method. **(5)**

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. **(5)**

TOTAL : 60

Note : Question paper is to be set so as to distribute the questions as per the contact hours for the topic.

TEXT BOOKS

1. *Holman, J.P., "Heat Transfer", McGraw Hill Book Co., SI Version, 10th Edition, 2009.*
2. *C.P.Kothandaraman and S.Subramanyan, "Heat and Mass Transfer Data Book", New Age International Publishers, 2008.*

REFERENCES

1. *Ozisik M.N.,"Heat Transfer", Mc Graw Hill., 1985.*
2. *Frank P. Incropera, David P. DeWitt, "Heat and Mass Transfer", John Wiley and Sons (ASIA) Pvt. Ltd., 2008.*
3. *P.K. Nag, "Heat and Mass Transfer", 3rd Edition, Tata McGraw Hill Co., 2011.*
4. *Domkundwar and Domkundwar, "Heat and Mass Transfer Data Book", Dhanpat Rai and Co., 2008.*

15ME52 - MACHINING TECHNOLOGY AND SURFACE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Calculate cutting force, tool life of single point and multi point tools, illustrate cutting tool geometry and chip formation, in orthogonal metal cutting process.*

CO2 *: Produce a machine part using centre lathe, boring, shaping, planning, drilling, milling machines, and illustrate gear manufacturing and forming.*

CO3 *: Use additive manufacturing process (Stereolithography, Selective laser sintering, Fused deposition modeling) to create complex component by virtual prototyping.*

CO4 *: Choose and apply unconventional machining processes (Chemical Machining, Electro-Chemical Machining, Grinding, Wire EDM, Laser, Electron Beam Machining, Water and Abrasive Jet Machining) to produce components from hard and smart materials.*

CO5 *: Use a suitable surface finishing process (Plating, Cladding, Case Hardening and metal Spraying and Deposition and surface texturing) for improving surface integrity of ferrous and non ferrous metal components.*

FUNDAMENTALS OF METAL CUTTING

Introduction - classification of cutting tools - Cutting tool geometry - design of single and multi-point cutting tools - tool signature. Mechanics of chip formation - merchant diagram - Relationship between friction, shear and rake angle - Analysis of cutting forces; single point and multipoint tool machining processes. Heat generation and cutting tool temperature analysis. Cutting fluid, failure of cutting tools, tool wear - tool life and machinability - surface finish - cutting tool materials - problems. **(12)**

MACHINE TOOLS

Introduction to machine, working principle and operations; Lathe, Boring, Shaping, Planing, Drilling, Milling, Grinding, Broaching and sawing - special purpose lathe - Gear manufacturing; Principles of generation and forming. **(8)**

RAPID PROTOTYPING PROCESSES

Introduction - Subtractive Processes - Additive Processes - Virtual Prototyping - Direct Manufacturing and Rapid Tooling.**(6)**

ADVANCED MACHINING PROCESSES

Introduction - Chemical Machining - Electro-Chemical Machining - Electro-Chemical Grinding - Electrical Discharge Machining - Wire EDM - Laser Beam Machining - Electron Beam Machining - Water Jet Machining - Abrasive Jet Machining - Nanofabrication - Micromachining - Economics of Advanced Machining Processes. **(9)**

SURFACE ENGINEERING

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. **(10)**

TOTAL : 45

TEXT BOOKS

1. *Rao P. N, "Manufacturing Technology", Vol. 2, 4th Edition, Tata McGraw-Hill, 2013.*
2. *Serope Kalpakjian, and Steven R. Schmid, "Manufacturing Engineering and Technology", 5th Edition, Pearson Education, 2015.*

REFERENCES

1. *Khan M. I. and SerajulHaque, "Manufacturing Sciences", PHI Learning Pvt. Ltd., 2011.*
2. *Prashant P. Date, "Introduction to Manufacturing Technologies: Principles & Practice", Jaico Publishing House, 2010.*
3. *Timings R. L., Wilkinson S. P., "Manufacturing Technology: Volume 2", 3rd edition, Longman, 2010.*

15ME53 - DESIGN OF MACHINE ELEMENTS

(Use of approved design data book is permitted)

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Determine a suitable size for a specified machine element to withstand a given load and permissible stress conditions (Normal , Shear , torsional combination of normal and shear stresses) using Principal stresses, Theories of failure, Fatigue failure (Soderberg, Goodman and Gerbers equations).*

CO2 *: Design using factor of safety and permissible stresses, and provide a drawing of a power transmission shaft, Flange, Hub, and Key for a Rigid and Flexible coupling to transmit specified power and torque.*

CO3 *: Design a spring (compression, co-axial, Leaf) or a flywheel for various applications (Railway buffer spring, Automobile suspension, Toys, Punching machine) to store energy and prevent unwanted shock and vibrations.*

CO4 *: Design metric bolts, rivets and welded joints (diameter, size and thickness) for centrally, axially and eccentrically loaded, unsymmetrical sections, to withstand specified loads.*

CO5 *: Design and choose a suitable bearing (ball, roller, or journal) using Design Data Book to with standard specified loads (axial and radial load) for specified life.*

DESIGN FUNDAMENTALS FOR MACHINE ELEMENTS

Introduction to design process-factors influencing in machine design - types of stresses, stress-strain diagram, 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. **(6+6)**

DESIGN OF SHAFTS AND COUPLINGS

Forces on shafts due to gears, belts and chains - design of shafts based on strength, torsional rigidity and critical speed. Design of square and taper key - use of standards - design of rigid coupling, flexible flange couplings, and applications. **(6+6)**

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. **(6+6)**

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. **(6+6)**

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. **(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Robert L Mott., "Mechanical Elements in Mechanical Design", 5th Edition, Macmillan Publishing Co., London, 2013*
2. *V. B. Bhandari, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Publishing Ltd., New Delhi, 2013.*

REFERENCES

1. *S. S. Wadhwa, Er. S. S. Tolly, "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", 8th Edition, McGraw-Hill, Inc., New Delhi, 2008.*
4. *Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 5th Edition, Wiley, 2011*
5. *Jacobson B. O., Bernard J. Hamrock and Steven R. Schmid, "Fundamentals of Machine Elements", Third 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".*

HAND BOOK

1. *PSG, "Design Data Book", Kalaikathir Achagam Publishers, 2011.*

15ME54 METROLOGY AND QUALITY CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Handle various linear and angular measuring instruments and able to design plug and ring gauges.*

CO2 *: Demonstrate various measurements in elements of screw thread and gear tooth parameters by using floating carriage micrometer, gear tooth vernier caliper.*

CO3 *: Illustrate surface finish measurements and Interferometry principles by using different types of stylus probe instruments, interferometers, projectors and microscopes.*

CO4 *: Demonstrate various SQC tools and analyse the data statistically to Interpret various control charts like $\overline{X}$, R, p, np, and C and decide upon action to be taken for controlling quality.*

CO5 *: Practice the concepts of sampling, constructing OC curves and reliability evaluation for inspection and quality control.*

INTRODUCTION TO METROLOGY

Basic concepts, importance of metrology, standards of measurement, concepts of limits, fits & tolerances, precision and accuracy, sources of errors, linear measuring instruments - advantages & limitation of commonly used precision instruments. Angular measuring instruments - Slip gauges, comparators, dial indicator, calibration, Interchangeability, Taylor's principle, design of plug and ring gauges. **(9)**

THREAD AND GEAR METROLOGY

Elements of screw thread, errors in threads, measurement of major diameter, minor diameter, effective diameter, pitch - floating carriage micrometer. Elements of gear, measurement of tooth thickness (constant chord method), gear tooth vernier, Measurement of pitch, profile errors and total composite errors of gears. **(9)**

SURFACE FINISH MEASUREMENTS AND INTERFEROMETRY

Surface topography - definitions, CLA, Ra, RMS, Rz values and their interpretation, measurement of surface finish stylus probe instruments - Talysurf profilometer and Tomlinson surface meter. Interferometry - principle, types of interferometers - Michelson, Twyman Green Specialisation of Michelson, NPL flatness Interferometers, The Pitter NPL gauge - laser interferometer. Optical projectors and microscopes. **(9)**

STATISTICAL QUALITY CONTROL AND CONTROL CHARTS

SQC, Seven QC tools, chance causes and assignable causes, case studies on application of SQC. Probability distributions - binomial, poisson, geometric, hyper geometric, poisson as an approximation to binomial, normal as an approximation to binomial, Need for control charts, control charts for variables - X bar and R chart, control charts for attributes - p, np, C charts, analysis of patterns of control charts, evaluation of process capability. **(9)**

ACCEPTANCE SAMPLING AND RELIABILITY

Sampling Inspection - concepts of acceptance sampling, sampling plans - simple - double - multiple and sequential sampling plans, producer risk and consumer risk Operating Characteristic (OC) curves - construction, average out going quality level, average total inspection,. Reliability - definition, Mean Time Between Failure (MTBF), Mean Time To Repair (MTTR), types of failure, failure rate, evaluation of reliability-series, parallel and series-parallel device configurations. Redundancy and improvement factors evaluations. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Mahajan.M., "A Text Book of Metrology", Dhanpat Rai and Sons, New Delhi, 2010.*
2. *Montgomery D.C., "Introduction to Statistical Quality Control", John Wiley and Sons, 2012.*

REFERENCES

1. *Gupta. I. C., "Text Book of Engineering Metrology", DhanpatRai and Sons, New Delhi, 2000.*
2. *Jain. R.K., "Engineering Metrology", Khanna Publishers, New Delhi, 2007.*
3. *ASTME, "Hand book of Industrial Metrology", Prentice hall of India Pvt. Ltd, New Delhi, 1992.*
4. *Mahajan. M., "Statistical Quality Control", Dhanpat Rai and Sons, New Delhi 2010.*

15ME55 - DESIGN AND MACHINE DRAWING PRACTICE

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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

CO1 *: Construct, read and interpret sectional views and missing views of machine component.*

CO2 *: Evaluate and recommend appropriate geometric tolerances and surface finish of the mechanical component based on their application.*

CO3 *: Design mechanical joints (riveted, welding and key) and cam profiles (type of follower and its motion).*

CO4 *: Prepare detailed assembly drawings of simple machine components.*

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.

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.

DESIGN AND REPRESENTATION OF RIVETED JOINTS

Rivet and riveting - classification of rivet - terminology of riveted Joint - types of joints - representation of different riveted joints.

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.

DESIGN AND REPRESENTATION OF WELD JOINTS

Introduction of welding- types of welded joints - representation of welds - symbols and its conventions - representation of different weld procedures.

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.

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.

TOTAL : 60

REFERENCES

1. *N.D.Bhatt and V.M.Panchal, "Machine Drawing", 46th Edition, Charotar Publishing house Pvt. Ltd., 2013.*
2. *K. C. John, "Text book of Machine Drawing", PHI Learning Pvt. Ltd, New Delhi, 2009.*
3. *N.Sidheswar, P.Kannaiah, and V.V.S.Sastry, "Machine Drawing", 33rd Reprint, Tata McGraw-Hill India Publications, 2010.*
4. *Gopalakrishna K. R., "Machine Drawing", 20th edition, Subhas Stores, Bangalore, 2007.*
5. *Gill.P.S., "Machine Drawing", Kataria.S.K& Sons, 2012.*
6. *"Design Data Book", PSG College of Technology, Kalaikathir Achagam, Coimbatore, 2012.*
7. *ASME Y 14.5 -2009, "Dimensioning and Tolerancing", ASME, New York, 2009.*

15ME56 - MACHINE SHOP PRACTICE AND FOUNDRY AND WELDING LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

MACHINE SHOP PRACTICE

COURSE OUTCOME

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

CO1 *: Demonstrate Principle and operations of a center lathe to produce cylindrical components of ferrous metals (mild steel).*

CO2 *: Apply taper turning process and create a conical shape component up-to 50 mm diameter made of ferrous and nonferrous metals by using center lathe.*

CO3 *: Apply threading process to generate external V - threads and find the pitch, speed and feed of center lathe.*

CO4 *: Apply metal removing process to generate holes by drilling process and enlarge it by boring process through a center lathe.*

CO5 *: Develop surface texture of cylindrical components by using knurling and chamfering processes by center lathe.*

CO6 *: Create a contour shape like concave and convex shapes on cylindrical components of ferrous and non ferrous using center lathe.*

LIST OF EXPERIMENTS

1. Study of machine shop layout and machine tools.
2. Plain and Step Turning.
3. Grooving and Taper Turning.
4. Knurling and Thread Cutting.
5. Drilling and Boring operation.
6. Form turning - Convex / concave.

REFERENCE

1. Machine shop and special machines practice Manual, Department of Mechanical Engineering, CIT.

FOUNDRY AND WELDING LABORATORY

COURSE OUTCOME

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

CO1 *: Differentiate the shielded metal arc from oxyacetylene welding process to join mild steel plate of 3 mm thickness using Butt, Lap, T, and Corner Joint configuration, as well as straight line laying of weld beads respectively.*

CO2 *: Practice Butt Joint, Lap joint, T Joint, and Corner Joint in mild steel of 3 mm thickness using shielded metal arc welding process, as well as cleaning of beads done using Chipping Hammer and welding wire brush.*

CO3 *: Practice straight laying of weld bead in mild steel of 3 mm thickness using oxyacetylene welding.*

CO4 *: Find suitable mold making process and pattern to perform Packing Gland, Bracket, Stepped Pulley, Bend Pipe, Loose Piece, and Square Box patterns.*

CO5 *: Justify that the sand molding process and wooden pattern also produce the Packing Gland, Bracket, Stepped Pulley, Bend Pipe, Loose Piece, and Square Box pattern.*

LIST OF EXPERIMENTS

Foundry Laboratory

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.

Welding Laboratory

1. Study of welding process and equipments.
2. Make a "Butt Joint" from the given M. S. plates by using of arc welding and write down the procedure.
3. Make a "Lap joint" from the given M. S. plates by using of arc welding and write down the procedure.
4. Make a "T Joint" from the given M. S. plates by using of arc welding and write down the procedure.
5. Make a "S Joint" from the given M. S. plates by using of arc welding and write down the procedure.
6. To prepare a straight line laying by oxy-acetylene welding.
7. Make a "Butt Joint" from the given M. S. plates by using of gas welding and write down the procedure.
8. Make a "Corner Joint" from the given M. S. plates by using of arc welding and write down the procedure.

REFERENCE

1. Foundry and Welding Laboratory Practice Manual, Department of Mechanical Engineering, CIT.

15ME61 - COMPUTER AIDED DESIGN AND MANUFACTURING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Write algorithms to generate primitives of line, circle and ellipse and visualize them in graphical display devices (raster & random scan systems).*

CO2 : *Set up transformations to translate, rotate, scale, shear and reflect 2-D and 3-D objects under specified conditions. Generate clipping algorithms used in a CAD system for viewing a 2-D entity. Will be able to generalize the visible surface detection methods (scan line, depth sorting, etc.) for viewing a 3-D entity.*

CO3 : *Derive equations of Hermite, Bezier and B-Spline curves, Bezier and B-Spline surfaces in explicit, implicit and parametric representations for curve and surface modelling and creation.*

CO4 : *Specify different process planning techniques (variant and generative) to manufacture a product using CNC machines. Will be able to set-up Flexible Manufacturing Systems and Group Technology (coding system) concepts for product variety.*

CO5 : *Apply MRP-I, MRP-II, Shop floor control, scheduling techniques and data acquisition system for enhancing the effective utilization of the men, machine, materials and etc.*

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-Computer Assisted Process Planning (CAPP) -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. *Ibrahim Zeid and R.Sivasubramanian, "CAD/CAM: Theory and Practice", McGraw Hill Education (P) Ltd., 2010.*
2. *Amarendra N Sinha and Arun D Udai, "Computer Graphics", Tata Mc Graw - Hill Publication Company Ltd., New Delhi, 2008.*
3. *Radhakrishnan.P and Kothandaraman C.P.,"Computer Graphics and Design", Dhanpat rai and Sons (P) Ltd., 2009*

REFERENCES

1. *Mikell.P.Groover and Emory Jimmers W, "CAD/CAM", Prentice Hall of India (P) Ltd., 2009.*
2. *Surendra Kumar and Jha A.K, " Technology of CAD/CAM", Dhanpat Rai and Sons (P) Ltd., 2009.*
3. *Radhakrishnan P and Subramaniam S,"CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., Delhi, 2010.*
4. *Donald Hearn and Pauline Baker, "Computer Graphics", Pearson Publication, 2011.*
5. *Banerjee.K, "Computer Management and Planning", Tata McGraw Hill Education (P) Ltd, New Delhi 2010.*

15ME62 - ENGINEERING OPTIMIZATION

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Formulate single or multi-variable engineering optimization problems and comply with the appropriate objective functions.*

CO2 *: Select the appropriate optimization technique for the specified engineering problems based on number of variables and constraints.*

CO3 *: Derive, develop and utilize the possible randomness or any other associated factors that would possibly occur during constrained and unconstrained optimization situations.*

CO4 *: Choose the right approach and suitable optimization technique for the formulated optimization problem.*

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. **(7+7)**

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. **(7+7)**

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. **(8+8)**

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. **(8+8)**

TOTAL : 60

TEXT BOOKS

1. *S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons, 2009.*
2. *K. Deb, "Optimization for Engineering Design", 2nd Edition, Prentice Hall India, 2012.*

REFERENCES

1. *J. S. Arora, "Introduction to Optimum Design", 4th Edition, Academic Press, 2016.*
2. *H. Adeli, "Advances in Design Optimization", Chapman and Hall, 2008.*
3. *Robert F. Rhyder, "Manufacturing Process Design and Optimization", Marcel Dekker: New York, 1997.*
4. *Mohan. C. Joshi & Kannan. M. Moudgalya, "Optimization Theory and Practice", Narosa Publishing House, 2004.*

15ME63 - AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Demonstrate the principles of automobile engineering, present development and future trends.*

CO2 *: Illustrate advanced combustion system for single and multicylinder engines, (recent developments of stratified charged engines, lean burn engines, turbocharged engines) and advanced technologies in automotive sector.*

CO3 *: Demonstrate automobile auxiliary systems like conventional and electronic fuel injection system, charging, starting and lighting system. .*

CO4 *: Apply working principles of transmission system, manual and automatic clutch and power train system.*

CO5 *: Demonstrate principle of steering, steering geometry and wheel alignment, specification tyres, types of steering gear box and suspension system.*

CO6 *: Demonstrate wheels, types of brakes and future trends of alternative fuel systems.*

INTRODUCTION

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

AUTOMOTIVE ENGINES

Types of engines (HCC, GDI, GDCI, TDI, Multijet Engine) - engine rating - multi cylinder - Power & Mechanical balance - firing order - rotary engines - stratified charged engines - Lean burn engines - Turbocharged engines- Emission and its control Exhaust gas Recirculation (EGR). **(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 system (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-Ethanol - Compressed Natural Gas (CNG) - Liquefied Petroleum Gas (LPG), alternative power plants, Nano flow - 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.*

REFERENCES

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", Sathya Prakashan 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", 4th edition, Prentice Hall, 2009.*
6. *Srinivasan S., "Automotive Mechanics", Tata McGraw Hill, 2nd Edition, 2003.*

15ME64 - ENGINEERING ECONOMICS AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Analyze the demand and supply and sketch a demand and supply curve*

CO2 *: Determine the Breakeven point and find out the strength and weakness of the Market Structure*

CO3 *: Sketch the curve for cost behavior for short run concepts*

CO4 *: Analyze and specify the causes and provide the solution to each cause*

CO5 *: Formulate the steps involved in a recruitment process as a chart and interpret it*

INTRODUCTION

Definition-Nature and Scope-Significance of Economics for Engineers **(5)**

BASICS OF MICRO ECONOMICS

Demand Analysis and Supply Analysis - Elasticity of Demand and Supply - Case Study in Demand Forecasting-Cost concepts-Classifications - Short run and Long run cost curves - Break-even Analysis **(8)**

MARKET STRUCTURE

Classification of Market - Perfect Competition-Characteristics -Monopoly - Monopolistic Competition - Oligopoly and Duopoly - Price Discrimination under different markets - Price and output determination in short run and long run. **(8)**

MONEY AND BANKING

Money - Quantity theory of Money -Supply of Money - RBI Measures of Money Supply - Banking - Functions of Commercial Banks and Central Banks- Balance of Payments - Meaning and methods of Exchange control Methods of Foreign Payments - IMF, IBRD,WTO- Agreements of WTO and its Impact on Indian Economy **(9)**

NATIONAL INCOME

Meaning - National Income - Concepts -Methods of Calculating and Problems in calculating National Income - Inflation - Causes - Measures -Deflation - Stagflation - Philips Curve - Unemployment New Environment Policy- Liberalisation -Privatisation - Globalisation. **(8)**

HUMAN RESOURCE MANAGEMENT

Principles of Management, Evolution of Management, Development of Managerial Skills- Human Resource Management-Importance- Objectives- Job Analysis- Recruitment- Selection and Placement and Training Development. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Dewett .K.K., & Navalur M.H., "Modern Economic Theory", S. Chand and Company Ltd, New Delhi, 2014*
2. *Lipsey & Chrystal, "Economics", Oxford University Press, 2010*
3. *V.S.Bagad, "Principles of Management", Technical Publication, Pune 2013*

REFERENCES

1. *Paul A Samuelson & William, "Economics", Tata McGraw Hill, New Delhi, 2012.*
2. *Francis Cheriunullem, "International Economics", McGraw Hill Education, 2011.*
3. *William A McEachern and Smrit Kaur, "Micro Economics", Cengage Learning, 2013.*
4. *William A McEachern and Indira A., "Macro Economics", Cengage Learning, 2014.*
5. *Lipsey & Chrystal, "Economics", Oxford University Press, 2010.*

15ME65 - DESIGN OF TRANSMISSION SYSTEMS

(Use of Approved design data book is permitted)

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Analyze stresses in belts and select suitable V belt and Narrow V belts and chains for the given power to be transmitted*

CO2 *: Analyze forces acting on the spur, helical, straight and spiral bevel gears and design gear drives based on strength and wear considerations for the given power to be transmitted*

CO3 *: Design pair of worm gears*

CO4 *: Construct ray and kinematic diagram and able to design constant mesh multi speed gear reducer upto 18 speeds*

CO5 *: Analyze forces in power screws and design power screws for screw jack and lathe for the given power to be transmitted.*

CO6 *: Design single plate, multiplate clutches and internal expanding shoe brakes for automotive applications*

DESIGN OF BELT AND CHAIN DRIVES

Belt - Types, belt materials, stresses in belts, condition for maximum power transmission, selection of V belts for the given power and velocity ratio, Selection of Classical (3V, 5V and 8V types) and Narrow V belts (SPZ, SPA, SPB, SPC types). Chain - Types, Geometric relations, polygonal effect, selection of transmission chain and sprockets, silent chains, chain lubrication. **(6+6)**

DESIGN OF GEAR DRIVES

Spur gear - Terminology, gear materials, force analysis, design of spur gear based on strength and wear considerations. Helical gear - terminology, force analysis, pressure angle in the normal and transverse planes, equivalent number of teeth, design of helical gear based on strength and wear considerations. Bevel gear - terminology, virtual number of teeth, force analysis, design of straight bevel gears. **(6+6)**

WORM GEARS AND MULTI SPEED GEAR BOX

Worm gear - Terminology, materials, force analysis, thermal considerations, efficiency, design of worm gears. Gear box- Geometric progression, step ratio, ray diagram, Kinematic diagram, design of multispeed gear box upto 18 speeds. **(6+6)**

POWER SCREWS

Forms of threads, terminology, torque requirement - lifting/lowering load, self-locking screw, efficiency, square and trapezoidal threads, collar friction, design of power screws for screw jack, lathe, selection of ball screw. **(6+6)**

FRICTION DRIVES

Clutches - role of clutches, classification, design of single plate, multiple plate and cone clutches. Brakes - Role of brakes, types, self-energizing brakes, design of internal expanding shoe brakes, calculation of heat generation and heat dissipation in brakes. **(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Bhandari V.B., "Design of Machine Elements", 3rd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2016*
2. *Joseph Edward Shigley, Charles R. Mischke, Richard Gordon Budynas, "Mechanical Engineering Design", 7th edition, McGraw Hill, Inc., New Delhi, 2012.*

REFERENCES

1. *Robert L Mott, "Machine Elements in Mechanical Design", Macmillan Publishing Co., London, 2010*
2. *Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill, New Delhi, 2012*
3. *Robert L Norton, "Machine Design - An Integrated Approach", Pearson Education, New Delhi, 2015*
4. *Prabhu T.J., "Design of Transmission Elements", Mani offset, Chennai, 2013*
5. *Darle W Dudley, "Hand Book of Practical Gear Design", CRC Press, Florida, 2015.*

HAND BOOK

PSG, "Design Data Book", Kalaikathir Achagam Publishers, 2011.

15ME66 - SPECIAL MACHINES LABORATORY AND CAD/CAM LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

SPECIAL MACHINES LABORATORY

COURSE OUTCOME

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

CO1 *: Create a cube, male and female stepped slide, angular slide and curve slide on component made of cast iron using shaping machine.*

CO2 *: Produce a hexagon, octagon profiles and square keyway on ferrous and non ferrous metals using slotting machine.*

CO3 *: Calculate cutting parameters and generate a spur gear and bevel gear of ferrous metals using gear hobbing machine.*

CO4 *: Predict indexing for square, a pentagon, a hexagon, and a triangular head and create them by a vertical milling machine.*

CO5 *: Calculate machining parameters and generate a spur gear and bevel gear by an universal milling machine.*

CO6 *: Create axial and radial holes and make metric threads internally by tapping using drilling machine on cylindrical and non cylindrical components.*

LIST OF EXPERIMENTS

1. To make a cube, stepped slide, male and female stepped slide, angular slide and curve slide using shaping machine.
2. To produce a hexagon, octagon profiles and square keyway using slotting machine.
3. To create a spur gear and bevel gear using gear hobbing machine.
4. To machine a square, a pentagon, a hexagon, and a triangular head using vertical milling machine
5. To produce a spur gear and bevel gear using universal milling machine.
6. To create holes and make threads by tapping using drilling machine.
7. To produce a smooth finished surface using a surface grinding machine.

REFERENCE

1. Special Machines and Workshop Manual, Department of Mechanical Engineering, CIT, 2015.

CAD/CAM LABORATORY

COURSE OUTCOME

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

CO1 *: Draw and reproduce a component in 2-D using sketching commands in modelling software's.*

CO2 *: Produce a 3-D components using basic level (Extrude, revolve,etc..) and advanced levels (equation based curve, surface) of modelling techniques in software's.*

CO3 *: Assemble mechanical engineering components, checking for interference, simulate for assembly mechanism.*

CO4 *: Generate CNC programs for the given component as per drawing by integrating through CNC (Turning and Milling) machines for machining of products.*

LIST OF EXPERIMENTS

Basic Function of Pro-E CAD Package - Sketcher Commands - Part Modeling (Basic Level) - Part Modeling (Advanced Level) - Blower Assembly and Kinematic Mechanism - Modeling of Upper Housing - Modeling of Lower Housing - Modeling of Cover - Modeling of Blower - Modeling of Motor and Shaft - Assembly of All Parts - Manufacturing Part - Surface Modeling (ProE/Creo Parametric)

Study of Turn CNC Lathe - Study of XL Mill / CNC Milling - Study of Feed Back Milling - Turning Model (Contour, Step, CW, CCW, Taper, Step Turn, Chamfer, Threading and Contouring with Facing, Drilling) - Stand alone CNC Lathe Practice - Feed back Milling (Linear Path, Circular Path) - XL Milling Practice. (MasterCAM).

REFERENCE

1. *CAD/CAM Laboratory Manual, Department of Mechanical Engineering CIT, 2015.*

15ME67 - METROLOGY LABORATORY AND HEAT TRANSFER LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

METROLOGY LABORATORY

COURSE OUTCOME

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

CO1 *: Calculate and compare various linear measurements by using vernier calipers, vernier height gauge, vernier depth gauge, micrometers and dial indicator for rectangular and circularshaped components.*

CO2 *: Find angular measurement and to set workpiece for a desired angle with the help of angle gauges, bevel protractor, sine bar and slip gauges for inclined components.*

CO3 *: Calculate various gear tooth parameters like tooth thickness, pitch, profile errors and total composite errors of a given spur gear using gear tooth vernier caliper.*

CO4 *: Find various screw thread elements like major diameter, minor diameter, effective diameter and pitch with the help of floating carriage micrometer, tool maker's microscope and profile projector for a given threaded component.*

CO5 *: Interpret and analyse data for various control charts like P chart, X bar chart and R chart for given specifications and comment on the nature of the process.*

LIST OF EXPERIMENTS

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

REFERENCE

Metrology Lab Manual, Department of Mechanical Engineering, CIT, 2015.

HEAT TRANSFER LABORATORY

COURSE OUTCOME

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

CO1 *: Apply basic concepts of conduction, convection, radiation and heat exchangers to conduct various experiments individually or in teams. Determine heat transfer rates, thermal conductivity, heat transfer coefficient, emissivity, and heat transfer efficiency.*

CO2 *: Operate equipment and use instruments to collect experimental data. Analyze experimental data and their uncertainties, and interpret them. Communicate these interpretations effectively by means reports.*

CO3 *: Find temperature distributions, thermal conductivity of various materials, convective heat transfer coefficient, interpret and analyze forced and free convection using dimensionless numbers; principles of radiation heat transfer and use analyze performance of heat exchangers and heat pipes.*

CO4 *: Identify empirical formulas develop practical problem solving skills and techniques. Develop skills to prepare experiment reports with tables, graphs and present standard format using software tools.*

CO5 *: Practice laboratory safety rules to carry out experiments.*

LIST OF EXPERIMENTS

1. Determination of Radiant Factor and Emissivity using Stefan Boltzmann Apparatus
2. Determination of convective heat transfer co-efficient in Forced Convection
3. Performance Test on Parallel flow and Counter flow Heat Exchangers
4. Determination of convective heat transfer co-efficient in Natural Convection
5. Determination of Thermal Conductivity in Composite walls
6. Determination of Thermal Conductivity in Metal Rod
7. Determination of Thermal Conductivity of Insulation Material using Two Slab Guarded Hot Plate Apparatus
8. Determination of Thermal Conductivity of Insulation Material in Lagged Pipe
9. Determination of Thermal Conductivity of Insulation Powder
10. Unsteady State Heat Transfer Analysis
11. Determination of Heat Transfer Rate in Heat Pipe
12. Determination of Heat transfer in a Pin Fin
13. Critical Heat Flux Apparatus
14. Performance Analysis of a Shell and Tube Heat Exchanger
15. Performance Analysis of a Cross Flow Heat Exchanger
16. Determination of emissivity of a radiating surface

REFERENCE

Heat Transfer Laboratory Manual, Department of Mechanical Engineering, CIT, 2015.

15ME68 - MINI PROJECT

L	T	P	C
0	0	2	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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

CO1 *: Apply skills and knowledge within the chosen area of technology for project development.*

CO2 *: Identify, analyze, formulate and handle simple innovative design and ideas, fabrication and management projects as a team or individual with a comprehensive and systematic approach*

CO3 *: Contribute as an individual or in a team in development of technical projects.*

CO4 *: Develop effective communication skills and financial management for presentation of project related activities.*

CO5 *: Apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline" "understanding of engineering principles and the ability to apply them to analyse key engineering processes." engineering practice includes: "awareness of nature of intellectual property and contractual issues" "ability to work with technical uncertainty."*

15ME71 - FINITE ELEMENT ANALYSIS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Solve governing differential equations of physical problems up to fourth order using variation and weighted residual methods with two and three parameter trial solutions.*

CO2 *: Generate finite element equation and solve simple 1D structural problem of bars, beams and trusses subjected to static loads using finite element method*

CO3 *: Formulate finite element model and solve 2D structural engineering problems under plane stress, planes strain and axisymmetric conditions, with and without numerical integration*

CO4 *: Develop finite element model for eigen value problems and determine the natural frequencies of longitudinal, transverse and torsional vibrations of 1D bar and cantilever and simply supported beams subjected to static loads*

CO5 *: Create finite element equation and analyze 1D and 2D conduction and convection heat transfer problems of composite walls and fins, and fluid flow problems in uniform cross section pipes and in porous media of variable cross section pipes.*

CO6 *: Create finite element model, analyse and interpret the results for real life problems such as structural, thermal, dynamic and fluid flow using ANSYS software*

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. **(6+6)**

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. **(7+7)**

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. **(7+7)**

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. **(5+5)**

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. **(5+5)**

(FOR INTERNAL EVALUATION)

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.

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.*

REFERENCES

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.*

15ME72 - OPERATIONS RESEARCH

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Mathematically formulate a given engineering problem as a linear programming problem, and apply Graphical, Simplex, Two-Phase or Big-M methods to obtain the optimal solution.*

CO2 : *Construct or modify objective functions and constraints using primal and dual relationship, and apply the Dual Simplex Method to obtain optimal solutions.*

CO3 : *Justify the determined feasible solution (processing time and transportation cost) as optimal solution using MODI method and Hungarian method.*

CO4 : *Determine the optimal project duration and cost using CPM and PERT technique, also construct complex project network and control the complex project.*

CO5 : *Categorize (Inventory, Game Theory, Sequencing and Queuing) and solve various decision making problems using mathematical modeling.*

CO6 : *Apply Monte-Carlo simulation technique to solve simple and real time problems.*

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. **(3+3)**

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. **(4+4)**

TRANSPORTATION AND ASSIGNMENT

Formulation of Transportation Problem, Initial Feasible Solution Methods, Optimality Test, Degeneracy in Transportation Problem; Assignment Problem, Hungarian Method, Traveling Salesman Problem. **(4+4)**

NETWORK MODELS

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

INVENTORY AND MODELS

Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model, Newsboy Problem. **(3+3)**

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+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. **(5+5)**

TOTAL : 60

TEXT BOOKS

1. *Mohan, C. and Deep, Kusum: "Optimization Techniques", New Age, 2009.*
2. *Mittal, K. V. and Mohan, C. "Optimization Methods in Operations Research and Systems Analysis", 4th Edition, New Age, 2016.*
3. *Taha, H. A, "Operations Research - An Introduction", Pearson, (9th Edition), 2014.*

REFERENCES

1. *Ravindran, A. , Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2014.*
2. *Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2015.*
3. *S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons, 2009.*

15ME73 - CONTROL THEORY AND MECHATRONICS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Construct a mathematical model of a control system in time domain and derive the transfer function to predict the response of the system in s-domain.*

CO2 *: Determine the stable conditions for a control system using root locus analysis and plot the roots for its characteristic equation in s-plane.*

CO3 *: Design a control system in frequency domain using bode plot and find the stability criteria using nyquist stability criterion method.*

CO4 *: Select a suitable sensor and actuator for a specific application and use it as a feedback device to set up the process again.*

CO5 *: Construct a ladder program for a PLC and thereby controlling a pneumatic, hydraulic or electrical circuits.*

CO6 *: Discuss about existing manual system into automated autonomous system .*

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. **(5+5)**

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. **(5+5)**

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. **(5+5)**

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. **(5+5)**

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, servo motor, DC motor, AC motor - simple problems. **(4+4)**

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. **(4+4)**

APPLICATION AND CASE STUDY

Integration of Mechatronics component subsystems into a complete Mechatronics system, Applications to CNC machines and Robotics. **(2+2)**

Note : Matlab or LabVIEW simulations are for internal evaluation.

TOTAL : 60

TEXT BOOKS

1. *I. J. Nagrath And M. Gopal, "Control Systems Engineering", 6th Edition, New Age Publisher, New Delhi, 2007*
2. *David G. Alciatore, and Michael B. Histand, "Introduction to Mechatronics and Measurement Systems", Tata McGraw Hill, New Delhi.*

REFERENCES

1. *Norman.Nise, " Control.Systems.Engineering", 6th Edition, John Wiley & Sons, Inc, 2011*
2. *Katsuhiko Ogata, " Modern Control Engineering", 5th Edition, Prentice Hall, 2010*
3. *W. Bolton, "Mechatronics", Pearson Education Asia, New Delhi.*
4. *Dan Necsulescu, "Mechatronics", Pearson Education Asia, New Delhi.*
5. *N. P. Mahalik, "Mechatronics", Tata McGraw Hill, New Delhi.*
6. *Wolfram Stadler, "Analytical Robotics and Mechatronics", McGraw-Hill Book Co.*
7. *EroniniUmez-Eronini, "System Dynamics & Control", Thomson Asia.*
8. *Shetty Devdas and Richard A Kolk, "Mechatronics System Design", Thomson Learning, Vikas Publishing House, New Delhi.*

15ME74 - PRODUCTION AND OPERATIONS MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy..*

CO2 *: Predict the future demand by using quantitative approach of various business models for time series analysis.*

CO3 *: Find a better solution for aggregate planning using LDR approach and disaggregate planning using MPS approach to optimize Production Planning.*

CO4 *: Analyze the measuring and available capacity, planned and unplanned loads to determine the available production capacity of an enterprise by using CRP.*

CO5 *: Demonstrate various maintenance schedule techniques for real time applications and also be able to identify the waste and the method of controlling and its disposal.*

INTRODUCTION

Introduction - Primary functions - Evolution of POM - Concept of Production - Production System - Production management - Operation system - Operations management -managing global operations - Factors affecting POM - Ways of studying POM - Design and development - Scope of production and operations. **(9)**

INFORMATION SYSTEMS IN POM

Information system for manufacturing and services - Productions and Operations - Contrasting production and Operations management - Business Model - Transformation process - Input/Output models -Cost and revenues, Profit - Productivity - stages of POM development - Organizational Positions and Career Opportunities in P/OM. **(9)**

MATERIALS MANAGEMENT AND AUTOMATION

Functions of Materials Management - Material Planning and Control - Purchasing - Stores Management - Inventory control - Standardization - Simplification - Value Analysis - Ergonomics - JIT - Automation - Types - Computer Integrated Manufacturing -Need for Automation - Automation Strategies - Automated Flow Lines - Automated Guided Vehicles Systems - Automated Storage/Retrieval Systems - Carousel Storage Systems - Carousel Storage Applications. **(9)**

MAINTENANCE MANAGEMENT AND WASTE MANAGEMENT

Introduction to Maintenance management - Objectives of Maintenance - Types of Maintenance - Maintenance Planning - Maintenance Scheduling - Maintenance Schedule Techniques - Total Productive Maintenance (TPM) - Waste Management - Reasons for Generation and Accumulation of Obsolete, Surplus and Scrap Items - Identification and Control of Waste - Disposal of Scrap. **(9)**

NEW PRODUCT DEVELOPMENT (NPD) AND SUSTAINABILITY

Introduction - Role of Organization - Competition for New Ideas, Resources, and Customers - Product Innovation Failures - Continuous Project Management - New Growth Platforms for Innovation - Dynamics of Brand Share - Innovators and Imitators. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Gupta and Martin Starr., "Production and Operations Management Systems", CRC Press, 2014.*
2. *Anil Kumar. S and Suresh. N., "Production and Operations Management", New Age international (P) Ltd, 2nd edition, 2008.*

REFERENCE BOOKS

1. *Norman Gaither, Frazier G., "Operations Management", Thomson Learning, 9th Edition, 2007.*
2. *Chary S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 3rd Edition, 2008.*
3. *R. Panneerselvam., "Production Planning and Control", PHI Learning, 3rd Edition, 2012.*
4. *Jay H. Heizer, Barry Render., "Production and Operations Management: Strategies and Tactics", Allyn & Bacon, 1991.*

15ME75 - ALTERNATE ENERGY RESOURCES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: (i) Analyze heat transfer in solar energy systems (focusing and non-focusing type) used in heating applications and electricity generation via solar thermal power plants. (ii) Analyze direct electricity generation technique by a solar photo-voltaic systems.*

CO2 *: Derive the expression for maximum possible electrical energy conversion from available wind energy for horizontal axis and vertical axis wind mills.*

CO3 *: Choose the type of conversion technique (bio-chemical and thermo-chemical) required to produce desired bio-fuels using available biomass.*

CO4 *: Analyze nuclear fission reactors with its control for electrical energy generation using heavy water nuclear power plant.*

CO5 *: Analyze energy conversion efficiency of geothermal energy conversion systems, OTEC, tidal power plants, wave energy generators, MHD generators, thermo-electric systems, thermionic systems and fuel cells for electrical energy generation*

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.*

REFERENCES

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.*

15ME76 - CONTROL THEORY AND MECHATRONICS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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

CO1 *: Choose appropriate sensors, actuators, DAQ's for open and closed loop control systems.*

CO2 *: Integrate LabVIEW software with hardware's to analyze the flow of data.*

CO3 *: Acquire real time data using Labview to control machines, equipment's and processes using sensors, actuators and feedback devices.*

CO4 *: Carryout simple assignments (pre-final and final year) in laboratory using virtual instrumentation engineering workbench considering societal and industrial problems*

LIST OF EXPERIMENTS

1) Introduction and Getting started with LabVIEW
2) Creating SubVI and its use
3) Function of a For loop, while loop and Waveform chart
4) Case structure, Flat sequence structure and shift register
5) Signal manipulation and waveform graphs
6) Study of DAQ and NI hardwares
7) Temperature measurement using
   a) Thermocouple and DAQ - 9213
   b) 3-Wire RTD and DAQ - 9219
   c) Convert °C to °F
   d) Temperature control system
8) Resistor simulation
9) Capacitor simulation
10) Measurement of stress and strain using Wheatstone bridge
11) Design of vehicle speed indicator

REFERENCE

Mechatronics laboratory Manual 2015, Department of Mechanical Engineering, CIT, 2015.

15ME81 - PROJECT WORK

L	T	P	C
0	0	6	6

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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

CO1 *: Analyze, estimate and manage a project within a stipulated project time line*

CO2 *: Refresh the mechanical engineering fundamental concepts and principles related to the project work.*

CO3 *: Enhance the management skills to achieve the project goal by working as a team and also improve technical writing skills.*

CO4 *: Demonstrate the technical skills to provide feasible solutions for real-life problems*

CO5 *: Know the importance of project management tools and the various costs associated with it.*

CO6 *: Manage and control the project with respect to time, resources, raw-materials, etc.*

15MEE01 - DESIGN OF JIGS AND FIXTURES

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Demonstrate the fundamentals concepts in design of jigs and fixtures such as degree of freedom and locating principles.*

CO2 : *Choose an appropriate locators and clamps shift loading and unloading.*

CO3 : *Find a suitable size of a locator, clamps and analyses the clamping forces and provide a assembly drawing with fits, tolerance, geometric dimensions.*

CO4 : *Choose suitable jigs for a drilling operation in mass production (blind, through hole, tapping and threading operation) to reduce the machining time and increase the productivity.*

CO5 : *Design suitable fixtures for holding the components by preventing axial movement and rotation to perform finishing operation. (slotting, broaching , grinding and welding)*

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 - **(6+6)**

LOCATING AND CLAMPING PRINCIPLES

Locating principles - Basic rules for locating, Locating methods and devices - Redundant Location - Standard parts-Principles of clamping - types of mechanical actuation clamps, pneumatic and hydraulic actuation clamping, special clamping operation. **(6+6)**

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. **(6+6)**

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. **(6+6)**

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. **(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Cyrill Donoldson.V.C and Others, "Tool Design", 4th Edition, Tata McGraw Hill, 2012.*

REFERENCES

1. *ASTM, "Hand book of Fixture design".*
2. *Joshi. "Jigs and Fixtures", Tata McGraw-Hill Education, 2001.*
3. *Venkataraman. K., "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.*
4. *Hoffman "Jigs and Fixture Design", Thomson Delmar Learning, Singapore, 2004.*

15MEE02 - ADVANCED STRENGTH OF MATERIALS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Deduce strain component in any direction and examine effect of motion on curves, surfaces and volumes of an object*

CO2 *: Demonstrate the concept of traction and stress tensor and to determine the shear stresses using Cauchy's method in arbitrary planes.*

CO3 *: Derive equilibrium equations and develop constitutive relations using Cauchy stress and Cauchy Green strain for isotropic materials and orthotropic materials.*

CO4 *: Formulate a boundary value problem for an isotropic material using equilibrium equations and solve using displacement and stress technique.*

CO5 *: Evaluate and compare the displacement and stresses due to bending in straight and prismatic members using strength of materials and elasticity approach and find the shear center for the given sections.*

INTRODUCTION

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, vector operators, Divergence theorem. **(5+5)**

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. **(5+5)**

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. **(5+5)**

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. **(5+5)**

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. **(5+5)**

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. **(5+5)**

TOTAL : 60

TEXT BOOK

1. *Chadwick P. "Continuum Mechanics: Concise Theory and Problems", Dover Publications, Inc., New York, 1999.*

REFERENCES

1. *L.S. Srinath, "Advanced Mechanics of Solids" Tata McGraw Hill, 2007.*
2. *A.R. Ragab, and S.E. Bayoumi, "Engineering Solid Mechanics: Fundamentals and Applications", CRC Press, 1999.*
3. *M.H. Sadd, "Elasticity: Theory, Applications and Numerics", Academic Press, 2006.*
4. *R.J. Atkin, and N. Fox, "An introduction to the theory of elasticity", Longman, New York, 1980.*
5. *G.A. Holzapfel, "Nonlinear Solid Mechanics", Wiley, New York, 2001.*

15MEE03 - MECHANICAL BEHAVIOR OF MATERIALS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Construct S-N curves using fatigue test results and conclude the effect of stress concentration, environment and estimate the fatigue life due to surface protection.*

CO2 *: Analyze low and high fatigue cycles to find the crack initiation and able to construct Goodman, Soderberg and Gerber curves.*

CO3 *: Determine the contribution of creep to the fracture mechanism from different creep tests.*

CO4 *: Examine the Fracture behaviour, failure mechanism and transition temperatures of notched and un-notched ductile/ brittle metal and alloy components.*

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. **(3+3)**

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. **(4+4)**

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. **(7+7)**

FUNDAMENTALS OF FRACTURE

Fracture behaviour of metals and alloys. The ductile/brittle transition temperatures for notched and unnotched components, Ductile rupture as a failure mechanism, Fracture at elevated temperature. **(3+3)**

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. **(8+8)**

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. **(5+5)**

TOTAL : 60

TEXT BOOKS

1. *Broek D., "Elementary Engineering Fracture Mechanics ", Kluwer Academic Publishers, Dordrecht,2012*
2. *Barsom J.M. and Rolfe S.T., "Fracture and Fatigue Control in Structures ", Prentice-Hall, Englewood Cliffs, NJ, 2007*

REFERENCES

1. *Anderson T.L., "Fracture Mechanics - Fundamentals and Applications ", CRC Press, Boca Raton,Florida, 2005.*
2. *Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw Hill, New Delhi, 2009.*
3. *Simha K.R.V., "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.*

15MEE04 - MACHINE TOOL DESIGN

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

At the end of the 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. **(6+6)**

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. **(6+6)**

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 guideways and LM guide ways. **(6+6)**

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. **(6+6)**

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. **(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Mehta N. K., "Machine Tool Design and Numerical control", Tata McGraw Hill, 2017.*
2. *Pal D.K., Basu S. K., "Design of Machine Tool", 4th Edition. Oxford IBH, 2005.*

REFERENCES

1. *Bhattacharya and Sen S. G., "Principles of Machine Tool", New central book agency Calcutta, 2011.*
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 NewYork, 2013.*

15MEE05 - MECHANICAL VIBRATIONS AND CONTROL

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Develop mathematical models of dynamical systems with single degree of freedom to determine their response to harmonic, transient and impulse loads.*

CO2 *: Develop mathematical models of dynamical systems with multiple degrees of freedom to calculate natural frequencies and mode shapes.*

CO3 *: Determine the natural frequencies and mode shapes of continuous systems such as strings in transverse vibrations, bars in longitudinal vibrations, and circular shafts in torsional vibrations using analytical and numerical methods.*

CO4 *: Evaluate the severity of vibration and choose a suitable vibration isolation system, perform static and dynamic balancing, and design suitable vibration absorber systems*

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. **(5+5)**

TWO DEGREE OF FREEDOM SYSTEM

Introduction - Undamped and damped free vibrations - Forced Vibration with Harmonic Excitation System- Coordinate Couplings and Principal Coordinates. **(4+4)**

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. **(8+8)**

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. **(5+5)**

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. **(8+8)**

TOTAL : 60

TEXT BOOKS

1. *Rao S S, "Mechanical Vibrations", 5th Edition, Prentice Hall, 2011.*
2. *Grover G K, "Mechanical Vibrations ", Nem Chand and Brothers, Roorkee, 2009.*

REFERENCES

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.*

15MEE06 - TRIBOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Point out the physical mechanisms (adhesion, abrasion, hysteresis, and interfacial zone of shear) that cause friction and wear in engineering components and systems, suggest remedial measures, and apply tribological concepts to select materials of mating parts during machine design.*

CO2 *: Infer the physical mechanisms such as wedging film action and squeeze film action that lead to fluid pressure development in hydrodynamic and hydrostatic film lubrication.*

CO3 *: Derive mathematical expressions of coefficient of friction by applying Bowden and Tabor's model of plastically deforming single asperity adhesion theory of friction, to predict friction between mating surfaces.*

CO4 *: Predict wear rate using Archard's theory of sliding wear in dry sliding contacts, including effects of surface contaminants.*

CO5 *: Calculate load carrying capacity and friction torque in long, high-speed, hydrodynamic journal bearings and hydrostatic thrust bearings.*

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. *Prasanta Sahoo, "Engineering Tribology", Prentice-Hall of India Private Limited, 2005.*
2. *Basu S. K., Sengupta S. N., Ahuja B. B., "Fundamentals of Tribology", Prentice-Hall of India Private Limited. New Delhi, 2005.*
3. *A. Cameron, "Basic lubrication theory", Wiley Eastern Limited, 3rd Edition, 1987.*
4. *Ludema K.C., "Friction, Wear, Lubrication", CRC Press, Boca Raton, 1996.*

REFERENCES

1. *Dowson D, "History of Tribology", Longman London, 1979.*
2. *E. Robinowics, "Friction and wear of materials", John Wiley and Sons, 1988.*

3. *"Friction, Lubrication and Wear Technology", Volume 18, ASM International Handbook Committee, 1992.*
4. *Szeri A.Z., "Fluid Film Lubrication - Theory and Design", Cambridge University Press. United Kingdom, 1998.*
5. *Khonsari M. M., Booser R.E., "Applied Tribology - Bearing Design and Lubrication", John Wiley & Sons Inc., New York, 2001.*
6. *Stachowiak G. W. and Batchelor A. W., "Engineering Tribology", 3rd Edition, Elsevier Inc., 2005.*
7. *Stolarski T.A., "Tribology in Machine Design", Butterworth-Heinemann, Oxford, 1990.*
8. *Gohar R., Rahnejat H., "Fundamentals of Tribology", 2nd Edition. Imperial College Press. London, 2012.*

15MEE07 - EXPERIMENTAL STRESS ANALYSIS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Demonstrate experimental methods commonly used in solid mechanics*

CO2 : Apply the principles and techniques of strain gauge measurement

CO3 : Demonstrate the techniques of photo elastic measurements

CO4 : Analyze experimental data and develop appropriate logical conclusions based on comparisons to theoretical results and other experimental evidence.

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. **(7+7)**

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. **(7+7)**

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. **(8+8)**

OTHER STRESS ANALYSIS TECHNIQUE

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. **(8+8)**

TOTAL : 60

TEXT BOOKS

1. *Dalley and Riley, "Experimental Stress Analysis", McGraw Hill, 1991.*
2. *Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1993.*

REFERENCES

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.*

15MEE08 - FLUID POWER CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

At the end of the 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.*

REFERENCES

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 Edition, Cambridge University Press, 2009.*

15MEE09 - DESIGN FOR MANUFACTURE AND ASSEMBLY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Design mechanical parts for use in a flexible automation system for the increased effectiveness and to automate assembly of existing design.*

CO2 *: Design such a system with no errors and defects so that they can be used for subsequent assembly and subassembly.*

CO3 *: Implement newer approaches for the better form design with the help of knowledge on positional tolerances.*

CO4 *: Design the components suitable for various manufacturing process such as welding, casting, machining.*

CO5 *: Identify and design components according to standards.*

INTRODUCTION

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

DFM APPROACH

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

GEOMETRIC ANALYSIS

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

FORM DESIGN

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

DESIGN FOR ASSEMBLY

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

TRUE POSITION THEORY

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

TOTAL : 45

TEXT BOOKS

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

REFERENCES

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

15MEE10 - DESIGN AND ANALYSIS OF EXPERIMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Demonstrate the fundamental concepts applied with mathematical knowledge, methodologies to bring knowledge of characterize, analyze and solve a wide range of problems between the purpose of a model and the appropriate level of complexity and accuracy.*

CO2 *: Plan, design and conduct experimental investigations efficiently and effectively; choose an appropriate experiment to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.*

CO3 *: Analyze the nature of variable, statistical inference, influence parameter selection, factorial concepts, Conduct Design of experiments; interpret the direct and interaction effects by using RSM.*

CO4 *: Analyze and apply the knowledge of DOE project practice with software like Matlab, ANOVA, and SYSTAT.*

INTRODUCTION

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

RANDOMIZED BLOCKS, LATIN SQUARES AND RELATED DESIGNS

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

FACTORIAL DESIGN

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

FRACTIONAL FACTORIAL DESIGN

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

RESPONSE SURFACE DESIGN

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

TOTAL : 45.

TEXT BOOKS

1. *C.F. Jeff Wu & Michael Hamada 2009, Experiments-Panning, Analysis, and Parameter Design Optimization, 2nd Edition, John Wiley & Sons. Inc.*
2. *D.C. Montgomery 2013, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons. Inc.*
3. *R. L. Mason, R. F. Gunst & J.L. Hess 2003, Statistical Design and Analysis of Experiments with Applications to Engineering and Science, 2nd Edition, John Wiley & Sons. Inc.*

REFERENCES

1. *T.B. Barker, Quality by Experimental Design, 2005, 3rd Edition, CRC Press, ISBN 0-8247-2309-0*
2. *Geoffrey Gordon, System Simulation, 2011, 2nd Edition (revised), PHI*
3. *Clewer, A.G. and D.H. Scarisbrick. 2001. Practical Statistics and Experimental Design for Plant and Crop Science. John Wiley and Sons, LTD. New York*
4. *Morris, T.R. 1999. Experimental Design and Analysis in Animal Sciences. CABI Publishing, New York*

15MEE11 - RAPID PROTOTYPING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Synthesis the right manufacturing technique for manufacture of prototypes.*

CO2 *: Develop an understanding on various additive manufacturing techniques for manufacture of critical and complex geometry products.*

CO3 *: Orient the input files and produce a product using the available rapid prototyping systems in cost effective way.*

CO4 *: Integrate and develop complex geometrical shapes with highest degree of accuracy and surface finish.*

CO5 *: Develop knowledge on the novel application of RP Technologies for future projected product manufacturing.*

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 - Poly Jet 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 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.*

REFERENCES

1. *Kai., C.C, Lim, C.S. and Leong, F.K., Rapid Prototyping: Principles and Applications in Manufacturing, Wiley Publication, 2008.*
2. *RafiqNoorani (2006), Rapid Prototyping : Principles and Applications, WileyJulia A McDonald, Chris J Ryall, David I Wimpenny (2001), Rapid Prototyping case book, Wiley.*

15MEE12 - NON-TRADITIONAL MACHINING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Differentiate the traditional and non-traditional machining techniques and select the appropriate method in mechanical machining processes.*

CO2 : *Judge the suitable method in Electro - Chemical processes based on the application and limitations of the process.*

CO3 : *Justify the appropriate method in laser machining process based on the application and limitations.*

CO4 : *Justify the appropriate method in lithography based on the application and limitations of the process and obtain the knowledge about nano-technology.*

CO5 : *Obtain a knowledge and understanding towards the adoptability of nontraditional techniques based on the application of use.*

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.*

REFERENCES

1. *Carl Sommer, "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, J.T.Black, 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 JMadou, "Fundamentals of Micro Fabrication", CRC Press, 2002.*
8. *Abdel, H. and El-Hofy, G. "Advanced Machining Processes", McGraw-Hill, USA, 2005.*

15MEE13 - NON-DESTRUCTIVE EVALUATION AND IMAGING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Assess fractured surfaces using Vision, lighting, Visual perception, direct and indirect method for simple parts like pipes and tubes.*

CO2 *: Examine the surface related failures upto 0.08 mm using liquid penetrant and magnetic particle testing, prepare the work piece after testing using solvent removable, water washable.*

CO3 *: Specific type of material (ferromagnetic, Paramagnetic materials) and failure, a student will be able to determine the testing parameters (direct / alternative currents, surface strength, Depth of penetration, Direct pulsating current) with the help of Circular magnetization techniques, right hand rule field and Prods technique.*

CO4 *: Analyze the subsurface failure of metal using ultrasonic inspection technique with the help of echo method, through transmission method, resonance method, contact testing, immersion testing and couplants.*

CO5 *: Safely diagnose the internal failures of material by radiography technique using Radio isotopic sources, radiographic cameras, X-ray sources and industrial X-ray tubes.*

CO6 *: Predict the subsurface defects and anomalies of materials including composites by means of heat sensitive paints/ papers and thermally quenched phosphors liquid crystals.*

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 -Radioisotopic 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 wave generation - 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 Focussing Techniques (SAFT), Time of Flight Diffraction (TOFD), Signal Analysis, Artificial Intelligence, Neural Network, Fussy logic, Guided waves ultrasonic testing. **(10)**

THERMOGRAPHY

Principles of Thermography - Contact and non-contact inspection methods - Heat sensitive paints - 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 limitation - 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.*

REFERENCES

1. *Paul E. Mix, " Introduction to Nondestructive Testing: A Training Guide, 2nd Edition", John Wiley & Sons, Inc., 2005.*
2. *Miller, Ronnie; and Paul McIntire, ed, "Non-Destructive Testing Handbook; Acoustic Emission Testing, VoL-5, 2nd Edition, Columbus, OH: American Society for Non-DestructiveTesting, 1987.*
3. *American Society for Metals, Non-Destructive Inspection and Quality Control: Metalshand Book, Vol-11, 8th Edition, Metals park Oh, 1976.*
4. *Non-Destructive Testing Hand Book: Radiography and Radiation Testing, VoI.3, 2nd Edition, Columbus, OH, American Society for Non-Destructive Testing, 1985.*
5. *Miller, Ronnie; and Paul McIntire, ed, Non-Destructive Testing Handbook; Acoustic Emission Testing, VoL-5, 2nd Edition, Columbus, OH: American Society for Non-DestructiveTesting, 1987.*
6. *Non - Destructive Evaluation and Quality control, ASM Hand book, Vol. 17.*

15MEE14 - ADVANCED FOUNDRY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Outline the use of foundry in manufacturing sector and design of patterns for steel and cast iron components.*

CO2 *: Analyze molding materials and methods such as Green sand, dry sand, Carbon dioxide, no bake, shell, Investment casting, die casting, centrifugal casting, and permanent molding for steel and cast iron weighing up to 25 kg.*

CO3 *: Design gates and risers for steel and cast iron components weighing up to 25 kg in weight.*

CO4 *: Compare the operations and operating parameters of crucible, Resistance furnaces for steel and cast iron components weighing up to 25kg in weight .*

CO5 *: Determine the composition, temperature, sand reclamation, moulding machines, foundry layout and mechanization for steel and cast iron components.*

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, CO2moulding, 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.*

REFERENCES

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.*

15MEE15 - ADVANCED WELDING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Categorize the fusion and solid state welding processes with its working principles, welding set-up, characteristics, heat input and applications to select the process for the fabrication of specified component.*

CO2 *: Predict the percentage of phase in microstructure in steel weldments with respect to cooling rate using TTT & CCT diagrams to obtain better mechanical and metallurgical properties towards reducing residual stresses & distortions in weldments.*

CO3 *: Assess the weldability of ferrous and non-ferrous materials to point out the welding process and welding procedures.*

CO4 *: Design to evolve good welded joint design for joining structural members subjected to static and fatigue loading.*

CO5 *: Differentiate and select the welding systems for engineering components and fulfill the requirements for mass production.*

SPECIAL WELDING PROCESSES

Introduction to advanced welding processes - Electron beam welding, Fundamentals and types of laser welding including hybrid processes - Laser beam welding, Ultrosonic welding, explosion welding, Elecrtoslag and Electrogas welding, Cold pressure welding, Friction welding, Friction stir welding - Friction stir spot welding - Electromagnetic pulse 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, aluminum 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.*
2. *Parmar. R.S, "Welding Engineering and Technology", Khanna Publishers, 2002.*

REFERENCES

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 MW, "Friction Stir Welding and Processing", ASM, 2007.*

15MEE16 - COMPOSITE MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Develop particulate or fibre reinforced PMC, MMC, and CMC materials for the application of Aerospace, Automobile, medical and Civil Engineering Structures*

CO2 *: Choose the most appropriate manufacturing process for fabricating thermosetting and thermoplastic polymer matrix composites reinforced with particulate and fibre*

CO3 *: Examine the effect of reinforcement volume/weight percentage and select suitable manufacturing process for MMC*

CO4 *: Select processing method and to create Ceramic matrix materials for the given application*

CO5 *: Analyze the failure modes, reliability and fatigue behavior of composite materials*

INTRODUCTION

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, fibre reinforced composites, laminar composites - types of fibres - smart materials - types and characteristics - material selection process - applications related to aerospace, automobile, medical, bridge and other civil engineering structures. **(8)**

POLYMER MATRIX COMPOSITES

Thermosetting and thermoplastic resins - Functions & properties of matrix - types & properties of reinforcement materials, role and selection of reinforcement materials, PMC processes - hand layup process, bag molding process, compression molding, reaction injection molding, resin transfer molding, pultrusion process, filament winding, injection molding process - fibre reinforced plastics, glass fibre 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, compo casting, 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 fibre filled lamina - volume fraction and weight fraction - woven roving, in-plane random fibres - fibre orientation - void - fibre orientation during flow, failure theories - laminate design consideration - stress analysis of laminated composite 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 behaviours 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., Broutman L.J. and Chandrashekhara K, "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 2006.*

REFERENCES

1. *Chawla, Krishan K, "Composite Materials Science and Engineering", Springer, 2012.*
2. *Matthews F.L., and Rawlings R.D, "Composite Materials: Engineering and Science", CRC Press and Woodhead Publishing Limited, 2002.*
3. *Hull D., and Clyne T. W, "An Introduction to Composite Materials", Cambridge University Press, 2nd Edition, 2012.*
4. *Peters S. T, "Handbook of Composites", Chapman & Hall, 2012.*

15MEE17 - ENGINEERING POLYMERS, COMPOSITES AND ALLIED MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Choose manufacturing processes for polymers and PMC materials to obtain required shapes by applying product design considerations*

CO2 *: Find the processes to develop new ceramic and cermet materials for manufacturing of high temperature cutting tools by applying design considerations*

CO3 *: Develop and characterize the nano-composites, MMCs, CMCs and PMCs for the engineering applications using secondary processing methods*

CO4 *: Synthesize, characterize, compaction and sintering of metal powders for application of P/M parts using powder metallurgy techniques*

CO5 *: Synthesize and characterize the nanostructured materials for fabricating electronic devices, MEMS, magnetic, electronic and optical sensors and fabricating carbon nano structured materials for fuel cell and energy storage applications*

SHAPING PROCESSES FOR PLASTICS

Properties of polymer melts - extrusion - production of sheet and film - fibre 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 tyres and other rubber products - product design considerations . **(5)**

SHAPING PROCESSES FOR POLYMER MATRIX COMPOSITES

Materials for PMC - open mold processes - closed mold processes - filament winding - pultrusion process - 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 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, pressure less 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. *Mikell P. Groover, "Fundamentals of Modern Manufacturing Materials, Processes and Systems", 4th Edition, John wiley & sons, Inc. 2015*
2. *Ajayan P. M., Schadler L. S., and Braun P. V, "Nanocomposite Science and Technology", John Wiley & Sons, Inc., 2014.*

REFERENCES

1. *Charles A. Harper, "Modern Plastics Handbook", McGraw-Hill, 2010*
2. *Sperling L.H., "Introduction to Physical Polymer Science", 3rd Edition, John Wiley & Sons, 2011*
3. *Chawla K.K., "Ceramic matrix composites", 1st Edition, Chapman & Hall, 2013.*
4. *Randall M German, "A-Z of Powder Metallurgy (Metal Powders Technology)", Elsevier science, 2007.*
5. *Upadhyaya G. S., "Powder Metallurgy Technology", Cambridge International Science Publishing, 2002.*

15MEE18 - INDUSTRIAL ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Examine the configuration of a robot and suggest a robot for a particular operation (pick and place, welding, vision, climbing etc.).*

CO2 *: Calculate the position, velocity and acceleration for a robot manipulator and solve the forward and inverse kinematics.*

CO3 *: Calculate mass and inertia for the links of a robot manipulator and also find its forward and inverse dynamics.*

CO4 *: Choose appropriate vision system for the robot and then extract these images to get the desired output.*

CO5 *: Write program to determine path for obstacle avoidance for a specific task, and can solve using matrix laboratory software.*

INTRODUCTION

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

GENERAL CONSIDERATION OF ROBOTIC MANIPULATORS

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

KINEMATICS OF ROBOT MANIPULATORS

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

ROBOT WORKSPACE AND MOTION TRAJECTORY DESIGN

General Structure of robotic workspaces, robotic workspace performance index, extreme reach of robotic hands, robotic task description, robotic motion, trajectory design, general design considerations on trajectories, 4-3-4 trajectory, 3-5-3 trajectory, simulation of robotic workspaces. **(8)**

MOTION CONTROL OF ROBOTIC MANIPULATORS

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

ROBOT SENSING AND ROBOT VISION SYSTEM

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

TOTAL : 45

TEXT BOOK

1. *Fu.K S, Gonzales .R.C., and Lee.C.S.G., "Robotic Control, Sensing, Vision and Intelligence", McGraw Hill International, 2006.*
2. *Ashitava Ghushal “Robotics : Fundamental Concepts and Analysis”, Oxford, 2006.*

REFERENCES

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

15MEE19 - BIO MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Identify the suitable material for human implants and perform mechanical and tribological characterization.*

CO2 *: Choose a bio compact material (calcium phosphate, ceramic, glass, bioinert ceramics, polymeric, HDPE, hybrid, metals and alloys, Ti Alloys - Co-Cr-Mo, Ni or Ta-Based Alloys - Other Non-Ferrous alloys) for a orthopedic joints.*

CO3 *: Develop successful implants (biological, mechanical, morphological Compatibility) for dental and bone applications.*

CO4 *: Carry out experiments for biomaterials, metals , ceramics polymers, micro/nano Surface modification, micro/nano fabrication to find the tensile strength and micro structure (SEM,AFM) evaluation (bonding , particle dispersion, size of the particle , internal defects).*

CO5 *: Estimate the percentage of reinforcement (particle, fiber, laminates) to increasing the strength (tensile, flextural, bending, fatigue, wear, and corrosion) under specified constraints (density) for human implants.*

CO6 *: Design a suitable shape of the implants for orthopedic joint applications.*

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 ORTHOPAEDIC 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 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

REFERENCES

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. *BikramjitBasu, 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.*

15MEE20 - WORK SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

At the end of the 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 *: Calculate Work Measurement with various types and techniques will be able to apply the time study for job and equipment selection*

CO3 *: Design, implement and improve systems that include people, materials, information, equipment, and energy.*

CO4 *: Compare the operations and using systematic approach to improve the shop floor operations.*

CO5 *: Develop equipment 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 formulas - 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.*

REFERENCES

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.*
5. *Marvin, E., Mundel. And David, L. "Motion & Time Study: Improving Productivity", Pearson Education, 2000.*
6. *PremVrat, "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.*

15MEE21 - TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Select and apply appropriate techniques in identifying customer needs, as well as the quality impact that will be used as inputs in TQM methodologies*

CO2 *: Describe, distinguish and use the several techniques and quality management tools to manufacturing and services processes.*

CO3 *: Measure the cost of poor quality and process effectiveness and efficiency to track performance quality and to identify areas for improvement*

CO4 *: Compare proven methodologies to enhance management processes, such as benchmarking and business process reengineering.*

CO5 *: Develop analytical skills for investigating and analyzing quality management issues in the industry*

INTRODUCTION

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

TQM PRINCIPLES

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

STATISTICAL PROCESS CONTROL

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

TQM TOOLS

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

QUALITY SYSTEM

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

TOTAL : 45

TEXT BOOK

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

REFERENCES

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

15MEE22 - PLANT LAYOUT AND MATERIAL HANDLING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Identify and analyse the problems in the existing layout/ material handling system and shall be able to the optimize the layout/ material handling system*

CO2 *: Demonstrate their knowledge, techniques and will be able to design an efficient plant layout and material handling systems for a given system.*

CO3 *: Select the appropriate techniques to evaluate the material flow and application of computer aided layout design.*

CO4 *: Develop algorithms for new planning layouts for typical applications in the industries and Suggesting appropriate material handling strategies in the industries.*

CO5 *: Identify, analyze, solve technical problems and successfully complete a comprehensive design project related to mechanical or manufacturing fields.*

INTRODUCTION

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

PLANT LAYOUT

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

TYPES OF PLANT LAYOUT AND LAYOUT PLANNING

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

QUANTITATIVE EVALUATION OF PLANT LAYOUT

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

MATERIAL HANDLING AND ANALYSIS

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

MATERIAL HANDLING SYSTEMS

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

TOTAL : 45

TEXT BOOKS

1. *Richard L Francis, Leon F McGinnis, Jr., and John A. White,"Facility Layout and Location - An Analytical Approach", Prentice Hall of India (P) Ltd., New Delhi , 2005.*
2. *Choudary.R.B. andTagore.G.R.N., "Plant Layout and Material Handling", Khanna Publishers, New Delhi, 2005.*
3. *James Apple "Plant layout & Materials Handling" John Wiley & Sons, NY, 1976.*

REFERENCES

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

15MEE23 - BUSINESS PROCESS REENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Gain knowledge about BPR, Factors affecting BPR operations and design BPR techniques.*

CO2 *: Use BPR tools, utilize concepts of BPR, analyse cost / Benefit and appreciate the need of IT in BPR.*

CO3 *: Incorporate changes in the business operation based on market demand and implement same in manufacturing system.*

CO4 *: Select an appropriate practice of the business re-engineering project by taking the practical situations into consideration.*

CO5 *: Provide the most feasible practical solution to the problem keepin in mind the considerations of business automation, value , processes and risks in launching the business reengineering project.*

INTRODUCTION TO BPR

Definition; the paradigm shifts in production; the need for BPR, advantages and benefits of BPR, constraining factors, challenges, the positioning concept; the re-engineering visions; The BPR Lifecycle Methodology, Guidelines for BPR steps, Role of Information Technology in BPR; process Improvement and Process Redesign; BPR Experience in Indian Industry. **(9)**

METHODOLOGIES AND TOOLS FOR BPR

Process management; dynamic business re-engineering change framework; steps to reengineer the process. Tools used in Modelling the Business: flow-charting, business activity maps, relational diagrams, benefit/cost analysis. The enabling role of information technology in business re-engineering. Conceptual Foundation of Business Process Re-engineering;; Process Identification and Mapping; Role/Activity Diagrams; **(9)**

CHANGE MANAGEMENT

Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business re-engineering. Process Visioning and Benchmarking. Business process Improvement, Business Process Redesign; Man Management for BPR mplementation; Re-organizaing People and Managing Change. **(9)**

GOVERNANCE & BPR

Total Quality Management, Risk Management, Organizational Structures, BPR Project Management, The Power of Habit in organizations. The role of eLearning environments. Applications, gaming, BPR facilitation, BPR in Software Development, Basic principles, Relation to BPR. **(9)**

BEST PRACTICES IN BPR

Research & Practice, Perspectives in BPR, Discussion on research challenges, and practice challenges for industry and governments Case studies: Nissan, Chrysler, Hewlett Packard etc. Work flow systems, Imaging technology, Floware, Business design facility tools, Risk and impact measurement. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Davenport, "Process Innovation: Reengineering work through information technology". Harvard Business School Press, 1993.*
2. *Hammer & Champy, "Reengineering the Corporation: A Manifesto for Business Revolution" Harper Business Books, 1993.*
3. *Hammer & Stanton, "The Reengineering Revolution" Harper Collins. London, 1995.*
4. *Hansen, "Automating Business Process Reengineering" Prentice Hall, New Delhi, 1993.*

5. *Johansson, McHugh, Pendlebury & Wheeler, "Business Process Reengineering: BreakPoint Strategies for Market Dominance", Wiley, New Delhi, 1993.*

REFERENCES

1. *Harmon, P, "Business Process Change : A Guide for Business Managers and BPM and Six Sigma Professionals", Elsevier/ Morgan Kaufmann Publishers, 2007.*
2. *R. Anupindi et al., "Managing Business Process Flows: Principles of Operations Management", Pearson Education Inc, 2006.*
3. *Kock, N.F., "Process Improvement and Organizational Learning: The Role of Collaboration Technologies", Idea Group, 1999.*
4. *Walford, R.B., "Business Process Implementation for IT Professionals and Managers" Artech House, 1999.*

15MEE24 - PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Demonstrate a project, production systems, project planning, networking and basic scheduling with AOA and AON networks.*

CO2 *: Plan and manage the time effectively by Time/Cost Tradeoffs or Cost Tradeoffs in Projects and to utilize the resources optimally.*

CO3 *: Plan, implement, monitor, control the project with PERT/Cost, to improve the team building and leadership qualities to complete the project in the shortest span of time.*

CO4 *: Assess the performance of a production system and to justify them for new products considering financial constraints.*

CO5 *: Employ management tools like MRP I, MRP II, JIT, Waste elimination techniques to identify, control and eliminate both bottlenecks and constraints in project.*

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

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 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 Edition 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.*

REFERENCES

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.*

15MEE25 - QUANTITY PRODUCTION METHODS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Relate and compare various manufacturing systems and suitable levels of production (Job, batch, mass and Quantity) and exploring the possibility of implementing automation in the manufacturing sector.*

CO2 *: Create sequential manufacturing steps for common engineering components and small size products in large volume by using different types of engineering production methods,*

CO3 *: Generate Process planning and scheduling techniques for quantity production in automatic lathes and design jigs and fixtures for machining.*

CO4 *: Employ and practice group technology, inspection and quality control methods, computers and robotics for quantity production.*

CO5 *: Demonstrate quantity production methods for non-traditional manufacturing processes as well as for various ceramic and polymer products.*

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.*

REFERENCES

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.*

15MEE26 - PRODUCTION PLANNING AND CONTROL

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

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

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

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

CO4 *: Compare and contrast different inventory models based on product types..*

CO5 *: Demonstrate knowledge on material requirement planning.*

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) **(4+4)**

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. **(4+4)**

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. **(4+4)**

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. **(4+4)**

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. **(4+4)**

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. **(4+4)**

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 **(4+4)**

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. **(2+2)**

TOTAL : 60

TEXT BOOKS

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

REFERENCES

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 Edition John Wiley and Sons, 2000.*
3. *KanishkaBedi, "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.*

15MEE27 - LEAN AND AGILE MANUFACTURING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Identify bottlenecks in the value chain and improve the efficiency of the value chain.*

CO2 *: Evaluate an "AS IS analysis" irrespective of the product type.*

CO3 *: Discriminate the difference between an efficient and inefficient supply chain.*

CO4 *: Demonstrate and understanding of coupling lean and agile system.*

CO5 *: Decide inputs for locating the decoupling points in a supply chain to optimum functionality.*

INTRODUCTION TO AGILE MANUFACTURING

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

AGILE BUSINESS STRATEGIES

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

INTRODUCTION TO LEAN MANUFACTURING SYSTEM

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

LEAN MANUFACTURING PRACTICES

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

IMPLEMENTATION OF LEAN MANUFACTURING SYSTEM

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

TOTAL : 45

TEXT BOOKS

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

REFERENCES

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

15MEE28 - MANUFACTURING PLANNING AND COST ESTIMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Execute manufacturing planning and cost estimation for different product and processes.*

CO2 *: Demonstrate about types of production, production control and its necessity in manufacturing planning.*

CO3 *: Calculate and analyse various elements of cost like material cost, labour cost and overhead expenses for a different products in manufacturing environment.*

CO4 *: Explain Distinction between fixed and variable expenses for different machine tools.*

CO5 *: Compute machining time for various production processes in lathe, shaping, grinding machine & amp; Estimation olso estimation of loses in forging shop.*

INTRODUCTION

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

MANUFACTURING PLANNING

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

ELEMENTS OF COST

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

ANALYSIS OF OVERHEADS

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

COSTING - MACHINES AND TOOLS

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

COST ESTIMATION FOR PRODUCTION PROCESSES

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

THEORY : 45

TEXT BOOKS

1. *Banga. T.R and Sharma. S.C., "Mechanical Estimating and Costing", Khanna Publishers, New Delhi, 2015.*
2. *Narang. G.B.S. and Kumar. V., "Production and Costing", Tata McGraw Hill, New Delhi, 2005.*

REFERENCES

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

15MEE29 - MANUFACTURING SYSTEMS MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Gain knowledge on the manufacturing and management methodologies besides types of manufacturing systems, plan, design layout, material flow and optimize & manufacturing operations.*

CO2 *: Perform Scheduling of tools and machines for improved efficiency and management systems.*

CO3 *: Make cost analysis and get exposure to global manufacturing.*

CO4 *: Develop skills necessary to effectively analyze and synthesis the many interrelationships inherent in complex socio-economic productive systems.*

ESSENTIALS OF A MANUFACTURING SYSTEM

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

PROCESS SYSTEM FOR MANUFACTURING

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

MANAGEMENT SYSTEMS FOR MANUFACTURING

Managerial Information Flow - Decision Problems in Managerial Information Flow, Aggregate Production Planning - Production Planning - Short Term and Multiple Objective Production Planning, Product Mix and Lot Size Analysis, Material Requirement Planning (MRP), Production Scheduling - Operation Scheduling, Project Scheduling- Inventory System-Multiple Product Inventory Managements - Just In Time (JIT) Production. **(12)**

VALUE AND SOCIAL SYSTEMS FOR MANUFACTURING

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

TOTAL : 45

TEXT BOOK

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

REFERENCES

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

15MEE30 - ADVANCED FLUID MECHANICS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Evaluate fluid velocities, accelerations, strain rates, stresses, and forces due to fluid stresses; Distinguish between incompressible and compressible flows*

CO2 : *Formulate problems using governing equations and obtain solutions for viscous flows in pipes and channels*

CO3 : *Distinguish between potential flows and rotational flows; Apply complex-variable theory to analyze and model some simple ideal flows*

CO4 : *Use boundary layer principles to analyze viscous flows over flat plates; Compute drag forces in laminar and turbulent flows*

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 equations, Bernoulli's Equation. **(6+6)**

EXACT SOLUTIONS OF NAVIER-STOKES EQUATIONS

Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections, Unsteady flows. **(6+6)**

POTENTIAL FLOWS

Stream function 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. **(6+6)**

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. **(6+6)**

TURBULENT FLOWS

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. **(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Frank M. White, "Fluid Mechanics", Tata McGraw-Hill, Singapore, 6th edition, 2008.*
2. *Muralidhar K. and Biswas G., "Advanced Engineering Fluid Mechanics", 2nd Edition, Narosa,2005.*

REFERENCES

1. *Batchelor G.K., "An Introduction to Fluid Dynamics", Cambridge University Press, 1983.*
2. *Robert Fox W., Alan McDonald T., "Introduction to Fluid Mechanics", 4th 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.*

15MEE31 - REFRIGERATION AND AIR CONDITIONING

(Use of approved refrigeration charts and Psychrometric Charts permitted)

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Perform basic calculations related to various refrigeration cycles and air conditioning processes.*

CO2 *: Differentiate between various types of refrigeration systems.*

CO3 *: Apply psychrometry principles.*

CO4 *: analyze thermodynamic processes occurring inside compressors, condensers and expansion devices used in refrigeration systems .*

AIR CYCLE REFRIGERATION

Review of thermodynamic principles of refrigeration. Bell Coleman air refrigeration - Aircraft cycle - simple, boot strap and regenerative cycle analysis - COP calculation. **(3+3)**

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. **(6+6)**

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. **(6+6)**

VAPOUR ABSORPTION SYSTEMS

Ammonia - water systems, three fluid systems. Water - lithium bromide system - Comparison - Steam jet refrigeration, solar refrigeration. **(6+6)**

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. **(4+4)**

AIR CONDITIONING SYSTEMS

Duct design (theoretical treatment) - economic considerations, methods - air distributing systems - humidification - air cleaning - controls - window air conditioners. **(4+4)**

TOTAL : 60

TEXT BOOKS

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

REFERENCES

1. *Arora C.P., "Refrigeration and Air Conditioning". Tata MC Graw Hill Publishing Company Ltd., New Delhi, 2010.*
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.*

15MEE32 - ADVANCED THERMODYNAMICS

(Use of Property Tables is permitted)

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Apply Maxwell's relations; Derive expressions for basic thermodynamic property relationships; Evaluate changes in thermodynamic properties*

CO2 *: Apply ideal gas, van der Waals and Redlich-Kwong equations of state to analyze thermodynamic processes undergone by various gases*

CO3 *: Analyze multi-component mixtures of ideal gases or real gases using various mixture models*

CO4 *: Apply First Law and Second Law principles to evaluate combustion-related processes and compute lost work*

THERMODYNAMIC PROPERTY RELATIONS

Fundamental postulate of thermodynamics, Fundamental equations of thermodynamics for simple compressible systems, Maxwell relations, Relations for cp and cv, Relationships for calculating changes in internal energy, enthalpy and entropy, Joule-Thompson coefficient. **(6+6)**

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. **(6+6)**

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. **(6+6)**

AVAILABILITY AND EXERGY

Reversible work, Irreversibility, Availability functions for closed and open systems, Degradation of exergy, Second law efficiency, Applications to various thermodynamic processes. **(6+6)**

COMBUSTION

Combustion process, Enthalpy of formation, First-law analysis of reacting systems, Enthalpy and internal energy of combustion, Heat of reaction, Adiabatic flame temperature, Second law analysis of reacting systems. **(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Nag P.K., "Engineering Thermodynamics", 3rd Edition, Tata McGraw-Hill, 2005.*
2. *Claus Borgnakke, Richard E. Sonntag, "Fundamentals of Thermodynamics", 7th Edition, International Student Version, Wiley, 2009.*

REFERENCES

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 Generalized 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 Edition, Tata McGraw-Hill, 2007.*
6. *Bejan A., "Advanced Engineering Thermodynamics", John Wiley, 1988.*

15MEE33 - CRYOGENICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Analyze different gas liquefaction systems and estimate their figure of merit*

CO2 *: Examine refrigeration systems used for above and below 2K and evaluate their performance parameters.*

CO3 *: Calculate the theoretical number of plates in rectification columns used for gas separation.*

CO4 *: Compare and choose appropriate system for measurement of temperature, pressure, flow rate, fluid quality, and liquid level at cryogenic temperatures.*

CO5 *: Design inner and outer vessel for cryogenic storage for given parameters of volume,pressure and material.*

CO6 *: Calculate pump-down time for a vacuum system. Choose appropriate insulation for a given cryogenic system and estimate the heat transfer rate through the insulation.*

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.*

REFERENCES

1. *MamataMukhopadhyay, "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.*

15MEE34 - COMBUSTION AND INTERNAL COMBUSTION ENGINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Apply principles of thermodynamics and chemical engineering to combustion and formulate governing equations for the same.*

CO2 *: Distinguish between different types of flames.*

CO3 *: Understand the difference between air standard cycles and actual cycles, identify the parameters causing the difference, and quantify the same..*

CO4 *: Develop simplified models of combustion in I.C. engines.*

CO5 *: Construct, explain and present indicated diagrams for I.C.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*

REFERENCES

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.*

15MEE35 - ENERGY CONSERVATION AND WASTE HEAT RECOVERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Identify the demand supply gap of energy in Indian scenario.*

CO2 *: Carry out energy audit of an industry/Organization.*

CO3 *: Draw the energy flow diagram of an industry and identify the energy wasted or a waste stream*

CO4 *: Select appropriate energy conservation method to reduce the wastage of energy*

CO5 *: Evaluate the techno economic feasibility of the energy conservation technique adopted.*

CO6 *: Acquire the knowledge of modern energy conversion and waste heat recovery technologies*

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. *SenguptaSubrata, Lee SS EDS, "Waste Heat Utilization and Management", Hemisphere, Washington, 1983.*

REFERENCES

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 (www.energymanagertraining.com).*

15MEE36 - DESIGN OF HEAT EXCHANGERS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

At the end of the 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 simulation: Analyze output of models/simulations to provide information for design decisions.*

CO3 *: Perform feasibility analysis and use results to choose candidate solutions; Evaluate quality of solutions to select the best ones.*

CO4 *: 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. **(7+7)**

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. **(6+6)**

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. **(6+6)**

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. **(4+4)**

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. **(5+5)**

TOTAL : 60

TEXT BOOKS

1. *SadikKakaç, Hongtan Liu, AnchasaPramuanjaroenkij, "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.*

REFERENCES

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.*

15MEE37 - TURBO MACHINERY

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

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

CO2 *: Generate 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. **(4+4)**

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. **(5+5)**

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. **(5+5)**

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. **(6+6)**

STEAM TURBINES

Classification - single stage impulse turbine, condition for maximum blade efficiency, stage efficiency. Compounding - need for compounding, method of compounding. Impulse staging - maximum utilization factor for multistage turbine with equiangular blades, effect of blades and nozzle losses. Reaction turbine maximum blade efficiency. **(5+5)**

HYDRAULIC TURBINES

Classification - Pelton, Francis and Kaplan turbines - velocity triangles, design parameters - efficiency different blade speeds. **(5+5)**

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.*

REFERENCES

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.*

15MEE38 - COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Demonstrate ability to use the Finite-Volume Method to analyze one-dimensional and two-dimensional problems in heat transfer and irrotational fluid flow*

CO2 *: Apply numerical techniques to solve systems of algebraic equations and integrate ordinary differential equations*

CO3 *: Evaluate heat transfer rates, fluid flow rates, etc.; Judge the correctness of the numerical solutions; Recognize need for turbulence models*

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.**(6+6)**

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. **(6+6)**

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. **(6+6)**

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. **(6+6)**

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 ($\kappa-\varepsilon$) models - Brief overview of advanced turbulent flow models.**(6+6)**

TOTAL : 60

TEXT BOOKS

1. *Ghoshdastidar.P.S, "Computer Simulation of Flow and Heat Transfer", Tata McGrawHill, 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.*

REFERENCES

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.*

15MEE39 - POWER PLANT ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Gain knowledge about the availability Power Scenario and Essential of power plants*

CO2 *: Understand the complete processes and operations of Steam, Gas Turbine, Nuclear power plants and its types, utilizations.*

CO3 *: Acquire knowledge in different Accessories used in individual power plants and its operational techniques.*

CO4 *: Understand the Non conventional energy operations, availability of resources, utilization along with its selection.*

ESSENTIALS OF POWER PLANT

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

STEAM POWER PLANT

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

GAS TURBINE AND NUCLEAR POWER PLANTS

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

ACCESSORIES AND CONTROLS

Fuel handling systems - types, ash - handling methods, gas cleaning methods and dust collection. Types of condensers - cooling towers - water treatment method. Economics of power plant operation - instrumentation and control - variable load operation and economics. **(9)**

NON CONVENTIONAL ENERGY SOURCES

Non- conventional power generating systems- MHD power plants- solar power plants, wind power generation, tidal power generation, geo thermal power plant, OETC plants- selection and installation of power plants. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Domkundwar. S., "Power Plant Engineering", Dhanpat Rai and Sons, 2013.*
2. *Sharma .P.C., "Power Plant Engineering", S.K Kataria and Sons, 2009.*

REFERENCES

1. *Nagpal .G.R ., " Power Plant Engineering", Khanna Publishers, 2002.*
2. *Morse .F.P , "Power Plant Engineering", Affiliated East West Press Ltd., 2003.*
3. *Nag.P.K. " Power plant Engineering", TMH,Publications,2010*

15MEE40 - SOLAR ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Calculate solar time, local time, earth-sun angles, direct and indirect solar radiation for the given location using earth-sun geometry.*

CO2 *: Estimate energy conversion efficiency of solar cells using I-V characteristic curves.*

CO3 *: Express overall heat transfer coefficient using network resistance method; apply relations for collector efficiency factor and collector heat removal factor of non- concentrating solar collectors.*

CO4 *: Calculate heating loads using F-chart method for air and liquid based solar heating systems.*

CO5 *: Analyze performance of thermo-electric generators, refrigerators and heat pumps works on the principles of Peltier effect and Seebeck effect.*

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. *D. Yogi Goswami, “Principles of Solar Engineering” Taylor and Francis, 2000, ISBN 10: 1-56032- 714-6*
2. *Garg H.P., Prakash J., "Solar Energy: Fundamentals & Applications", Tata McGraw Hill, New Delhi, 1997.*

REFERENCES

1. *Applied Photovoltaics, Stuart Wenham, Martin Green, and Muriel Watt, Earthscan, 2007.*
2. *Photovoltaic Engineering Handbook, F. Lasnier and T. G. Ang, IOP Publishing UK (Adam Hilger USA) 1990.*
3. *Semiconductor Devices, Physics, and Technology, Second Edition, S. M., Sze, New York, NY: Wiley, 2001.*
4. *Solar Cells: Operating Principles, Technology and system Applications, Martin A. Green, Published by the University of New South Wales, 1998.*
5. *S. P. Sukhatme, "Solar Energy", Tata McGraw Hill, New Delhi, 1999.*
6. *J. A. Duffie and W.A.Beckman, " Solar Engineering of Thermal Processes", Jhon Wiley and Sons, New York, 2005.*
7. *Tiwari G.N.,Suneja S., "Solar Thermal Engineering System", Narosa Publishing House, New Delhi, 1997.*
8. *T.Bhattachariya, "Terrestial solar Photovoltaic", Narosa Publishers, New Delhi, 2008.*
9. *H.S.Rauschenbach, "Solar Cell Array Design Hand Book", Van Nostrand Rheinhold Company, New York, 1980.*

15CEE35 - DISASTER MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Identify natural and manmade disasters*

CO2 *: Explain in detail about causes and effects of natural and manmade disasters.*

CO3 *: Apply geospatial techniques (including GIS) that can enhance vulnerability assessments*

CO4 *: Identify and analyse the factors that give rise to differential vulnerabilities and levels of community resilience and suggest necessary mitigation plans*

CO5 *: Assess and manage these vulnerabilities through disaster planning and policy-making.*

NATURAL DISASTERS

Cyclones, Floods, Drought and Desertification - Earthquake, Tsunami, Landslides and Avalanche. **(9)**

MAN MADE DISASTERS

Chemical industrial hazards, major power breakdowns, traffic accidents, Fire, War, Atom bombs, Nuclear disaster- Forest Fire- Oil fire -accident in Mines. **(9)**

GEOSPATIAL TECHNOLOGY

Remote sensing, GIS and GPS applications in real time disaster monitoring, prevention and rehabilitation- disaster mapping. **(9)**

RISK ASSESSMENT AND MITIGATION

Hazards, Risks and Vulnerabilities - Disasters in India, Assessment of Disaster Vulnerability of a location and vulnerable groups- Preparedness and Mitigation measures for various Disasters- Mitigation through capacity building -Preparation of Disaster Management Plans. **(9)**

DISASTER MANAGEMENT

Legislative responsibilities of disaster management- Disaster management act 2005- post disaster recovery & rehabilitation, Relief & Logistics Management; disaster related infrastructure development- Post Disaster, Emergency Support Functions and their coordination mechanism. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Khanna B K, "All You Wanted To Know About Disasters", New India Publishing Agency, New Delhi, 2005.*
2. *Ramana Murthy, "Disaster Management", Dominant, New Delhi, 2004.*
3. *Rajdeep Dasgupta, "Disaster Management and Rehabilitation", Mittal Publishers, New Delhi, 2007.*

REFERENCES

1. *Disaster Management in India- A Status Report- Published by the National Disaster Management Institute, Ministry of Home Affairs, Govt. of India, 2004.*
2. *Murthy D. B. N., "Disaster Management: Text and Case Studies", Deep and Deep Publications (P) Ltd., New Delhi, 2007.*
3. *Sundar I. and Sezhiyan T., "Disaster Management", Sarup and Sons, New Delhi, 2007.*

15CEE36 - RENEWABLE ENERGY RESOURCES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After successful completion of the course, student will be able to

CO1 *: Explain the current energy scenario and future energy usage in India.*

CO2 *: Explain the concepts of solar energy, wind energy, tidal energy and biomass energy.*

CO3 *: Compare the energy utilization from wind energy, solar energy, biomass energy and tidal energy.*

CO4 *: Discuss the challenges and problems associated with the use of energy sources.*

ENERGY PERSPECTIVES

Conventional and non conventional energies - Energy and sustainable development - Global energy scenario - Energy scenario in India - Energy consumption pattern in rural and urban regions in India - Energy efficiency and economy - Energy losses and its control - Renewable energy potential mapping - Plant load factor **(9)**

SOLAR ENERGY PERSPECTIVES

Concept of solar energy - Solar energy to light and to thermal conversions - Total energy and necessary infrastructure - Units and measurement of solar radiation - Temperature dependent collecting devices and their efficacies - Design aspects - Typical applications: heating, cooling, lighting, power generation and cooking. **(9)**

WIND ENERGY PERSPECTIVES

Wind potential in India - Wind turbines and their types - Merits and demerits - Wind power and appropriate coefficient - Efficiency and performance of wind machines -Energy conversion and storage - Synchronous invertors - Various storage aspects: battery, fly wheel, hydrogen and compressed air. **(9)**

BIOMASS ENERGY PERSPECTIVES

Biomass potential in India - Gobar gas and producer gas - Characteristics of biomass - Operation and design of biogas plants - Objectives, principles and operational aspect of biogassifiers - Pyrolysis and incineration - Power generation from municipal solid waste and industrial Sludges - Application of biodiesel plants - Fuel cells. **(9)**

TIDAL ENERGY PERSPECTIVES

Tidal aspects in coastal India - Tidal energy conversion system: mechanical to electrical and thermal to electrical - Tidal force calculation and power generation - conceptualization and potential of geothermal energy - Geothermal vents. **(9)**

TOTAL : 45

TEXT BOOK

1. *Sukathme, S.P, "Solar Energy", Tata McGraw-Hill Book Co., New Delhi, 1993.*

REFERENCE BOOKS

1. *Rai, G.D., "Solar Energy Utilization", Khanna Publishers, New Delhi, 1993.*
2. *Angrist, S.W, "Direct Energy Conversion", Allied Publishers Ltd., Boston, 1971.*

15CEE38 - ENVIRONMENTAL IMPACT ASSESSMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Outline the overall perspectives of Environmental Impact Assessment.*

CO2 *: Design the necessary tools pertaining to assessment of various impacts.*

CO3 *: Recognize and synthesis the diversified socio-economic impacts on the society.*

CO4 *: Design and develop the significant protocols for Environment Management Plan.*

CO5 *: Synthesize and discretise the various impacts originating from typical developmental projects.*

ENVIRONMENTAL IMPACT ASSESSMENT PERSPECTIVES

Impact assessment introduction -Historical perspective -Scope and goals of EIA - Legal and Regulatory aspects in India - Types and limitations of EIA - Scope studies for Environmental Impact Studies (EIS). Preparation for EIS Planning, Public Participation and Review of EIS. **(9)**

ASSESSMENT AND MONITORING

Environmental setting - environmental impact assessment methodology- cost benefit analysis, environmental indices and indicators for describing affected environment, Life cycle assessment. Role of remote sensing and GIS in Environmental Impact Assessment **(9)**

SOCIO-ECONOMIC IMPACT ASSESSMENT

Types, steps in performing socio-economic impact assessment, analysis of public services and facilities impacts, social impacts, impacts of economic profile of the community. **(9)**

ENVIRONMENTAL MANAGEMENT PLAN

Environmental Management Plan - preparation, implementation and review - Mitigation and Rehabilitation Plans - Policy and guidelines for planning and monitoring programmes - Post project audit - Ethical and Quality aspects of Environmental Impact Assessment. **(9)**

SECTORAL ENVIRONMENTAL IMPACT ASSESSMENT

EIA related to the following sectors - Infrastructure -construction and housing Mining - Industrial - Thermal Power - River valley and Hydroelectric projects-Nuclear Power- EIA for coastal projects. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Canter.R.L, "Environmental Impact Assessment", McGraw Hill, New Delhi, 1996.*
2. *Shukla,S.K., Srivastava.P.R., "Concepts in Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.*

REFERENCE BOOKS

1. *Rao, J.G., and Wotten, D.C., "Environmental Impact Analysis, Handbook", McGraw-Hill, 1980.*
2. *Van Nostr, and Reinhold, J.E. Heer, Hagerty,D. J., "Environmental Assessment and Statement", 1977.*
3. *Canter, L.W., "Environmental Impact Assessment", McGraw-Hill, New York, 1996.*
4. *"Environmental Assessment Source book", Vol. I, II &III, The World Bank, Washington, D.C, 1991.*

15CEE39 - SOLID AND HAZARDOUS WASTE MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After successful completion of the course, student will be able to

CO1 *: Outline the salient features of solid waste management and handling.*

CO2 *: Deduce the source reduction, recycling and reuse techniques of solid waste.*

CO3 *: Analyze the collection systems and method of transfer of solid waste.*

CO4 *: Describe the processing techniques for solid and hazardous waste.*

CO5 *: Select the suitable methods for disposal of solid and hazardous waste.*

CO6 *: Interpret the legislation for management, handling and disposal of solid and hazardous waste.*

CHARACTERISTICS AND SOURCE REDUCTION OF SOLID WASTE

Definition, sources, and types of solid waste - Composition, physical, chemical and biological properties of solid wastes - Per capita generation rates - Sampling and characterization of solid waste - Source reduction of wastes -Waste exchange - Recycling and reuses - Salient features of Indian legislations on management and handling of municipal solid wastes. **(9)**

COLLECTION AND TRANSPORT OF SOLID WASTE

Estimation of solid waste and factors affecting generation rates - On-site handling, storage, and processing- Collection services: municipal and commercial - Industrial services - Collection systems: Hauled-container system (HCS) and stationary container system (SCS) - Vehicle and labour assessment - Assessment of collection route - Transfer and transport - Transfer station location- Means and methods of transfer. **(9)**

PROCESSING AND DISPOSAL OF SOLID WASTE

Objective of processing - material separation and processing technologies- biological, chemical and thermal conversion technologies- disposal in Landfills: site selection methods and operations, leachate and gas generations and movement and control of gas and leachate techniques - Composting: aerobic and anaerobic - Resource and energy recovery schemes. **(9)**

HAZARDOUS WASTE CHARACTERIZATION AND MANAGEMENT

Definitions and Identifications of hazardous waste - Origin and characterization of hazardous solid waste- Typical hazardous wastes in MSW - Hazardous waste management: minimization, collection, storage, handling, transport, and disposal - design of hazardous waste landfills - TCLP tests - National and International legislation for hazardous waste management - Atomic Energy Regulatory Board -International Atomic Energy Agency - Department of Atomic Energy - Nuclear Power Corporation - Nuclear power plants in India. **(9)**

NUCLEAR WASTE AND e-WASTE

Sources - classification - effects of nuclear waste- initial treatment of nuclear waste - vitrification, ion exchange, synroc - long term management - above ground disposal, geological disposal, ocean dumping, transmutation, space disposal - reuse of waste - nuclear safety and waste regulation - case study on nuclear disaster - source of e- waste - material composition of e - waste - recycling and recovery - integrated approaches to e - waste recycling - socio economic factors - treatment option - disposal option - e - waste legislation. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Tchobanoglous, G. et al., "Integrated Solid Waste Management", McGraw-Hill Publication., New York, 1993.*
2. *Ronald E. Hester, Roy M. Harrison "Electronic Waste Management", Royal Society of Chemistry, 2009.*

REFERENCE BOOKS

1. *Peavy, SH, Rowe, RD and Tchobanoglous, G, "Environmental Engineering", McGraw-Hill Inter Edition, 1985.*
2. *Charles, A.W., "Hazardous Waste Management", McGraw-Hill Publication, 2002*

15CEE40 - PRINCIPLES OF SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Outline the concepts, components and factors affecting Sustainable development.*

CO2 *: Discuss the significance of International summits, conventions and agreements on Sustainable development.*

CO3 *: Describe the necessity and importance of Indian and International legal aspects in Sustainability.*

CO4 *: Illustrate the socio economic policies and public participation in Sustainable development.*

CO5 *: Discuss the role and commitment of developed countries in Sustainable development.*

CO6 *: Describe the concepts of Life cycle Assessment and Environmental Standards.*

CONCEPTS OF SUSTAINABLE DEVELOPMENT

Sustainable development- Evolution of Environmental awareness and Sustainable development, global Sustainable development goals -components and factors affecting Sustainable development-Demographic dynamics and sustainability- Environmental issues and crisis- ozone layer depletion, global warming and climate change -International Environmental summits, conventions and agreements- Action plan for Sustainable development- Transboundary issues - Role of developed and developing countries in sustainable development. **(9)**

ENVIRONMENTAL ASPECTS

Biodiversity- Types of biodiversity-Threats to biodiversity- Ecological indicators- Ecological foot print- Carbon foot print- Conservation biology- Strategic species concepts- Ecological economics- Environmental impact of agriculture, animal husbandry, fishery and land use- Habitat fragmentation- Desertification- Natural disasters, geological, hydrological, meteorological and health- Nuclear issues. **(9)**

ECONOMIC ASPECTS

Production, Consumption, Investment and Exchange of Goods and Services - Macroeconomic Aggregates, Circular Flow of Income and its Criticism- Methods of Calculating National Income- GNP and GDP- The Goods Market: determination of equilibrium output -Financial Markets: demand for money and interest rates- Goods and Financial markets: IS-LM Model- General Overview of Fiscal and Monetary Policies-relative effectiveness- International Transactions and exchange rates- Market failure & Incomplete markets Externalities -UN Sustainable development policies through trade- World Trade Organization- International monetary fund and World bank. **(9)**

SOCIAL ASPECTS

Indigenous Knowledge and Natural Resource Management (NRM) - Commodification, marginalization and degradation - Indigenous knowledge and its relevance to sustainable development - Biopiracy and Biopolitics over Traditional Ecological knowledge (TEK)- Environmental Degradation in developing countries - Overview of development- Globalisation and the structural adjustments- Governance and welfare state- Development processes and social justice -Social inequality as a global challenge- marginalized/vulnerable groups, indigenous people, resettlement & rehabilitation and development. **(9)**

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Economic growth, carrying capacity- Resource depletion and resource protection-Sustainable Management of Forest, Land, water, fishery, agriculture, energy and ecosystem- Natural Disaster management- Cleaner Production, definition, aim, application- Generic process of Cleaner Production Assessment- Life cycle Assessment- definition, necessity and elements- ISO Environmental standards- Environmental Audit.

(9)

TOTAL : 45

TEXT BOOKS

1. *Brian Snowdon and Howard R. Vane, "Modern Macroeconomics", Edward Elgar, USA, 2005*
2. *Gupta N.K., "Macroeconomics", National Council of Educational Research and Training, New Delhi, 2012*
3. *Arun Kumar, "Macroeconomic Aspects of Goods and Services Tax", Economic and Political Weekly, 2015*
4. *Ramakrishnan, P. S., "Ecology and Sustainable Development", National Book Trust, New Delhi, 2001*
5. *Paul Robbins, John Hintz, and Sarah A. Moore, "Environment and Society: A Critical Introduction", Wiley-Blackwell, 2014*

REFERENCE BOOKS

1. *Nick Hanley, Jason F. Shogren and Ben White, "Environmental Economics in Theory and Practice", Macmillan Publishers, UK, 1997*
2. *Tietenberg T. and Lynne Lewis, "Environmental and Natural Resource Economics", Harper Collins, Routledge, 2016*
3. *Kolstad Charles D., "Environmental Economics", Oxford University Press, 2003*

15CEE41 - SAFETY ENGINEERING IN BUILDINGS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After successful completion of the course, student will be able to

CO1 *: Demonstrate the safety concepts, policy and techniques.*

CO2 *: Demonstrate the issues related to physical and chemical hazards and control methods to reduce hazards.*

CO3 *: Outline the fire engineering and explosion control.*

CO4 *: Identify the method of safety provision in execution of civil works.*

CO5 *: Identify the safety consideration in erection and closing operations and material handling in civil construction works.*

CONCEPTS OF SAFETY ENGINEERING

Concept of safety - Evolution of modern safety concept- Safety policy - Safety Organization - line and staff - functions for safety- Safety Committee- budgeting for safety. Techniques- Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit. **(9)**

OCCUPATIONAL HEALTH AND HYGIENE

Physical hazards - Noise, noise exposure regulation, occupational damage, risk factors, and permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, control measures. Chemical hazards - Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, Methods of Control. Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations - occupational related diseases, levels of prevention of diseases. **(9)**

FIRE ENGINEERING AND EXPLOSION CONTROL

Fire chemistry - Dynamics of fire behavior - Fire properties of solid, liquid and gas - Fire spread - Toxicity of products of combustion. Building evaluation for fire safety - Fire load -Fire resistance materials and fire testing -Structural Fire protection - Exits and egress. Statutory Rules and Techniques of fire fighting - Indian Explosive acts and rules -Techniques of fire fighting and demonstration. **(9)**

SAFETY IN CONSTRUCTION

General safety consideration - analyzing construction jobs for safety - Contract document -Safety certificate for statutory authorities for old building and construction. Safety in Erection and closing operation - Construction materials -Specifications - suitability - Limitations. Safety in typical civil structures - Dams-bridges-water Tanks-Retaining walls-Critical factors for failure-Regular Inspection and monitoring. **(9)**

SAFETY IN MATERIAL HANDLING

General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps, Arresting gears. Selection, operation and maintenance of Industrial Trucks - Mobile Cranes - Tower crane -Checklist - Competent persons. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Krishnan N.V., "Safety Management in Industry", Jaico Publishing House, Bombay, 1997.*
2. *"Accident Prevention Manual for Industrial Operations", NSC Chicago, 1982.*

REFERENCES

1. *"Handbook of Occupational Health and Safety", NSC Chicago, 1982.*
2. *James, D., "Fire Prevention Handbook", Butterworths, London, 1986.*
3. *Gupta R.S., "Handbook of Fire Technology", Orient Longman, Bombay, 1997.*
4. *Fulman, J.B., "Construction Safety, Security, and Loss Prevention", John Wiley and Sons, 1979.*
5. *Alexandrov, M.P., "Material Handling Equipment", Mir Publishers, Moscow, 1981.*
6. *Rudenko N., "Material Handling Equipments", Mir Publishers, Moscow, 1981.*

15MEOE01 - ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Examine the configuration of a robot and suggest a robot for a particular operation (pick and place, welding, vision, climbing etc..).*

CO2 *: Calculate the position, velocity and acceleration for a robot manipulator and solve the forward and inverse kinematics for a specific robot.*

CO3 *: Calculate mass and inertia for the links of a robot manipulator and also find its forward and inverse dynamics.*

CO4 *: Choose appropriate vision system for the robot and extract images for the desired output.*

CO5 *: Write a program to determine a path for obstacle avoidance for a specific task using matrix laboratory software.*

INTRODUCTION

Brief history of robots, robot definitions, today's practical importance of robot applications, challenges faced by robots in industrial situations, future scope of robotics. **(6)**

GENERAL CONSIDERATION OF ROBOTIC MANIPULATORS

Introduction - Brief history of robotics- Robot geometrical configurations - wrist and gripper subassemblies - robot drive systems - robot software. **(7)**

KINEMATICS OF ROBOT MANIPULATORS

Homogeneous representation of objects, robot manipulator joint coordinate system, Euler angles and Euler transformations, Denavit- Hartenburg (D-H) representations, direct kinematics in robotics, inverse kinematic solutions, geometrical approach in inverse Kinematics, Jacobian of transformation in robotic manipulation. **(13)**

ROBOT WORKSPACE AND MOTION TRAJECTORY DESIGN

General Structure of robotic workspaces, robotic workspace performance index, extreme reach of robotic hands, robotic task description, robotic motion, trajectory design, general design considerations on trajectories, 4-3-4 trajectory, 3-5-3 trajectory, simulation of robotic workspaces. **(9)**

ROBOT SENSING AND ROBOT VISION SYSTEM

Desirable features of sensor- range sensors - proximity sensors - tactile sensors-force sensors, torque sensing detectors - TV cameras - illumination techniques - fundamentals of image processing visual data acquisition - image enhancement - image segmentation - image extraction and recognition- object and model matching - image

extraction. Typical vision systems, robot programming languages - characteristics of robot- level languages - characteristics of task level languages, simulation languages. **(10)**

TOTAL : 45

TEXT BOOK

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

REFERENCE BOOKS

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

15MEOE02 - LOW COST AUTOMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

INTRODUCTION

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

HYDRAULIC PUMPS AND MOTORS

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

HYDRAULIC VALVES

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

BASIC HYDRAULIC CIRCUITS

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

PNEUMATICS

Air preparation units - Filter, Regulator and Lubricator. Valve configuration and controls. Pneumatic actuators, diaphragm actuators, back pressure sensors. Pneumatic circuits design - Cascade method. **(7)**

HYDRO PNEUMATICS AND ELECTRO PNEUMATICS

Hydro-pneumatics and electro-pneumatic elements and circuits, KV map method and Ladder diagram **(5)**

FLUIDICS

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

TOTAL : 45

TEXT BOOKS

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

REFERENCE BOOKS

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

15MEOE03 - ADAPTIVE CONTROL AND PROCESS DYNAMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Explain the different computer process control systems and its application.*

CO2 *: Develop the different digital controllers to suitable processes with or without time delay systems.*

CO3 *: Evaluate 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.*

15MEOE04 - PROJECT PLANNING AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 and develop a project schedule.*

CO4 *: Develop a suitable budget for a new project and Identify important risks.*

CO5 *: 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 Monitoring and Control with PERT / Cost. Team Building and Leadership in Projects; 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 Edition 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.*

15MEOE05 - SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Outline the manufacturing and product life cycle management process involved in a product.*

CO2 : *Formulate the forecasting methods and inventory modelling*

CO3 : *Estimate the right procurement and logistics strategy based on the supply chain and product criterion requirements.*

CO4 : *Design and analyze the right supply chain structure for the product along with distribution network*

CO5 : *Produce the supply chain network diagram incorporating supply chain strategy and competitive strategies involving material and information flow lines*

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 & TRANSPORTATION

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)**

INFORMATION TECHNOLOGY 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 and 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.*

15MEOE06 - RESOURCE MANAGEMENT TECHNIQUES

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Mathematically formulate a given engineering problem as a linear programming problem, and apply Graphical, Simplex, Two-Phase or Big-M methods to obtain the optimal solution.*

CO2 *: Construct or modify objective functions and constraints using primal and dual relationship, and apply the Dual Simplex Method to obtain optimal solutions.*

CO3 *: Justify the determined feasible solution (processing time and transportation cost) as optimal solution using MODI method and Hungarian method.*

CO4 *: Determine the optimal project duration and cost using CPM and PERT technique, also construct complex project network and control the complex project.*

CO5 *: Categorize (Inventory, Game Theory, Sequencing and Queuing) and solve various decision making problems using mathematical modeling.*

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. **(3+3)**

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. **(4+4)**

TRANSPORTATION AND ASSIGNMENT

Formulation of Transportation Problem, Initial Feasible Solution Methods, Optimality Test, Degeneracy in Transportation Problem; Assignment Problem, Hungarian Method, Traveling Salesman Problem. **(4+4)**

NETWORK MODELS

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

INVENTORY AND MODELS

Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model, Newsboy Problem. **(3+3)**

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+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. **(5+5)**

TOTAL : 30+30 = 60

TEXT BOOKS

1. *Mohan, C. and Deep, Kusum: "Optimization Techniques", New Age, 2009.*
2. *Mittal, K. V. and Mohan, C. "Optimization Methods in Operations Research and Systems Analysis", Fourth Edition, New Age, 2016.*
3. *Taha, H. A, "Operations Research - An Introduction", Pearson, (9th Edition), 2014.*

REFERENCE BOOKS

1. *Ravindran, A., Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2014.*
2. *Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2015.*
3. *S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons, 2009.*

15MEOE07 - SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Infer environmental sustainability and to implement in more suitable ways to the society.*

CO2 *: Identify methods for reducing energy consumption and to implement lower carbon technologies to achieve sustainable society.*

CO3 *: Collect and organize information about historical perspectives of sustainability and for further development of sustainable industries.*

CO4 *: Compare the balance between food production and population growth to plan the optimal usage of water resources and to evaluate the solution for the problems of urban sprawl.*

CO5 *: Explore the fossil fuels formation of oil, natural gas and coal, environmental effects of mining and metals processing and it's time to depletion.*

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, population growth, exponential and logistic growth, variation in population among nations,population policy, Food production,Protecting and Promoting Human Health - Food security and nutrition and sustainable agriculture- Water resources, Urban sprawl. **(9)**

NON-RENEWABLE RESOURCES

Fossil fuels - Formation of fossil fuels: oil, natural gas, coal. Modelling of oil reserves. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies-Time-to-depletion. **(12)**

TOTAL : 45

TEXT BOOKS

1. *Tatyana P. Soubbotina, "An Introduction to Sustainable Development", Washington, 2nd Edition, 2004.*

REFERENCE BOOKS

1. *Jeffrey D. Sachs, "The Age of Sustainable Development", Columbia University Press, 4th Edition, 2015.*
2. *K.A.Rasure, "Globalization And Sustainable Development", Oxford book company, 2nd Edition, 2010.*
3. *Barry Dalal Clayton and Stephen Bass., "Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.*
4. *Karel Mulder, "Sustainable Development for Engineers"- A Handbook and Resource Guide, Green Leaf Publishing, 2006.*

15MEOE08 - PROCESSING AND APPLICATIONS OF BIOMATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Identify the suitable material for human implants and perform mechanical and tribological characterization. (Tensile, compression, hardness, wear, corrosion and water absorption).*

CO2 *: Choose a bio compact material (calcium phosphate, ceramic, glass, bioinert ceramics, polymeric, HDPE, hybrid, metals and alloys, Ti Alloys - Co-Cr-Mo, Ni or Ta-Based Alloys - Other Non-Ferrous alloys) for a orthopedic joints.*

CO3 *: Develop successful implants (biological, mechanical, morphological Compatibility) for dental and bone applications.*

CO4 *: Evaluate biomaterials, metals, ceramics, polymers, micro/nano for Surface modification, micro/nano fabrication to find the tensile strength and micro structure.*

CO5 *: Estimate the percentage of reinforcement (particle, fiber, laminates) to increasing the strength (tensile, flexural, bending, fatigue, wear, and corrosion) under specified constraints (density) for human implants.*

CO6 *: Design a suitable shape of the implants for orthopedic joint applications.*

FUNDAMENTALS OF BIOMATERIALS AND BIOCOMPATIBILITY

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

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

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

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

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

TEXT BOOK

1. *BikramjitBasu, Ashok Kumar and Katti S., 'Advanced Biomaterials - Fundamentals, Processing and Applications', John Wiley & Sons, INC, Publication, 2015.*

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. *Dee KC, Puleo and DA, Bizios R, 'An introduction to tissue-biomaterial interactions', John Wiley & Sons, 2007.*

15MEOE09 - NUMERICAL SIMULATION OF FLUID FLOW

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Demonstrate ability to use the Finite-Volume Method to analyze one and two-dimensional problems of heat transfer and irrotational fluid flow*

CO2 *: Apply numerical techniques to solve systems of algebraic equations and integrate ordinary differential equations*

CO3 *: Evaluate heat transfer rates, fluid flow rates, etc.*

CO4 *: Judge the correctness of the numerical solutions;*

CO5 *: Recognize the need for turbulence models*

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 McGrawHill, 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.*

15MEOE10 - SOLAR ENERGY UTILISATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

At the end of the course student will be able to

CO1 *: Calculate solar time, local time, earth-sun angles, direct and indirect solar radiation for the given location using earth-sun geometry.*

CO2 *: Categorize solar cell materials with its properties and calculate energy conversion efficiency of solar cells using I-V characteristic curves.*

CO3 *: Derive the expression for overall heat transfer coefficient using network resistance method, relations for collector efficiency factor and collector heat removal factor of non- concentrating solar collectors.*

CO4 *: Calculate heating loads using F-chart method for air and liquid based solar heating systems.*

CO5 *: Analyze the Performance of the following thermo-electric devices: generators, refrigerators and heat pumps.*

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. *Principles of Solar Engineering, D. Yogi Goswami, Taylor and Francis, 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. *Applied Photovoltaics, Stuart Wenham, Martin Green, and Muriel Watt, Earthscan, 2007, ISBN 1-84407-407-3*
2. *Photovoltaic Engineering Handbook, F. Lasnier and T. G. Ang, IOP Publishing UK (Adam Hilger USA) 1990, ISBN 0-85274-311-4*
3. *Semiconductor Devices, Physics, and Technology, Second Edition, S. M., Sze, New York, NY: Wiley, 2001. ISBN: 0471874248*
4. *Solar Cells: Operating Principles, Technology and system Applications, Martin A. Green, Published by the University of New South Wales, 1998, ISBN 0 85823 580 3*
5. *S. P. Sukhatme, "Solar Energy", Tata McGraw Hill, New Delhi, 1999.*
6. *J. A. Duffie and W.A.Beekman, " Solar Engineering of Thermal Processes", Jhon Wiley and Sons, New York, 2005.*
7. *Tiwari G.N.,Suneja S., "Solar Thermal Engineering System", Narosa Publishing House, New Delhi, 1997.*
8. *T.Bhattachariya, "Terrestial solar Photovoltaic", Narosa Publishers, New Delhi, 2008.*
9. *H.S.Rauschenbach, "Solar Cell Array Design Hand Book", Van NostrandReinfold Company, New York, 1980.*

15EEOE01- ENERGY AUDITING

L	T	P	C
3	0	0	3

COURSE OUTCOME

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

CO1 *: Understand the current energy scenario and the need for energy auditing.*

CO2 *: Describe the energy conservation schemes in steam systems.*

CO3 *: Identify the design considerations for minimizing energy consumption in compressors, fans and blowers.*

CO4 *: Understand the concepts of energy efficient electrical systems.*

CO5 *: List the techno commercial statement for the investment for energy saving.*

POWER AND ENERGY MANAGEMENT

Energy Scenario -Role of Energy Managers in Industries - Energy Monitoring, Auditing and Targeting - Economics of various energy conservation schemes -Total Energy Systems. **(9)**

ENERGY CONSERVATION IN MECHANICAL PROCESSES

Energy Audit -Various Energy Conservation Measures in Steam - Losses in Boiler - Energy Conservation in Steam Systems - Case studies. **(9)**

ENERGY CONSERVATION IN PRODUCTIVE PROCESSES

Energy Conservation in Centrifugal pumps, Fans, Blowers and Air compressor - Energy Consumption - Energy saving potentials - Design Consideration. **(9)**

ENERGY CONSERVATION IN NON-PRODUCTIVE PROCESSES

Refrigeration and Air conditioning - Heat load estimation - Energy conservation in cooling towers and Spray ponds - Energy Efficiency in Lighting - Case studies. **(9)**

ENERGY CONSERVATION CONTROL STRATEGIES AND IMPLEMENTATION

Control : Thermostats - Boiler controls - Proportional, Integral and Derivative control - Adaptive control - Compensators. Implementation: Investment and Pay back calculations for energy conservation measures - Organizational support for energy management motivation. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical publications, 1990.*
2. *Reay D.A, "Industrial Energy Conservation", Pergamon Press, 1st Edition, 1977.*
3. *Larry C Witte et. al, "Industrial Energy Management & Utilization". Springer Publication, 1st Edition, 1990.*

REFERENCES

1. *D P Kothari and I J Nagrath, "Power System Engineering", Tata McGraw-Hill Co, 2nd Edition, 2008.*
2. *https://www.beeindia.gov.in/content/energy-auditors (Guide Book link)*

GUIDE BOOKS

2.1. General Aspects of Energy Management & Energy Audit

2.2. Energy Efficiency in Thermal Utilities

2.3. Energy Performance Assistance for Equipment And Utility Systems

2.4. Energy Efficiency in Electrical Utilities

15EEOE02 - SOLAR AND WIND ENERGY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Describe the solar radiation, measurements and characteristics of solar PV cell.*

CO2 *: Develop the model of a PV system and its applications.*

CO3 *: Describe the basic types and mechanical characteristics and model of wind turbine.*

CO4 *: Analyze the electrical characteristics and operation of various wind-driven electrical generators.*

CO5 *: Understand various power electronic converters used for hybrid system.*

SOLAR RADIATION AND SOLAR CELL FUNDAMENTALS

Basic Characteristics of Sunlight - Solar Spectrum - Insolation specifics - Irradiance and Irradiation Pyrometer - Solar Energy statistics - Solar PV cell - I-V Characteristics - P-V Characteristics- Fill Factor . Modeling of solar cell - Maximum Power Point Tracking. **(9)**

SPV SYSTEM PERFORMANCE AND APPLICATIONS

PV module - Blocking diode and Bypass diodes - Composite characteristics of PV module - PV array - Solar Cell Array Design concepts - Peak power operation - System components. PV-powered fan- PV fan with Battery Backup - PV Powered pumping system -PV Powered lighting systems - Grid connected PV systems. **(9)**

WIND ENERGY FUNDAMENTALS AND COMPONENTS

Wind source - Wind statistics - Energy in the wind - Basic principle of wind energy conversion - Nature of wind power - Wind turbine power characteristics - Parts of wind turbines - Braking systems - Tower-Maximum power operation. **(9)**

WIND TURBINE TYPES AND CONTROL

Classification of WECS - Generating Systems - DC Generator - Synchronous Generator - Induction Generator - Doubly fed Induction Generator - Direct Driven generator - Generator Control - Load Control. **(9)**

SYSETM INTEGRATION

Energy Storage - Power Electronic Converters for interfacing wind electric generators - Power Quality issues - Hybrid system: Wind-Diesel systems - Wind-Solar systems. **(9)**

TOTAL : 45

TEXT BOOKS

1. *S N Bhadra, S Banerjee and D Kastha, "Wind Electrical Systems", Oxford University Press, 1st Edition, 2005.*
2. *Chetan Singh Solanki, "Solar Photovoltaic's: Fundamentals, Technologies and Applications", PHI Learning Publications, 2nd Edition, 2011.*

REFERENCES

1. *Roger A. Messenger and Jerry Ventre, "Photovoltaic Systems Engineering", Taylor and Francis Group Publications, 2nd Edition, 2003.*
2. *M.Godoy Simoes and Felix A. Farret, "Alternative Energy Systems: Design and Analysis with Induction Generators", CRC press, 2nd Edition, 2008.*
3. *Ion Boldea, "The Electric Generators Hand Book - Variable speed generators", CRC press,2010.*

15EEOE03 - HYBRID SMART VEHICLES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Explain the dynamics of vehicle motion and propulsion systems.*

CO2 *: Identify various energy storage devices used in hybrid vehicles.*

CO3 *: Understand the application of electric machines in electric vehicles.*

CO4 *: Describe the working of hybrid electric drive train*

CO5 *: Describe the control and energy management strategies in hybrid vehicles.*

INTRODUCTION

Introduction to Hybrid Electric Vehicles - Social and Environmental importance of Hybrid and Electric vehicles - Components - Vehicle mechanics - Roadway fundamentals - Vehicle kinetics - Dynamics of vehicle motion - Propulsion system. **(9)**

ENERGY STORAGE

Energy Storage Requirements in Hybrid and Electric Vehicles - Battery - Fuel Cell - Super Capacitor - Flywheel based energy storage and its analysis - Hybridization of different energy storage devices. **(9)**

DC AND AC ELECTRICAL MACHINES

Motor and Engine rating - Requirements - DC machines -Three phase AC machines - Induction machines - Permanent Magnet machines - Switched Reluctance machines.Matching the Electric Machine and Internal Combustion Engine (ICE) - Sizing the motor - Sizing the power electronics - Selecting the Energy Storage Technology - Communications - Supporting subsystems. **(9)**

HYBRID ELECTRIC DRIVE-TRAIN

Basic Concept of Electric traction, Transmission configuration - Components - Gears - Differential - Clutch - Brakes: Regenerative braking - Motor sizing. Hybrid traction - Various hybrid drive-train topologies - Power flow control in hybrid drive-train topologies - Fuel Efficiency Analysis. **(9)**

ENERGY MANAGEMENT STRATEGIES

Energy Management strategies used in Hybrid and Electric vehicles - Component level control and Supervisory control - Comparison and its Implementation issues of different energy management strategies.

Case study: Volvo XC90 T8 Plug-In Hybrid, Nissan X-Trial hybrid. **(9)**

TOTAL : 45

REFERENCES

1. *Iqbal Hussain, "Electric & Hybrid Vehicles - Design Fundamentals", CRC Press, 2nd Edition, New York, 2010,*
2. *Mehrdad Ehsani, Yi MiGao, Sebastian E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2004.*
3. *James Larminie and John Lowry, "Electric Vehicle Technology Explained", Wiley Publishers,2003.*

15EEE07 - ELECTRICAL SAFETY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Expand skills in identifying the presence of electrical hazards, implementing measures to minimize risks.*

CO2 *: Develop skills in investigative techniques for determining the cause of electrical accidents, fires and explosions.*

CO3 *: Analyze and apply various grounding and bonding techniques.*

CO4 *: Select appropriate safety method for low, medium and high voltage equipment.*

CO5 *: Assess and provide solutions to a practical case study.*

INTRODUCTION AND HAZARDS OF ELECTRICITY

Introduction - Hazard Analysis: Primary and Secondary hazards- Arc, Blast, Shocks - Causes and Effects - Summary of Causes - Protection and Precaution - Injury and Death protective strategies - IE Rules 1956 - Basic rules for new installations: Power system, Domestic and Industry.(Qualitative treatment only) **(9)**

ELECTRICAL SAFETY EQUIPMENT

General inspection and Testing procedure for electrical safety equipment - Electrical safety equipment for external protection: Flash and Thermal protection - Head and Eye protection - Insulation protection. Electrical safety equipment for internal protection: Over voltage, Short circuit, Earth Fault, Leakage current, High/Low frequency - Single Line diagram of industrial power system with safety control - Electrician's Safety Kit and Materials. **(9)**

SAFETY PROCEDURES

Introduction - Six-Step Safety Method - Job briefings - Energized or De-energized - Safe switching of power systems - General Energy Control Programs - Lockout - Tag out - Voltage measurement techniques- Placement of safety grounds - Flash hazard calculations and approach distances - Calculating the required level of arc protection (Flash hazard calculations) - Barriers and Warning signs - Tools and Test equipment - Field marking of potential hazards - Shock avoidance techniques- One-minute safety audit. **(9)**

GROUNDING AND ELECTRICAL MAINTENANCE

Need for Electrical Equipment grounding - System grounding - Equipment grounding- Types of Earthing - Earth Testing for electrical equipment's in Power house and Industry - Eight Step Maintenance program - Maintenance requirements for specific equipment and location - IEC and UL standard. **(9)**

VOLTAGE SAFETY SYNOPSIS AND MEDICAL SAFETY MANAGEMENT

Safety equipment's and safety procedures for low voltage and high voltage system - Electrical safety around electronic circuits - Electrical safety for medical equipment like Over current safety, Isolation, EMI and Harmonics - Battery Maintenance Procedure - Stationary Battery Safety - Accident Prevention- Accident Investigation - First Aid- Rescue Techniques - Electrical safety program structure and development - Safety Meetings - Safety Audits. **(9)**

TOTAL : 45

TEXT BOOKS

1. *John Cadick, Mary Capelli-Schellpfeffer and Dennisneitzel, "Electrical Safety Handbook",Mcgraw Hill Publishing Company Ltd., 3rd Edition, 1994.*
2. *Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", McGraw-Hill Education, 4th Edition, 2012.*

REFERENCES

1. *Mohamed A El-Sharkawi, "Electric Safety: Practice and Standards", CRC press, New York, 2013.*
2. *Martha J. Boss and Gayle Nicoll, "Electrical Safety: Systems, Sustainability, and Stewardship", CRC press, New York, 2014.*
3. *Ray A. Jones and Jane g. Jones, "The Electrical Safety Program Guide", National Fire Protection Association, Quincy, 2011.*
4. *James H. Wiggins JR., "Managing Electrical Safety", Abs Consulting, Maryland, 2011.*
5. *Maxwell Adams. J, "Electrical Safety- A Guide to the Causes and Prevention of Electric Hazards", The Institution of Electric Engineers, 1994.*
6. *Ray A. Jones and Jane G. Jones, "Electrical Safety in the Workplace", Jones & Bartlett Learning, Technology and Engineering, 2000.*
7. *Video Link: Electrical Safety in the Workplace Seminar DVD - NFPA National Fire Protection Association.*
   http://www.nfpa.org/training-and-events/archived/training-videos/electrical-safety-videos
8. *E-Book: Johncadick, Marycapelli-schellpfeffer, Dennisneitzel, "Electrical Safety Handbook", McGraw Hill publishing company Ltd., 3rd Edition, 1994.*
   https://installist.files.wordpress.com/2009/12/electrical-safety-handbook.pdf

15EEE14 - ENERGY EFFICIENT LIGHTING SYSTEM

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

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

COURSE OUTCOME

CO1 : *Understand the properties of light, importance of lighting in various fields and types of lighting.*

CO2 : *Understand the properties and laws of illumination, working of discharge lamps, fluorescent lamps, tungsten filament lamps and light control.*

CO3 : *Compare the various lighting techniques and employ lighting control methods.*

CO4 : *Choose the building materials and construction techniques for energy efficient lighting.*

CO5 : *The students should be able to employ renewable energy methods for energy efficient lighting.*

LIGHTING

Lighting - importance of lighting in buildings, Interior designing, Photography, Architecture - Difference between good and bad lighting - Challenges in lighting - Types of lighting. **(9)**

ILLUMINATION FUNDAMENTALS AND VARIOUS ILLUMINATION METHODS

Introduction - Terms used in illumination - Laws of illumination - Polar curves - Photometry - Integrating sphere - Sources of light - Discharge lamps, Incandescent lamps - MV and SV lamps. **(9)**

ENERGY EFFICIENT LIGHTING

Smart lighting - Fluorescent lamps - Comparison between tungsten filament lamps and fluorescent tubes - Basic principles of light control - Types and design of lighting and flood lighting.- CFL - LED - High Intensity Discharge lamps. **(9)**

BUILDING MANGEMENT SYSTEM

Energy efficient landscape design - Natural lighting - Choice of building materials for energy efficient lighting - Light pipes - Light fixtures - Green buildings - Construction techniques **(9)**

CASE STUDY

Solar lighting techniques - Lighting using wind power - Energy conservation building code - Energy efficient buildings in the country. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Philip Gordon, 'Principles and Practices of Lighting Design: The Art of Lighting Composition' , Blue Matrix Publications, 2011.*
2. *Jerry Yudelson 'Green Building Through Integrated Design', The McGraw Hill Publishers, 2009.*

REFERENCE BOOKS

1. *Derek Phillips, "Daylighting: Natural Light in Architecture“, Elsevier, 2004.*
2. *Jerry Yudelson, "Greening Existing Buildings", The McGraw Hill Publisher, 1st Edition, 2009.*
3. *Sam Kubba, "Handbook of Green Building Design and Construction", Elsevier, 2012.*
4. *Solanki.C.S, 'Solar Photovoltaic Technology and Systems', PHI, 2013.*
5. *J.F. Manwell, J.G. Mcgowan and A.L. Rogers, “Wind Energy Explained : Theory, Design and Applications”, Wiley Publications, 2nd Edition, 2009.*

15ECOE01 - CONSUMER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 *: Describe the fundamental concepts, construction and working of Audio systems*

CO2 *: Analyze the recording and reproduction techniques of Audio Systems*

CO3 *: Differentiate between the types of electronic music synthesizers*

CO4 *: Describe the fundamental concepts, construction and working of Video systems*

CO5 *: Identify the problem and troubleshoot the consumer electronic products like TV, Washing Machines, Air Conditioners*

AUDIO SYSTEM

Microphone - Characteristics of Microphones - Gun Microphones - Wireless Microphones - Headphones and Headsets - Electrostatic Phones - Electret Electrostatic Headphones - Hearing Impairments - Hearing Aids - Ideal Loudspeaker - Basic Loudspeaker - Loudspeaker Construction - Woofers - Mid range, Extended range and High frequency Loudspeakers - Multispeaker systems - Baffles - Horns - Stereo Systems. **(10)**

RECORDING AND REPRODUCTION

Making the Record - Stereo Pickup Techniques - Stereo Recording Systems - Disc Equipment: Recording and Playback Characteristics - Stereo Pickup heads - Magnetic recording and Playback - Magnetic Erasing - Optical Recording and Reproduction - Mono, Stereo and Quad - Stereo Multiplexing - Equalisers and Mixers. **(9)**

ELECTRONIC MUSIC SYNTHESIZERS

Typical Generator - Basic Modifiers - Voltage Control - Envelope Generator - Electric Guitar - Electric Wind Instrument -Recording - Digital Computer - Public Address System - Speaker Matching Systems - Theater Sound System: Sound track, Types of sound film, Theater Sound Reproduction system, Working of a Projector. **(9)**

VIDEO SYSTEMS AND DISPLAYS

Monochrome - Color TV standards - TFT, Plasma, HDTV, LCD,LED TV, Video Telephone and Video Conferencing. **(9)**

DOMESTIC AND CONSUMER APPLIANCES

In Car Computers - Washing machines - Microwave ovens - Air-conditioners and Refrigerators - Airline Reservations - Remote controls Automated Teller Machines - Set top Boxes - Bar Codes - RFID. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Bali, Consumer Electronics, Pearson Education,1st Edition, 2005.*
2. *Philip Hoff, Consumer electronics for Engineers, Cambridge University Press,1st Edition, 1998.*

REFERENCES

1. *Sridhar Canumalla, Puligandla ViswanadhamP.S.Bimbra, Portable Consumer Electronics: Packaging, Materials, and Reliability, Pennwell Books, 1st Edition, 2010.*
2. *Douglas Kinney, A Beginners Guide to Consumer Electronics Repair: Hand Book and Tutorial, iUniverse, Inc, 1st Edition, 2006.*
3. *Thomas M. Coughlin, Digital Storage in Consumer Electronics: The Essential Guide, Elsevier Inc., 1st Edition, 2008.*
4. *U.S. Consumer Electronics Industry in Review, Electronic Industries Association, Consumer Electronics Group, 1993.*
5. *https://www.pssurvival.com/ps/electronic*

15ECOE02 - ARM SYSTEM ARCHITECTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 *: Distinguish between the feature of ARM7 and cortex microcontroller and infer the architecture, instruction set and programming model of ARM Cortex.*

CO2 *: Interpret interrupt service handler & exception types of ARM processor to develop ALP programs.*

CO3 *: Exemplify memory mapping technique in ARM embedded system.*

CO4 *: Illustrate the programming concepts in real time embedded application.*

CO5 *: Examine debugging technique to develop application software for real time system.*

EMBEDDED HARDWARE

ARM Embedded system-CISC and RISC philosophy-Embedded system Hardware-ARM and Cortex architecture- Programming model- Date flow- Operating modes - Instruction sets. **(9)**

INTERRUPT AND EXCEPTIONS

Interrupts in ARM and cortex- Exception Types- Fault Exceptions- The NVIC and Interrupt Control - Interrupt Behavior. **(9)**

MEMORY SYSTEMS

Memory System Features Overview- Memory Maps- Memory Access Attributes- Default Memory Access Permissions- Bit-Band Operations- Unaligned Transfers- Exclusive Accesses and Endian Mode. **(9)**

PROGRAMMING

Exceptions Programming- Advanced Programming Features and System Behavior- Efficient C Programming- FIR and IIR filter implementation-Introduction to RTOS. **(9)**

SYSTEM DEBUGGING

Debugging Features- CoreSight- Debug Modes- Debugging Events- Breakpoint- Accessing Register - Debugging Components- Case study: Embedded system (using ARM/cortex) for monitoring- controlling and industrial automation. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Andrew N. Sloss Dominic Symes Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier Inc 2010.*
2. *Joseph Yiu, "The Definitive Guide to the ARM Cortex-M", Elsevier- Newness, 2014.*

REFERENCES

1. *Peter Barry Patrick Crowley "Modern Embedded Computing Designing Connected, Pervasive, Media- Rich Systems", Elsevier, 2012.*
2. *Steve Furber, "ARM system on Chip Archiecture", Addison Wesley professional, 2nd Edition, 2000.*
3. *Jonathan N Valveno, "Embedded Systems : Introduction to ARM @ Cortex TM-Microcontrollers" 5th Edition, 2015.*
4. *Rajkamal, "Embedded system Architecture Programming and Design," Tata McGraw Hill, 2nd Edition, 2009.*
5. *Shibu K.V., "Introduction to Embedded Systems", Tata McGraw Hill, 1st Edition, 2009.*

15ECOE03 - BROADBAND COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 *: Describe the concepts and applications of Microwave and Millimeter wave communication*

CO2 *: Comprehend and explain the operation of Satellite communication and navigation systems*

CO3 *: Illustrate the operation of optical communication systems and high speed networks*

CO4 *: Exemplify the features and functionalities of cellular communication from 2G to 4G and beyond*

CO5 *: Distinguish and describe different wireless technologies based on its features and applications*

MICROWAVE AND MILLIMETER WAVE COMMUNICATION

Microwave concepts - devices and lines - waveguides and cavity resonators -Microwave semiconductor diodes-Microwave tubes - antennas - Microwave and millimeter applications. **(9)**

SATELLITE COMMUNICATION

Satellite orbits - Satellite Communication Systems - Satellite subsystems - Ground stations - Applications - Global Navigation satellite systems. **(9)**

OPTICAL COMMUNICATION

Optical principles - optical communication systems - fiber optics cables - optical transmitters and receivers - wavelength division multiplexing - passive optical networks -40/100Gbps networks and beyond. **(9)**

CELLPHONE TECHNOLOGIES

Cellular telephone systems - Cellular industry overview - 2G and 3G digital cell phone systems -Long term evolution and 4G cellular systems - Base stations and small cells. **(9)**

WIRELESS TECHNOLOGIES

Wireless LAN - PANs and Bluetooth - Zigbee and mesh wireless networks - Wi-Max and wireless Meteroploitan area networks - Infrared wireless - Radio frequency identification - Ultra wideband wireless-wireless applications. **(9)**

TOTAL : 45

TEXT BOOK

Louis E.Frenzel,"Principles of Electronic Communication Systems", Mc-Graw Hill Education,4th edition,2016

REFERENCES

1. *Kennedy G, "Electronic Communication Systems", Tata McGraw Hill, 4th Edition, 1999.*
2. *Rappaport,T.S, "Wireless communications", Pearson Education, 2nd Edition, 2010*
3. *William Stallings, "Wireless Communications and networks", Pearson Prentice Hall of India, 2nd Edition, 2009.*
4. *David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 1st Edition, 2005.*
5. *Aditya K.Jagannathan, "Principles of Modern Wireless Communication Systems: Theory and Practice", Mc-Graw Hill Education, 2016.*

15ECOE04 - ROBOTICS FOR INDUSTRIAL APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 *: Comprehend and appreciate the significance and role of industrial robot in the present contemporary world*

CO2 *: Exemplify the features and functionalities of the sensors in Robot*

CO3 *: Develop different language programs to design and develop robotic based systems*

CO4 *: Develop system for industrial automation and medical application*

CO5 *: Illustrate the methodologies to provide automatic solution for replacing humans in life threatening area*

SCOPE OF ROBOTS

The scope of industrial Robots - Definition of an industrial robot - Need for industrial robots -Economic and Social Issues- applications. **(4)**

ROBOT COMPONENTS

Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume -Precision of movement - End effectors - Sensors. **(9)**

ROBOT PROGRAMMING

Robot Programming - Methods - Interlocks textual languages, Characteristics of Robot level languages, characteristic of task level languages. **(9)**

ROBOT WORK CELL

Robot Cell Design and Control - Remote Center compliance - Safety in Robotics. **(9)**

FUTURE TRENDS

Telepresence robot, Autonomous mobile robots, Walker Robots, Solar-ball Robot, Underwater bots, Aerobots - Advanced robotics in Space - Specific features of space robotics systems - longterm technical developments, Next generation robots. **(14)**

TOTAL : 45

TEXT BOOKS

1. *Robert J. Schilling, "Fundamentals of Robotics- Analysis and Control", Pearson Education, 2006.*
2. *John M. Holland, "Designing Autonomous Mobile Robots-Inside the mind of an Intelligent Machine", Newnes Publication, 2004.*

REFERENCES

1. *Mikell P.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill Book Company 1986.*
2. *John Iovine, "Robots, Android and Animatronics", Second Edition, McGraw-Hill, 2012.*
3. *Fu K.S. Gonzaleaz R.C. and Lee C.S.G.,"Robotics Control Sensing, Vision and Intelligence",McGraw Hill, International Editions, 1987.*
4. *Bernard Hodges and Paul Hallam, "Industrial Robotics", British Library Cataloging in Publication 1990.*
5. *Deb, S.R., "Robotics Technology and flexible automation", Tata McGraw Hill, 1994.*

15ECOE05 - SIGNAL PROCESSING AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 *: Compute the Discrete Fourier Transform (DFT) of a given discrete time sequence using Radix-2 Fast Fourier Transform algorithms and design FIR/IIR Filters*

CO2 *: Apply source coding procedure to calculate coding efficiency based on entropy & mutual information and outline different pulse analog modulation techniques*

CO3 *: Analyze various equalization techniques and compare its performance*

CO4 *: Calculate channel capacity using Shannon's channel capacity theorem and develop channel error control codes*

CO5 *: Analyze speech processing methods in time and frequency domain and design codec methods for speech compression techniques*

ORTHOGONAL TRANSFORMS AND DIGITAL FILTER STRUCTURES

DFT-DCT-Properties of DFT- Computation of DFT, FFT and structures-Decimation in time-Decimation in frequency - Linear convolution using DFT

Basic FIR/IIR filter structures-FIR/IIR Cascaded lattice structures-Parallel allpass realization of IIR transfer functions- Sine cosine generator - Computational complexity of filter structures **(10)**

DATA COMPRESSION

Information entropy-Source coding-Huffman algorithm-Delta Modulation-Adaptive Delta Modulation- Continuously Variable Slope Delta Modulation-Differential Pulse Code Modulation - Adaptive Differential Pulse Code Modulation. **(8)**

SIGNAL PROCESSING IN COMMUNICATION RECEIVER

Temporal Equalization-Space Time Equalization-Frequency Domain Equalization-Symbol Timing Recovery- Channel Quality Estimation- Automatic Frequency Control-Overall Receiver Block. **(9)**

ERROR CORRECTING CODES & CHANNEL CODING

Error Correcting codes-Error Correction-Linear Block Codes-Cyclic Codes- Bose, Chaudhari and Hocquenghem Codes-Convolution Codes-Viterbi Decoding-Interleaving Codes-Concatenated Codes- Turbo Codes. **(9)**

SPEECH CODING

Speech Coding-Adaptive Predictive Coding-Sub Band Coding,-Vocoders-Liner Predictive Coding- Image Coding-Joint Photo Graphic Expert Group(JPEG)-Moving Pictures Expert Group(MPEG), the layer-3 of MPEG-1 Algorithms(MP3),Lempel- ZIV Algorithms - Recognition techniques:Speech Recognition and Image recognition **(9)**

TOTAL : 45

TEXT BOOKS

1. *V. Oppenheim, R. W. Shafer and J.R.Buck, "Discrete-Time Signal Processing", Pearson Education, 4th Edition,2011*
2. *Simon Haykins, "Digital Communications Systems", 1st Edition, Wiley, 2013.*

REFERENCES

1. *Sanjit. K. Mitra and Sanjit Kumar Mitra, "Digital Signal Processing - A computer based approach", Tata McGraw Hill, 4th Edition, 2011.*
2. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 2005.*
3. *Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003*
4. *L.R.Rabiner and R.W.Schaffer "Digital Processing of Speech signals" Prentice Hall, 1978.*
5. *Nirmal K. Bose, Calyampudi Radhakrishna Rao, "Signal Processing and Its Applications" North-Holland, 1993*

15CSOE01 - FUNDAMENTALS OF SOFTWARE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Describe the various software life cycle models and choose an appropriate model for a given application.*

CO2 *: Identify the functional requirements, prepare data flow, ER diagrams and Software Requirement Specifications.*

CO3 *: Employ suitable architectural styles, software design methodologies, coding standards and practices in developing practical applications*

CO4 *: Discuss various testing techniques and their application in defect removal.*

INTRODUCTION

The Software Engineering Discipline - Software Development Projects - Software Life Cycle Models: Use of Life Cycle Models - Classical Waterfall Model-Iterative Waterfall Model-Prototype model-Evolutionary Model-Spiral Model **(9)**

SOFTWARE REQUIREMENTS AND ANALYSIS

Requirements Analysis and Specification - Requirements Gathering and Analysis- Value of good SRS - Requirement process- Requirement Specification - desirable characteristics, components and Structure of requirements document - Functional Specification with use cases - basics - developing Use Cases -DFDs - Data Dictionary - ER Diagrams. **(8)**

SOFTWARE DESIGN

Design concepts - Cohesion and Coupling- The Open-Closed Principle - Function Oriented Software Design: Structured charts - Structured design methodology - Detailed Design: Logic / Algorithm design - State Modeling of Classes. **(10)**

CODING

Programming principles and guidelines - Structured programming - Information hiding - some programming practices - Coding standards - Code inspection - Planning- Self review - Group review meeting. **(7)**

TESTING

Testing Fundamentals -Black Box Testing: Equivalence Class Partitioning - Boundary Value Analysis - White box Testing: Control Flow based criteria - Data Flow based Testing - Levels of Testing: Unit Testing - Integration Testing - System Testing - Acceptance Testing. **(11)**

TOTAL : 45

TEXT BOOK

1. *Pankaj Jalote, "Software Engineering A precise Approach", Wiley India, Third edition 2012.*
2. *Rajib Mall, "Fundamentals of Software Engineering", PHI Learning Private Limited, Third Edition 2013.(Introduction only)*

REFERENCE BOOKS

1. *Roger.S.Pressman "Software Engineering A Practitioner's Approach", McGraw Hill International Edition, Seventh Edition, 2014.*
2. *Ian Sommerville, "Software Engineering", Dorling Kindersley (India) Private Ltd., Eighth Edition, 2008.*

15CSOE02 - INTRODUCTION TO DATA WAREHOUSING AND DATA MINING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Describe the basic concepts, architecture, data models of database management systems and data warehouse.*

CO2 *: Demonstrate the multidisciplinary fields of data mining and illustrate the techniques for data preprocessing.*

CO3 *: Find frequent item set and generate association rules for the given transactions.*

CO4 *: Analyze different types of data using classification and clustering techniques.*

BASIC CONCEPTS OF DATABASE SYSTEM

Purpose of DBMS - Applications - Views of data - Data Abstraction - Instances and Schemas - Data Models - Database Languages - Relational Databases - Database Architecture - Database users and administrators - History of Database systems **(8)**

DATA MINING

Data Mining - On What Kind of Data-Data Mining Functionalities - Classification of Data Mining Systems - Data Mining Task Primitives - Integration of a Data Mining System with a Database or Data Warehouse System-Major Issues in Data Mining. **(9)**

DATA WAREHOUSING

Data Warehouse - Introduction-Multidimensional Data Model-Data Warehouse Architecture -Data Warehouse Implementation - From Data Warehousing to Data Mining. **(8)**

DATA PREPROCESSING AND ASSOCIATION RULES

Data Preprocessing: Needs Preprocessing the Data - Data Cleaning- Data Integration and Transformation-Data Reduction-Discretization and Concept Hierarchy Generation. Associtation Rules: Basic concepts - Apriori Algorithm - Generation of association rules from frequent item sets - FP Tree Algorithm - Pattern evaluation methods **(10)**

CLUSTERING AND CLASSIFICATION

Cluster analysis - Partitioning Methods - K-Means and K-Medoid algorithm - CLARA - CLARANS - Hierarchical clustering - BIRCH - Density based clustering - DBSCAN - Decision tree induction. **(10)**

TOTAL : 45

TEXT BOOKS

1. *Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Tata McGraw Hill, Sixth Edition, 2013. (Basic Concepts of Database System only)*
2. *Jiawei Han & Micheline kamber, "Data Mining-Concepts and Techniques" Morgan Kaufmann Publishers, Third Edition, 2012.*

REFERENCE BOOKS

1. *Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, Sixth Edition, 2013.*
2. *Arun K Pujari, "Data Mining Techniques" Universities Press India Ltd., Third Edition, 2012.*
3. *Dunham, "Data Mining- Introductory and Advanced Topics", Pearson Education, New Delhi, First Edition, 2006.*
4. *Pieter Adriaans, Dolf Zantinge, "Data Mining ", Pearson Education, Third Edition 2009,Delhi.*
5. *Sam Anahory, Dennis Murray, "Data Warehousing in the Real World ", Pearson Education, Seventh indian Reprint New Delhi,2003.*
6. *George M. Marakas, " Modern Data Warehousing, Mining, & Visualization Core concepts", Pearson Education, First Edition, 2003*
7. *Paulraj Ponnaiah, "Data Warehousing Fundamentals", Wiley Publishers, Singapore, First Edition, 2001.*

15CSOE03 - INTRODUCTION TO EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Examine the characteristics and challenges in embedded system development*

CO2 *: Identify the parameters affecting CPU performance and develop optimized code*

CO3 *: Demonstrate the scheduling of given set of real-time tasks using the appropriate scheduling algorithm*

CO4 *: Design embedded system for simple applications*

INTRODUCTION

Characteristics of embedded computing applications- Challenges in embedded computing design - Performance in embedded computing.Embedded System Design Process - Computer Architecture Taxonomy - ARM Processor -Assembly Language Programming. **(10)**

CPU PERFORMANCE

I/O Primitives - Busy -Wait I/O - Interrupts - Memory System Mechanisms: Cache, Memory Management Unit and Address Translation - Pipelining - CPU Power Consumption **(8)**

DEVELOPMENT AND DEBUGGING

Development environments - Debugging Techniques - Debugging challenges - System Level Performance analysis - Program Level Performance analysis - Program Optimization **(9)**

SCHEDULING

Scheduling states of a Process-Running Periodic Processes - Preemption - Priorities- Rate Monotonic Scheduling - Earliest Deadline First Scheduling - Priority Inversion - Data dependency. **(10)**

NETWORKS

Bus Standards: I2C, CAN Bus, Field Bus. CASE STUDY: Alarm Clock, Elevator Controller. **(8)**

TOTAL : 45

TEXT BOOK

1. *Marilyn Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman, Third Edition, 2012*

REFERENCE BOOKS

1. *Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education, First Edition, 2009. (For Scheduling)*
2. *David. E. Simon, "An Embedded Software Primer", Pearson Education, First Edition, 2012*
3. *Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill, Third Edition, 2014.*

15CSOE04 - INTERNET PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Gain knowledge in overview of www and web based application.*

CO2 *: Design and develop dynamic and interactive web pages using DHTML.*

CO3 *: Design and develop web applications using servlets.*

CO4 *: Gain knowledge on E-business Models and E-marketing.*

BASIC WEB CONCEPTS

Basic Web Concepts - Web based Client/Server model -Web Protocols- Working of web browser - Browser & Server Communication - Review of HTML: Markup Languages, Introduction to HTML- forms - frames - tables. **(9)**

CLIENT SIDE PROGRAMMING

Client-side Programming (Review of JavaScript): Introduction, Writing Comments, Variables, Operators, Statements, Alert, Confirm, and Prompt Boxes, Functions, Event and Error Handling, Introduction to Built-in Classes, Form Validation, Cookies. **(9)**

DYNAMIC HTML

Dynamic HTML :Introduction - cascading style sheets-object model and collections - event model - filters and transition - data binding - data control - ActiveX control - handling of multimedia data. **(9)**

SERVER SIDE PROGRAMMING

Servlets - Deployment of simple servlets - web server (Java web server / Tomcat / Web logic) - HTTP GET and POST requests - session tracking - cookies - JDBC - simple web applications - Multi-tier applications. **(9)**

WEB BASED APPLICATIONS AND ITS TECHNOLOGIES

Rails:Overview of Rails-Ajax:Overview of Ajax Rails with Ajax- e-Business Models-e-Marketing-online payments-Security. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Deital & Deital, "Internet and World Wide Web-How to Program", Pearson Education Fifth Edition, 2011.*
2. *Robert W.Sebesta, "Programming with World Wide Web", Pearson Education, Eighth Edition, 2015.*

REFERENCE BOOKS

1. *Scot Johnson, Keith Ballinger,Davis Howard Chapman, "Special Edition Using Active Server Pages", Prentice Hall of India,paperback 1999.*
2. *Ravi Kalakota and Andrew B Whinston, "Frontiers of e-commerce", Addison Wesley, paperback 1999.*
3. *Jeffrey C. Jackson," Web Technologies: A Computer Science Perspective", Pearson Education, Reprint 2011.*
4. *Elliotte Rusty Harold, "Java Network Programming", O'Reilly Publishers, Fourth Edition 2013.*

15CSOE05 - CUSTOMER RELATIONSHIP MANAGEMENT ESSENTIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: State the evolution of marketing and define CRM architecture explaining customer acquisition, retention and segmentation.*

CO2 *: Describe the business value, its costs and deploying data mining for CRM with proper guidelines for privacy.*

CO3 *: Demonstrate the scoring process and apply the various CRM optimization techniques to optimize CRM process in order to improve customer profitability.*

CO4 *: Evaluate CRM tools using tool assessment and methodology to choose the appropriate tool for real time applications.*

INTRODUCTION

Most profitable Customer - CRM: Custom centered database, Managing campaigns, Evolution of marketing, Closed loop marketing, CRM architecture - Customer profitability - Customer acquisition - Cross selling - Customer retention - Customer segmentation. **(9)**

BUILDING THE BUSINESS CASE

Introduction - Uncovering the needs for data mining - Defining the business value - The costs - Deploying Data mining for CRM: Introduction - Define the problem - Define the user - Define the data - Scope the project - Trial - Quality assurance - Education - Launch - Continuation. **(10)**

COLLECTING CUSTOMER DATA

Introduction - Three types of customer data - Collecting customer data - Connecting customer - Customer data and privacy - Privacy and data mining - Guidelines for privacy - Legal issues associated with data mining. **(8)**

SCORING YOUR CUSTOMER

Introduction - Process - Scoring architectures and configurations - Preparing the data - Integrating scoring with other applications - Optimizing the CRM process: Introduction - Improved customer profitability through optimization - Optimized CRM - Complete loop - Optimal CRM process - Optimization techniques. **(8)**

OVERVIEW OF DATA MINING AND CRM TOOL MARKETS

Introduction - Data mining market place - Taxonomy of data mining tools - Tool assessment attributes and methodology - Tool evaluation - Other data mining tools -CRM tools - Next generation for CRM. **(10)**

TOTAL : 45

TEXT BOOK

1. *Alex Berson, Stephen Smith, Kurt Thearling, "Building Data mining Applications for CRM", Tata McGraw Hill, Fifteenth Reprint, 2008.*

REFERENCE BOOKS

1. *Francis Buttle, Stan Maklan "Customer Relationship Management: Concepts and Technologies", Routledge, Third Edition, 2015.*
2. *Roger J. Baran, Robert J. Galka, "CRM: The Foundation of Contemporary Marketing Strategy", S.Chand (G/L) & Company Ltd, Second Edition, 2017.*

15CSOE06 - E-COMMERCE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Describe the features of e-commerce, various business models and marketing strategies used in e-commerce.*

CO2 *: Use the knowledge on the mechanics of building a secure e-commerce website and payment systems.*

CO3 *: Comprehensive online retailing, marketing and impact of social media.*

CO4 *: Illustrate the procurement process and supply chain management in B2B e-commerce.*

INTRODUCTION

E-commerce: E-commerce and E-business - Features of E-commerce Technology - Types of E-commerce. Understanding E-commerce: Technology - Business and Society. E-commerce Business Models and Concepts: Eight Key Elements - Strategy, Structure and Process: Industry Structure - Industry Value Chains - Firm Value Chains - Firm Value Webs - Business Strategy. **(7)**

BUILDING E-COMMERCE WEBSITE

Building an Ecommerce Presence: Systematic Approach - Choosing Software and Hardware: Web Server Software - Application Servers - Merchant Server Software Functionality and Packages - Web Services and Open Source Options - Other E-commerce Site Tools - Developing Mobile Website and Building Mobile Applications. **(8)**

E-COMMERCE SECURITY AND PAYMENT SYSTEMS

Ecommerce Security Environment - Security Threats - Management Policies, Business Procedures and Public Laws - Payment Systems - E-commerce Payment Systems. **(7)**

SOCIAL, MOBILE AND LOCAL MARKETING

Introduction to Social, Mobile and Local Marketing - Social Marketing: Social Marketing Players - The Social Marketing Process - Face book Marketing - Twitter Marketing - Pinterest Marketing - The Downside of Social Marketing - Mobile Marketing: Basic Mobile Marketing Features - Mobile Marketing Tools - Mobile Marketing Campaign - Local and Location Based Marketing: Location Based Marketing Platforms - The Technologies - Marketing Tools - Marketing Campaign - Marketing Results. **(8)**

ONLINE RETAIL SERVICES, AUCTIONS AND PORTALS

E-commerce in Action: E-tailing Business Models: Virtual Merchants - Multi-channel Merchants - Catalog Merchants - Manufacturer Direct - Online Financial Services - Online Travel Services - Online Career Services. Online Auctions: Measuring Growth of Auctions and Dynamic Pricing - Benefits of Auctions - Risks and Costs of Auctions for Consumers and Businesses. E Commerce Portals: Types of Portals - Portal Business Models. **(9)**

E-COMMERCE, SUPPLY CHAIN AND COLLABORATIVE MANAGEMENT

Defining and Measuring the Growth of B2B Commerce - Benefits and Challenges of B2B E-commerce - The Procurement Process and Supply Chain - Types of Procurement. Trends in Supply Chain Management and Collaborative Commerce: Just-in-Time and Lean Production - Supply Chain Simplification - Adaptive Supply Chains - Accountable Supply Chains - Sustainable Supply Chains - Electronic Data Interchange - Supply Chain Management Systems - Collaborative Commerce. **(6)**

TOTAL : 45

TEXT BOOK

1. *Kenneth C. Laudon,Carol Guercio Traver, "E-Commerce-Business,Technology, Society", Pearson India, Tenth edition, 2016.*

REFERENCES

1. *Ravi Kalakota, Andrew Whinston, "Frontiers of Electronic Commerce", Pearson India, fourteenth Reprint 2007.*
2. *Dave Chaffey, "E - Business and E - Commerce Management: Strategy, Implementation, and Practice:" Pearson India, Sixth Edition, 2013.*
3. *Henry Chan, Raymond Lee, Tharam Dillon, Elizabeth Chang, "E-Commerce, Fundamentals and Applications", Wiley India Private Ltd Reprint 2008.*

15ITOE01 - DIGITAL COMPUTER BASICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Explain various schemes of number system representations, code conversions and perform arithmetic operations.*

CO2 *: Describe Boolean Algebra, formulate and simplify Boolean expressions using K-Maps and illustrate the logic gates realization..*

CO3 *: Describe the working of basic combinational circuits and sequential circuits.*

CO4 *: Describe the structure and functioning of various memory schemes.*

NUMBER SYSTEMS

Binary Numbers, Number Base Conversions, Octal and Hexadecimal Numbers. Complements of Numbers - Signed Binary Numbers. Binary Codes : Binary-Coded Decimal(BCD) Code, Gray Code, ASCII Character Code, Error Detecting Code. BCD Addition - Decimal Arithmetic. Binary Storage and Registers. **(9)**

BINARY LOGIC AND BOOLEAN ALGEBRA

Definition of Binary logic. Boolean Algebra - Basic Definitions - Theorems and Properties of Boolean Algebra - Canonical and Standard Forms. Digital Logic Gates : Integrated Circuits. Gate-Level Minimization: Map Method - Four?Variable K-Map - Product?of?Sums Simplification. Realization of Boolean functions using Gates. **(10)**

COMBINATIONAL CIRCUITS

Adder : Half Adder - Full Adder - Binary Parallel Adder - BCD Adder. Subtractor : Half Subtractor - Full Subtractor. Code Conversion. Decoders - De-Multiplexer - Encoders - Multiplexers. **(9)**

SEQUENTIAL CIRCUITS

Storage Elements- Latches, Flip?Flops-RS,D,JK and T flip-flops-Triggering of flip-flops- Characteristic Tables- Characteristic Equations. Registers -Shift Registers. Counters: Binary ripple counter - Updown binary counter. **(9)**

MEMORY AND PROGRAMMABLE LOGIC

Random Access Memory - Memory Decoding - Read?Only Memory - Types of ROMs, Programmable Logic Array, Programmable Array Logic. **(8)**

TOTAL : 45

TEXT BOOK

1. *M. Morris Mano and Michael D. Ciletti,"Digital Design with an Introduction to the Verilog HDL, Pearson Education, Fifth edition, 2013.*

REFERENCE BOOKS

1. *M. Morris Mano, "Digital Logic and Computer Design", Pearson Education, First edition, 2008.*
2. *Thomas L.Floyd, "Digital Fundamentals", Pearson Education, Tenth edition, 2011.*

15ITOE02 - PROGRAMMING IN JAVA

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Describe the fundamental aspects of object oriented programming paradigm.*

CO2 *: Develop java programs using features like methods, classes, constructors, overloading and string handling.*

CO3 *: Write exception handling routines for practical applications.*

CO4 *: Describe multithreading, synchronization and networking features of Java.*

CO5 *: Demonstrate use of applets and database connectivity in developing practical Applications.*

OBJECT ORIENTED PROGRAMMING

Introduction to object oriented languages - Evolution of object oriented languages - Object oriented programming paradigm - Basic concepts of object oriented programming - Procedural Vs object oriented programming. **(6)**

INTRODUCTION TO JAVA

Java and Internet - Byte Code - Features of Java - Java Development Environment- Java Programming: Methods and Classes - Constructor - Garbage Collection - Overloading - Inheritance - Overriding - Packages and Interfaces - Java IO systems - String Handling : String and String Buffer. **(12)**

EXCEPTION HANDLING

Exception Handling: Fundamentals of Exception handling and types - Built in Exceptions - user defined Exceptions. **(5)**

MULTI THREADS

Multithreaded Programming : Thread Model - Thread properties - Thread priorities -Synchronization- Inter thread communication- Networking : Inet address - Datagrams - Sockets - URL connections. **(11)**

APPLET AND DATABASE CONNECTIVITY

Introduction to Abstract Window Tool kit - Applet class - HTML applet tags - Parameter passing - Audio clip interface - Event class: Keyboard and Mouse events handling. **(11)**

TOTAL : 45

TEXT BOOK

1. *Herbert Schilt :" Java 2 - Complete Reference ", Tata McGraw Hill, Ninth Edition, McGraw Hill Education, 2014.*

REFERENCE BOOK

1. *Deitel H.M and Deitel P.J, "Java - How to Program", Prentice Hall of India, Ninth Edition, 2012.*

15ITOE03 - FUNDAMENTALS OF DATABASE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Describe the database system concepts and explain the key features of Relational data models.*

CO2 : *Describe the features of Entity Relationship diagram and draw Entity Relationship diagram for the given real world application*

CO3 : *Design a normalized database system and carry out data retrieval using SQL.*

CO4 : *Demonstrate various transaction concepts and various concurrency control mechanisms*

DATABASE SYSTEMS

Data Vs Information-Introducing the database and DBMS- Importance of Database Design- Files and File systems-Problems with File System Data Management, Database Systems.

Relational Database Model: Logical view of Data- Keys- Integrity Rules- Relational Set Operators- Data Dictionary and the system catalog -Codd's relational database rules. **(10)**

RELATIONAL MODEL

Entity Relationship Model: Entities-Attributes-Relationship-Connectivity and cardinality-Existence Dependence-Relationship Strength-Weak Entities-Relationship participation-Relationship Degree-Recursive Relationship-Developing an ER Diagram. **(8)**

STRUCTURED QUERY LANGUAGE

Introduction to SQL- Data Definition Commands- Data Manipulation Commands-Advanced Data Definition and SELECT Commands - Virtual Tables -Creating Views- Joining Database Tables. **(8)**

DATABASE DESIGN

Database Tables and Normalization- Need for Normalization- Normalization Process-Improving the Design-Surrogate Key Considerations, High level Normal Forms, Normalization and Database Design-Denormalization. **(10)**

TRANSACTION MANAGEMENT

Transaction Concepts: Transaction Properties- Transaction Concurrent Executions. Concurrency control with Locking Methods: Lock Granularity-Lock Types-Two-Phase Locking to Ensure Serializablity-Deadlocks-Database Recovery Management-RAID. **(9)**

TOTAL : 45

TEXT BOOK

1. *Peter Rob, Corlos M.Coronel, "Database Systems: Design, Implementation and Management", Thompson Learning Course Technology, Tenth edition, 2012.*

REFERENCE BOOKS

1. *Abraham Silberschatz, Henry F.Korth,S.Sudharshan,"Database System Concepts", McGraw-Hill, Sixth Edition, 2013.*
2. *Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, Sixth Edition, 2013.*
3. *Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw Hill Education, Third Edition, 2014.*
4. *Thomas M.Connolly and Carolyn E.Begg, " A Practical Approach to Design, Implementation and Management", Pearson, 6th Edition, 2014.*

15ITOE04 - CLOUD COMPUTING FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Understanding the client- server, distributed collaborative and cloud computing architecture along with cloud storage and services.*

CO2 : *Classify the different virtualization environments and techniques.*

CO3 : *Illustrate various services deployed from a cloud architecture supported by different providers.*

CO4 : *Analyze the major security challenges and privacy problems in the cloud and virtual environment.*

INTRODUCTION

Understanding Cloud Computing- history of cloud computing: Client/Server computing, Peer to peer computing, Distributed computing and Collaborative computing.- Understanding cloud architecture, cloud storage and services-Pros and cons of cloud computing. **(9)**

VIRTUALIZATION

Introduction-Characteristics of Virtualized Environments - Taxonomy of Virtualization Techniques - Virtualization and Cloud Computing - Pros and Cons of Virtualization - Technology Examples **(9)**

CLOUD COMPUTING ARCHITECTURE

Cloud reference model: Architecture, Infrastructure - and Hardware as a service, Platform as a service-Software as a service, Types of cloud: Public clouds, Private clouds, Hybrid Cloud, Community Clouds. **(9)**

CLOUD SERVICES

Discovering Cloud services Development services and tools: Amazon, Google App Engine, IBM, Salesforce.com, Other Cloud Services development tools. **(9)**

CLOUD SECURITY

Security Overview - Cloud Security Challenges - Software as a Service Security - Security Governance - Risk Management - Security Monitoring - Security Architecture Design - Data Security - Application Security - Virtual Machine Security. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Michael Miller, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online",1st Edition, Pearson Education, New Delhi, 2009.*
2. *Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, "Mastering Cloud Computing", Tata McGraw Hill, 2013.(Virtualization, Cloud Computing Architecture)*
3. *John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management,* and Security", CRC Press, 2010. (Cloud Security)

REFERENCES BOOKS

1. *Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.*
2. *Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.*
3. *Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.*

15ITOE05 - INFORMATION SECURITY FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Identify and analyze the security threats and attacks and apply device suitable security policies and standards.*

CO2 *: Assess the risks and apply suitable risk control strategies.*

CO3 *: Employ appropriate intrusion detection and prevention systems to ensure information security.*

CO4 *: Discuss various national and international laws of information security and its framework.*

INTRODUCTION, NEED FOR SECURITY

Introduction to Information Security - The History of Information Security- Critical Characteristics of Information - NSTISSC Security Model - Components of an Information System - Securing Components - Balancing Information Security and Access - The Systems Development Life Cycle - The Security Systems Development Life Cycle. The Need for Security: Introduction - Business Needs First -Threats -Attacks. **(5)**

RISK MANAGEMENT AND INFORMATION SECURITY

Introduction - An Overview of Risk Management - Risk Identification -Risk Assessment - Risk Control Strategies - Selecting a Risk Control Strategy - Risk Management Discussion Points - Recommended Practices in Controlling Risk. **(6)**

POLICIES, STANDARDS, PRACTICES AND BUSINESS CONTINUITY

Introduction - Information Security Policy, Standards and Practices -The Information Security Blueprint: ISO 17799/BS 7799, ISO 27001and its controls, NIST Security Models, Design of Security Architecture - Security Education, Training and Awareness Program - Continuity Strategies. **(6)**

SECURITY TECHNOLOGY

Introduction - Intrusion Detection and Prevention Systems: IDPS Terminology, Use of IDPS, Strengths and Limitations of IDPS - Honey Pots, Honey Nets, and Padded Cell Systems - Scanning and Analysis Tools, Access Control Devices - **(8)**

BIOMETRIC CONTROLS

Biometrics - Nature of Biometrics Identification/Authentication Techniques - Biometric Techniques - Matching and Enrollment Process in Biometrics - Benefits Over Traditional Authentication Methods. **(6)**

SECURITY OF WIRELESS NETWORKS

Attacks on Wireless Networks: Other Security Risks in Wireless Networks, Management and Mitigations for Wireless Networks Attacks. **(7)**

LAWS AND LEGAL FRAMEWORK

Introduction - Information Security and the Law: The Rising Need -Understanding the Laws for Information Security: A Conceptual Framework - The Indian IT Act - Laws for Intellectual Property Rights (IPR) -Health Insurance Portability and Accountability Act (HIPAA) - Building Security into Software/System Development Life Cycle. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Michael E Whitman and Herbert J Mattord, "Principles of Information Security", Course Technology, New Delhi, Fourth Edition, 2012 Reprint.*
2. *Nina Godbole, "Information Systems Security-Security Management, Metrics, Frameworks and Best Practices", Wiley India Pvt. Ltd., New Delhi, First Edition, 2009.(Biometric Controls, Security of Wireless Networks, Laws and Legal Framework)*

REFERENCE BOOKS

1. *Thomas R.Peltier, "Information Security Fundamentals", Auerbach Publications, Second Edition, 2013.*
2. *Micki Krause and Harold F.Tipton, "Information Security Management Handbook", Auerbach Publications, Sixth Edition,2008.*
3. *Mark Merkow and Jim Breithaupt," Information Security - Principles & Practices", Second Edition, Pearson Education, 2014.*

15ITOE06 - INTRODUCTION TO HUMAN COMPUTER INTERACTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Describe the importance and need for effective user friendly Graphical User Interfaces(GUI).*

CO2 *: Choose suitable interactions devices/tools to meet application specific requirements.*

CO3 *: Design Graphical User Interfaces(GUI) using apt components and apply the design guidelines for user-friendly navigation and presentation.*

CO4 *: Asses graphical user interfaces for compliance against the screen design guidelines.*

INTRODUCTION

Importance of User Interface: Definition-Importance of good design-Benefits of good design-Human-centered development and Evaluation-Human Performance models-A Brief history of screen design. **(9)**

THE GRAPHICAL USER INTERFACE & DESIGN PROCESS

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system -Characteristics - Web user - Interface Popularity - Characteristics and Principles of User Interface.

Design process: Human Interaction with computers - Importance of Human Characteristics - Human Consideration - Human Interaction Speeds and Understanding Business Junctions. **(9)**

SCREEN DESIGNING

Design Goals - Screen Planning and Purpose - Organizing Screen Elements - Ordering of Screen Data and Content - Screen Navigation and Flow - Visually Pleasing Composition - Amount of Information - Focus and Emphasis - Presenting Information Simply and Meaningfully - Information retrieval on web - Statistical Analysis - Technological considerations in Interface Design. **(11)**

WINDOWS & COMPONENTS

Windows: New Navigation Schemes - Selection of Window - Selection of Devices Based on Screen Based Controls.

Components: Text and Messages - Icons and Increases - Multimedia - Colors - Uses -Problems - Choosing colors. **(9)**

SOFTWARE TOOLS AND INTERACTION DEVICES

Specification Methods - Interface Building Tools - Keyboard and Function Keys - Pointing Devices Speech Recognition. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Wilbert O Galitz, "The Essential Guide to User Interface Design", Third Edition, Wiley India Pvt., Ltd., 2007.*
2. *Ben Shneidermann, "Designing the User Interface", Fifth edition, Pearson Education Asia, 2013. (Software Tools and Interaction Devices)*

REFERENCE BOOK

1. *Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition, 2004.*

15ITOE07 - ENTERPRISE RESOURCE PLANNING CONCEPTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Describe the operational aspects of ERP system and its related technologies.*

CO2 : *Demonstrate the steps required for ERP Project management and implementation process by choosing the right vendors/consultants, employee training and monitoring.*

CO3 : *Categorize the business modules of an ERP package inorder to define the functionality of various departments in a company.*

CO4 : *Analyze the ERP marketplace and its vendors, and assess how Enterprise Application Integration (EAI), e-business help the company use ERP to its utmost benefit.*

INTRODUCTION

Enterprise - An Overview - Introduction to ERP - Benefits Of ERP - ERP and Related Technologies - Business Process Reengineering (BPR) - Data Warehousing - Data Mining -OLAP - SCM. **(9)**

ERP IMPLEMENTATION

ERP Implementation Lifecycle - Implementation Methodologies - ERP deployment methods - Package Selection - Process Definition - Vendors and Consultants - Contract with Vendors, Consultants and Employees - Training and education- Project Management and Monitoring. **(10)**

THE ERP BUSINESS MODULES

Business modules of an ERP Package - Finance - Manufacturing - Human Resources - Plant Maintenance - Materials Management - Quality Management - Sales and Distribution. **(9)**

THE ERP MARKET & ERP - Present and Future

ERP Marketplace and Marketplace Dynamics - ERP Vendors - SAP AG, Oracle Corporation, Microsoft Dynamics, EPICOR, QAD, RAMCO Systems - Enterprise Application Integration (EAI)- ERP and E-Business- Future Directions and Trends in ERP. **(9)**

SAP

Gateway to SAP: Architecture of SAP R/3 -SAP Integrated-Three Tier Architecture - SAP Easy Access - Understanding ABAP Workbench **(8)**

TOTAL : 45

TEXT BOOKS

1. *Alexis Leon," ERP Demystified", Tata McGraw Hill, New Delhi, Third Edition, 2014.*
2. *Dreamtech Press, "SAP R/3, Black Book", Dreamtech Software Team, 2006. (SAP)*

REFERENCE BOOKS

1. *Ellen F.Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Course Technology Ptr, Fourth Edition, 2013.*
2. *Vinod Kumar Garg and Venkitakrishnan N.K., "Enterprise Resource Planning - Concepts and Practice", Prentice Hall of India, New Delhi, Second Edition, 2012.*

15CHOE01- INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 *: Practice the safety norms and inspect turning machines, boring machines, milling machine, planning machine, grinding machines, CNC machines and wood working machinery to create risk free working environment.*

CO2 *: Assess the adequacy of machinery guarding to eliminate or reduce the hazards from the point operation, flying chips and sparks and moving parts.*

CO3 *: Apply t the safety concepts in welding, gas cutting,storage and handling of gas cylinders, metal forming processes, etc.,*

CO4 *: Predict, identify and evaluate, hazardous conditions and practices safety rules in in cold forming and hot working of metals*

CO5 *: Employ the safety rules in inspection and testing process and take plan the preventive measures in health and welfare of workers'aspects in engineering industry.*

SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types,safety principles, electrical guards, work area, material handling,inspection, standards and codes- saws, types, hazards. **(9)**

PRINCIPLES OF MACHINE GUARDING

Guarding during maintenance, Zero Mechanical State (ZMS), Definition,Policy for ZMS - guarding of hazards - point of operation protectivedevices, machine guarding, types, fixed guard, interlock guard,automatic guard, trip guard, electron eye, positional control guard, fixedguard fencing- guard construction- guard opening. Selection andsuitability: lathe - drilling - boring - milling - grinding - shaping - sawing- shearing presses - forge hammer - flywheels - shafts - couplings -gears - sprockets wheels and chains pulleys and belts - authorized entryto hazardous installations-benefits of good guarding systems **(9)**

SAFETY IN WELDING AND GAS CUTTING

Gas welding and oxygen cutting, resistance welding, arc welding and cutting, common hazards, personal protective equipment, training,safety precautions in brazing, soldering and metalizing - explosive welding, selection, care and maintenance of the associated equipmentand instruments - safety in generation, distribution and handling ofindustrial gases-colour coding - flashback arrestor - leak detection-pipeline safety-storage and handling of gas cylinders. **(9)**

SAFETY IN COLD FORMING AND HOT WORKING OF METALS

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operatedpresses, power press electric controls, power press set up and dieremoval, inspection and maintenance-metal sheers-press brakes. Hotworking safety in forging, hot rolling mill operation, safe guards in hotrolling mills - hot bending of pipes, hazards and control measures.Safety in gas furnace operation, cupola, crucibles, ovens, foundry healthhazards, work environment, material handling in foundries, foundryproduction cleaning and finishing foundry processes. **(9)**

SAFETY IN FINISHING, INSPECTION AND TESTING

Heat treatment operations, electro plating, paint shops, sand and shotblasting, safety in inspection and testing, dynamic balancing, hydrotesting, valves, boiler drums and headers, pressure vessels, air leaktest, steam testing, safety in radiography, personal monitoring devices,radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal **(9)**

TOTAL : 45

TEXT BOOKS

1. *Wells G.L.,R.M.C. Seagrave-Flow sheeting for safety, Indian Institute of Chemical Engineering, London U.K,1977.*
2. *TrevurKletz Butterworth, Learning from accidents, - London, 1988.*
3. *John Barton and Richard Rogers, Chemical reaction Hazards - A guide to safety, Institution of Chemical Engineering London, 1997.*
4. *Philip Hagan "Accident Prevention Manual for Business and Industry", N.S.C.Chicago, 13th edition 2009.*

REFERENCES

1. *Rohatgi A.K, Safety handling of Hazardous Chemicals Enterprises, Bombay, 1986.*
2. *Shukla S.K., Envirohazards and Techno Legal aspects, Shashi Publications, Jaipur India, 1993.*
3. *John V.Grimaldi and Rollin H.Simonds," Safety Management", Richard D Irwin, 1994.*
4. *Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.*
5. *"The Indian boilers act 1923 with amendments", Law Publishers (India) Pvt. Ltd., Allahabad.*
6. *"Health and Safety in welding and Allied processes", Welding Institute, UK, High Tech. Publishing Ltd., London, 1989.*
7. *"Safe use of wood working machinery", HSE,UK,2005.*

15CHOE02 - RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 *: Identify individual hazards in a process and deduce the associated risks.*

CO2 *: Identify radiation intensity and effects of explosion*

CO3 *: Perform risk analysis of various types of problems*

CO4 *: Evaluate effect about key hazard identification techniques*

CO5 *: Apply risk analysis techniques and Hazop study*

INTRODUCTION AND DISPERSION MODELS

Risk analysis introduction, quantitative risk assessment, rapid risk analysis - Comprehensive risk analysis - Emission and dispersion - Leak rate calculation. Single and two-phase flow - Dispersion model for dense gas - Flash fire - Plume dispersion - Toxic dispersion model - Ealuation of risk. **(9)**

RADIATION INTENSITY

Radiation - Tank on fire - Flame length - Radiation intensity calculation and its effect on plant, people and property radiation VCVCE - Explosion due to over pressure - Effects of explosion, risk contour -Effects, explosion, BLEVE - Jet fire - Fire ball. **(9)**

RISK ANALYSIS

Overall risk analysis - Generation of meteorological data - Ignition data - Population data - Consequences analysis and total risk analysis - Overall risk contours for different failure scenarios - Disaster management plan - Emergency planning - On site and off site emergency planning, risk management ISO 14000, EMS models case studies - Marketing terminal, gas processing complex, refinery. **(9)**

HAZARD ANALYSIS

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough - Mexico - Madras - Vizag - Bopal analysis **(9)**

CASE STUDIES

Hazop - Guide words, parameters, derivation - Causes - Consequences - Recommendation - Coarse Hazop study - Case studies - Pumping system - Reactor - Mass transfer system. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ragavan K.V., Khan A.A., Methodologies in Hazard identification and assessment -Manual, CLRI publication, 1990.*
2. *Marcel.V.C., Major Chemical Hazard, Ellis Hawood Ltd., Chi Chester, UK, 1987.*
3. *Skeleton B., Process Safety Analysis, Institution of chemical Engineers, U.K., 1997.*

REFERENCE BOOKS

1. *Daniel A Crowl., Louvar J.F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, New Jersey, 2002.*

15CHOE03 - GREEN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 *: Outline the green technology concepts and relevance in twenty first century requirements.*

CO2 *: Defend the environmental and sustainability issues, role of CSR and CER and Indian corporate structure and environment.*

CO3 *: Recall the indicators of sustainability and their use and can also find the alternate theories.*

CO4 *: Criticize the environmental reporting, ISO 14001, ISO 14064, financial initative by UNEP, etc.*

CO5 *: Analyze the green tax incentives and rebates, business redesign and its models.*

INTRODUCTION

The concept of green technology; evolution; nature, scope, importance and types; developing a theory; green technology in India; relevance in twenty first century. **(9)**

SUSTAINABILITY & ENVIRONMENT

Organizational environment; internal and external environment; Indian corporate structure and environment; how to go green; spreading the concept in organization; environmental and sustainability issues for the production of high-tech components and materials, life cycle analysis of materials, sustainable production and its role in corporate social responsibility (CSR) and corporate environmental responsibility (CER).

(9)

ECOSYSTEM APPROACHES

Approaches from ecological economics; indicators of sustainability; ecosystem services and their sustainable use; bio-diversity; Indian perspective; alternate theories **(9)**

ACTS OF GREEN TECHNOLOGY

Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP; green energy technology; green product technology. **(9)**

GREEN ECONOMICS

Definition; green techniques and methods; green tax incentives and rebates (to green projects and companies); green project technology in action; business redesign; eco-commerce models. **(9)**

TOTAL : 45

REFERENCES

1. *Green Technology and Green Technologies: Exploring the Causal Relationship by Jazmin Seijas Nogarida, 2008.*
2. *Green Marketing and Technology: A global Perspective by John F. Whaik, 2005.*
3. *The Green Energy Technology Book by Leo A. Meyer.*
4. *Green Project Technology by Richard Maltzman and David Shiden.*
5. *Green Marketing by JacquelinOttman.*
6. *Green and World by Andrew S. Winston.*

15CHOE04 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Classify the types of corrosion and theories and also relate the various controlled corrosion process.*

CO2 *: Examine the factors involved in the corrosion and control methods of various corrosion.*

CO3 *: Analyze the mechanism of corrosion and evaluate the effects like pH, temperature, flow rate on corrosion.*

CO4 *: Design and develop the corrosion control methods like cathodic protection, sacrificial anode and impressed current anodes and anodic protection.*

CO5 *: Predict the different corrosion testing, monitoring and inspection tests by surface analytical studies.*

INTRODUCTION

Introduction, classification, economics and cost of corrosion.emf series, galvanic series, corrosion theories derivation of potential - Current relations of activities controlled and diffusion controlled corrosion process. Potential - pH diagram, Fe-H_2O system, application and limitation. Passivation - Definition, anodic passivation theory of passivation, oxidation laws, effects of oxygen and alloying on oxidation rates. **(9)**

CORROSION CONTROL METHODS

Forms of corrosion - Definition, factors and control methods of various forms of corrosion such as pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, fretting corrosion, hydrogen embitterment, corrosion processes and control methods in fertilizers, petrochemical, chemical building industries **(9)**

MECHANISM OF CORROSION

Environmental aspects, atmospheric corrosion - Classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods, corrosion in immersed condition, effect of dissolved gases, salts, pH, temperature, and flows rates on corrosion, marine corrosion, underground corrosion. Biological corrosion, definition, mechanism of corrosion, control of bio-corrosion. **(9)**

CORROSION PREVENTION

Corrosion control aspects, electrochemical methods of protection-theory of cathodic protection design of cathodic protection, sacrificial anodes, impressed current anodes, anodic protection. Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system - Boiler water system.Organic coating, surface preparation, natural, synthetic resin, paint, formulation and application. Design aspects in corrosion prevention, corrosion resistant materials. **(9)**

CORROSION TEST

Corrosion testing, monitoring and inspection, laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by DC and AC methods, corrosion monitoring methods, chemical and electrochemical removal of corrosion products, newer techniques to study corrosion processes, inspection methods by NDT. Surface analytical techniques such as AES, ESCA, SEM. Evaluation of paints by conventional and electrochemical methods. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Roberge P. R., Corrosion Engineering, McGraw Hill, New York, 2008.*
2. *Fontana M.G., Greene N.D., Corrosion Engineering, Third Edition, McGraw Hill, NewYork, 2005.*
3. *Uhling H. H., Revie R.W., Corrosion and Corrosion Control, John Wiley and Sons, Inc, 1985.*

REFERENCES

1. *Banarjee.S.N., An introduction to corrosion and corrosion inhibitors, Oxonian Press Ltd., New Delhi, 1985.*

15CHOE05 - INTRODUCTION TO CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 *: Express the fundamentals of chemical engineering and to solve problems.*

CO2 *: Ability to develop basic fluid concepts, transfer and separation operations.*

CO3 *: Design equipments for transport and separation processes.*

CO4 *: Apply material and Energy balance to precisely calculate material requirement of a process.*

CO5 *: Apply steady state balances to develop process flow sheet.*

OVERVIEW OF CHEMICAL ENGINEERING

Concepts of unit operations and unit processes, and more recent developments, The Chemical Industry-scope, features & characteristics. Flow sheets, and symbols for various operations. **(9)**

MATERIAL AND ENERGY BALANCE CALCULATIONS

Material balances in simple systems involving physical changes and chemical reactions; systems involving recycle, purge, and bypass, combustion reactions, Forms of energy, optimum utilization of energy, Energy balance calculations in simple systems. Introduction to Computer aided calculations-steady state material and energy balances, combustion reactions. **(9)**

BASIC FLUID CONCEPTS

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non Newtonian viscosity, Dimensional Analysis (Buckingham PI theorem), Types of flows, Methods of Analysis, Fluid Statics. pipe flow, Pumps, Agitation and Mixing, Compressors. **(9)**

HEAT TRANSFER OPERATIONS

Review of conduction, resistance concept, extended surfaces, lumped capacitance; Introduction to Convection, natural and forced convection, correlations; Radiation; Heat exchangers- Fundamental principles and classification of heat exchangers, Evaporators. **(9)**

MASS TRANSFER OPERATIONS

Fundamental principles and classification of Distillations, Adsorption, Absorption, Drying, Extraction, Membrane Process.Energy and Mass Conservation in process systems and industries.Introduction to chemical reactors. **(9)**

TOTAL : 45

REFERENCES

1. *G.T. Austin, R.N. Shreve, Chemical Process Industries, 5th ed., McGraw Hill, 1984.*
2. *W.L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 6th Edition, McGraw Hill, 2001.*
3. *R. M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd ed., John Wiley, New York,2004.*
4. *L.B. Anderson and L.A. Wenzel, Introduction to Chemical Engineering, McGraw Hill, 1961.*
5. *H.S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed., Prentice-Hall, 2006.*

15MOE01 - GRAPH THEORY AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide fundamental concepts on Graph Theory and its application for the study of Engineering.

OUTCOME

CO1 *: The students will be able to understand the idea of graph theory and to solve the real time problem.*

CO2 *: To relate the Graph theory Algorithms' in their field of engineering and apply the same in their respective main stream.*

CO3 *: To become familiar with Special graphs for modeling the networks.*

CO4 *: Able to design and solve Coloring concepts for defined problems.*

CO5 *: Model the networks using graph theory.*

GRAPHS AND SUBGRAPHS

Graph --Standard Concepts in Graphs - Subgraphs -Complete Graph - Bipartite Graph - Isomorphism - Adjacency Matrix and Incidence Matrix - Walk, Trail and Path -Bipartite Graph -Connectedness- The Shortest Path Problem- Disjkstra's Algorithm **(9)**

TREES

Trees- Characterization- Blocks - Block Graphs - Cayley's Formula - Spanning Trees- Spanning Tree Algorithms - Kruskal's and Prim's Algorithm **(9)**

EULERIAN AND HAMILTONIAN GRAPHS

Eulerian graphs - Euler's theorem -Hamiltonian graphs - Dirac's and Ore's theorems - Closure of a graph - Bondy-Chvatal theorem - Traveling salesman problem -The Chinese Postman Problem- Fleury's Algorithm. **(9)**

COVERING AND COLORING

Covering - Independent Sets - Matching - Perfect Matching- Applications- The Personal Assignment Problem- Coloring - Chromatic Number - Four Color Problem - Chromatic Polynomials - Application. **(9)**

DIRECTED GRAPHS

Digraph - Orientation - Strongly, Weakly and Unilaterally Connected Digraphs - Directed acyclic graph - Adjacency matrix and Incidence Matrix of graph - Network Flows- Transport Networks- Max-Flow Min- Cut Theorem- Activity Network **(9)**

THEORY : 45

TEXT BOOK

1. *Gary Chatrand and Ping Zhang, Introduction to Graph Theory, McGraw Hill Education (India), 2006.*
2. *Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall of India Private Limited, 2004.*

REFERENCES

1. *Douglas B.West, "Introduction to Graph Theory" II Edition, Prentice Hall of India Private Limited, 2000.*
2. *Reinhard Diestel, "Graph Theory", II Edition, Springer Publications, 2006.*
3. *Clark J. and Holton D.A, "A First Look at Graph Theory", Allied Publishers, 1995.*
4. *Frank Harary, Graph Theory, 10th Edition, Narosa Publishing House, 2001.*

15MOE02 - METHODS OF APPLIED MATHEMATICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide fundamental concepts on Method of Applied Mathematics and its application for the study of Engineering.

OUTCOME

CO1 *: The students will be able to understand the idea of integral equations and to solve the real time problems.*

CO2 *: To familiarize the students with basic concept of ordinary differential equations, special functions and solve problems associated with engineering applications.*

CO3 *: To achieve an understanding of the basic concepts of boundary value problems and characteristic function representations and method of solving them.*

CO4 *: Able to construct and solve a mathematical model for heat flow problems in real life situation*

CO5 *: Able to use the concepts of Calculus of variations and basic concepts for solving equations involving functional.*

INTEGRAL EQUATIONS

Relation between integral and differential equations - Green's function. Fredholum's equation with separable Kernals Hilbert Schmidt theory, interactive methods for solving equations of second kind **(9)**

SECOND ORDER ORDINARY DIFFERENTITAL EQUATIONS AND SPECIAL FUNCTIONS

Singular points, Series solutions and the methods of Frobenius, Bessel Equation,Bessel Functions, modified Bessel functions and their properties, Ber and BeifunctionsLegendre equation. Legendre functions,associatedLegendre functions and their properties, Series solutions Valid for large arguments. **(9)**

BOUNDARY PROBLEMS AND CHARACTERISTIC FUNCTION REPRESENTATIONS

Sturm -Liouviller problems. Orthogonal functions and expansions in series of Orthogonal functions.Stodola and Vianello method for Sturm - Liouviller problems Fourier, Fourier - Bessel and Legedre Series. Fourier Integral. Applications to Rotating shafts and buckling columns. **(9)**

PARTIAL DIFFERENTITAL EQUATIONS

Linerar and quasi - linear equations of the first and second order. Characterstics of first and second order linear equations. Heat flowequations.Problems in one, two and three dimensions. Fourier method.

Wave equation. Vibrating string andMembrance Fourier Method. Non -homogeneous problems and the method of variation of parameters. **(9)**

INTEGRAL TRANSFORM METHODS

Applications of Laplace transform and Fourier Transforms to PDE - Calculus of Variations :

Variational notation, Constraints and Lagarangian multipliers, variable and points, Rayleigh - Ritz method. **(9)**

TOTAL : 45

TEXT BOOK

1. *M.K.Venkatraman, Higher Mathematics for Engineering and Science, third Edition , The National Publishing Company,(2014)*
2. *F.B. Hildebrand : Advanced Calculus for applications second Edn. (EEE). Prentice Hall of India P.Ltd., (2014)*

REFERENCES

1. *F.B. Hildebrand - Methods of Applied Mathematics , second Edn. Prentice Hall of India P.Ltd., (2012)*
2. *C.Stephenson : An introduction to partial differential equation for Science students , ELBS.*
3. *E. D. Rainville : Special Functions.*
4. *Dettman : Mathematical methods in physics and Engineering.*

15MOE03 - LINEAR AND NON - LINEAR PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide fundamental concepts on Linear & Non- Linear Programming and its application for the study of Engineering.

OUTCOME

CO1 *: The students will be able to understand the idea of linear Programming problems and to solve the real time problems.*

CO2 *: To familiarize the students with basic concept of Transportation models and solve problems associated with engineering applications.*

CO3 *: To achieve an understanding of the basic concepts of Assignment problems and method of solving them.*

CO4 *: Able to construct and solve a Game theory models in real life situation*

CO5 *: Able to use the concepts of Non-linear Programming problems for solving Constrained and unconstrained equations.*

LINEAR PROGRAMMING

Formulation of LPP - Graphical methods for two variables - The Simplex method - Artificial Variables Techniques - Big M - method -The Two Phase method - Dual Simplex Method **(9)**

TRANSPORTATION MODEL

Mathematical formulation of a Transportation problem -Methods for finding initial basic feasible solution - North West corner rule -Least cost method - Vogle's Approximation method -Modified distribution method - Degeneracy in Transportation problems **(9)**

ASSIGNMENT PROBLEM

Mathematical formulation of an Assignment problem - Hungarian Method - Unbalanced Assignment Models - Maximization case in Assignment Problems - Restrictions in Assignments -Travelling Salesman Problem **(9)**

GAME THEORY

Two person zero- sum Games -The Maxmini - Minimax Principle -Saddle Point and value of the game - Games without saddle points, Mixed Strategies-Matrix Oddment method for n×n games -Dominance Property-Graphical Method of 2× n or m×2 games. **(9)**

NON-LINEAR PROGRAMMING

Non-linear Programming Algorithm - Unconstrained Non-linear Algorithms - Constrained Non-linear Lagrange multipliers, Kuhn-Tucker optimality conditions. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Operations Research An Introduction, Eight Edition, Hamdy A.TAHA , Pearson Prentice Hall 2007, New Delhi*
2. *Resource management techniques by V.Sundaresan, Tenth Edition, 2016 A.R Publications, Chennai*

REFERENCES

1. *Andrews L.C. and Phillips R.L., "Mathematical Techniques for Engineers and Scientists", Prentice Hall of India Pvt.Ltd., New Delhi, 2005.*
2. *O'Neil, P.V., "Advanced Engineering Mathematics", Thomson Asia Pvt. Ltd., Singapore, 2003.*

15MOE04 - PROBABILITY AND RANDOM PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

OBJECTIVE

To provide fundamental concepts on probability and Random process and its application for the study of Engineering.

OUTCOME

CO1 : *The students will be able to understand the idea probability problems and to solve the real time problems.*

CO2 : *To familiarize the students with basic concept of probability distributions and solve problems associated with engineering applications.*

CO3 : *To achieve an understanding of the basic concepts of Correlation and regression and method of solving them.*

CO4 : *Able to solve a signal processing problems by using random process concepts.*

CO5 : *Able to use the concepts of Correlation functions and Power spectral densities for solving Electrical and Electronics problem.*

THEORY OF PROBABILITY

Sample Space, Events, Axioms of probability, Conditional probability, Independent events, Theorem of total probability, Baye's Theorem. **(9)**

PROBABILITY DISTRIBUTIONS

Definition of Discrete and Continuous random Variables **(9)**

Discrete distributions : Binomial, Poisson and Geometric - Properties and Simple problems

Continuous distributions : Normal, Uniform Exponential - Properties and Simple problems.

CORRELATION AND REGRESSION

Correlation - Meaning and scope of Correlation - Scatter diagram, Karl Pearson's co-efficient of Correlation, Spearman's Rank Correlation, Multiple Correlation and partial correlation - simple problems.

Regression Analysis - Meaning and Scope of regression- Regression in two variables - Uses of Regression. **(9)**

RANDOM PROCESSES

Classification - Stationary process - Markov process - Poisson process - Random telegraph process. **(9)**

CORRELATION AND SPECTRAL DENSITIES

Auto Correlation functions -Cross Correlation functions -Properties -Power spectral density - Cross spectral density -Properties. **(9)**

TOTAL : 45

TEXT BOOKS

1. *S.C.Gupta and V.K. Kapoor , Fundamental of Mathematical Statistics , Tenth revised edition ,2002.*
2. *T.Veerarajan , Probability ,Statistics and Random Processes ,Second Edition ,TataMcGraw-Hill 2007*

REFERENCES

1. *Rohatgi V.K. (2002) : Introduction to Mathematical Statistics, Wiley. 2. Bhat, B. R. (2005) : Modern Probability Theory - An Introductory Text Book, Third Edition, New Age International.*
2. *Cochran, W.G.(2007): Sampling Techniques, Wiley Eastern Private Limited*
3. *Sukhatme, P.V. and Sukhatme, B.V.(1977): Sampling Theory of Survey with Applications, Asia publishing House.*
4. *Venkataraman M .K , "Higher mathematics for Engineering and Science" National Publishing Company ,2000*
5. *Ibe, O.C., "Fundamentals of Applied Probability and Random processes", 1st Indian Reprint , Elsevier , 2007.*
6. *Peebles, P.Z., " Probability, Random Variables and Random Signal Principles" , Tata McGraw Hill , 4th Edition , New Delhi, 2002.*

15POE01 - INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.*

CO2 *: Understand the different classes of nanomaterials.*

CO3 *: Identify the principles of processing, manufacturing and characterization of nanomaterials and nanostructures.*

CO4 *: Outline the applications of nanotechnology and develop an ability to critically evaluate the promise of a nanotechnology device.*

BASICS OF NANOTECHNOLOGY

Introduction - Time and length scale in structures -Definition of a nanosystem -Dimensionality and size dependent phenomena -Surface to volume ratio -Fraction of surface atoms - Surface energy and surface stress- surface defects-Effect of nanoscale on various properties - Structrural,thermal, mechanical,magnetic, optical and electronic properties. **(9)**

DIFFERENT CLASSES OF NANOMATERIALS

Classification based on dimensionality-Quantum Dots,Wells and Wires- Carbon based nano materials (bucky balls, nanotubes, graphene)- Metal based nanomaterials (nanogold, nanosilver and metal oxides) - Nanocomposites-Nanopolymers - Nano ceramics -Biological nanomaterials. **(9)**

SYNTHESIS OF NANOMATERIALS

Chemical Methods:Metal Nanocrystals by Reduction -Sol - gel processing -Solvothermal Synthesis-Photochemical Synthesis - Chemical Vapor Deposition(CVD) - Metal Oxide - Chemical Vapor Deposition (MOCVD).Physical Methods : Ball Milling - Electrodeposition - Spray Pyrolysis - DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE). **(9)**

CHARACTERIZATION OF NANOSTRUCTURES

Introduction, structural characterization, X-ray diffraction (XRD-Powder/Single crystal), Small angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM) - Energy Dispersive X-ray analysis (EDAX)- Transmission Electron Microscope (TEM) - Scanning Tunneling Microscope (STM)-Atomic Force Microscopy (AFM), UV-vis spectroscopy (liquid and solid state) - Raman spectroscopy -X-ray Photoelectron Spectroscopy (XPS) - Auger Electron Spectroscopy (AES). **(9)**

APPLICATIONS

Solar energy conversion and catalysis - Molecular electronics and printed electronics -Nanoelectronics -Polymers with a special architecture - Liquid crystalline systems - Applications in displays and other devices -Nanomaterials for data storage -Photonics, Plasmonics- Chemical and biosensors -Nanomedicine and Nanobiotechnology. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, Kamali Kannargare., Geoff Smith Overseas Press (2005)*
2. *A Textbook of Nanoscience and Nanotechnology,Pradeep T., Tata McGrawHill Education Pvt. Ltd., 2012.*
3. *Nanostructured Materials and Nanotechnology,Hari Singh Nalwa,Academic Press, 2002.*
4. *Introduction to Nanotechnology, Charles P.Poole,FrankJ.Owens,Wiley Interscience (2003)*
5. *Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, Baldev Raj, B BRath, James Murday, Springer Science & Business Media, 2013.*

REFERENCES

1. *Nanotechnology: A gentle introduction to the next Big idea, Mark A.Ratner, Daniel Ratner, Mark Ratne, Prentice Hall P7R:1st Edition (2002)*
2. *Fundamental properties of nanostructed materials Ed D. Fioran, G.Sberveglier, World Scientific 1994*
3. *Dupas C., Houdy P., Lahmani M.,Nanoscience: Nanotechnologies and Nanophysics, Springer-Verlag Berlin Heidelberg, 2007*

15POE02 - PHYSICS AND TECHNOLOGY OF THIN FILMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Recognize the fundamental growth and material parameters of thin films.*

CO2 *: Evaluate and use models for nucleation and growth of thin films.*

CO3 *: Asses the relation between deposition technique, film structure, and film properties.*

CO4 *: Identify modern techniques for the characterization of thin films*

CO5 *: Demonstrate the applications of thin films*

PREPARATION OF THIN FILMS

Preparation methods: electrolytic deposition, cathodic and anodic films, thermal evaporation, cathodic sputtering, chemical vapour deposition. Molecular beam epitaxy and laser ablation methods. Thickness measurement and monitoring: electrical, mechanical, optical interference, microbalance, quartz crystal methods. **(9)**

GROWTH KINETICS OF THIN FILMS

General features.- nucleation theories - energy formation of a nucleus - critical nucleation parameters; spherical and non spherical (cap, disc and cubic shaped) - Effect of electron bombardment on film structure. Post- nucleation growth, epitaxial films and growth. **(9)**

ANALYTICAL TECHNIQUES OF CHARACTERIZATION

X-ray diffraction - photoluminescence - UV-Vis-IR spectrophotometer - Atomic Force Microscope - Scanning Electron Microscope - Hall effect - Vibrational Sample Magnetometer - Secondary Ion Mass Spectrometry - X-ray Photoemission Spectroscopy - Auger emission spectroscopy. **(9)**

PROPERTIES OF THIN FILMS

Dielectric properties - experimental technique for the determination of dielectric properties - optical properties - experimental technique for the determination of optical constants - mechanical properties - experimental technique for the determination of mechanical properties of thin films - magnetic and superconducting properties. **(9)**

APPLICATIONS

Optoelectronic devices : LED, LASER and Solar cell - Micro Electromechanical Systems (MEMS) - Fabrication of thin film capacitor - application of ferromagnetic thin films; data storage, Giant Magnetoresistance (GMR) - sensors - fabrication and characterization of thin film transistor and FET. **(9)**

TOTAL : 45

TEXT BOOKS

1. *A. Goswami, Thin Film Fundamentals, New Age international (P) Ltd. Publishers, New Delhi, 2006.*
2. *L.I. Maissel and Glang (Eds.), Handbook of Thin film Technology, McGraw- Hill, 1970.*
3. *K.L. Chopra, Thin Film Phenomena, McGraw-Hill (1983)*

REFERENCES

1. *Thin-Film Deposition : Principles and Practice, Smith Donald Donald L Smith Smith, McGraw-Hill Professional Pub, 1995*
2. *J.C. Anderson, The Use of Thin Films in Physical Investigation, Academic Press 1966.*
3. *J.J. Coutts, Active and Passive Thin Film Devices, Academic Press 1978.*
4. *George Hass, Physics of Thin Films: Volumes 1.:12, Academic Press 1963.*
5. *KiyotakaWasa, Makoto Kitabatake, Hideaki Adachi, Thin Films Material Technology, Springer-Verlag Berlin Heidelberg, 2004.*

15POE03 - SOLAR CELL FUNDAMENTALS AND MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Demonstrate the knowledge about photovoltaics.*

CO2 *: Gain knowledge about principle of operation of solar cells*

CO3 *: Realization about semiconducting materials used in the manufacture of PV cells*

CO4 *: Outline the various advanced solar cell technologies, their current status and future technological challenges*

EVULAUTION OF SOLAR CELLS

Historical development; present and future global issues- commercialization/economic factors- basic components of PV systems- The solar spectrum - terrestrial and space spectra; air mass (AM0, AM1.5) -Introduction to 1st, 2nd and 3rd generation photovoltaics. **(9)**

SOLAR CELL FUNDAMENTALS

Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell - light absorption- creating charge carriers forming the electric field - driving the charge carriers - solar cell parameters- electrical characteristics - the ideal solar cell, solar cell in practice, the quantum efficiency and spectral response, optical properties - basics of solar cell device design. **(9)**

SEMICONDUCTOR PROPERTIES

Overview of semiconductor properties relevant to solar cell operations- semiconductor band structure, carrier statistics in semiconductors, the transport equations, carrier mobility, carrier generation by optical absorption-band to band transitions, free-carrier absorption, recombination- bulk recombination processes, surface recombination, minority carrier life time. **(9)**

SILICON AND THIN FILM SOLAR CELLS

Si photovoltaics-single crystal silicon cells - semicrystalline and polycrystalline silicon cells - overview of various thin film solar cells:gallium arsenide solar cells - fabrication techniques, InP & cadmium telluride based solar cells - copper indium diselenide solar cells - multijunction cells -environmental and health aspects. **(9)**

ADVANCED SOLAR CELLS

Advanced solar cell concepts -organic (polymer) photovoltaics -new concepts - quantum dots, wires, intermediate band, multiple exciton generation - Dye sensitized solar cells - perovskite solar cells - challenges in materials and device design -current and future research trends in PV. **(9)**

TOTAL : 45

TEXT BOOKS

1. Fonash S. J., Solar Cell Device Physics, Academic, 2010.
2. Goetzberger, J. Knobloch, and B. Voss Crystalline Silicon Solar Cells, Wiley,1998.
3. Green M. A. Third Generation Photovoltaics: Advanced Solar Energy Conversion" Springer, 2006.

REFERENCES

1. *Chetan Singh Solanki., Solar Photovoltaic: Fundamentals,Technologies and Application, PHI Learning Pvt., Ltd., 2009.*
2. *Jha A.R., Solar Cell Technology and Applications, CRC Press,2010.*

15POE04 - ADVANCED MATERIAL PROCESSING TECHNOLOGIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Recognize the criteria for material selection based on properties of materials and to choose the required material for a specified application.*

CO2 *: Understand various metallurgical forming processes such as casting, rolling extrusion, drawing, development of grain structure and processing of different composite types.*

CO3 *: Demonstrate knowledge about powder metallurgy, ceramic and polymer processing methods.*

CO4 *: Identify and choose the required surface treatment technique for coating formation on account of enhancing the surface properties of the mechanical components for engineering applications.*

CO5 *: Understand the applicable joining and machining techniques and their limitations*

SELECTION OF MATERIALS.

Motivation for selection - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability, corrosion and wear resistance - Relationship between materials selection and processing - Case studies - aero, auto, marine, machinery and nuclear applications.High and low temperature materials, superconductors, supramagnetic materials, high entropy alloys,nanomaterials and biomaterials. **(9)**

METALLURGICAL FORMING AND PROCESSING OF COMPOSITES

Metallurgical forming: Casting, rolling extrusion, drawing, development of grain structure for specific properties. Processing of composites: lay up methods, press/ autoclave / resin transfer moulding, Reinforced reaction injection molding (RRIM), obtrusion and filament winding. **(9)**

POWDER METALLURGY, CERAMIC AND POLYMER PROCESSING

Powder metallurgy and ceramic processing: green fabrication methods, sintering, hot pressing, Hot isostatic pressing (HIP), spark plasma sintering, development of microstructure in powder processed materials.Polymer processing: extrusion, injection moulding, blow moulding, rotational moulding, vacuum forming and related processes processing of cellular polymers. **(9)**

COATING METHODS

Introduction to surface Engineering, Differences between surface and bulk, Properties of surfaces-wear, wettability. Chemical vapour deposition, physical vapour deposition, electro deposition, electroless deposition, thermal spray processes. Principle of various coating processes, process parameters, controlling the yield of coating and various surface properties of the coating. Criteria for selection of a surface coating technology. Product oriented surface coating technology. **(9)**

JOINING AND MACHINING

Joining: fusion welding, solid state welding, adhesive bonding, mechanical joining and recent advancements in welding. machining: Electromachining (electrochemical and electro-discharge), mechanical machining and recent advancements. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Charles J.A., Crane, F.A.A and Furness, J.A.G., Selection and use of Engineering Materials, 3rd Edition, Butterworth-Heinemann, 1977.*
2. *BetzalelAvitzu, Metal Forming- Processes and Analysis, Tata McGraw Hill, 1977.*
3. *William F Hasford, Robert M Caddell, Metal Forming: Mechanics and Metallurgy, Cambridge University Press P.ltd,2007.*
4. *Angelo P C and Subramanian R, Powder Metallurgy Science, Technology and Applications, Prentice Hall of India, New Delhi, 2012.*

REFERENCES

1. *Michael Barsoum, Fundamentals of Ceramics, McGraw Hill Publishing Co., INC, 1997*
2. *Gowariker V R, Viswanathan N V, JayadevSreedhar, Polymer Science, New Age International P Ltd., 2005.*
3. *David S. Rickerby, Allan Matthews,Advanced surface coatings: a handbook of surface engineering, Blackie, 1991.*
4. *Parmar, R.S, Welding Engineering and Technology, Khanna Publishers, 2003.*

15COE01 - MEDICAL NANO TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 *: Understand the essential features of nanomedicine*

CO2 *: Identify the medical based nanotools*

CO3 *: Assess health effects due to nanoparticle exposure*

ASSESSING NANOTECHNOLOGY HEALTH

Nanomaterials : The Current State of Nanotechnology Application - Nanotechnology Risks - Risk Analysis - Hazard Identification - Exposure Assessment for Nanomaterials - Risk Characterization - Risk Management - Best Practices for Nanomaterials in the Workplace - Safety Research - Needs for Engineered Nanoscale Materials **(9)**

RISK ASSESSMENT AND ENVIRONMENTAL PROTECTION

Context for Technological Risk - Need for Risk Assessment for Nanotechnology - Adaptive Risk Assessment for Nanomaterials - Origins and Development of Risk Assessment - Risk Assessment Used in Environmental Decision Making - Issues in Applying the Four Steps of Risk Assessment to Nanotechnology - Hazard Assessment - Exposure Assessment - Dose - Response Evaluation **(9)**

SUSTAINABLE NANOTECHNOLOGY DEVELOPMENT

Necessity of Risk Assessment in Nanotechnology - The Pace of Nanotechnology Development and the Paucity of Information - Potential for Wide Dispersion in the Environment Amid Uncertainty - Few Standards or Guidelines - Environmental Risk Issues - Carbon Nanotubes - Defining the Toxic Dose - Environmentally Friendly Nanotechnology - Life Cycle Analysis for Sustainable Nanotechnology **(9)**

HUMAN HEALTH, TOXICOLOGY, AND NANOTECHNOLOGY RISK

Mechanisms of Toxicity - Types of Toxicological Studies - Pulmonary Toxicity Studies - Gastro intestinal Toxicity - In Vitro Studies - Dermal - In Vitro Toxicity Studies **(4)**

ENVIRONMENTAL RISKS

Antimicrobial Properties of Nanoscale Silver - Buckyballs, Titanium Dioxide - Short-term Toxicity Tests - Daphnia LC50 Assays - Studies of Nanomaterial Toxicity to Fish - Buckyballs and Bass-TiO_2 in Arsenic - Field Studies - Environmental Exposures - Nanoscale Zerovalent Iron **(9)**

NANOELECTRONIC DEVICES

Resonant tunneling diodes - Field effect transistors - Single electron transfer devices - Potential effect transistors - Light emitting diodes and lasers - Nanoelectromechanical system devices - Quantum dot cellular automata **(5)**

TOTAL : 45

TEXT BOOKS

1. *GerogeW.Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, 2007*
2. *Vladimir V. Mithin et.al, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications" Cambridge University Press, 2012*

REFERNCES

1. *Mithin.V, Kochelap.V and Stroscio.M, "Introduction to Nanoelectronics", Cambridge University Press, 2008*
2. *Karl Gosar et.al, "Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum devices", Springer, 2005.*

15COE02 - ADVANCED DRUG DELIVERY SYSTEM

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: The students will be able to know the fundamentals of Nanoscience and their applications in pharamacological industries*

CO2 *: The students will able to describe polymeric drug delivery systems and their encapsulation methodology to study targeted drug delivery with different polymeric systems*

CO3 *: The students will able to identify lipids-nanocarriers and their application in biological system*

CO4 *: The students will able to study site specific drug delivery for gene therapy*

THEORY OF ADVANCED DRUG DELIVERY

POLYMERS Dendrimers- Synthesis -Nanoscale containers- Dendritic Nanoscafold systems Biocompatibility of Dendrimers, Gene transfection. pH based targeted delivery- chitosan and alginate. Copolymers in targeted drug delivery- PCL,PLA, PLGA. **(8)**

Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery. Transport of Nanoparticles - In Vitro and Ex Vivo Models. **(10)**

LIPID BASED NANOCARRIERS

Liposomes, niosomes and solid lipid nanoparticles. Ligand based delivery by liposomes. Cubosomes. **(9)**

MICROBES AND ANTIBODY BASED NANOCARRIERS

Bacterial dependent delivery of vaccines. Drug delivery and subcellular targeting by virus, Drug packaging and drug loading. Delivery of therapeutics by antibodies and antibody bioconjugates. **(9)**

SITE SPECIFIC DRUG DELIVERY

Concepts and mechanism of Site specific drug delivery- Microneedles, Micropumps, microvalves. Implantable microchips. **(9)**

TOTAL : 45

REFERENCES

1. *Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman, Oxford University Press, 2001.*
2. *Drug Delivery and Targeting, A.M. Hillery, CRC Press, 2002.*
3. *Drug Delivery: Principles and Applications, B. Wang, Wiley Intersceince, 2005.*
4. *Nanoparticle Technology for Drug Delivery, Ram B. Gupta, Uday B. Kompella Taylor & Francis, 2006.*

15COE03 - BIOSENSORS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: The students will able to understand protein based biosensors and their enzyme reactivity, stability and their application in protein based nano crystalline thin film processing*

CO2 *: The students will able to describe DNA based biosensors to study the presence of heavy metals in the food products*

CO3 *: The students will able to understand fluorescence, UV-Vis and electrochemical applications of biosensors*

CO4 *: The students will able to study about the fabrication of biosensors and its application as nanochip analyzer*

PROTEIN BASED BIOSENSORS

Nano structure for enzyme stabilization - Single enzyme nano particles - Nanotubes microporus silica - Protein based nano crystalline Diamond thin film for processing **(9)**

DNA BASED BIOSENSOR

Heavy metal complexing with DNA and its determination water and food samples - DNA zymo biosensors **(9)**

ELECTRO CHEMICAL APPLICATION

Detection in biosensors - Flurorescence - Absorption - Electrochemical. Integration of various techniques - Fibre optic biosensors **(9)**

FABRICATION OF BIOSENSORS

Techniques used for microfabrication - Microfabrication of electrodes - On chip analysis **(9)**

BIOSENSORS IN RESEARCH

Future direction in biosensor research - Designed protein pores-as components of biosensors - Molecular design - Bionanotechnology for cellular biosensing - Biosensors for drug discovery - Nanoscale biosensors **(9)**

TOTAL : 45

REFERENCES

1. *Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004*
2. *Nanomaterials for Biosensors, Cs. Kumar, Willey - VCH, 2007*
3. *Smart Biosensor Technology, G.K. Knoff, A.S. Bassi, CRC Press, 2006.*

15COE04 - NANOCOMPOSITES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 *: Study the different synthesis techniques of metal ceramic nanocomposites and their functionality*

CO2 *: Describe the processing techniques for heterometallic nanocomposites and to study their electromagnetical property*

CO3 *: Understand the design of super hard nanocomposites with improved mechanical properties*

CO4 *: Study the polymer based carbon nanotube composites, to study their mechanical properties and their industrial applications*

NANO CERAMICS

Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. **(9)**

METAL BASED NANOCOMPOSITES

Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties. **(9)**

DESIGN OF SUPER HARD MATERIALS

Super hard nanocomposites, its designing and improvements of mechanical properties. **(9)**

NEW KIND OF NANOCOMPOSITES

Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Electrical property of fractal based nanocomposites. Core-Shell structured nanocomposites. **(9)**

POLYMER BASED NANOCOMPOSITES

Preparation and characterization of diblock Copolymer based nanocomposites; Polymercarbon nanotubes based composites, their mechanical properties, and industrial possibilities. **(9)**

TOTAL : 45

REFERENCES

1. *Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.*
2. *Physical Properties of Carbon Nanotubes- R. Saito 1998.*
3. *Carbon Nanotubes (Carbon, Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.*
4. *The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999*
5. *Electromagnetic and magnetic properties of multi component metal oxides, hetero*
6. *Nanometer versus micrometer-sized particles-Christian Brosseau,Jamal Ben, Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003*
7. *Diblock Copolymer, - Aviram (Review Article), Nature, 2002*

15COE05 - BIOREFINERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 *: Understand various renewable feedstocks for biofuels production*

CO2 *: Understand the broad concept of second and third generation biofuel products from biomass and other low-cost agri-residues and biowastes.*

CO3 *: Analyze the design processes for biofuel production*

CHEMISTRY & BIOCHEMISTRY OF BIOMASS

Types of biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Composition of lignocellulose (lignin, hemicellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of cellulose; triichoderma cellulases; bacterial cellulases; and comparison with degradation of high starch. **(9)**

BIODIESEL

Sources and processing of biodiesel, nature of lipids, fatty acids and triglycerides.Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodiesel, (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). Environmental issues of biodiesel; major policies and regulations pertaining to the production, distribution, and use of biodiesel. **(9)**

BIOMETHANE OR BIOGAS

Hydrolysis; anaerobic digestion; methanogenesis (acetoclastic, hydrogenotrophic), rates of methane formation; and one and two stage fermentation.Thermal depolymerization.Use of exhaust gases (e.g. CO_2, H_2S and H_2) from geothermal power plants and industrial operations (e.g. coal and oil refineries) as an energy sources (methane and hydrogen) **(9)**

GASIFICATION & PYROLYSIS TECHNOLOGIES

Gasification processes and the main types of gasifier designs; production of electricity by combining a gasifier with a gas turbine or fuel cell.Combined- cycle electricity generation with gas and steam turbines, and generation of heat and steam for district heating systems or CHP, including kalina Cycle. Production of synthesis gas (i.e. CO, H_2, H_2O, CO_2) tar vapor and ash particles) for subsequent conversion to hydrogen and transport fuels; advanced gas cleaning technologies for biomass. Biological conversion of syngas into liquid biofuels. Fast pyrolysis technology to produce a range of fuels, chemicals, and fertilizers; biorefineries, and new uses for glycerine in biorefineries. **(9)**

POLICIES AND FUTURE R&D OF BIOFUELS & BIOENERGY

Analysis of both current and future EU regulations and directives on biofuels and bioenergy.Tax regulations. Evaluation of different production alternatives to produce bioenergy; competitiveness of bioenergy alternatives in agriculture compared to other energy sources. Evaluation of current and future R&D needs; legal framework to support sustainable development and increased use of biofuels; government policies and programs with regard to biofuels and investment opportunities worldwide. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Robert C.Brown, "Biorenewable Resourses: Engineering", New Products from Agriculture, Wiley- Blackwell Publishing, 2003*
2. *Samir K.Khanal, "Anaerobic Biotechnology for Bioenergy Production: Principles and Application", Wiley- Blackwell Publishing 2008*

REFERENCE

1. *Martin Kaltschmitt; Hermann Hofbauer. " Biomass Conversion and Biorefinery", Springer Publishing, 2008*

15HOE01 - PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Design the Management function for a given organization*

CO2 *: Design and develop a strategic approach for the completion of the project*

CO3 *: Analyze the behavior of individuals and groups in organizations in terms of the key factors*

CO4 *: Formulate the procedure for recruitment, selection, training of staff to establish an organization*

INTRODUCTION TO MANAGEMENT

Meaning, Definition and Significance of Management-Basic functions of Management-Development of Management Thought **(9)**

MANAGEMENT CONCEPTS

Planning, Organizing, Staffing, Directing and Controlling- MBO-Six sigma **(9)**

ORGANIZATIONAL BEHAVIOR

Significance of OB, Role of Leadership, Personality and Motivation, Stress, Attitudes, Values and Perceptions at work **(9)**

BUSINESS PROCESS REENGINEERING

Need for BPR, Various phases of BPR, Production and Productivity-Factors influencing Productivity. **(8)**

HUMAN RESOURCE MANAGEMENT

Evolution of Management- Development of Managerial skills-Human Resource Management - Objectives -Job analysis - Recruitment -Selection and Placement and Training Development **(10)**

TOTAL : 45

TEXT BOOK

1. *Harold Koontz, Heinz Weihrich and Ramachandra Aryasri, "Principles of Management" Tata Mcgraw Hill, New Delhi, 2013*
2. *Mamoria, CB, "Personnel Management", Sultan Chand and Sons, New Delhi 2013*

REFERENCE BOOKS

1. *Robbin Finchanm and Peter Rhodes, "Principles of Organizational Behavior" Oxford University Press, 2010*
2. *CB Gupta "Management Theory and Practice" Sultan Chand and Sons, New Delhi, 2009*
3. *VSP Rao " Management Text and Cases" Excel Books, New Delhi, 2009*
4. *Fred Luthans " Organizational Behavior" Mc-Graw hill, New York 2005*
5. *Knanna OP "Industrial Engineering and Management", Dhanpat Rai publications, New Delhi 2003*

15HOE02 - CURRENT TRENDS IN INDIAN ECONOMY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Outline the structure of our Indian Economic System*

CO2 *: Access the role of industrial sector in Indian economy*

CO3 *: Interpret the demographic trends for the current scenario*

CO4 *: Analyze the role of two tier for the achievement of common national goals*

NATIONAL INCOME AND AGRICULTURE SECTOR

Economics Development-Meaning-National Income and Per capita Income in India- Indian Planning-Agricultural Development of India: Major crops- Production-Productivity-Contribution to GDP and Exports **(8)**

INDUSTRIAL SECTOR

India's industrial development-Industrial policies of 1948, 1956 and 1991-Liberalisation-Public sector-Privatization-Disinvestment policy-Role and importance of large scale industries and small scale industries-Special economic zones-Contribution to GDP-Growth rate **(8)**

POPULATION

Growth and policy issues-Demographic trends-Vital statistics-India's population: size and growth rate-Demographic dividend-HDI-Population policy-Issues of Unemployment, Poverty and inequality in India **(10)**

SERVICE SECTOR

Service sector in India-Banking-Insurance-Telecommunication-IT sector-Sofware exports-BPO-Contribution to GDP **(9)**

FEDERAL SYSTEM AND FOREIGN TRADE

Federal setup in India-Taxes: Direct and Indirect Tax-Value added Tax-Foreign direct investment-Merits and Demerits-India's imports and exports: Composition and direction-Foreign exchange reserve position- MNC's in India **(10)**

TOTAL : 45

TEXT BOOK

Ruddar Datt and Sundaram, KPM, Indian Economy, S.Chand and company, New Delhi-2015 Ramesh Singh Indian Economy, McGraw hill Education 7th edition, 2015

REFERENCES

www.jagranjosh.com

15HOE03 - MONETARY ECONOMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Evaluate the monetary measures formulated through static and dynamic role of money*

CO2 *: Design the driving force of circular flow of money*

CO3 *: Analyse how quantity theory of money fluctuate the price level*

CO4 *: Estimate the demand and supply of money based on the Interest rate*

NATURE AND SIGNIFICANCE OF MONEY

Definition of Money-Functions of Money-Static and Dynamic role of Money-Circular flow of Money-Monetary standards-Gold standard-Paper currency standard-Principles of Note issue-Measures of Money supply **(9)**

QUANTITY THEORY OF MONEY

Fisher's quantity theory of Money-Assumptions-Cash Balance Approach (Cambridge Equations)- Equation of Marshall, Pigou and Keynes-Similarities and dissimilarities of cash balance and cash transaction approaches-Income and expenditure theory-Superiority of Income and expenditure theory-Demand for Money: Classical and Keynesian liquidity preference theory approach **(9)**

INFLATION AND DEFLATION

Meaning-Types-Causes of Inflation-Demand Pull and Cost push inflation -Inflationary Gap-Phillips Curve-Effects of Inflation-Deflation-Causes-Measures to control Inflation and Deflation-Stagflation **(9)**

COMMERCIAL BANKING AND FINANCIAL MARKETS

Functions of Commercial Banks-Credit Creation-Meaning and constitute of Money Markets-Capital Market-Institutional structure of Capital Market-Primary Market-Secondary Market-Indian capital Market-Non-Banking financial intermediaries **(9)**

CENTRAL BANKING AND MONETARY POLICY

Central Banking-Functions-Organization-Instruments of Credit control-Monetary Policy: Meaning, Objectives, and Recent policy changes in RBI-Monetary Policy in a developing economy **(9)**

TOTAL : 45

TEXT BOOK

1. *Jhinghan ML "Monetary Economics:" Vrinda Publications, New Delhi 2013*

REFERENCE BOOKS

1. *Sethi TT, "Monetary Economic Theory", S Chand & Co, New Delhi 1996*
2. *Mithani DN, "Money Banking and International Trade", Himalaya, Mumbai 2013*

15HOE04 - ACCOUNTING FOR MANAGERIAL DECISIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Differentiate Financial and Management Accounting*

CO2 *: Analyze the profit and loss of the firm using the classifications of ratio analysis*

CO3 *: Prepare a fund flow statement*

CO4 *: Sketch the Break even chart and interpret the results for a given data*

MANAGEMENT ACCOUNTING

Introduction to Management Accounting - Nature and Scope of Management Accounting - Importance - Functions - Distinguish between Financial and Management Accounting - Tools in Management Accounting - Limitations - Disadvantages **(9)**

FINANCIAL STATEMENTS

Ratio Analysis - Meaning - Significance - Classifications - Liquidity Ratios - Turnover Ratios - Profitability Ratios - Solvency Ratios **(8)**

FUND FLOW AND CASH FLOW STATEMENT

Meaning and concept of flow of Funds-Meaning of fund Flow Statement - Difference between Fund flow statement and Income statement - Preparation and Interpretation of cash flow statement **(9)**

INVESTMENT DECISION

Budgeting - Objectives - Features - Advantages - Disadvantages - Cash Budget - Flexible Budget **(9)**

MARGINAL COSTING AND WORKING CAPITAL MEASUREMENT

Marginal Costing - Importance - Advantages - Breakeven Point - Breakeven Chart - Margin of Safety - Profit Volume Analysis - Working Capital - Importance - Factors Affecting Working Capital - Computation of Working Capital Requirements **(10)**

TOTAL : 45

TEXT BOOK

1. *R.K.Sharma and Sasi K.Gupta, "Management accounting", 2014*

15HOE05 - ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Develop an entrepreneurial mindset by learning key skills such as creative thinking, innovations and funding for business*

CO2 *: Formulate a business plan*

CO3 *: Assess the strengths and weaknesses of business plan*

CO4 *: Prepare a business plan for selecting a product*

LAUNCHING ENTREPRENEURIAL VENTURES

Creativity, Innovations, Methods to Initiate Ventures, Legal Challenges, Search for Entrepreneurial Capital **(8)**

BUSINESS PLAN FOR NEW VENTURES

Meaning and Objectives of a Business Plan, Advantages and cost of preparing a Business Plan, Elements, Critical Assessment **(9)**

STRATEGIC PERSPECTIVES

Strategic Growth, Need for Strategic Planning, Understanding the growth stage, Unique managerial Concerns of growing enterprise, Valuation Concerns **(10)**

ENTREPRENEURSHIP

Indian Perspective: Historical Perspective, Global Indian Entrepreneurs, Institutions, Modern Entrepreneurs **(9)**

PROJECT WORK

Students have to prepare a detailed business plan selecting a product(s), Presentation of such business plans and submission after necessary corrections suggested by subject faculty. **(9)**

TOTAL : 45

TEXT BOOK

1. *Robert D Hisrich, Michael P Peters & Dean Shepherd, "Entrepreneurship", Tata McGraw Hill, 2013*

REFERENCES

1. *Thomas W.Zimmerer, Norman M.Scarborough, "Essentials of Entrepreneurship and Small Business Management", Prentice Hall of India, 2009*
2. *G.S.Sudha, "Management and Entrepreneurship Development", Indus Valley Publication, 2009*

15HOE06 - EMPLOYABILITY SKILLS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Set a goal and outline strategies to achieve it

CO1 *: Prepare a job application letter with a resume for a position in a corporate sector.*

CO2 *: Analyse the listening comprehension and answer the questions*

CO3 *: Find a solution for a problem in the corporate sector applying problem solving skills*

GOAL SETTING AND TIME MANAGEMENT

Goal Setting - Immediate, Short Term and Long Term Goals - Smart Goals - Strategies to Achieve Goals - Confidence Building, Self-esteem, Motivation - Time Management - Identifying Time Wasters - Time Management Skills. **(9)**

SPEAKING

Ice-breakers - Self introduction - Role Play - Debate - Group Discussion: Purpose - Group Behavior - Analyzing Performance. Job Interviews: Identifying Job Openings - Interview Process - Types of Questions - Mock Interviews - Professional Grooming. **(11)**

READING AND WRITING

Reading Comprehension - Speed Reading Necessary for Reading Letters and Files - Vocabulary Development - Preparing Job Applications - Writing Covering Letter and Résumé - Applying for Jobs Online - Creative Writing - Article Writing - Book Review **(9)**

LISTENING

Listening to - Conversations, Long Speeches, Narrations, Descriptions, Famous Speeches. **(8)**

LEADERSHIP AND TEAM MANAGEMENT

Qualities of a Good Leader - Leadership Styles - Decision Making - Problem Solving - Etiquettes - Email, Professional, Dining & Telephone - Team Building - Team Work - Delegation. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Aruna Koneru. "Professional Communication". Tata MacGraw Hill Publishing Company Limited. New Delhi, 2008.*
2. *Jones, Leo and Richard Alexander. "New International Business English" Cambridge University Press, 2003.*

REFERENCE BOOK

1. *Corneilssen, Joep. "How to Prepare for Group Discussion and Interview". New Delhi: Tata-McGraw-Hill, 2009.*

15HOE07 - ENGLISH FOR ACADEMIC PURPOSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Write a description of a system.*

CO2 *: Formulate a research paper*

CO3 *: Listen to a lecture and prepare a summary.*

CO4 *: Construct dialogues using appropriate expressions.*

FOCUS ON LANGUAGE

Sentence construction- Types of clauses- Sequence- Co ordination- Subordination- Paragraphing Information - Describing a system & procedure **(8)**

READING

Understand a writer's purpose - Use strategies to ascertain meaning from unfamiliar vocabulary encountered in context - Recall and use vocabulary regarding urbanization and mega cities - To identify and outline main ideas in a passage - Skim a reading passage for main ideas - Summarize texts and images - Using a dictionary to obtain lexical, phonological and orthographical information - Identify and use target vocabulary words - Highlight important parts and texts. **(8)**

WRITING

Achieving appropriate tone and style in Academic Writing - Writing a Research Article - Types of Research Designs - Choosing a Research Problem- The Abstract - The Introduction - The Literature Review - The Methodology - The Results - The Discussion - The Conclusion - Citing Sources - Proof reading Your Paper **(10)**

LISTENING

Listening to conversation - Lectures - Topics - Discussions - Listening comprehension on specific topics - Listening to recognize formal and informal spoken English **(8)**

SPEAKING

Seminar skills - Engage in verbal role playing in formal and informal situations - Express advice and personal opinions with supporting information - Paraphrase stories and information - Expressing requests - Suggestions - Complaints - Apology - Giving and accepting compliments - Making invitations - Refusing invitations **(11)**

TOTAL : 45

TEXT BOOK

1. *MLA Hand book 8th Edition Published 2016, ISBN : 9781603292627*

REFERENCE BOOK

1. *English for writing research papers, Authors : Wall work, Adrian Published 2016. Spinger Publication.*

15HOE08 - ENGLISH FOR COMPETITIVE EXAMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Listen to TOEFL, GRE & IELTS exercises and formulate appropriate answers.*

CO2 *: Speak using right grammar and appropriate pronunciation on general and academic topics.*

CO3 *: Analyze the passage and answer the questions.*

CO4 *: Generate and organize ideas on a given topic*

LISTENING

Listening to conversation - Narration - Suggestion - Assumptions - Predictions - Implications - Problems - Academic conversations - discussions - Lectures **(11)**

SPEAKING

Independent speaking - Integrated speaking - Speaking about a personal experience - Preferences - Report the speakers opinion - Explain a problem and solution give a summary of an Academic lecture. **(13)**

READING

Read and understand short passages - Integrated reading tasks - Read the passage and choose the right summary of the passage - Reading for main ideas - Scanning the passage for synonyms - Making inferences - Identifying exceptions - Locating references **(12)**

WRITING

Independent writing - Integrated writing - Writing short essays - Writing dialogues - Articles - Sentence construction **(9)**

TOTAL : 45

TEXT BOOK

1. *Sharpe J.Pamela. Barron's How to prepare for the TOEFL Test of English as a foreign Language. 11th Edition, Galgotia publications Pvt.Ltd: New Delhi, 2004.*

REFERENCE BOOK

1. *Sharpe J.Pamela. Barron's TOEFL iBT Internet- Based Test. 12th Edition, Galgotia publications Pvt.Ltd: New Delhi, 2009.*
2. *Longman Introductory course for the TOEFL test.*

15HOE09 - LIFE AND LITERATURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 *: Compose an essay on the prose piece*

CO2 *: Analyse the poem and write a critical appreciation of it*

CO3 *: Read the story and find the moral values implied in the stories*

CO4 *: Write a review of the fiction*

PROSE

The Postmaster by Rabindranath Tagore,
Snapshot of a Dog by J G Thurber
On the Rule of the Road by A.G. Gardiner
The Village Schoolmaster by Oliver Goldsmith
Incident of the French Camp by Robert Browning **(13)**

POEMS

Stopping By Woods on a Snowy Evening by Robert Frost
The Ballad of Father Gilligan by W.B. Yeats **(9)**

SHORT STORIES

The Model Millionaire by Oscar Wilde
The Ant and the Grasshopper by W. Somerset Maugham
The Doll's House by Katherine Mansfield, Biography **(10)**
Albert Einstein and Steve Jobs

FICTION

The Old Man and the Sea by Ernest Hemmingway
The Scarlet Pimpernel by Baroness Emma Orczy
Practice in creative writing, review writing **(13)**

TOTAL : 45

TEXT BOOK

1. *Kumara Pillai. ed. A Book of Modern Short Stories. Macmillan: New Delhi, 2009*
2. *Colleen and Darius Krishnaraj. ed. Convergence, A Book of Short Stories. Macmillan: New Delhi, 2009*
3. *Ernest Hemmingway. The Old Man and the Sea. Arrow: Warwickshire, 2000*
   Baroness Emma Orczy, The Scarlet Pimpernel. Hutchinson : 1995

REFERENCE BOOK

1. *Xavier. ed. An Anthology of Popular Essays and Poems. Macmillan: New Delhi, 2009.*