COIMBATORE INSTITUTE OF TECHNOLOGY

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

VISION AND MISSION OF THE INSTITUTE

VISION

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

COIMBATORE INSTITUTE OF TECHNOLOGY

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

DEPARTMENT OF MECHANICAL ENGINEERING

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.

COIMBATORE INSTITUTE OF TECHNOLOGY

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

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The student will :

PEO1 : Acquire fundamental knowledge and expertise necessary for successful professional practice in mechanical engineering and allied fields, and for higher studies.

PEO2 : Attain and demonstrate essential technical skills to identify, analyze and solve complex problems and design issues in mechanical engneering.

PEO3 : 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.

COIMBATORE INSTITUTE OF TECHNOLOGY

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

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF MECHANICAL ENGINEERING

PROGRAMME OUTCOMES (POs)

The students will be able to :

S No.	Program Outcomes
1.	Engineering knowledge : Apply the knowledge of mathematics, science, engineering fundamentals, and Mechanical engineering to the solution of complex engineering problems.
2.	Problem analysis : Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3.	Design/development of solutions : Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4.	Conduct investigations of complex problems : Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5.	Modern tool usage : Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6.	The engineer and society : Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7.	Environment and sustainability : Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8.	Ethics : Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9.	Individual and teamwork : Function effectively as an individual, and as a member or leader in diverse team, and in multidisciplinary settings.
10.	Communication : Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11.	Project management and finance : Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12.	Life-long learning : Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes :

The students will be able to

1. Apply principles of mechanical engineering and physical sciences to model, analyze, design and select appropriate materials and manufacturing processes to create engineering solutions (products, systems, or processes) during their Mini-Project and Thesis Project Work.
2. Work with contemporary technologies through multi-pronged opportunities such as industry linked One Credit Courses, In-plant Training, and Internships together with a Fast-tracked curriculum.
3. Participate in team hackathons and develop critical thinking skills via hands-on-experience in research experiments to become an entrepreneur or initiate a start-up.

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University)

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF MECHANICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

Curriculum from the Academic Year 2019 - 2020 and onwards

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	L	T	P	C	Category
19MEM31	Ordinary and Partial Differential Equations	3	1	0	4	BSC
19ME31	Engineering Thermodynamics	3	1	0	4	PCC
19ME32	Engineering Mechanics for Mechanical Engineers	3	1	0	4	PCC
19ME33	Fluid Mechanics and Machinery	3	0	0	3	PCC
19ME34	Embedded Processor Architecture and Programming	3	0	0	3	ESC
19HSS01	Science of Creativity and Professional Ethics	1	1	0	1	HS
19MEL35	Computer Aided Machine Drawing - I	0	0	2	1	PCC
19MEL36A / 19MEL36B	Fluid Mechanics & Machinery Laboratory / Electrical Machines & Drives and Embedded Systems Laboratory	0	0	2	0.5	PCC
	One Credit Course - Elective I	1	0	0	1	EEC
19HOC31	Communication Skills for Engineers - I*	0	0	2	1	EEC
	TOTAL CREDITS				**22.5**	

Semester IV

Course Code	Course Name	L	T	P	C	Category
19ME41	Applied Thermodynamics	3	1	0	4	PCC
19ME42	Strength of Materials	3	1	0	4	PCC
19ME43	Mechanics of Machines	3	1	0	4	PCC
19ME44	Materials Engineering	3	0	0	3	PCC
19ME45	Manufacturing Processes - I	3	0	0	3	PCC
19MEL46	Computer Aided Machine Drawing - II	0	0	2	1	PCC
19MEL36A / 19MEL36B	Fluid Mechanics & Machinery Laboratory / Electrical Machines & Drives and Embedded Systems Laboratory	0	0	2	0.5	PCC

19MEL47A / 19MEL47B	Material Characterization and Testing Laboratory / Manufacturing Processes Laboratory	0	0	2	0.5	PCC
	One Credit Course - Elective II	1	0	0	1	EEC
19HOC41	Communication Skills for Engineers - II*	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

* Not to be counted for GPA. Pass is required.

Semester V

Course Code	Course Name	L	T	P	C	Category
19ME51	Heat and Mass Transfer	3	1	0	4	PCC
19ME52	Design of Machine Elements	3	1	0	4	PCC
19ME53	Manufacturing Processes - II	3	0	0	3	PCC
19ME54	Metrology and Quality Control	3	0	0	3	PCC
19ME55	Operations Research	3	1	0	4	HS
	Elective 1	3	0	0	3	PEC
19MEL47A / 19MEL47B	Material Characterization and Testing Laboratory / Manufacturing Processes Laboratory	0	0	2	0.5	PCC
19MEL56A / 19MEL56B	Applied Thermal Sciences Laboratory / Dynamics and Metrology Laboratory	0	0	2	0.5	PCC
	One Credit Course - Elective III	1	0	0	1	EEC
19INT51	Internship - I	0	0	0	1	EEC
19ME67	Mini Project	0	0	3	0	EEC
19HOC51	Employability and Personality Development Skills - I*	0	0	2	1	
	TOTAL CREDITS				**25**	

Semester VI

Course Code	Course Name	L	T	P	C	Category
19ME61	Refrigeration and Air-conditioning	3	0	0	3	PCC
19ME62	Finite Element Analysis	3	1	0	4	PCC
19ME63	Design of Transmission Systems	3	1	0	4	PCC
19ME64	Computer Aided Engineering	3	1	0	4	PCC
	Elective 2	3	0	0	3	PEC
19MEL56A / 19MEL56B	Applied Thermal Sciences Laboratory / Dynamics and Metrology Laboratory	0	0	2	0.5	PCC
19MEL65	CAD / CAM Laboratory	0	0	2	1	PCC
	One Credit Course - Elective IV	1	0	0	1	PCC
19INT61	Internship - II	0	0	0	1	EEC
19ME67	Mini Project	0	0	3	3	EEC
19HOC61	Employability and Personality Development Skills - II*	0	0	2	1	
	TOTAL CREDITS				**25.5**	

* Not to be counted for GPA. Pass is required.

Semester VII

Course Code	Course Name	L	T	P	C	Category
19ME71	Control Theory and Mechatronics	2	0	2	3	PCC
19ME72	Quality Engineering and Management	3	0	0	3	PCC
	Elective 3	3	0	0	3	PEC
	Elective 4	3	0	0	3	PEC
	Elective 5	3	0	0	3	OEC
	Elective 6	3	0	0	3	OEC
19ME73	Project Work Phase - I	0	0	6	3	EEC
	TOTAL CREDITS				**21**	

Semester VIII

Course Code	Course Name	L	T	P	C	Category
	Elective 7	3	0	0	3	PEC
	Elective 8	3	0	0	3	PEC
19ME81	Project Work Phase - II	0	0	10	5	EEC
	TOTAL CREDITS				**11**	

Semester 1	20
Semester 2	19
Semester 3	22.5
Semester 4	22
Semester 5	25
Semester 6	25.5
Semester 7	21
Semester 8	11
Total Credits	**166**

List of Professional Elective Courses (PEC)

STREAM : MATERIALS AND DESIGN

Course Code	Course Name	L	T	P	C
19MEE01	Composite Materials	3	0	0	3
19MEE02	Design for Manufacturing and Assembly	3	0	0	3
19MEE03	Design of Jigs and Fixtures	3	0	0	3
19MEE04	Mechanical Behaviour of Materials	3	0	0	3
19MEE05	Machine Tool Design	3	0	0	3
19MEE06	Mechanical Vibrations and Control	3	0	0	3
19MEE07	Tribology	3	0	0	3
19MEE08	Experimental Stress Analysis	3	0	0	3
19MEE09	Fluid Power Control Systems	3	0	0	3
19MEE10	Sensor Technology	3	0	0	3
19MEE11	Smart Materials	3	0	0	3
19MEE12	Non-Destructive Evaluation and Imaging	3	0	0	3
19MEE13	Automotive Electronics and Power Train Systems	3	0	0	3
19MEE14	Bio-materials	3	0	0	3
19MEE15	Micro and Nano Electro-mechanical Systems	3	0	0	3

STREAM : THERMAL SCIENCES

Course Code	Course Name	L	T	P	C
19MEE16	Solar Energy Technology	3	0	0	3
19MEE17	Gas Dynamics and Space Propulsion	3	0	0	3
19MEE18	Computational Fluid Dynamics	3	0	0	3
19MEE19	Alternative Energy Conversion Techniques	3	0	0	3
19MEE20	Advanced Fluid Mechanics	3	0	0	3
19MEE21	Advanced Thermodynamics	3	0	0	3
19MEE22	Cryogenics	3	0	0	3
19MEE23	Combustion and Internal Combustion Engines	3	0	0	3
19MEE24	Energy Conservation and Waste Heat Recovery	3	0	0	3
19MEE25	Design of Heat Exchangers	3	0	0	3
19MEE26	Turbo machines	3	0	0	3
19MEE27	Power Plant Engineering	3	0	0	3

STREAM : MANUFACTURING AND MANAGEMENT

Course Code	Course Name	L	T	P	C
19MEE28	Industrial Psychology	3	0	0	3
19MEE29	Work System Design	3	0	0	3
19MEE30	Total Productivity Management	3	0	0	3
19MEE31	Plant Layout and Material Handling	3	0	0	3
19MEE32	Project Management	3	0	0	3
19MEE33	Rapid Prototyping	3	0	0	3
19MEE34	Advanced Welding Technology	3	0	0	3
19MEE35	Advanced Foundry Technology	3	0	0	3
19MEE36	Supply Chain Management	3	0	0	3
19MEE37	Quantity Production Methods	3	0	0	3
19MEE38	Production Planning and Control	3	0	0	3
19MEE39	Lean and Agile Manufacturing	3	0	0	3
19MEE40	Production and Operations Management	3	0	0	3
19MEE41	Smart Manufacturing	3	0	0	3
19MEE42	Manufacturing Planning and Cost Estimation	3	0	0	3
19MEE43	Manufacturing Systems Management	3	0	0	3

ONE CREDIT COURSES (ELECTIVES) OFFERED

Course Code	Course Name	Category	L	T	P	C
19MEOC01	MATLAB Programming*	OC	1	0	0	1
19MEOC02	Non-Destructive Evaluation	OC	1	0	0	1
19MEOC03	Advanced Industrial Automation Systems*	OC	1	0	0	1
19MEOC04	Recent Trends in Quality	OC	1	0	0	1
19MEOC05	Foundry Practice and Procedures	OC	1	0	0	1
19MEOC06	Basics of Automotive Electrical Systems*	OC	1	0	0	1
19MEOC07	Design Thinking - A Primer	OC	1	0	0	1
19MEOC08	Aircraft Maintenance*	OC	1	0	0	1
19MEOC09	Inspection and Quality Control in Manufacturing*	OC	1	0	0	1
19MEOC10	Constitution of India	OC	1	0	0	1
19MEOC11	Biology for Engineers	OC	1	0	0	1
19MEOC12	Human Values	OC	1	0	0	1
19MEOC13	E-Commerce Security*	OC	1	0	0	1
19MEOC14	Innovation and Entrepreneurship	OC	1	0	0	1
19MEOC15	3-D Scanning Technology	OC	1	0	0	1

* Employability enhancement courses

COIMBATORE INSTITUTE OF TECHNOLOGY

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

LIST OF OPEN ELECTIVES

DEPARTMENT OF CIVIL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CEOE01	Town Planning and Architecture	3	0	0	3	All Branches
19CEOE02	Climate Change and Adaptation	3	0	0	3	All Branches
19CEOE03	Metro Systems and Engineering	3	0	0	3	All Branches
19CEOE04	Renewable Energy Sources	3	0	0	3	All Branches
19CEOE05	Principles of Sustainable Development	3	0	0	3	All Branches
19CEOE06	Disaster Management	3	0	0	3	All Branches

DEPARTMENT OF MECHANICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19MEOE01	Design of Experiments	3	0	0	3	All branches
19MEOE02	Engineering Optimization	3	0	0	3	All branches
19MEOE03	Engineering Polymers, Composites and Allied Manufacturing Processes	3 3	0 0	0 0	3 3	Mechanical Chemical & Civil
19MEOE04	Industrial Robotics	3	0	0	3	Mechanical EEE and ECE
19MEOE05	Business Process Re-engineering	3	0	0	3	All branches
19MEOE06	Engineering Economics and Financial Management	3	0	0	3	All branches

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19EEOE01	Energy Auditing	3	0	0	3	ECE, Mech, Chemical, Civil
19EEOE02	Solar and Wind Energy systems	3	0	0	3	ECE, Mech, Chemical
19EEOE03	Electrical Safety Procedures and Management	3	0	0	3	All Branches
19EEOE04	Energy Efficient Illumination Systems	3	0	0	3	All Branches
19EEOE05	Electric Vehicle Technology	3	0	0	3	All Branches except Civil & Chemical
19EEOE06	Energy Efficiency in Thermal and Electrical Utilities	3	0	0	3	EEE & Mechanical

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19ECEOE01	Signal Processing and its Applications	3	0	0	3	Chemical, Mechanical & Civil
19ECEOE02	Smart Sensors and IoT	3	0	0	3	All Branches
19ECEOE03	Consumer Electronics	3	0	0	3	Mechanical & Civil
19ECEOE04	Robotics	3	0	0	3	Mechanical, CSE & IT
19ECEOE05	Information Theory and Coding Techniques	3	0	0	3	All Branches
19ECEOE06	Wireless Sensor Networks	3	0	0	3	All Branches
19ECEOE07	Automotive Embedded Systems	3	0	0	3	All Branches
19ECEOE08	5G Technologies and Applications	3	0	0	3	All Branches
19ECEOE09	Vehicular Communication	3	0	0	3	All Branches
19ECEOE010	Sensing for Automotive Systems	3	0	0	3	All Branches

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CSOE01	Customer Relationship Management	3	0	0	3	All Branches
19CSOE02	Fundamentals of Software Engineering	3	0	0	3	All Branches
19CSOE03	Internet Programming	3	0	0	3	All Branches
19CSOE04	Introduction to Data Warehousing and Data Mining	3	0	0	3	All Branches
19CSOE05	Introduction to Embedded Systems	3	0	0	3	All Branches

DEPARTMENT OF INFORMATION TECHNOLOGY

Course Code	Course Name	L	T	P	C	Eligible Branches
19ITOE01	Digital Computer Basics	3	0	0	3	Civil, Mech, Chem
19ITOE02	Programming in Java	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE03	Fundamentals of Database Systems	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE04	Cloud Computing Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE05	Information Security Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE06	Introduction to Human Computer Interaction	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE07	Enterprise Resource planning Concepts	3	0	0	3	EEE, ECE, Mech, Civil & Chemical

DEPARTMENT OF CHEMICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CHOE01	Industrial Safety Engineering	3	0	0	3	All Branches
19CHOE02	Risk Analysis and Hazop	3	0	0	3	All Branches
19CHOE03	Green Technology	3	0	0	3	All Branches
19CHOE04	Corrosion Science and Engineering	3	0	0	3	All Branches
19CHOE05	Introduction to Chemical Engineering	3	0	0	3	All Branches
19CHOE06	Nanomaterial Synthesis and Characterization Laboratory	0	0	6	3	All Branches
19CHOE07	Multivariate Statistics Laboratory	0	0	6	3	All Branches

DEPARTMENT OF MATHEMATICS

Course Code	Course Name	L	T	P	C	Eligible Branches
19MOE01	Graph Theory & its Applications	3	0	0	3	All Branches
19MOE02	Methods of Applied Mathematics	3	0	0	3	All Branches
19MOE03	Linear and Non - Linear Programming	3	0	0	3	All Branches
19MOE04	Probability and Random Processes	3	0	0	3	All Branches

DEPARTMENT OF PHYSICS

Course Code	Course Name	L	T	P	C	Eligible Branches
19POE01	Introduction to Nanoscience and Nanotechnology	3	0	0	3	All Branches except IT
19POE02	Physics and Technology of Thin Films	3	0	0	3	Mechanical, EEE, Chemical & ECE
19POE03	Solar Cell Fundamentals and Materials	3	0	0	3	EEE, ECE & Chemical
19POE04	Advanced Material Processing Technologies	3	0	0	3	Mechanical & Chemical

DEPARTMENT OF CHEMISTRY

Course Code	Course Name	L	T	P	C	Eligible Branches
19COE01	Medical Nanotechnology	3	0	0	3	Chemical
19COE02	Advanced Drug Delivery Systems	3	0	0	3	Chemical
19COE03	Biosensors	3	0	0	3	Chemical, ECE & EEE
19COE04	Nanocomposites	3	0	0	3	Mechanical, Chemical & Civil
19COE05	Biorefinery	3	0	0	3	Mechanical & Chemical

DEPARTMENT OF HUMANITIES

Course Code	Course Name	L	T	P	C	Eligible Branches
19HOE01	Principles of Management	3	0	0	3	Common to all branches
19HOE02	Current Trends in Indian Economy	3	0	0	3	Common to all branches
19HOE03	Monetary Economics	3	0	0	3	Common to all branches
19HOE04	English for Academic Purposes	3	0	0	3	Common to all branches
19HOE05	English for Competitive Exams	3	0	0	3	Common to all branches
19HOE06	Life and Literature	3	0	0	3	Common to all branches

SEMESTER - III

19MEM31 - ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO 1 *: Solve field problems in engineering involving PDEs.*

CO 2 *: Formulate and solve problems involving random variables.*

CO 3 *: Apply statistical methods for analyzing experimental data.*

ORDINARY DIFFERENTIAL EQUATIONS (ODE)

Higher order ODE with constant coefficients, Euler and Legendre Linear Homogeneous ODEs, Method of variation of parameters, Solution of Simultaneous ODEs with constant coefficient. **(15)**

PARTIAL DIFFERENTIAL EQUATIONS (PDE)

Formation of PDE, Solution of I order Non-linear PDE (standard types only), Solution of I order Linear (Lagrange) Equations, Solution of higher order homogeneous PDEs, Classification of homogeneous II order PDEs. **(15)**

BOUNDARY VALUE PROBLEMS- I

Initial and boundary conditions, Solution of 1 dimensional wave equation by variable separable method, D'Alembert's solution for 1 dimensional wave equation, Solution of 1 dimensional steady and unsteady state Heat diffusion equation by variable separable method. **(15)**

BOUNDARY VALUE PROBLEMS- II

Two-dimensional steady state heat (Laplace) equation in Cartesian and Curvilinear coordinates. **(15)**

SPECIAL FUNCTIONS

Bessel functions: Generating function, recurrence formulae, Bessel integral, orthogonal property and Bessel expansion of arbitrary function.

Legendre Polynomials: Rodrigues formula, values, Orthogonality, generating functions, recurrence formulae and expansion of function as Legendre Polynomials. **(15)**

TOTAL : 60

TEXT BOOKS

1. *Grewal, B S, Higher Engineering Mathematics, 44th edition, Khanna Publishers, 2018.*
2. *Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2018.*

REFERENCES

1. *N.P. Bali and Manish Goyal, A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2019.*
2. *Alan Jeffrey, Advanced Engineering Mathematics, Academic Press, 2018.*
3. *Riley K F and M P Hobson, Foundation Mathematics for the Physical Sciences, Cambridge University Press, 2017.*

19ME31 - ENGINEERING THERMODYNAMICS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Apply concepts of energy conservation to open and closed systems.*

CO2 : *Arrive at benchmark performances of heat engines and refrigerator / heat pump and compute entropy changes.*

CO3 : *Depict various thermodynamic processes on property diagrams, estimate properties of mixtures and quantify deviation from ideal gas behavior.*

CO4 : *Calculate changes in properties during different ideal gas processes.*

BASIC CONCEPTS OF THERMODYNAMICS

Basic Concepts-Macroscopic & Microscopic approach, Concept of Continuum, Thermodynamic system & control volume, Thermodynamic properties, quasi-static process, Thermodynamic Equilibrium. Temperature - Zeroth law of thermodynamics - Temperature scales. Pressure measurement - Barometer.

Energy and Work transfer - Forms of energy - forms of work transfer - point and path function.

Pure Substances- phases of pure substances - property diagrams - Property tables - Ideal gas equation of state - Compressibility factor - Vander Waals equation of state - vapor pressure and phase equilibrium.**(15)**

FIRST LAW OF THERMODYNAMICS

First of Law of Thermodynamics applied to Non-flow Systems - Ideal gas processes - Vapor processes. Flow Systems - Mass balance (Continuity equation) - Energy balance (Steady Flow Energy Equation) - Some Steady flow Engineering Devices **(15)**

SECOND LAW OF THERMODYNAMICS

Thermal Energy Reservoir-Cyclic Heat Engine, Refrigerator and heat pump -Second Law statements - PMM-2 -reversibility and irreversibility - Causes of irreversibility - Types of irreversibility - Carnot Cycle - Reversed Carnot Cycle - Carnot's Theorem - Absolute Thermodynamic Temperature Scale. **(15)**

ENTROPY AND EXERGY

Entropy - Clausius Theorem - Inequality of Clausius - Entropy of Isolated system - Third law of Thermodynamics - Tds relations - Entropy change of liquids and solids - Entropy change of ideal gases.

Exergy - Reversible work and Irreversibility - Second law efficiency- Exergy change of non-flow system - Exergy change of flow stream. **(15)**

THERMODYNAMIC RELATIONS AND IDEAL GAS MIXTURES

Thermodynamics Relations - Gibbs and Helmholtz Functions, Maxwell Relations, Joule Kelvin effect, Clausius Clapeyron equation.

Ideal Gas Mixtures-Mass and Mole Fractions, Dalton's Law of partial pressures, Amagat-Leduc law of additive volumes -Properties of Ideal Gas mixture. **(15)**

TOTAL : 60

TEXT BOOKS

1. *Yunus A. Cengel, Introduction to Thermodynamics and Heat Transfer, McGraw-Hill Companies, Inc., 2nd Edition, 2017.*
2. *C. P. Kothandaraman and Domkundwar, A Course in Thermodynamics (Thermal Engineering), DhanpatRai and Co. Ltd., 2018.*
3. *Nag P K., Engineering Thermodynamics, Tata McGraw Hill, 2019.*
4. *Mahesh M. Rathore, Thermal Engineering, Tata McGraw Hill, 2018.*

REFERENCES

1. *Van Wylen, Fundamentals of Thermodynamics, John Wiley and Sons, 9th Edition, 2018.*
2. *Jones and Dugan, Engineering Thermodynamics, Prentice Hall of India, 2018.*
3. *https://nptel.ac.in/courses/112/104/112104113/*

19ME32 ENGINEERING MECHANICS FOR MECHANICAL ENGINEERS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Analyze the effect of forces on rigid bodies in equilibrium.*

CO2 *: Compute the first and second moment of inertia for simple and composite geometries.*

CO3 *: Apply concepts of energy conservation and virtual work to predict stability of equilibrium.*

CO4 *: Analyze translatory and rotary motions and examine the frictional and gyroscopic effects.*

CO5 *: Examine free and forced vibrations in damped and undamped systems.*

RIGID BODY EQUILIBRIUM

Rigid body equilibrium in space- Analysis of force and moments of system - Analysis of trusses- Method of section and joints, beams - Cables, frames and machine bodies. **(9)**

SYSTEM OF PARTICLES

First moment of mass/area of simple geometry using first principles - Centre of Mass of composite sections. Second moment of mass/area of standard geometry - Ring, disc, sphere - Parallel and perpendicular axis theorem- Moment of Inertia for composite sections and geometries. **(9)**

ENERGY CONSERVATION AND CONCEPTS OF VIRTUAL WORK

Principle of virtual work - Virtual displacements of rigid bodies, degrees of freedom - Systems with friction - mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium. **(12)**

KINEMATICS OF PARTICLES

Analysis of translatory and rotary motions- Displacement- Velocity- Acceleration for motion in straight line- Projectile- Circular motion - Newton's law of motion- Rate of change of momentum/angular momentum - Impulse- Collision- Elastic and Inelastic. Rotation about a fixed axis - Absolute and relative velocity- Instantaneous center of rotation - Effects of friction in rolling- Rolling with and without slipping. Gyroscope- gyroscopic couple in automobile, aircrafts and ships - grinding mills. **(15)**

MECHANICAL VIBRATIONS

Analysis of Free vibration of damped 1 DOF system - Newton's II law and Energy Method - equivalent springs and dashpots - damped frequency - Logarithmic decrement - Forced vibration - harmonic excitation - forced and motion transmissibility - resonance - vibration isolation with and without damper - whirling of shafts - critical speed of shaft - longitudinal and transverse vibration - Free torsional vibration of two and three rotor system with geared systems. **(15)**

TOTAL : 60

TEXT BOOKS

1. *F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II, - Dynamics, 12th Edition, Tata McGraw Hill, 2019.*
2. *Irving H. Shames, Engineering Mechanics, 4th Edition, Prentice Hall, 2018.*

REFERENCES

1. *R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press, 14th Edition, 2017.*
2. *Andy Ruina and Rudra Pratap, Introduction to Statics and Dynamics, Oxford University Press, 2019.*
3. *S. S. Bhavikkatti, Engineering Mechanics, New age international, 2019.*
4. *https://nptel.ac.in/courses/112/106/112106286/*

19ME33 - FLUID MECHANICS AND MACHINERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO 1 *: Explain fluid properties, apply principles of manometry and analyze stability of floating bodies.*

CO 2 *: Develop conservation equations of mass, momentum and energy for non-reactive fluid flows.*

CO 3 *: Deduce Non-dimensional numbers using Buckingham's Pi theorem and explain similarity laws.*

CO 4 *: Analyze laminar boundary layer over a flat plate and distinguish between laminar and turbulent flows.*

CO 5 *: Estimate head loss through pipes and explain velocity measurement using venturimeter, orifice meter and Pitot tubes.*

CO 6 *: Analyze turbines using velocity diagrams.*

FLUID PROPERTIES AND FLUID STATICS

Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies. **(7)**

GOVERNING EQUATIONS OF FLUID MOTION; DIMENSIONAL ANALYSIS

Control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Euler & Bernoulli's Equations; Buckingham's Pi theorem - applications - similarity laws and models. **(11)**

LAMINAR BOUNDARY LAYER AND ELEMENTARY TURBULENT FLOW

Viscous flow of incompressible fluids, boundary layers, elementary turbulent flow. **(10)**

FLOW LOSSES AND MEASUREMENT

Flow through pipes, head losses in pipes, bends and fittings. Flow & velocity measurement - venturi, orifice, pitot tubes. **(6)**

FLUID MACHINERY

Classification of Fluid Machines, Euler Turbomachine equation, Velocity triangles, Centrifugal Pumps - working principle and performance; Rotary Pumps - classification; Reciprocating pump - working principle, Pelton, Francis and Kaplan Turbines - Working Principle and Performance. **(11)**

TOTAL : 45

TEXT BOOKS

1. *Fox R W, Mc Donald A and Pritchard, Introduction to Fluid Mechanics, Wiley, 2018.*
2. *F. M. White, Fluid Mechanics, 8th Edition, McGraw Hill India, 2019.*

REFERENCES:

1. *Muralidhar, K. and Biswas, G., Advanced Engineering Fluid Mechanics, Alpha science international limited, 3rd Edition, New Delhi, 2018.*
2. *Bansal, R. K., A textbook of Fluid Mechanics and Hydraulic Machines, Lakshmi Publications, 9th edition (revised), 2018.*
3. *John. M. Cimbala and Yunus A. Cengel, Fluid Mechanics: Fundamentals and Applications, 4th Edition, McGraw-Hill, 2019.*
4. *https://nptel.ac.in/courses/112/104/112104117/*
5. *https://nptel.ac.in/courses/112/105/112105206/*
6. *https://nptel.ac.in/courses/112/104/112104118/*

19ME34 - EMBEDDED PROCESSOR ARCHITECTURE AND PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Distinguish between RISC and CISC processors.*

CO2 *: Use the programmer's model and outline the architecture of the ARM processor.*

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

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

CO5 *: Write the assembly language program to control the speed of the 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 assembly 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, 2018.*
2. *Andrew Sloss, ARM System Developer's Guide, Morgan Kaufmann Publishers, 2017.*

REFERENCES

1. *David E. Simon, An Embedded Software Primer, Pearson Education Asia, 2017.*
2. *Raj Kamal, Embedded Systems Architecture, Programming and Design, Tata McGraw Hill, 2017.*
3. *Jonathan W. Valvano, Introduction to ARM Cortex - M Microcontrollers, 5th Edition, 2017.*
4. *ARM Architecture reference manual, 2018.*
5. *https://nptel.ac.in/courses/106/105/106105193/*

19HSS01 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of course, students will be able to

CO1 : *Understand the principles of karma yoga, duty consciousness and evolution of the universe.*

CO2 : *Analyze the benefits of yoga and meditation.*

CO3 : *Understand the benefits of harmony, introspection and examine human values for sustained growth in career and life*

LIFE FORCE, CONCIOUSNESS AND EVOLUTION OF UNIVERSE

Science of Creativity and Personality Development - Principles of Karma Yoga - Duty Consciousness - Law of Nature - Life Force -Potentiality of the Life Force - Consciousness - Pancha Thanmatras - Biomagnetism. Evolution of the Universe: Creation Theory - Evolution Theory - Evolution of Living Beings: Absolute Space and Force - Seven Constituent Layers in the Body. **(6)**

YOGA AND ITS BENEFITS

Simple and Safe yoga - Upa yoga Practices : Yoga for peace, health, joy, love, well-being and success. Physical exercise - Meditation - Seven centers of meditation - benefits - effect of good vibrations - cause and effect system. **(3)**

HARMONY IN LIFE, INTROSPECTION AND HUMAN VALUES

Harmony in Life : Self, family, society and nature - Introspection : Analysis of thought, Moralization of desire, Neutralization of anger, Eradication of worries and Self realization.

Morals, Values and Ethics - Integrity - Work ethics - Service learning - Virtues - Respect for others - Valuing time - Co-operation -Commitment - Empathy - Self confidence - Challenges in work place - impact of cyber space on individual. **(6)**

TOTAL: 15

TEXT BOOKS

1. *Yogiraj Vethathri Maharishi, "Karma Yoga - The Holistic Unity", Vethathri Publications 4th Edition, 2009.*
2. *R.S.Naagarazan, "A Textbook on Professional Ethics and Human Values", New Age International Publishers, New Delhi, 2011.*

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. *Mike W. Martin and Roland Schinzinger,"Ethics in Engineering", 4th Edition McGraw Hill, NewYork, 2005.*
4. *M. Govindarajan, S. Natarajan, V.S. Senthilkumar, "Engineering Ethics", 1st Edition, Prentice Hall of India, 2009.*

19MEL35 - COMPUTER AIDED MACHINE DRAWING - I

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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.*

CONTENT

Introduction to AutoCAD - Drafting practice using basic commands - Practice to use, edit and modify commands - Advanced editing commands - object controlling commands, hatching and blocks-Creating Text and Inquiry Commands & Geometric Dimensioning and System Variables- Isometric Drawings, Advanced Drawing Commands, Script Files and Plotting Commands- Creation of 2D sectional drawing.

1. Drawing of Simple machine components.
2. Drawing orthographic views of simple blocks.
3. Drawing isometric views of simple blocks.
4. Drawing of 2D assembled machined 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.

REFERENCES

1. *CIT, VRET Training Centre Manual, AutoCAD Level-I, (Preliminary Level). 2019.*
2. *Prof. Sham Tickoo, AutoCAD 2017 for Engineers and Designers, Dream Tech Press, 2017.*
3. *George Omura, Mastering AutoCAD 2019 and AutoCAD LT 2019, Wiley India Pvt. Ltd, 2019.*
4. *http://www.nptelvideos.in/2012/12/computer-aided-design.html*

19MEL36A - FLUID MECHANICS AND MACHINERY LABORATORY

L	T	P	C
0	0	2	0.5

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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, 2018.*
2. *https://eerc03-iiith.vlabs.ac.in/*
3. *https://www.vlab.co.in/ba-nptel-labs-civil-engineering*

19MEL36B - ELECTRICAL MACHINES AND DRIVES AND EMBEDDED SYSTEMS LABORATORY

ELECTRICAL MACHINES & DRIVES LABORATORY

L	T	P	C
0	0	2	0.5

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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 using converters and chopper fed drive and also to demonstrate the speed control of AC motors 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 using drive.*

LIST OF EXPERIMENTS

1. Load test on single phase Alternator.
2. Load test on three phase squirrel cage IM.
3. AC voltage controller for fan motor speed control.
4. Load test on single phase Capacitor start IM.
5. Speed control of three phase induction motor using AC drive.

REFERENCE

1. Electrical Drives and Controls laboratory manual, Department of Electrical Engineering, CIT, 2018.

EMBEDDED SYSTEMS LABORATORY

COURSE OUTCOMES

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. Display interfacing (LED, 7 segment LED and LCD).
2. Temperature sensor interfacing.
3. Stepper motor interfacing.
4. Interrupt programming.
5. DC Motor interfacing.

REFERENCES

1. *Embedded processor architecture and programming laboratory Manual, Department of Electrical Engineering, CIT, 2018.*
2. *Jonathan W. Valvano, Introduction to ARM Cortex - M Microcontrollers", 4th edition, 2017.*
3. *Joseph Yiu, A Definitive guide to the ARM Cortex-M0, Newnes, 2018.*

19HOC31 - COMMUNICATION SKILLS FOR ENGINEERS - I

L	T	P	C
0	0	2	1

COURSE OUTCOMES

The student will be able to

CO1 : *Gain confidence, enhance Personality and develop positive attitude in their work and life.*

CO2 : *Effectively communicate and present opinions using appropriate functional expressions for a given situation.*

CO3 : *Compose Emails, Reports for a given business scenario using appropriate sentence construction and in the prescribed format.*

CO4 : *Generate ideas and speak confidently on a given topic in a competitive scenario like Debate, Group Discussion, and Public Speaking.*

PERSONALITY DEVELOPMENT

Motivation and Self Confidence, SCOT Analysis - Personality Development - What is Personality, Developing Positive Attitude towards work and life, Building Relationship with others - Personality Development - Paradigms of Human Interaction, Fear Management. **(4)**

VERBAL COMMUNICATION

English Conversation - Asking and Giving Opinions - English Conversation -Thanking People, Asking and Giving Suggestions - English Conversation - Asking for Direction, Agreeing and Disagreeing - Role Play-Business. **(5)**

BUSINESS COMMUNICATION

Email Writing - Format, Etiquettes and Tips - Report Writing - Introduction, elements and tips - Drafting a report - Error Identification - Rules, Common Mistakes and Exercises - Sentence Completion Filler (fill in the blanks using apt words). **(5)**

PUBLIC SPEAKING

How to start and sustain a conversation - Debate - Extempore - Group Discussion - Importance and Process - Public Speaking - Introduction, Tips - Drafting a Public Speech - Interview - Types, Dos and Don'ts - Mock Press. **(6)**

REFERENCES

1. *https://nptel.ac.in/content/storage2/courses/109104030/references/references.pdf (online resource)*
2. *John Seelay, Oxford Guide to Effective Writing and Speaking, 2nd Edition, Kindle Edition by Oxford University Press, 2007.*
3. *Sabina Pillai, Agna Fernandez, Soft Skills and Employability Skills - Published by Cambridge University Press, 2017.*

SEMESTER - IV

19ME41 - APPLIED THERMODYNAMICS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of this 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 IC 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 : *Use psychrometric chart or 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 and Dual Cycles - Efficiency, mean effective pressure. Testing and performance of internal combustion engines. **(15)**

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. **(15)**

GAS POWER CYCLES

Gas Turbine Cycles - ideal and actual Brayton cycle - open and closed cycle gas turbines - modifications in Brayton cycle - regeneration - compressor inter-cooling - turbine reheat. **(15)**

STEAM POWER CYCLES and STEAM NOZZLES

Ideal and actual Rankine cycle - superheat - reheat - regeneration. Steam nozzles - Application of steady flow energy equation, effect of friction. Pressure compounding and Velocity compounding of turbines (descriptive treatment only). **(15)**

PSYCHROMETRY

Atmospheric air - Psychometric Properties - Dry Bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, Saturated Air, Vapour pressure, Degree of saturation -Adiabatic Saturation, Carrier's Equation - Psychrometric chart. **(15)**

TOTAL : 60

TEXT BOOKS

1. *Mahesh M Rathore, Thermal Engineering, Tata McGraw-Hill, 2018.*
2. *Kothandaraman C. P. and Domkundwar, Thermodynamics and Thermal Engineering, Dhanpat Rai and Sons, 2018.*
3. *Rajput R. K., Thermal Engineering, Laxmi Publications, 10th Edition, 2018.*

REFERENCES

1. *Nag P.K., Engineering Thermodynamics, 5th Edition, Tata McGraw-Hill, 2019.*
2. *Richard E. Sonntag, Claus Borgnakke, Gordon J. Van Wylen, Fundamentals of Thermodynamics, 9th Edition, Wiley, 2018.*
3. *Ganesan V., Internal Combustion Engines, Tata McGraw-Hill, 2017.*
4. *Mathur M. L. and Sharma R. P., Internal Combustion Engines, Dhanpat Rai and Sons, 2018.*
5. *https://nptel.ac.in/courses/112/103/112103275/*

19ME42 - STRENGTH OF MATERIALS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Recognize various types of loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components.*

CO2 : *Evaluate the strain and deformation that will result due to the elastic stresses developed within the materials for simple types of loading.*

DEFORMATION IN SOLIDS

Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations - strain energy - proof resilience- volumetric, linear and shear strains-toughness and elastic recovery- principal stresses and principal planes- Mohr's circle. **(15)**

SHEAR FORCE AND BENDING MOMENTS - STRESSES IN BEAMS

Transverse loading on beams- shear force and bending moment diagrams - singularity functions - simply supported and overhanging beams, cantilevers. Theory of bending of beams - bending stress distribution - neutral axis, shear stress distribution for different loadings. **(15)**

DEFLECTION OF BEAMS

Differential equations of elastic curve - Deflection by integration - singularity functions - deflection by superposition, Maxwell's reciprocal theorems. **(15)**

TORSION

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs. **(15)**

STRESS IN CYLINDERS, SHELLS AND COLUMNS

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure, critical load of long and slender columns, short columns, eccentric loading of different columns with end conditions. **(15)**

TOTAL : 60

TEXT BOOKS

1. *R. Subramanian, Strength of Materials, Oxford University Press, 2018.*
2. *Rattan S S, Strength of Materials, 3rd Edition, Tata McGraw Hill, 2017.*

REFERENCES

1. *Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2017.*
2. *Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd., New Delhi 2017.*
3. *https://nptel.ac.in/courses/112/107/112107146/*
4. *https://nptel.ac.in/courses/105/105/105105108/*
5. *https://nptel.ac.in/courses/112/106/112106141/*

19ME43 - MECHANICS OF MACHINES

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: To understand the kinematics and rigid-body dynamics of kinematically driven machine components.*

CO2 *: To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link.*

CO3 *: To be able to design some linkage mechanisms and cam systems to generate specified output motion.*

CO4 *: To understand the kinematics of gear trains.*

FUNDAMENTALS OF MECHANISMS

Kinematic links -Pairs - Lower and Higher pairs - Degrees of freedom, mobility-Grubbler's equation. Grashof's law - Kinematic inversions of four bar chain and slider crank chains. Study of Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms. **(9)**

KINEMATIC AND DYNAMIC ANALYSIS OF MECHANISMS

Displacement, velocity and acceleration analysis of four bar and slider crank mechanisms - loop closure equations - instantaneous center of rotation - graphical method (not for examination) - Coriolis component of acceleration. Dynamic equivalence of two mass systems- static force analysis - dynamics of four bar mechanism - slider crank - piston effect, crank effect. **(15)**

CAMS AND FOLLOWERS

Classification - Displacement diagrams - Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions - specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers. **(9)**

GEARS AND GEAR TRAINS

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack and pinion gears, epicyclic and regular gear train kinematics. **(15)**

BALANCING OF MASSES

Balancing - masses in single and multiple planes, reciprocating masses - primary and secondary forces and moment balancing - multi-cylinder in-line and V-engines - direct and reverse crank methods. **(12)**

TOTAL : 60

TEXT BOOKS

1. *Thomas Bevan, Theory of Machines, 3rd Edition, CBS Publishers & Distributors, 2019.*
2. *Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2018.*

REFERENCES

1. *Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2019.*
2. *Ghosh A. & Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 2018.*
3. *https://nptel.ac.in/courses/112/104/112104121/*
4. *https://nptel.ac.in/courses/112/105/112105268/*
5. *https://nptel.ac.in/courses/112/106/112106270/*

19ME44 - MATERIALS ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Identify crystal structures for various materials and understand the defects in such structures.*

CO2 *: Explain how to tailor material properties of ferrous and non-ferrous alloys.*

CO3 *: Quantify mechanical integrity and failure in materials.*

CRYSTAL STRUCTURE AND IMPERFECTIONS

Unit cells, Metallic crystal structures - Density computation, Polymorphism and Allotropy. Imperfection in solids: Point, line and volume defects.

Dislocations and strengthening mechanisms -characteristics of dislocation - slip systems - dislocation by twinning. Grain size reduction - solid solution strengthening and strain hardening - recovery - recrystallization and grain growth. **(9)**

ALLOYS 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. **(8)**

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, carburizing, nitriding, cyaniding, carbonitriding - flame and induction hardening, Ageing. **(9)**

FERROUS AND NON-FERROUS MATERIALS

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, Aluminium and its alloys, Nickel and its alloys, titanium and its alloys, super alloys: Ni based, Fe based and Co based, Maraging steels, Bearing alloys, Metal matrix composites, preparation, properties and applications. **(10)**

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. **(9)**

TOTAL : 45

TEXT BOOKS

1. *W. D. Callister, Materials Science and Engineering-An Introduction, 6th Edition, Wiley India, 2018.*
2. *Agarwal B.K., Introduction to Engineering Materials, Tata McGraw-Hill Publishing Company, New Delhi, 25th reprint, 2018.*

REFERENCES

1. *Avner S. H., "Introduction to Physical Metallurgy", Tata McGraw-Hill Publishing Company, New Delhi, 2nd Edition, 2017.*
2. *Lakhtin Y., Weinstein N., "Engineering Physical Metallurgy", University Press of the Pacific, 2017.*
3. *Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice - Hall of India, 2018.*
4. *V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 2017.*
5. *https://nptel.ac.in/courses/113/102/113102080/*
6. *https://nptel.ac.in/courses/112/106/112106293/*
7. *https://nptel.ac.in/courses/113/106/113106032/*

19ME45 - MANUFACTURING PROCESSES - I

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After the completion of this course, 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 *: Differentiate various metal forming processes such as Hot and Cold Working, Rolling, Forging, Extrusion and Drawing Processes.*

CO3 *: Compute blanking forces, design punches and dies, and develop process plans for making sheet metal products.*

CO4 *: Assess the suitability of using SMAW, GMAW, GTAW, SAW to weld ferrous alloys, and examine the effect of residual stresses and distortion.*

CO5 *: Perceive the basics of Powder metallurgy and application of powder metallurgy*

CO6 *: Classify different plastic molding processes, Extrusion of Plastic and Thermoforming.*

METAL CASTING PROCESS

Patterns- Pattern materials, types of pattern, Pattern allowances-types of molding sand and its properties, mold sand composition- Core making-Methods of sand testing- gating and risering System- Melting Practices: cupola, Induction furnaces construction and operations- Casting cleaning and casting defects-Inspection methods. Special casting processes: Investment casting process, Die casting process, shell molding process-centrifugal casting process-CO2 Process. **(9)**

BULK DEFORMATION PROCESSES

Hot working and cold working of metals-Forging processes-Open, impression and closed die forging-types of Forging machines-Typical forging operations-Swaging-Rolling of metals-Types of rolling mills-Flat strip rolling- Shape rolling operations-Defects in rolled parts-principle of rod and wire drawing-Tube drawing-Principles of extrusion-Types of Extrusion-hot and cold extrusion - Equipments used. **(9)**

SHEET METAL PROCESSES

Sheet metal characteristics-Typical shearing operations, bending and drawing operations, blanking, piercing, punching, trimming, etc. -formability of sheet metal-test methods of formability-Presses for sheet metal working, Elements of a simple die; punch and die clearances; Progressive, compound and combination dies and Blanking force Calculations. Special forming methods: Explosive forming, electromagnetic forming, electro hydraulic forming, composite molding. **(9)**

METAL JOINING PROCESSES

Fusion welding processes-Types of Gas Welding-Fuel Gases, Oxy-Acetylene Welding Equipment-Flame characteristics- Filler and Flux materials, Electric-Arc Welding, Electrodes, Coated electrode designation for manual metal arc welding, Carbon Arc Welding, Inert-Gas Shielded Arc Welding, Tungsten Inert-Gas Welding (TIG), Gas Metal-Arc Welding (GMAW), Submerged Arc-Welding (SAW), Other Arc-Welding Processes, Resistance Welding-Welding Defects. Basic principles of Thermit Welding, Laser Beam welding, Electron Beam Welding, Friction welding, Friction stir welding and Ultrasonic welding. **(9)**

POWDER METALLURGY

Definition-Advantages, Disadvantages/Limitations of powder metallurgy-Applications of powder metallurgy-Manufacture of parts by powder metallurgy-Production of metal powders-Blending of metal powders-pressing or compaction of metal powders-sintering-finishing operations. **(4)**

PLASTIC PROCESSING

Processing of plastics: General aspects-Plastic processing methods-compression moulding-Transfer moulding-Injection moulding-Expandable bead moulding- rotomoulding-blow moulding-Extrusion-Thermoforming. **(5)**

TOTAL : 45

TEXT BOOKS

1. *Rao, P. N., "Manufacturing Technology 4e (Vol. 1&2)", Tata McGraw Hill 2017.*
2. *Kalpakjian, S. and Schmid, S. R, "Manufacturing Engineering and Technology" 8th Edition, Pearson Education, 2018.*

REFERENCES

1. *Groover, M. P., "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley and Sons Inc.,2015.*
2. *R. K. Rajput "A Textbook of Manufacturing Technology: Manufacturing Processes", 3rd edition, Laxmi publications, 2018.*
3. *https://nptel.ac.in/courses/112/107/112107144/*

19MEL46 - COMPUTER AIDED MACHINE DRAWING - II

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

CO1 *: Construct the Surface Modelling 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 *: Practice limits, fits, tolerance and also geometrical tolerance.*

CONTENT

Surface Modelling and the User Coordinate System (WCS, UCS) - Solid Modelling, Viewports, Model space, Paper space and Layouts - Blocks Attributes and External Reference - Menus, Macros and Advanced Rendering and Animation.

1. 3D surface modelling of machine components - Part Drawing
2. 3D surface modelling of machine components Assembly Drawing
3. 3D Solid Modelling of a given component - Model 1
4. 3D Solid Modelling of a given component - Model 2
5. Creating line types

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.

REFERENCES

1. *CIT, VRET Training Centre Manual, AutoCAD Level-I, (Preliminary Level), 2019.*
2. *Prof. Sham Tickoo, AutoCAD 2017 for Engineers and Designers, Dream Tech Press, 2017.*
3. *George Omura, Mastering AutoCAD 2019 and AutoCAD LT 2019, Wiley India Pvt. Ltd, 2019.*
4. *http://www.nptelvideos.in/2012/12/computer-aided-design.html*

19MEL47A - MATERIAL CHARACTERIZATION AND TESTING LABORATORY

L	T	P	C
0	0	2	0.5

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

CO1 *: Evaluate grain size, morphology, microstructure and microhardness of metals and alloys.*

CO2 *: Estimate hardness and conduct impact tests on specimens.*

CO3 *: Perform tension, shear, torsion and deflection tests on a given specimen.*

LIST OF EXPERIMENTS

1. Evaluation of grain size, morphology, distribution of the reinforcement in copper metal matrix composites.
2. Evaluation of microstructure and microhardness of the friction stir welded steel and aluminium alloy.
3. Evaluation of microstructure of the post weld heat treated SMA welded mild steel.
4. Measurement of hardness of the quenched sample using Jominy End Quench Test Apparatus.
5. Tension & Shear test on mild steel rod.
6. Hardness test - Brinell & Rockwell.
7. Impact test on metals (Izod and Charpy tests)
8. Test on helical spring.
9. Deflection test on wooden beams (simply supported and cantilever)
10. Torsion test on mild steel rod.

REFERENCES

1. *Strength of Materials Laboratory Manual, Department of Civil Engineering, CIT, 2018.*
2. *Rajput R.K, "Strength of Materials", S.K. Kataria and Sons, New Delhi, 2018.*
3. *I.S: 3495 Part I to IV, "Methods of Test for Burnt Clay Building Bricks", Bureau of Indian Standards, New Delhi, 2017.*
4. *Materials and Metallurgy Laboratory Manual, Department of Mechanical Engineering, CIT, 2019.*
5. *https://nptel.ac.in/courses/113/106/113106034/*
6. *https://nptel.ac.in/courses/115/103/115103030/*

19MEL47B - MANUFACTURING PROCESSES LABORATORY

L	T	P	C
0	0	2	0.5

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

CO1 : *Identify suitable mold making process and pattern to perform Packing Gland, Bracket, Stepped Pulley, Bend Pipe, Loose Piece and Square Box patterns.*

CO2 : *Demonstrate Principle and operations of a center lathe to produce cylindrical components of ferrous metals (mild steel) and apply threading process to generate external V - threads and find the pitch, speed and feed of center lathe.*

CO3 : *Apply taper turning process and create a conical shape component made of ferrous and nonferrous metals using center lathe and create a contour shape like concave and convex shapes on cylindrical components of ferrous and non-ferrous using center lathe.*

CO4 : *Perform Butt Joint, Lap joint, T Joint, and Corner Joint in mild steel of 3 mm thickness using welding process, also prepare WPS for different joints.*

CO5 : *Calculate cutting parameters and generate a spur gear and helical gear of ferrous metals using a milling/gear hobbing machine.*

CO6 : *Calculate cutting parameters and generate different shapes using special purpose machines.*

LIST OF EXPERIMENTS

1. Determine the Grain size, Permeability and Compressive Strength of the Moulding Sand.
2. Prepare green sand mould using a solid pattern/ split pattern.
3. Prepare green sand mould using loose piece patterns.
4. Prepare "Butt Joint / lap joint" using MMAW Process and prepare a welding procedure specification (WPS Sheet) & report on post weld inspection.
5. Prepare a WPS Sheet for making "T Joint/ Corner Joint" using TIG/MAG welding Process and perform visual inspection to identify welding defects on weld bead.
6. Prepare a lap Joint on the given work pieces using spot welding equipment.
7. Prepare a component by Lathe machine using operations like Plain, Step Turning and chamfering and Calculate the machining time.
8. Machine a tapered surface in a cylindrical object using any one taper turning method, create a hole and make Convex / concave profile on it. Prepare a dimensional inspection report for the component produced.
9. To produce a spur gear and helical gear using a universal milling machine / gear hobbing machine. Prepare a dimensional inspection report for the component produced.
10. To create holes and make threads by tapping using a drilling machine also make a square keyway using a slotting machine. Prepare a dimensional inspection report for the component produced.
11. To make a cube, stepped slide, male and female stepped slide, angular slide and curve slide using a shaping machine. Prepare a dimensional inspection report for the component produced.
12. To machine a square, a pentagon, a hexagon, and a triangular head using a vertical milling machine. Prepare a dimensional inspection report for the component produced.

19HOC41 - COMMUNICATION SKILLS FOR ENGINEERS - II

L	T	P	C
0	0	2	1

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of the student will be able to

CO1 : *Solve objective questions on analogy, Statement and Argument, Statement and Conclusion, Data Sufficiency and Sentence improvement within a given time.*

CO2 : *Construct grammatically correct sentences.*

CO3 : *Speak confidently to describe a process, present information on the specified topic and disseminate information in a professional manner.*

SELF EVALUATION

Self believe and self Esteem - Activities based on Current Events **(2)**

VERBAL AND LOGICAL RESONING

Analogy - Introduction, Types and Exercises - Statement and Argument - Statement and Conclusion - Data Sufficiency - Sentence Improvement - Critical Reasoning / Theme Detection **(5)**

GRAMMAR

Basic Grammar- Subject Verb Agreement - One word substitute - Preposition- Cause and Effect - Basic level questions and Moderate level questions. **(4)**

PRESENTATION TECHNIQUES

Describing a Process - Presentation Skills - Introduction, Planning and Preparation - Presentation on a Topic - Group Discussion - Dos and Don'ts - Functional Expressions used in Group Discussion - Interview Skills - Ideal Grooming for an interview, Preparing for the Interview **(9)**

REFERENCES

1. *Sanjay Kumar, Pushp Lata, Communication Skills, 2nd Edition, Oxford University Press, New Delhi, India, 2015.*
2. *Anthony Manning, Chris Sowton and Craig Thaine, Cambridge Academic English, published by Cambridge University Press, U P, India, 2012.*

SEMESTER - V

19ME51 - HEAT AND MASS TRANSFER

(Use of approved HMT data book is permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Deduce and estimate heat transfer rate for one dimensional steady and unsteady state heat transfer problems with relevant boundary and initial conditions.*

CO2 : *Choose appropriate empirical correlations for convective heat transfer to determine the values of heat transfer coefficients and calculate heat transfer rates.*

CO3 : *Calculate the radiation heat exchange between gray surfaces in non-participating media*

CO4 : *Classify phase change heat transfer processes and draw analogy between heat and mass transfer mechanisms.*

CO5 : *Design a heat sink for a given heat duty and convective heat transfer coefficient*

CO6 : *Analyze heat exchangers using LMTD and Effectiveness-NTU methods*

CONDUCTION

Introduction - Modes of Heat Transfer - General Heat Conduction Equation for constant thermophysical properties (2-D) - One dimensional heat flow through composite walls, cylinders and spheres (with and without heat generation) - Effect of variable thermal conductivity - insulation - critical thickness. Unsteady heat conduction - lumped parameter analysis, Unsteady heat conduction with spatial variation - plane wall (problems using Heisler charts) - Infinite solids (Qualitative Treatment). **(12)**

CONVECTION

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

Free Convection - Vertical surfaces - Horizontal surfaces - heat transfer coefficient - heat transfer rate calculation using empirical correlations. **(12)**

RADIATION

Mechanism -types of surfaces - Stefan Boltzmann's law - Emissivity-absorptivity - reflectivity - transmissivity - emissive power - Kirchhoff's Law - shape factor for simple geometries -Radiation heat exchange between gray surfaces surrounded by non-participating media - Radiation shields. **(12)**

BOILING, CONDENSATION AND MASS TRANSFER

Boiling - Pool Boiling and Flow Boiling Regimes, Condensation - Filmwise and drop wise condensation.

Introduction to mass transfer - Modes of mass transfer - Fick's Law - Diffusion mass transfer - Equimolar counter diffusion, Analogy between heat and mass transfer **(12)**

HEAT SINKS, HEAT EXCHANGERS AND HEAT PIPES

Heat sinks - Applications - Construction & types, One-dimensional extended surface analysis - component performance parameters -Effectiveness and Efficiency - Design for a heat duty. Heat exchangers - Classification of Heat exchangers - LMTD and Effectiveness NTU Methods - Parallel, Counter and Cross flow, Multi passes flow - fouling factor. Heat pipes (Qualitative treatment) - Introduction, classification and applications. **(12)**

TOTAL : 60

TEXTBOOKS

1. *Yunus A Cengel and Afshin J Ghajar, "Heat and Mass Transfer: Fundamentals and Applications", 5th Edition, McGraw Hill Education, 2015.*
2. *P.K. Nag, "Heat and Mass Transfer", 3rd Edition, Tata McGraw Hill Co., 2011.*

REFERENCES

1. *Frank P Incropera, "Principles of Heat and Mass Transfer", John Wiley and Sons (Asia) Ltd., 2013.*
2. *Amir Faghri, "Heat Pipe Science and Technology", 2nd edition, Global Digital Press, 2016.*
3. *C.P.Kothandaraman and S.Subramanyan, "Heat and Mass Transfer Data Book", New Age International Publishers, 2008.*
4. *Mahesh M Rathore, "Engineering Heat and Mass Transfer", 2nd Edition, Laxmi Publications, 2015.*
5. *J P Holman, "Heat Transfer", Tata McGraw Hills Education,10th Edition, 2010.*
6. *https://nptel.ac.in/courses/112/101/112101097/*

19ME52 - DESIGN OF MACHINE ELEMENTS

(Use of approved design data book is permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Calculate 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) for standard specified loads (axial and radial load) and specified life.*

DESIGN FUNDAMENTALS FOR MACHINE ELEMENTS

Introduction to design process-factors influencing in machine design - principles of standardization, selection of materials - types of stresses, factor of safety., theories of failure. Stress concentration, fluctuating stresses, fatigue failure, fatigue limit, S-N curves, Soderberg, Goodman and Gerber equations, combined stress. **(12)**

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. **(12)**

DESIGN OF ENERGY STORING ELEMENTS

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. **(12)**

DESIGN OF JOINTS

Joint strength equations, efficiency, design of riveted joints - joints of uniform strength, eccentrically loaded riveted joints, design of longitudinal and circumferential boiler joints Welded joints - strength of welds, centrally loaded, unsymmetrical sections, axially loaded and eccentrically loaded joints -design of bolted joints. **(12)**

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. **(12)**

TOTAL : 60

TEXT BOOKS

1. *Robert L Mott., "Mechanical Elements in Mechanical Design", 6th Edition, Macmillan Publishing Co., London, 2018*
2. *V. B. Bhandari, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Publishing Ltd., New Delhi, 2017.*

REFERENCES

1. *Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 7th Edition, Wiley, 2019*
2. *https://nptel.ac.in/courses/112/105/112105124/*
3. *https://nptel.ac.in/courses/112/105/112105125/*
4. *https://nptel.ac.in/courses/112/106/112106137/*
5. *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, 2020.*

19ME53 - MANUFACTURING PROCESSES - II

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 : *Illustrate operation such as Turning, Facing, Threading, Knurling and Grooving on Centre Lathe and special purpose lathes.*

CO3 : *Demonstrate and Produce a component using boring, shaping, planning, drilling, milling, sawing and broaching machines.*

CO4 : *Demonstrate the proper setups, uses, and operations associated with the grinding machine, its accessory devices and illustrate gear manufacturing and forming.*

CO5 : *Choose and apply advanced 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.*

THEORY OF METAL CUTTING

Introduction: material removal processes: Nomenclature of a single point cutting tool, mechanics of metal cutting, orthogonal and oblique cutting, Mechanism of chip formation, Types of chips Use of chip breaker in machining, Machining forces and Merchant circle diagram (MCD), Cutting tool materials-Thermal aspects-tool wear and tool life, surface finish, cutting fluids. **(9)**

CENTRE LATHE AND SPECIAL PURPOSE LATHES

Centre lathe, constructional features, cutting tool geometry, various operations, taper turning methods, thread cutting methods, special attachments, Capstan and turret lathes automats single spindle, Swiss type, automatic screw type, multi spindle - Turret Indexing mechanism, Bar feed mechanism. **(9)**

SPECIAL MACHINE TOOLS

Reciprocating machine tools: shaper, planer, slotter. Milling: types, milling cutters, operations. Hole making: drilling Introduction, Reaming, Boring, Tapping Other Hole-Making Operations- Sawing machine: hack saw, band saw, circular saw-Broaching machines: broach construction push, pull, surface and continuous broaching machines. Work holding devices-Concept of Jigs and Fixtures and its applications. **(9)**

ABRASIVE PROCESSES AND GEAR MANUFACTURING

Abrasive processes: Introduction-Grinding wheel: Designations and selection, types of grinding machines cylindrical grinding, surface grinding, Centreless grinding Grinding Process parameters- honing, lapping, super finishing, polishing and buffing, - Gear cutting, forming, generation, shaping, hobbing. **(9)**

ADVANCED MACHINING PROCESSES

Need for Advanced machining processes, Electric-Discharge Machining (EDM) -Electrochemical Machining-Ultrasonic Machining-chemical Machining-Laser Beam machining, Abrasive Water Jet machining (AWJM), electron Beam Machining (EBM), Ion Beam Machining (IBM), Plasma Arc Machining (PAM)-Equipments- Process- Process Parameters and Machining Characteristics, Applications, Limitations - Nanofabrication - Micromachining - Economics of Advanced Machining Processes. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Rao, P. N., "Manufacturing Technology 4e (Vol. 1&2)", Tata McGraw Hill 2017.*
2. *Kalpakjian, S. and Schmid, S. R, "Manufacturing Engineering and Technology" 8th edition, Pearson Education, 2018.*

REFERENCES

1. *Groover, M. P., "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley and Sons Inc., 2015.*
2. *R. K. Rajput "A Textbook of Manufacturing Technology: Manufacturing Processes", 3rd edition, Laxmi publications, 2018.*
3. *https://nptel.ac.in/courses/112/105/112105126/*

19ME54 - METROLOGY AND QUALITY CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

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

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

CO3 : *Illustrate surface finish measurements and interferometry principles 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 and decide upon the 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 & limitations 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, analysis of patterns of control charts, control charts for variables - X bar and R chart, control charts for attributes - p, np, C 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, Operating Characteristic (OC) curves - construction, average outgoing quality level, average total inspection, producer risk and consumer risk. 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. *Montgomery, D. C. "Introduction to Statistical Quality Control", 8th edition, John Wiley & Sons, 2018.*
2. *Mahajan, M, "A Textbook of Metrology", Dhanpat Rai & Sons, New Delhi, 2010.*

REFERENCES

1. *Gupta, I. C, "Textbook of Engineering Metrology", Dhanpat Rai & Sons, New Delhi, 2018.*
2. *Jain, R. K. "Engineering Metrology", 21st edition Khanna Publishers, New Delhi, 2018.*
3. *https://nptel.ac.in/courses/112/106/112106179/*
4. *https://nptel.ac.in/courses/112/104/112104250/*

19ME55 - OPERATIONS RESEARCH

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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 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 modelling.*

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. **(6)**

DUALITY AND SENSITIVITY ANALYSIS

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

TRANSPORTATION AND ASSIGNMENT

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

NETWORK MODELS

Definition of network models - minimal spanning tree algorithm, shortest route algorithm, maximal flow algorithms, PERT, CPM- LP formulation of minimal spanning, maximum flow and PERT, CPM calculations. **(6)**

INVENTORY AND MODELS

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

GAME THEORY AND SEQUENCING

Two Person Zero Sum Game, Pure and Mixed Strategies, Algebraic Solution Procedure, Graphical Solution, Solving by Linear Programming; Sequencing Problem, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem. (8)

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. **(7)**

Total : 60

TEXT BOOKS

1. *Taha, H. A, "Operations Research - An Introduction",10th Edition, Pearson, 2017.*
2. *Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", 10th Edition, Tata McGraw Hill, 2015.*

REFERENCES

1. *Michael W. Carter, Camille C. Price, Ghaith Rabadi, Operations Research Practical Introduction, 2nd Edition, CRP Press, 2019*
2. *Mittal, K. V. and Mohan, C. "Optimization Methods in Operations Research and Systems Analysis", 4th Edition, New Age,2016.*
3. *S. S. Rao, "Engineering Optimization: Theory and Practice", 5th Edition, John Wiley & Sons, 2019.*
4. *https://nptel.ac.in/courses/111/107/111107128/*
5. *https://nptel.ac.in/courses/112/106/112106134/*

19MEL56A - APPLIED THERMAL SCIENCES LABORATORY

L	T	P	C
0	0	2	0.5

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

CO1 *: Identify and explain components and mechanisms of IC engines.*

CO2 *: Conduct performance tests on IC engines, reciprocating compressors and refrigeration systems.*

CO3 *: Evaluate performance of refrigeration system*

CO4 *: Estimate heat transfer parameters - radiant factor, emissivity, free and forced convection heat transfer coefficients*

CO5 *: Estimate thermal conductivity of different solids*

CO6 *: Conduct performance tests on pin-fin and heat exchangers*

LIST OF EXPERIMENTS

1. Construction of Port timing (2S) and Valve timing (4S) diagrams for a single-cylinder engine.
2. Performance test on four stroke multi-cylinder petrol engine (MPFI).
3. Heat balance test on four stroke single-cylinder diesel engine.
4. Determination of volumetric efficiency of reciprocating air compressor.
5. Viscosity of lubricating oil - Redwood viscometer.
6. Performance test on vapor compression refrigeration system.
7. Determination of Radiant Factor and Emissivity using Stefan Boltzmann Apparatus
8. Determination of Convective heat transfer coefficient in Free and Forced Convection
9. Determination of Thermal Conductivity in Composite walls, Insulation Sheets and Insulation Powder
10. Unsteady state Heat Transfer Analysis
11. Determination of Heat Transfer in Pin-Fin
12. Performance Analysis of Plate Heat Exchanger, and Shell and Tube Heat Exchanger

REFERENCES

1. *Thermal Engineering Laboratory Manual, Department of Mechanical Engineering, CIT, 2015.*
2. *Heat Transfer Laboratory Manual, Department of Mechanical Engineering, CIT, 2019.*
3. *Frank P Incropera, "Principles of Heat and Mass Transfer", John Wiley and Sons (Asia) Ltd., 2013.*
4. *C.P.Kothandaraman and S.Subramanyan, "Heat and Mass Transfer Data Book", New Age International Publishers, 2008.*

19MEL56B - DYNAMICS AND METROLOGY LABORATORY

DYNAMICS LABORATORY

L	T	P	C
0	0	2	0.5

ASSESSMENT : PRACTICAL

DYNAMICS LABORATORY

COURSE OUTCOMES

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

CO1 *: Model and analyze the mechanism to evaluate the position, velocity and acceleration using MATLAB.*

CO2 *: Demonstrate the working principle of gyroscope, governor and cam.*

CO3 *: Examine the balancing of reciprocating mass.*

CO4 *: Inspect the critical speed of the shaft under the given load conditions.*

CO5 *: Determine the vibration response of different systems.*

LIST OF EXPERIMENTS

1. Kinematic and Dynamic analysis of a four bar and slider crank mechanism using MATLAB.
2. Study of gyroscopic couple using motorized gyroscope apparatus.
3. Determination of the whirling speed of a shaft using whirling of shafts demonstrator.
4. Using universal vibration apparatus,

a. Determining the radius of gyration of a compound pendulum;

b. Determining the radius of gyration of a body using bifilar suspension;

c. Determining the radius of gyration of a body using tri-filar suspension;

5. Experiment on different types of cam and followers.
6. Determination of the controlling force at a given speed, sensitiveness at given limits of lift and governor effort and power of various types of governors.
7. Study on balancing of reciprocating mass.
8. Determination of vibration response using free and forced vibration test.

REFERENCES

1. *Mechanisms and Machines Laboratory manual, Department of Mechanical Engineering, CIT, 2015.*
2. *http://mdmv-nitk.vlabs.ac.in/*
3. *http://mm-nitk.vlabs.ac.in/*
4. *Kinematics and Dynamics of Mechanical Systems, Second Edition: Implementation in MATLAB® and SimMechanics® 2nd Edition, Kindle Edition by Kevin Russell, Qiong Shen, Rajpal S. Sodhi, 2019.*

METROLOGY LABORATORY

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

CO1 : *Find angular measurement to set work piece for a desired angle with the help of angle gauges, bevel protractor, sine bar, and slip gauges for inclined components*

CO2 : *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.*

CO3 : *Measure screw thread elements - major diameter, minor diameter, effective diameter and pitch using floating carriage micrometer, tool maker's microscope and profile projector for a given threaded component.*

CO4 : *Interpret and analyse data for P-chart, X bar chart and R chart for given specifications and comment on the nature of the process.*

LIST OF EXPERIMENTS

1. Measurement of angle (taper rod/piece) using sine bar and slip gauges.
2. Measurement of external taper angle using slip gauges and Rollers.
3. Calibration of dial gauge using dial tester.
4. Measurement of gear tooth thickness using gear tooth vernier caliper.
5. Measurement of thread parameters using profile projector.
6. Measurement of thread elements using Tool maker's microscope.
7. Measurement of screw thread parameters using three wire method (Floating Carriage Micrometer).
8. Draw P chart for given specifications and comment on the nature of the process.
9. Draw X and R chart for given specifications and comment on the nature of the process

REFERENCES

1. *Metrology laboratory Manual, Department of Mechanical Engineering, CIT, 2015.*
2. *https://nptel.ac.in/courses/112/104/112104250/*
3. *https://nptel.ac.in/courses/112/106/112106179/*

19HOC51 - EMPLOYABILITY AND PERSONALITY DEVELOPMENT SKILLS - I

L	T	P	C
0	0	2	1

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Solve objective questions on Syllogisms, Data Interpretation, Critical Reasoning, Theme Detection, Sentence Completion and Business Vocabulary*

CO2 : *Develop appropriate responses for business phone calls and negotiate effectively.*

CO3 : *Speak with appropriate body language for a technical speaking task.*

CO4 : *Project the appropriate grooming and the right etiquettes, for interview and group discussion task.*

VERBAL APTITUDE

Syllogisms-Paragraph Comprehension -Data Interpretation -Critical Reasoning/Theme Detection - Grammar -Sentence Completion Filler - Business Vocabulary- Foreign phrases used in English **(3)**

PROFESSIONAL COMMUNICATION

Telephonic Conversation Skills - Telephonic Interview -Etiquettes - Professional, Dining & Telephone - Employability skills - Importance and Employability level of present Y and Z Generation - Interpersonal Skills - Negotiation Skills - Types, Expressions used in formal and informal negotiations, Stages of Negotiation - Time Management - Pareto principle, Prioritizing tasks, Barriers to time management **(7)**

THE ART OF SPEAKING

Types of Speaking - Barriers to Speaking - Presentation on a Technical Topic - Speaking on Current Trends in the Industry **(5)**

NON-VERBAL COMMUNICATION

Interview Skills -Non Verbal Communication - Smiling, Posture, Handshake, Tone of Voice and Eye Contact - GD tips & techniques and Mock GD- Body Language - Grooming. **(5)**

REFERENCES

1. *Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.*
2. *Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.*
3. *John Hayes. Interpersonal Skills at Work. Second Edition. Routledge publication. 2005*

SEMESTER - VI

19ME61 - REFRIGERATION AND AIR CONDITIONING

(Use of approved refrigeration charts and Psychrometric Charts is permitted)

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of this 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 and condensers and expansion devices used in refrigeration systems .*

AIR CYCLE REFRIGERATION

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

REFRIGERANT SELECTION

Properties, Eco-friendly refrigerants, Selection of Refrigerants. Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics **(2)**

VAPOUR COMPRESSION REFRIGERATION SYSTEM

T-s and P-h charts - analysis - Performance of systems under varying operating conditions. Multi-stage refrigeration working principles, Analysis. **(8)**

BALANCING OF COMPONENTS

Condensers - Air cooled, water cooled and evaporative condensers. Evaporator - flooded, dry expansion, shell and tube and double pipe. Compressors - reciprocating, rotary and centrifugal types. Expansion devices - capillary and TEV. **(8)**

VAPOUR ABSORPTION SYSTEMS

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

AIR CONDITIONING

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

AIR CONDITIONING SYSTEMS

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

TOTAL: 45

TEXT BOOKS

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

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*
5. *ASHRAE-Fundamental volume, ISHRAE Handbook*
6. *https://nptel.ac.in/courses/112/107/112107208/*

19ME62 - FINITE ELEMENT ANALYSIS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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 eigenvalue 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 analyse 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 -Continuum and discrete modeling - Initial Value Problems and boundary value problems - Energy methods - Variational approach - Rayleigh-Ritz method - Weighted Residual Method: Least squares, Collocation method, Galerkin methods - Strong and weak forms - Solving boundary value problems using finite element method. **(9)**

ONE-DIMENSIONAL ANALYSIS

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

TWO-DIMENSIONAL ANALYSIS

Plane strain, plane stress and axi-symmetric analysis - Global and natural coordinates, 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-Problems. **(9)**

APPLICATION TO HEAT TRANSFER AND FLUID MECHANICS

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

DYNAMIC ANALYSIS AND COMPUTER IMPLEMENTATION

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

(FOR INTERNAL EVALUATION)

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, J and T. Belytschko, 'A first Course in Finite Elements', John Wily Sons, 2007.*
2. *Seshu. P., 'Textbook of Finite Element Analysis' Prentice Hall of India, 2012.*

REFERENCES

1. *Reddy, J.N., 'Introduction to Finite Element Method', 4th Edition (Indian edition), Tata McGraw-Hill Education, 2020*
2. *Daryl L. Logan., 'A First Course in the Finite Element Method', 6th Edition, 2016*
3. *Rao S.S., 'The Finite Element Method in Engineering' 6th Edition, Elsevier ,2019.*
4. *Krishnamoorthy. C., 'Finite Element Analysis: Theory and Programming' 2nd edition, Tata McGraw-Hill Education, 2017.*
5. *Senthil S and R. Panneerdhass, 'Finite Element Analysis' Lakshmi publications, 2016.*
6. *https://nptel.ac.in/courses/112/104/112104193/*
7. *https://nptel.ac.in/courses/112/104/112104116/*

19ME63 - DESIGN OF TRANSMISSION SYSTEMS

(Use of approved design data book is permitted)

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of this 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, multi-plate 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. **(9)**

DESIGN OF SPUR, HELICAL AND BEVEL GEARS

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. Buckingham's equation for dynamic load; surface strength and durability; heat dissipation; design for strength and wear. **(9)**

WORM GEARS AND MULTI SPEED GEAR BOX

Worm gear - Terminology, materials, force analysis, thermal considerations, efficiency, design of worm gears. Gearbox- Geometric progression, step ratio, ray diagram, Kinematic diagram, Design of sliding mesh gear box, constant mesh gear box, speed reducer unit; Variable speed gearbox; Fluid couplings, Torque converters for automotive applications. **(9)**

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. **(9)**

DESIGN OF CLUTCHES AND BRAKES

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. **(9)**

Total : 60

TEXT BOOKS

1. *Bhandari V.B., "Design of Machine Elements", 3rd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2016*

REFERENCES

1. *Darle W Dudley, "Hand Book of Practical Gear Design", CRC Press, Florida, 2015*
2. *Robert L Norton, "Machine Design - An Integrated Approach", Pearson Education, New Delhi, 2015*
3. *https://nptel.ac.in/courses/112/106/112106137/*
4. *https://nptel.ac.in/courses/112/105/112105234/*

HAND BOOK

PSG, "Design Data Book", KalaikathirAchagam Publishers, 2020.

19ME64 - COMPUTER AIDED ENGINEERING

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

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 etc.*

INTRODUCTION

Introduction- Need and Scope of Computer Aided Design, Fundamental of CAD and CAE, 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, 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. File format DXF & DXB. **(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 viewport coordinate transformation, viewing functions. Cohen-Sutherland and Cyrus-beck line clipping algorithms, Sutherland - Hodgeman polygon clipping algorithm. **(7)**

GEOMETRICAL REPRESENTATION

Curve representation, parametric representation, and analytical curve -Line-circle-ellipse, spline representation. Hermite curve, Bezier curve and B-Spline curves, Bezier and B-Spline surfaces. Basic illumination models, polygon - rendering methods.3-D Object Representation - Polygon surfaces, quadric surfaces. **(7)**

3D - GEOMETRICAL 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 subdivision and octree methods. **(7)**

COMPUTER AIDED MANUFACTURING (CAM)

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

COMMUNICATION, INFORMATION AND PRODUCTION MANAGEMENT SYSTEM

Materials Requirement Planning (MRP), MRP-II, Scheduling and its importance, management of systems-shop floor control system, networking, data acquisition system, supervisory and hierarchical computer system. **(7)**

Total : 60

TEXT BOOK

1. *Mikell P. Groover and Emory Jimmers W., "CAD/CAM", Pearson Education., 2013*

REFERENCES

1. *NPTEL courses http//nptel.iitm.ac.in/courses.php- web and video resources on Computer Aided Design and Manufacturing. https://nptel.ac.in/courses/112/104/112104031/*
2. *https://nptel.ac.in/courses/112/104/112104252/*

19MEL65 - CAD/CAM LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Produce a 3-D component drawing using basic and advanced levels of modeling techniques in software.*

CO2 : *Assemble mechanical engineering components, check for interference and simulate the assembly mechanism.*

CO3 : *Generate CNC programs for a given component as per part drawing by integrating through CNC turning and machining center.*

CO4 : *Use a real time CNC turning and machining center with Fanuc software to produce components of simple shape.*

CO5 : *Select the advanced manufacturing technology solution for a particular application*

EXPERIMENTS ON CAD

1. Creation of 2D drawing for a given component using various commands in the software.
2. Modeling of various profiles using extrude, revolve, sweep, pattern, helical and Rib features through basic commands.
3. Design of equation-based curves using modeling software.
4. Assemble machine components; explore mechanisms with constraints using modeling software.
5. Generate part drawings having various sectional views from assembly drawing and list out the Bill of Materials (BOM) for manufacturing.

EXPERIMENTS ON CAM

1. Study of CNC turning and machining center - specification and part programming codes for various operations.
2. Programming and simulation of CNC turning center - its operation such as step, taper, profile and thread turning using Fanuc software.
3. Programming and simulation of CNC machining center-its operation such as linear interpolation, circular interpolation, mirror and pocketing operation using Fanuc software.
4. Study on abrasive water jet machining process - working principles, operation, effect of process parameters and application.
5. Study on additive manufacturing machine- working principles, operation, effect of process parameters and application.

REFERENCES

1. *CAD/CAM Laboratory Manual, Department of Mechanical Engineering CIT.*
2. *https://nptel.ac.in/courses/112/104/112104252/*

19HOC61 - EMPLOYABILITY AND PERSONALITY DEVELOPMENT SKILLS - II

L	T	P	C
0	0	2	1

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Exhibit Corporate Etiquettes with assertiveness and personal effectiveness.*

CO2 *: Build teams and solve problems at workplace.*

CO3 *: Manage conflicts in a professional manner*

CO4 *: Simulate an actual Job Interview scenario to prepare a candidate for a real Interview*

CORPORATE ETIQUETTE

Corporate Etiquette: Dos and Don'ts, - Conversational dos and don'ts - Creating elusive first impression- Assertiveness-Personal Effectiveness **(4)**

LEADERSHIP AND TEAM MANAGEMENT

Leadership Skills - Understanding Traits and Styles - Team Building: Bonding, Development and Delegation - Adaptability and Work Ethics - Handling Team Dynamics- Giving and Receiving Feedback- Problem Solving Skills **(5)**

STRESS AND CONFLICT MANAGEMENT

Emotional Intelligence: Recognition, Understanding and Managing - Stress Management: Techniques and Benefits - Conflict Management: Introduction - Handling Conflicts - Conflicts settlement **(6)**

GROUP DISCUSSION AND INTERVIEW SKILLS

Mock GD - Interview Skills - Answering challenging questions - Common Interview Questions **(5)**

REFERENCES

1. *Barun K Mitra., Personality Development and Soft Skills. Second Edition. Oxford University Press. 2016*
2. *N.Krishnaswamy & Lalitha Krishnaswamy - Mastering Communication Skills and Soft Skills. New Delhi. Bloomsburry. 2015*
3. *Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.*

SEMESTER - VII

19ME71 - CONTROL THEORY AND MECHATRONICS

L	T	P	C
2	0	2	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the student will be able to:

CO1 : Explain control systems and the mathematical approach of designing them.

CO2 : To select suitable control systems for mechanical actuators.

CO3 : To explain electrically controlled mechanical actuators and methods of controlling

CO4 : To design and integrate electronics components with various mechanical machines for better performance

MODELING IN TIME DOMAIN

Review of Laplace transformation, Basic system models, closed loop and open loop control systems, Mathematical modelling of mechanical systems , Dynamic responses of system, Natural and forced response, Linear system, , blocks diagram representation and reduction, Transient and steady state Response Analysis, system transfer function, First & Second order Systems, types of input. **(8)**

MODELING IN THE FREQUENCY DOMAIN

Frequency response for first order and second order systems, Stability Analysis, Phase Lead and Phase Lag in Sinusoidal Response, Stability of control systems, poles/ zeros, complex plane, Routh- Hurwitz criterion, Bode Diagrams, Polar Plots, Gain margin, Phase margin **(8)**

ROOT-LOCUS TECHNIQUE

Root-Locus Plots - General Rules for Constructing Root Loci, Typical sketches of root locus plots, Root locus approach to control system design **(6)**

CONTROLLER DESIGN

Proportional, integral, derivative, PI, PD and PID controllers, Pneumatic Controllers, Hydraulic Controllers, Electronic Controllers **(6)**

SENSORS AND ACTUATORS

Introduction - Adaptive control with optimization, Adaptive control with constraints, Application of Adaptive control in Machining operations. Types of inspection methods and equipment, CMM, Types, methods of CMM control, Machine vision- Introduction, image acquisition, and image processing applications of machine vision. **(8)**

PROGRAMMABLE LOGICAL CONTROLLERS

Programmable logic controllers, basic structure, selection of PLC, Ladder Diagram, latching circuit, timers, internal relays and counters, shift register, master and jump controls. **(6)**

APPLICATIONS TO MECHATRONICS SYSTEM DESIGN

Review of applications of control in Machine tools, and Control of pick and place robot **(3)**

TOTAL: 45

TEXT BOOK

1. *W. Bolton, "Mechatronics", Pearson Education Asia, New Delhi, 6th edition, 2015.*
2. *A. NagoorKani, "Control Systems", RBA Publications, 3rd edition, 2017.*

REFERENCES

1. *Shetty Devdas and Richard A Kolk, "Mechatronics System Design", Cengage Learning, New Delhi, 2nd edition, 2010.*
2. *Katsuhiko Ogata, "Modern Control Engineering, Pearson, 5th edition, 2015.*

19ME72 - QUALITY ENGINEERING AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Outline the quality engineering system with various types of evaluation of loss function.*

CO2 *: Analyze the characteristics and schedules in preventive maintenance along with various quality tools.*

CO3 *: Design on-line quality control system for various production environments by considering feedback and various process control parameters.*

CO4 *: Define quality management axioms and implement Deming philosophy along with action plans.*

CO5 *: Demonstrate and implement various quality management tools.*

QUALITY ENGINEERING AND LOSS FUNCTION

Quality value and engineering- overall quality system-quality engineering in product design - quality engineering in design of production processes - quality engineering in production - quality engineering in service. Derivation - loss function for products/system- justification of improvements- loss function and inspection- quality evaluations and tolerances-N type, S type, L type. **(9)**

QUALITY ENGINEERING AND TPM

Preventive Maintenance (PM) schedules- PM schedules for functional characteristics- PM schedules for large scale systems. Quality tools-fault tree analysis, event tree analysis, failure mode and effect analysis. ISO quality systems. **(9)**

ON-LINE QUALITY CONTROL

On-line feedback quality control variable characteristics-control with measurement interval- one unit, multiple units-control systems for lot and batch production. On-line process parameter control variable characteristics- process parameter tolerances- feedback control systems- measurement error and process control parameters. **(9)**

QUALITY MANAGEMENT

Definitions of the terms - quality planning, quality control, quality assurance, quality management, total quality management as per ISO 8402 - overview on TQM - the TQM axioms - Commitment - scientific knowledge - involvement Consequences of total quality. Six sigma, Cp, Cpk, Ppk Deming's fourteen points on quality management - five DDs - implementing the Deming philosophy - action plan - the Deming cycle - Case study. **(9)**

TECHNIQUES IN QUALITY MANAGEMENT

Kaizen and innovation - the kaizen management practices - Total Quality Control (TQC) -- small group activities - quality circles - Comparison of Kaizen and Deming's approach with illustration. Affinity diagram - brainstorming - cause and effect analysis -checklist- flow charts - Pareto analysis - quality costing - Quality Function Deployment (QFD) - Training of quality - self managing teams. **(9)**

TOTAL: 45

TEXT BOOKS

1. *De Feo J A and Barnard WW, "Six Sigma: Breakthrough and Beyond", Tata McGraw-Hill, New Delhi,2005.*
2. *Krishnamoorthi, K.S and Ram Krishnamoorthi. V. "A First Course in Quality Engineering: Integrating Statistical and Management Methods of Quality, CRC Press, 2nd Edition, 2016*

REFERENCES

1. *Kaniska Bedi, "Quality Management", Oxford University Press, Chennai, 2007.*
2. *Brue G, "Six Sigma for Managers", Tata-McGraw Hill, New Delhi, Second reprint, 2002.*
3. *Taguchi G, Elsayed E A and Hsiang, T.C.,"Quality Engineering in Production Systems", Mc-Graw-HillBook company, Singapore, 1989.*
4. *Deming W E, "Out of the Crisis", MIT Press, Cambridge, MA, 1982.*
5. *Juran J M and Juran on "Leadership for Quality" An Executive Handbook, The Free Press, New York,1989.*
6. *Salor J.H., "TQM-Fleld Manual," McGraw Hill, New York, 1992.*
7. *Crosby P.B., "Quality is Free," McGraw Hill, New York, 1979*
8. *Pyzdek T and Berger R W, "Quality Engineering Handbook", Tata-McGraw Hill, New Delhi, 1996.*
9. *LogotheticsN ., "Managing for total quality - From Deming to Taguchi and SPC", Prentice hall Ltd, New Delhi, 1997.*
10. *Juran J.M &Gryna F.M., "Quality Planning and Analysis - From Product development through use",TataMcGrawHill Publishing Limited, new Delhi, 3rd Edition , 1995*
11. *https://nptel.ac.in/courses/110/104/110104080/*

PROFESSIONAL ELECTIVES

COURSE CONTENTS FOR ELECTIVES IN MATERIALS AND DESIGN STREAM

19MEE01 - COMPOSITE MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Develop a particulate or fiber 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 fiber.*

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

CO4 : *Select a 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, fiber reinforced composites, laminar composites - types of fibers - smart materials - types and characteristics -material selection process - applications related to aerospace, automobile, medical, bridge and other civil engineering structures. **(8)**

POLYMER MATRIX COMPOSITES

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 - fiber reinforced plastics, glass fiber reinforced plastics. **(8)**

METAL MATRIX COMPOSITES

Types of metal matrix composites - characteristics - advantages and limitations of MMC- effect of reinforcement - volume fraction - rule of mixtures - processing of MMC - vacuum hot pressing, powder metallurgy process, liquid metal infiltration, compo casting, squeeze casting. **(7)**

CERAMIC MATRIX COMPOSITES

Ceramic matrix materials - properties - advantages - limitations - Processing - Hot pressing, liquid infiltration technique, Lanxide Process, in situ chemical reaction techniques - Interface in CMCs - Applications. **(7)**

GEOMETRICAL ASPECTS AND ANALYSIS

Characteristics of fiber filled lamina - volume fraction and weight fraction - woven roving, in-plane random fibers - fiber orientation- void - fiber 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 behaviors of CMCs - Fatigue of particle and whisker reinforced composites - Hybrid composites- Thermal fatigue - Creep. **(7)**

TOTAL: 45

TEXT BOOKS

1. *Mallick P.K., "Fiber-Reinforced Composites: Materials, Manufacturing and Design", 3rd edition, CRC Press, 2019.*
2. *Agarwal B.D., Broutman L.J. and Chandrashekhara K, "Analysis and Performance of Fiber Composites", 4th edition, John Wiley and Sons, New York, 2017.*

REFERENCES

1. *Chawla, Krishan K, "Composite Materials Science and Engineering", 4th Edition, Springer, 2019.*
2. *Hull D., and Clyne T. W, "An Introduction to Composite Materials", Cambridge University Press, 3rd Edition, 2019.*
3. *Matthews F.L., and Rawlings R.D, "Composite Materials: Engineering and Science", Cambridge : Elsevier Science, 2014*
4. *https://nptel.ac.in/courses/112/104/112104168/*
5. *https://nptel.ac.in/courses/112/104/112104229/*
6. *https://nptel.ac.in/courses/112/104/112104221/*

19MEE02 - DESIGN FOR MANUFACTURING AND ASSEMBLY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 processes 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, Poka Yoke 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 worksheets 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.*
3. *Palaniyappan Kailasam, "Geometric Dimensioning and Tolerancing", Prolotek Technologies Private Limited, Bangalore, 2018.*

REFERENCES

1. *https://nptel.ac.in/courses/107/103/107103012/*
2. *https://nptel.ac.in/courses/112/101/112101005/*
3. *https://nptel.ac.in/courses/112/106/112106249/*

19MEE03 - DESIGN OF JIGS AND FIXTURES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Understand the basics of jigs and fixtures and its principle*

CO2 : *Design appropriate locating systems to arrest the possible degrees of freedom exhibited by the component.*

CO3 : *Suggest and design appropriate clamping for specified operations.*

CO4 : *Design appropriate Jig for given component for efficient and effective manufacturing.*

CO5 : *Design and develop appropriate fixture for a given component.*

INTRODUCTION

Objectives of tool design - Functions and Advantages of Jigs and Fixtures- Difference between Jigs and Fixtures - Basic elements of Jigs and Fixtures - Fool Proofing - Types of jigs and Fixtures- materials for jigs and fixtures - Degrees of freedom - 3-2-1 principle of location - Essential features of jigs and fixtures - General Design Principles - Design steps, Economics of jigs and fixtures. **(9)**

LOCATING AND CLAMPING PRINCIPLES

Principles of location - Basic rules for locating - Locating methods and devices - pins and stud locators, V-locators, bush locators and nest locators - Redundant location - Standard parts-Principles of clamping - clamping devices - mechanical actuation clamps - Pneumatic and hydraulic actuation clampings - magnetic clamps- spherical clamping operation. **(9)**

ANALYSIS OF CLAMPING FORCES

Analysis of clamping force - strap clamp, toggle clamp, cam operated clamp and screw clamp. Limit and fits, types of tolerance -Geometric dimensioning - Tolerance and error analysis. **(9)**

DRILL BUSHES AND DRILL JIGS

Drill bushes - materials for drill bushes, design principles for drill bushings, types of drill bushes - type of drill bushes - clearance.

Drill jigs - Types of jigs-Post, Turnover, Channel, latch, box, pot, angular post jigs - Indexing jigs - Pneumatic and hydraulic operated drill jig-chip control - Common defects in jig design - Design and development of jig for given component **(9)**

FIXTURES

Fixture - design principles - types of fixtures - Design of boring fixtures, milling fixtures, turning fixtures, Broaching fixtures, Grinding fixtures, Welding fixtures -consideration for welding fixtures - Assembly and Inspection fixtures - Modular fixturing systems- Air operated fixtures. Design and development of fixture for a given component.

Assembly drawings of a simple jig or fixture using computer software AUTOCAD or any other CAD software

TOTAL: 45

TEXT BOOKS

1. *Joshi, P.H., "Jigs and Fixtures", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 3rd Edition, 2017.*
2. *Cyril Donaldson, George H. Lecain, GooldV. C and JoyjeetGhose., "Tool Design", Tata McGraw Hill, 5th edition, 2017.*

REFERENCES

1. *ASTME, "Handbook of Fixture design"*
2. *Goroshkin A.K., "Jigs and Fixtures Handbook", MIR Publishers, Moscow*
3. *M. H. A. Kempster., "Introduction to Tool Design and Jigs and Fixtures", 2013*
4. *Venkataraman. K., "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2015.*
5. *ASTME, "Fundamentals of Tool Design", Prentice Hall of India.*
6. *PSG, "Design Data Book", Kalaikathir Achagam Publishers, 2020*

19MEE04 - MECHANICAL BEHAVIOR OF MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *demonstrate an understanding of the mechanical properties and behaviour of materials.*

CO2 : *Explain concept of linear elastic fracture mechanics and estimate the effects of cracks in material and structure.*

CO3 : *Identify engineering problem in using plastic deformation, fatigue, fracture and creep*

CO4 : *Asses and describe the mechanism loading to failure when provided with a failure example.*

ELASTICITY

Limit of elastic response: uniaxial and multiaxial, Mechanisms in crystalline materials: dislocations, twins, and APBs, Mechanisms in non-crystalline materials, Strengthening via microstructure, environment, and physical size **(15)**

CREEP

Time-dependent plasticity, Deformation mechanism maps of elasto-plasticity. **(10)**

FRACTURE

Evolution of fracture models: ultimate failure, Microstructural mechanisms of fracture strengthening. **(10)**

FATIGUE

Failure below fracture stress: insidious failure, Empirical fatigue models, Microstructural mechanisms of prolonged fatigue lifetime **(10)**

TOTAL : 45

TEXTBOOKS

1. *Dieter, G.E., "Mechanical Metallurgy", 3rd Edition, McGraw-Hill, 2017.*
2. *Davis. H. E., Troxell G.E., Hauck.G. E. W., "The Testing of Engineering Materials", 4th Edition, McGraw-Hill, 2015.*

REFERENCES

1. *Honey combe R. W. K., "Plastic Deformation of Materials", Edward Arnold Publishers, 1984.*
2. *Suryanarayana, A. V. K., "Testing of Metallic Materials", Kindle Edition, BSP BOOKS Publisher, 2020.*
3. *https://nptel.ac.in/courses/113/106/113106101/*
4. *https://nptel.ac.in/noc/courses/noc22/SEM1/noc22-mm04/*

19MEE05 - MACHINE TOOL DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools.*

CO2 : *Apply the design procedures for different types of design problems such as gearbox design, guide way design, shaft loading and its associated parts, rolling bearings, die design and jigs and fixtures and so on.*

CO3 : *Design, develop, and evaluate cutting tools and work holders for a manufactured product.*

INTRODUCTION

General requirement of machine tool design, techno-economic prerequisites. **(9)**

DESIGN OF CUTTING TOOLS

Cutting tool materials, properties, classification, selection, tool wear, tool life. Single point tools: nomenclature, types and styles, design and manufacture of tools in HSS and carbides, tools for turning, boring, shaping, planning and slotting operations, form tools, tools and holders for CNC applications. Multipoint cutters, nomenclature, classification and selection, construction methods, design and manufacture of drills, reamers, taps, dies, thread chasers, milling cutters, broachers, hobs and gear shaping cutters. **(9)**

MACHINE TOOLS

Kinematics structure & mechanical, hydraulic and electrical drives, design of hydrostatic, hydrodynamic and antifriction guideways, design of spindles, design of speed box and feed box, stepped and step less regulations of speed and feed diagram, ray diagram, layout of spindles drive and feed drive in machine tools, machine tool structures, design of bed, heard stock, spindle supports and power screws, machine tool dynamics. **(9)**

JIGS AND FIXTURES DESIGN

Applications in manufacturing, principle of location & clamping, types of locators and clamps, design of jigs and fixtures, selection of materials. **(9)**

DIE AND PUNCH DESIGN

Applications in manufacturing, design of various types of dies, selection of materials for casting and forging dies. **(9)**

TOTAL: 45

TEXT BOOKS

1. *Mehta, N. K., Machine Tool Design & Numerical Control, McGraw Hill, New Delhi, 2017.*
2. *Cyrill Donoldson .V. C, Tool Design, 4th Edition, Tata McGraw Hill, 2017.*

REFERENCES

1. *Pandey, P.C. and Singh, C.K., Production Engineering Sciences, Standard Publishers, 7th Edition, New Delhi (2013).*
2. *Basu, S. K. and Pal, D.K., Design of Machine Tools, Oxford & IBH Publishing Co Pvt.Ltd, 2018.*
3. *Ranganath, B.J., Metal cutting and tool design, Vikas Publishing House Pvt.Ltd., New Delhi 2018.*
4. *Sen, G.C. and Bhattacharya, A., Machine Tools, New Central Book Agency, 2015.*

19MEE06 - MECHANICAL VIBRATIONS AND CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Develop mathematical models of dynamical systems with a 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. **(9)**

TWO DEGREE OF FREEDOM SYSTEM

Introduction - Undamped and damped free vibrations - Forced Vibration with Harmonic Excitation System- Coordinate Couplings and Principal Coordinates. **(8)**

MULTI-DEGREES OF FREEDOM SYSTEM AND CONTINUOUS SYSTEM

Multi Degrees of freedom system - Influence coefficients - Natural frequencies and mode shapes - Modal analysis of undamped, damped and forced vibrations - Matrix inversion method - Continuous System: Vibration of String, longitudinal vibration of bars and torsional vibration of circular shafts. **(10)**

MULTI-DEGREES OF FREEDOM SYSTEM AND NUMERICAL METHODS

Approximate Methods - Rayleigh's method, Dunkerley method, Stodola's method, Rayleigh-Ritz method, Method of matrix iterations and Holzer Methods - Natural frequencies for multi-rotor systems - geared systems. **(9)**

VIBRATION CONTROL

Specification of Vibration Limits - Vibration severity standards - Vibration as condition Monitoring tool - Vibration Isolation methods - Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber - Damped Vibration absorbers- Control by Design Modification - Active Vibration Control. **(9)**

TOTAL: 45

TEXT BOOKS

1. Rao S S, "Mechanical Vibrations", 6th Edition, Pearson Education, 2018.

2. Grover G K, "Mechanical Vibrations ", Nem Chand and Brothers, 8th Edition, Roorkee, 2018.

REFERENCES

1. *Ambekar A G, "Mechanical Vibrations and Noise Engineering", PHI Learning Pvt. Ltd., 2006.*
2. *https://nptel.ac.in/courses/112/107/112107088/*
3. *https://nptel.ac.in/courses/112/107/112107087/*
4. *https://nptel.ac.in/courses/112/104/112104040/*
5. *https://nptel.ac.in/courses/112/103/112103111/*

19MEE07 - TRIBOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Understand the basic concepts and measurement methods of friction and wear*

CO2 *: Know the influence of structure of the bearing and the nature of fluid flow on the loads that can be supported.*

CO3 *: Understand the modeling of elasto-hydrodynamic lubrication as infinite and finite structures.*

INTRODUCTION

Fundamentals and History of tribology, Interdisciplinary Approach, Economic Benefits. **(6)**

FRICTION

Causes of friction - Theories of Friction - Sliding and Rolling Friction, laws of friction, Friction properties of metallic and non-metallic materials - Friction instability - measurement methods. **(8)**

WEAR

Types of wear-Mechanism of wear - testing methods - wear resistant materials -Wear debris analysis - wear reduction methods- wear measurements **(8)**

LUBRICATION AND LUBRICANTS

Importance of lubrication - Boundary Lubrication - mixed lubrication - solid lubrication - Hydrostatic and Hydrodynamic lubrication - Elastohydrodynamic lubrication - Lubricants - Types, and properties of lubricants - Additives - Selection of Lubricants - Lubricants standards **(9)**

FLUID FILM LUBRICATION

Fluid mechanics concepts, Equations of Continuity and Motion, Generalized Reynolds Equation with Compressible and Incompressible Lubricants **(8)**

APPLICATION OF TRIBOLOGY

Introduction, Rolling Contact Bearings, Gears, Journal Bearings - Finite Bearings **(6)**

TOTAL: 45

TEXT BOOK

1. *Ludema K.C., "Friction, Wear, Lubrication: A Textbook in Tribology", 2nd Edition, CRC Press, 2018.*

REFERENCES

1. *Gwidon Stachowiakand Andrew Batchelor., "Engineering Tribology", Butterworth-Heinemann., 4th Edition, 2016.*
2. *Bharat Bhusan, "Introduction to Tribology", 2nd edition, A John Wiley & Sons, 2013*
3. *Shigley J.E., Mischke C.R., "Mechanical Engineering Design", Tata McGraw - Hill Publishing Company Limited, 2019.*
4. *https://nptel.ac.in/courses/112/102/112102015/*
5. *https://nptel.ac.in/courses/113/108/113108083/*
6. *https://nptel.ac.in/courses/112/102/112102014/*
7. *http://www.nptelvideos.in/2012/12/tribology.html*

19MEE08 - EXPERIMENTAL STRESS ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

Optical Methods Work as Optical Computers- Stress, Strain and Displacement Fields- Physical Principle of Strain Gauges and Photoelasticity - Introduction to Brittle Coatings and Holography- Hologram Interferometry, Speckle Methods - Introduction to Shearography, TSA, DIC and Caustics - Fringe Patterns - Richness of Qualitative Information - Multi-Scale Analysis in Experimental Mechanics- Selection of an Experimental Technique. **(10)**

TRANSMISSION PHOTOELASTICITY

Introduction to Transmission Photoelasticity - Ordinary and Extraordinary Rays - Light Ellipse, Passage of Light Through a Crystal Plate- Retardation Plates, Stress-optic Law- Plane Polariscope- Jones Calculus- Circular Polariscope- Determination of Photoelastic Parameters at an Arbitrary Point - Tardy's Method of Compensation- Calibration of Photo elastic Materials- Fringe Thinning Methodologies- Fringe Ordering in Photoelasticity -Three Dimensional Photoelasticity- Overview of Digital Photoelasticity. **(12)**

PHOTOELASTIC COATINGS AND BRITTLE COATINGS

Introduction to Photo elastic Coatings - Correction Factors for Photo elastic Coatings - Coating Materials, Selection of Coating Thickness, Industrial Application of Photo elastic Coatings - Calibration of Photoelastic Coatings- Analysis of Brittle Coatings. **(5)**

STRAIN GAUGES

Strain Sensitivity of a Strain Gauge, Bridge Sensitivity, Rosettes - Strain Gauge Alloys, Carriers and Adhesives - Performance of Strain Gauge System - Temperature Compensation, Two wire and Three-wire Circuits - Strain Gauge Selection - Bonding of a Strain Gauge - Soldering, Accounting for Transverse Sensitivity Effects - Correction Factors for Special applications- Special Gauges. **(10)**

OTHER STRESS ANALYSIS TECHNIQUES

Moiré fringe method- 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)**

TOTAL : 45

TEXT BOOKS

1. *Dalley and Riley, "Experimental Stress Analysis", 4th Edition, College House Enterprises, LLC., 2005.*
2. *Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2009.*

REFERENCES

1. *https://nptel.ac.in/courses/112/106/112106068/*
2. *https://nptel.ac.in/courses/112/106/112106247/*
3. *https://nptel.ac.in/courses/112/106/112106198/*

19MEE09 - FLUID POWER CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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", 7th edition, Kindle Edition, Pearson, 2013*
2. *Majumdar S.R., "Oil Hydraulics - Principles and Maintenance", Tata McGraw-Hill, 2017.*
3. *Andrew Parr, "Hydraulics and Pneumatics - A technician's and engineer's Guide", 3rd edition,Jaico Publishing House, 2011.*

REFERENCES

1. *John Watton., "Fundamentals of Fluid Power Control", 1st Edition, Cambridge University Press, 2014.*
2. *https://nptel.ac.in/courses/112/106/112106175/*
3. *https://nptel.ac.in/courses/112/106/112106300/*
4. *https://nptel.ac.in/courses/112/105/112105047/*

19MEE10 - SENSOR TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Understand the various principles of sensing technology.

CO2 : Identify the various sensors and derive its characteristics.

CO3 : Select the sensors for various industrial applications.

CO4 : Understand and analyse the various signals.

CO5 : Design and develop a sensing method and signal conditioning for simple application.

SENSORS FUNDAMENTALS AND CHARACTERISTICS

Sensors and Transducer: Definition, Principles, Classification, static and dynamic characteristics - Electrical, Mechanical, Thermal, Optical and Chemical characterization - Errors in Measurements: Gross errors, Systematic errors and its estimation, Statistical analysis of Random errors. **(9)**

PHYSICAL PRINCIPLES OF SENSORS

Introduction to physical principle of sensor, Resistive potentiometer, Strain gauge, Inductive sensor, Capacitive sensor, Thermal sensor, Magnetic sensor, Radiation sensor. **(6)**

SENSOR TYPES AND APPLICATIONS

Introduction to types of sensor, Flow rate sensors, Pressure sensors, Temperature sensors, Oxygen sensors, Torque and position sensors, Static pressure sensors, fluid velocity sensor, airflow direction sensor, Air speed measuring sensor. **(12)**

SIGNALS

Review of Laplace and Fourier Transforms, Signals: Definition, Classifications, Standard test signals, Periodic signal, (Complex form representation, Line spectra), Aperiodic signals, Bandwidth, Modulated signals (Amplitude, Frequency and Angle modulation), Sampled data: Pulse modulation, Pulse code modulation. **(12)**

SIGNAL PROCESSING CIRCUITS

Introduction, DC power supplies, Sampling circuits: Diode-bridge linear gate, shunt transistor gate, Distinction between sample and hold(SH) and track and hold(TH) circuits, SH using two op-amps,SH using one op-amp.Digital to Analog and Analog to Digital Converters. **(6)**

TEXT BOOKS

1. *Patranabis, "Sensors and Transducers", 2nd edition, PHI learning private limited, 2013*
2. *D.V.S.Murty, Transducers and Instrumentation, 2nd edition, PHI learning private limited, 2011*

REFERENCES

1. *A.K. Sawney and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", Dhanpat Rai& Co, New Delhi, 2017.*
2. *J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer. Fifth Edition,2014.*
3. *https://nptel.ac.in/courses/108/108/108108147/*

19MEE11 - SMART MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

On Completion of the course, the students should be able to:

CO1 *: Analyze the various types of smart materials.*

CO2 *: Evaluate the characteristics of smart material for different domains.*

CO3 *: Analyze and select a smart material according to the requirement.*

INTRODUCTION AND HISTORICAL PERSPECTIVE

Smart materials -The principal ingredients of smart materials - Generation of smart materials - Diverse areas of smart materials - Primitive functions of smart materials - System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems - Wolff's law, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect. **(9)**

PIEZOELECTRIC MATERIALS

Electrostriction - Pyroelectricity - Piezoelectricity -Piezoelectric effect direct and converse-Industrial piezoelectric materials - PZT - PVDF - PVDF film - Properties of piezoelectric materials - Piezoceramics, Piezopolymers - Bimorphs - SAW filters. Piezeoelctric Strain Sensors, Accelerometers, Active Fibre Sensing. **(9)**

SHAPE - MEMORY (ALLOYS) MATERIALS

Shape memory alloys (SMA) - Nickel - Titanium alloy (Nitinol) - Materials characteristics of Nitinol - Thermoelastic martensitic transformations -SMA memorization process, Shape memory effect (SME), One way and two-way SME, training of SMAs, Functional properties of SMAs - Applications of SMA - SMA fibers - Micro robot actuated by SMA - Satellite antenna applications. **(9)**

ELECTRO-RHEOLOGICAL AND MAGNETORHEOLOGICAL FLUIDS

Bingham-body model - Newtonian viscosity and non-Newtonian viscosity - Principal characteristics of electro rheological and magnetorheological fluids - The electrorheological phenomenon - Charge migration mechanism for the dispersed phase -Magnetorheological effect Applications of electrorheological and magnetorheological fluids. **(9)**

SMART POLYMERS AND HYDROGELS

Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Drug delivery using smart polymers

Hydrogel: Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Hydrogels in microfluidics. **(9)**

TOTAL : 45

TEXT BOOK

1. *M. V. Gandhi and B.S. Thompson, Smart Materials and Structures, Chapman and Hall, London, 1st Edition, 1992.*
2. *K. Otsuka, C.M. Wayman (Eds.), Shape Memory Materials, Cambridge University Press, 1998.*

REFERENCES

1. *I. Galaev, B. Mattiasson (Eds.), Smart Polymers: Applications in Biotechnology and Biomedicine, 2nd Edition, CRC Press, 2008.*
2. *N. Yui, R. J. Mrsny, K. Park (Eds.), Reflexive Polymers and Hydrogels: Understanding and Designing Fast Responsive Polymeric Systems, CRC Press, 2004.*

19MEE12 - NON-DESTRUCTIVE EVALUATION AND IMAGING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 workpiece 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, Fuzzy 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. *Prasad J and Krishnadas Nair C.J. "Non-Destructive Test and Evaluation of Materials", 2nd Edition, McGraw Hill Education, 2017*

REFERENCES

1. *American Society for Metals, Non-Destructive Inspection and Quality Control: Metals hand Book, Vol-11, 8th Edition, Metals park Oh, 1976.*
2. *Peter J. Shull, "Non-destructive Evaluation: Theory, Techniques, and Applications", CRC Press, 2002.*
3. *Chuck Hellier, "Handbook of Nondestructive Evaluation, Second Edition", McGraw Hill Professional, 2012.*
4. *https://nptel.ac.in/courses/113/106/113106070/*

19MEE13 - AUTOMOTIVE ELECTRONICS AND POWER TRAIN SYSTEM

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Know the various electrical and electronics systems of the engine.*

CO2 *: Describe the powertrain parts performance and manufacturing parameters.*

CO3 *: Assemble and Disassemble the engine parts.*

C04 *: Match the characteristics of the customer, the vehicle and the engine.*

FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS

Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Parameters to be controlled in SI and CI engines. **(9)**

SENSORS AND ACTUATORS

Classification of sensors, sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors and relay. **(9)**

ELECTRONIC ENGINE CONTROLS

Concept of an electronic engine control system, electronic fuel injection - throttle body fuel injection, multi point fuel injection, gasoline direct injection, common rail direct injection, electronic ignition control, engine mapping, on-board diagnostics - engine control module and powertrain control module. **(9)**

LIGHTING SYSTEM

Insulated and earth return system, details of head light and side light, LED lighting system, headlight dazzling and preventive methods. Horn, wiper system and trafficator fuses, cables, connectors and selection. Multiplexing and demultiplexing, Immurements cluster and tell-tales. **(9)**

OVERVIEW OF POWER TRAIN

Mobility, automobiles and systems, engine characteristics, classification, efficiencies, parameters, engine and systems, driveline, HVAC, etc. Emission requirements, thermodynamic principle review, well to wheel efficiency, efficiency improvements, engine dismantling & assembly. **(9)**

TOTAL : 45

TEXTBOOKS

1. *M.L.Mathur & R.P.Sharma, Internal Combustion Engines, Dhanpat Rai Publications (P) Ltd., 2018.*
2. *Robert Bosch, "Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive" Springer Vieweg , Plochingen, Germany, 2014*

REFERENCES

1. *William B Ribbens, "Understanding Automotive Electronics- An Engineering Perspective", The Boulevard, Langford Lane, Kidlington, Oxford, 2017.*
2. *James D Halderman, "Automotive Electricity and Electronics" 5th Edition, Pearson, 2016.*
3. *A l Santini, "Automotive Electricity and Electronics" Delmar Learning, 2016.*
4. *https://nptel.ac.in/courses/107/106/107106088/*

19MEE14 - BIO-MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO3 : *Choose a bio compact material for an orthopaedic joint.*

CO4 : *Develop successful implants (biological, mechanical, morphological Compatibility) for dental and bone applications.*

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

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. **(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)**

MATERIALS FOR ORTHOPAEDIC 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 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 - CoCr-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)**

BIOMATERIAL APPLICATIONS

Applications in Medicine, Biology, and Artificial Organs - Cardiovascular Medical Devices - Extracorporeal Artificial Organs - Orthopedic Implants - Dental Implantation - Bioadhesive - Ophthalmologic 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. *Joon. B. Park and Joseph D. Bronzino 'Bio Materials - Principles and Applications', CRC press, 2013.*

REFERENCES

1. *Park J. B. and Lakes R.S., 'BioMaterials - An Introduction', Plenum Press, New York, 2012.*
2. *J. L. Ong, Mark R. Appleford, Gopinath Mani., 'Introduction to Biomaterials: Basic Theory with Engineering Applications', Cambridge University Press, UK, 2014.*
3. *https://nptel.ac.in/courses/113/104/113104009/*
4. *https://nptel.ac.in/courses/102/106/102106057/*

19MEE15 - MICRO AND NANO ELECTRO MECHANICAL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Grain a knowledge of basic approaches for micro/nano system design*

CO2 : *Gain a knowledge of state-of-the-art lithography techniques for micro/nanosystems*

CO3 : *Learn new materials, science and technology for micro/nanosystem applications*

CO4 : *Understand materials science for micro/nano system applications*

CO5 : *Understand state-of-the-art micromachining and packaging technologies*

CO6 : *Develop experience on micro/nanosystems for power and energy applications*

CO7 : *Have a good vision to the future of micro/nano technology*

INTRODUCTION AND SCALING

MEMS and microsystems - development of MEMS technology - MEMS future and applications, microsystems and microelectronics - MEMS challenges - scaling - scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, electricity, fluid mechanics, heat transfer. **(7)**

MATERIALS FOR MEMS

Introduction - substrates and wafer - silicon substrate - crystal structure, miller indices, properties - silicon compounds - silicon dioxide, silicon carbide, silicon nitride, polycrystalline silicon - gallium arsenide - quartz - piezoelectric crystals - polymers - polymers for MEMS, conductive polymers. **(7)**

FABRICATION PROCESS

Physical Vapour Deposition (PVD) - evaporation, sputtering - Chemical Vapour Deposition (CVD) - etching process - wet chemical etching, plasma etching, Ion milling - patterning - lithography, lift off process - wafer bonding - silicon fusion bonding, anodic bonding- annealing - chemical mechanical polishing - doping - diffusion, implant. **(12)**

MEMS TECHNOLOGIES AND PACKAGING

Bulk micromachining - Isotropic and anisotropic etching, wet etchants, etch stop, dry etching, comparison of wet and dry etching - surface micromachining - Introduction, process, associated problems - LIGA Process and electroplating - Integration of electronics and MEMS technology - packaging - post fabrication process, package selection, die attach, Wire bond and Sealing. **(12)**

NEMS TECHNIQUES AND APPLICATIONS

Introduction to NEMS and its architecture - carbon nanotube electronics - modeling - introduction, analysis and simulation - simulation of Actuators, FET, Pressure transducer - applications and future challenges. **(7)**

TOTAL : 45

TEXT BOOKS

1. *James J Allen, "Micro Electro Mechanical System Design", CRC Press - Taylor & Francis, New York, 2005.*
2. *Tai Ran Hsu, "MEMS and Microsystems, Design, Manufacture and Nanoscale Engineering", John Wiley & Sons, New Jersey. 2008.*

REFERENCES

1. *Tai Ran Hsu, "MEMS and Microsystems: Design & Manufacture", McGraw Hill Education. 2017.*
2. *G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre "Micro and Smart Systems", Wiley India Pvt Ltd, 2019.*
3. *Vijay K. Varadan, Vinoy. K.J, Gopalakrishnan.S, "Smart material Systems and MEMS: Design and Development Methodologies", John Wiley & Sons, New York, 2011.*
4. *https://nptel.ac.in/courses/112/106/112106222/*
5. *https://nptel.ac.in/courses/117/105/117105082/*

COURSE CONTENTS FOR ELECTIVES IN THERMAL SCIENCES STREAM

19MEE16 - SOLAR ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Calculate earth-sun angles and determine solar radiation on the earth's surface*

CO2 *: Analyze the performance of solar collectors with its optical properties*

CO3 *: Apply solar thermal conversion principles for different applications*

CO4 *: Calculate solar cell output voltage for solar photovoltaic system*

CO5 *: Analyze the performance and life cycle cost for hybrid solar systems*

SOLAR RADIATION

Properties of sunlight - Absorption by the atmosphere -Solar time - Earth-sun geometry - Calculation of solar irradiance at earth surface - Measuring instruments. **(9)**

SOLAR COLLECTORS

Types of solar collectors - Thermodynamic description of solar collectors - Optical properties of solar collectors and technologies for fabrication. **(9)**

SOLAR THERMAL APPLICATIONS

Solar liquid and air heating - Solar active and passive space heating - Solar thermal power plants - Solar pond - Solar cookers - Solar furnace - Storage of solar thermal energy. **(9)**

SOLAR CELL SYSTEMS

Solar cells and modules -System components and their functions - Calculating output and dimensioning of solar cell systems - Concentrated sunlight and solar power (CSP) - Properties of optical concentration systems - Overview of the different components in a CSP system and their functions. **(9)**

HYBRID SYSTEMS AND COST ANALYSIS

Combinations of solar thermal and solar cell systems. Overview of different applications. Financial Analysis, Life Cycle Costing, Environmental Analysis. **(9)**

TOTAL: 45

TEXTBOOKS

1. *Sukhatme S. P.and Nayak J. K. , "Solar Energy", McGraw Hill, New Delhi, 4th edition, 2017.*
2. *Garg H.P. and Prakash J., "Solar Energy: Fundamentals & Applications", Tata McGraw Hill, New Delhi, 2012.*

REFERENCES

1. *Duffie J. A. and Beckman W. A., "Solar Engineering of Thermal Processes", John Wiley & Sons Inc., New York, 4th edition, 2013.*
2. *Tiwari G.N. and Suneja S., "Solar Thermal Engineering System", Narosa Publishing House, New Delhi, 2016.*
3. *Rai G.D., "Solar energy Utilization", Khanna Publishers, New Delhi, 2002.*
4. *T. Bhattachariya, "Terrestrial solar Photovoltaic", Narosa Publishers, New Delhi, 2008*

19MEE17 - GAS DYNAMICS AND SPACE PROPULSION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Determine geometric design parameters required to accelerate or decelerate an isentropic flow for a given type of nozzle or diffuser, operating under specified conditions*

CO2 : *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*

CO3 : *Analytically evaluate changes in physical properties when a normal shock occurs in one-dimensional constant area or variable area ducts*

CO4 : *Analyze flow through different components of aircraft and rocket propulsion systems using principles of thermodynamics*

INTRODUCTION OF COMPRESSIBLE FLOWS, AND NORMAL SHOCK WAVES

Compressibility of fluids - Compressible and incompressible flows - Acoustic wave propagation speed - Mach number - Sonic, stagnation states -Governing equations of one-dimensional, isentropic, and steady flows, normal shock waves - Normal shock solution - T-s and p-v diagrams - Further insights into the solution. **(9)**

RAYLEIGH FLOW, AND FANNO FLOW

Governing equations of Rayleigh flow, Fanno flow-T-s and p-v diagrams - Thermal choking -Friction choking -Solution procedures. **(8)**

QUASI-ONE-DIMENSIONAL FLOWS, OBLIQUE SHOCK WAVES

Governing equations of quasi-one-dimensional flow- Impulse function and thrust - Area-velocity relation - Geometric choking - Area-Mach number relation- Mass flow rate-Convergent, convergent-divergent nozzles- Interaction between nozzle flow, Fanno flow, and Rayleigh flows.

Oblique shock waves - Mach number at entry and exit, deflection angle. **(12)**

AIRCRAFT 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 turbojet engine, ram jet engine. **(8)**

ROCKET PROPULSION SYSTEMS

Rocket propulsion - Types of rocket engines and propellants - thrust equation - effective jet velocity - specific impulse - rocket engine performance. **(8)**

TOTAL: 45

TEXT BOOK

1. *Yahya S. M., "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International (P) Ltd., 3rd Edition, 2017.*

REFERENCES

1. *John D. Anderson, "Modern Compressible Flow: With Historical Perspective", McGraw Hill India, 3rd Edition, Noida, 2017.*
2. *Robert D. Zucker, Oscar Biblarz, "Fundamentals of Gas Dynamics", Wiley, 3rd Edition, New Jersey, USA, 2019.*
3. *Philip Hill, Carl Peterson, "Mechanics and Thermodynamics of Propulsion", Pearson, 2nd Edition, New Delhi, 2011.*
4. *Jack D. Mattingly, Keith M. Boyer, "Elements of Propulsion: Gas Turbines and Rockets,"American Institute of Aeronautics& Astronautics, 2nd Edition, USA, 2016.*
5. *H. I. H. Saravanamuttoo, H. Cohen, G. F. C. Rogers, Paul Straznicky, A. C. Nix, "Gas Turbine Theory," Pearson, 7th Edition, New Delhi, 2019.*
6. *https://nptel.ac.in/courses/112/106/112106166/*

19MEE18 - COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of this 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, Classification of PDEs and Physical Significance **(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. *Suhas V. Patankar, "Numerical Heat Transfer and Fluid Flow", Ane Books Pvt. Ltd. New Delhi, 2017.*
2. *John D, Anderson, Jr., "Computational Fluid Dynamics - The basics with Applications", McGraw Hill, New Delhi, 9th reprint, 2015.*

REFERENCES

1. *Versteeg H.K. and Malalasekara W., "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Pearson Education, 2nd Edition, England, 2007.*
2. *Ghoshdastidar P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill, New Delhi, 1999.*
3. *Muralidhar K., Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2014.*
4. *Chung T.J., "Computational Fluid Dynamics", Cambridge Univ. Press, New York, 2002.*
5. *Titus Petrila and Damian Trif., "Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics", Springer, Boston, 2005.*
6. *https://nptel.ac.in/courses/112/105/112105045/*
7. *https://nptel.ac.in/courses/112/105/112105254/*

19MEE19 - ALTERNATIVE ENERGY CONVERSION TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 system.*

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 (biochemical 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 - photovoltaic 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 - biochemical and thermochemical 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., 3rd Edition, 2012.*

19MEE20 - ADVANCED FLUID MECHANICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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. **(9)**

EXACT SOLUTIONS OF NAVIER-STOKES EQUATIONS

Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections, Unsteady flows**(9)**

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. **(9)**

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. **(9)**

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. **(9)**

TOTAL: 45

TEXTBOOKS

1. *Frank M. White, "Fluid Mechanics", Tata McGraw-Hill, Singapore, 7th edition, 2011.*
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, 2000.*
2. *Robert Fox W., Alan McDonald T., "Introduction to Fluid Mechanics", 6th Edition, John Wiley & Sons, 2003.*
3. *Frank M. White, "Viscous Fluid Flow", Third Edition, McGraw-Hill Series of Mechanical Engineering, 2017.*
4. *John D. Anderson Jr., "Modern Compressible Flow with Historical Perspective", 3rd edition McGraw-Hill, 2002.*
5. *Schlichting H., "Boundary Layer Theory", 7th edition, Springer Verlag, 2014.*
6. *Tennekes H. and Lumley J.L., "A First Course in Turbulence", The MIT Press, 1972.*

19MEE21 - ADVANCED THERMODYNAMICS

(Use of Property Tables is permitted)

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

Some mathematical theorems, Fundamental postulate of thermodynamics, Fundamental equations of thermodynamics for simple compressible systems, TdS relations, Maxwell relations, Relations for cp and cv, Relationships for calculating changes in internal energy, enthalpy and entropy, Joule-Thompson coefficient. **(9)**

REAL GAS BEHAVIOR

Real gas equations of state (EOS) e.g. van der Waals, Redlich-Kwong EOS, Determination of EOS model constants from critical point data, Property relationships for real gases, Ideal gas vs. real gas mixtures, Dalton and Amagat models, Mixture rules for real gas mixtures, Entropy of mixing, problems.**(9)**

MULTI-COMPONENT SYSTEMS

Chemical work, Fundamental equations of thermodynamics for multi-component systems, Maxwell relations, Chemical work and chemical potential, Partial molar properties, Gibbs-Duhem equation. **(9)**

AVAILABILITY AND EXERGY

Available Energy, Available Energy referred to cycle, Reversible work, Irreversibility, Availability functions for closed and open systems, Availability of exergy balance, Quality of Energy, Degradation of exergy, II law efficiency, Applications to various thermodynamic processes. **(9)**

REACTIVE SYSTEM

Degree of reaction, Heat of reaction, Combustion process, Enthalpy of formation, First-law analysis of reacting systems, Enthalpy and internal energy of combustion, Adiabatic flame temperature, Second law analysis of reacting systems.

TOTAL: 45

TEXT BOOKS

1. *Nag P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, 2019.*
2. *Claus Borgnakke, Richard E. Sonntag, "Fundamentals of Thermodynamics", 8th Edition, International Student Version, Wiley, 2013.*

REFERENCES

1. *Jones J. B., Dugan R. E., "Engineering Thermodynamics", Indian Edition, PHI Learning Private Limited, 1996.*
2. *Michael 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, 1995.*
5. *Dittman R.H., Zemansky M.W., "Heat and Thermodynamics", 8th Edition, Tata McGraw-Hill, 2011.*
6. *Bejan A., "Advanced Engineering Thermodynamics", 4th Edition, John Wiley, 2016.*

19MEE22 - CRYOGENICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of this 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 vessels 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.*

PREREQUISITE

Insight on Cryogenics-Basics, Properties of Cryogenic fluids Historical Development of Cryogenic Treatment

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.Benefits of cryogenic treatment-Wear resistance, Stress Relieving, Hardness **(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. *Mamata Mukhopadhyay, "Fundamentals of Cryogenic Engineering", Prentice Hall of India, 2010.*
2. *Peter Kittel, "Advances in Cryogenic Engineering", Plenum Press, 1998.*
3. *Cryogenic Technology, Materials, Process and equipment, Resource Material, IIT Kharaghpur.*
4. *Guglielmo Ventura and Lara Risegari, "The art of Cryogenics - Low Temperature Experimental Techniques", Elsevier, 2008.*
5. *Guy K. White, "Experimental Techniques in Low Temperature Physics", Clarendon Press, Oxford, 1987.*
6. *https://nptel.ac.in/courses/112/101/112101004/*

19MEE23 - COMBUSTION AND INTERNAL COMBUSTION ENGINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 : *Distinguish 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 KINETICS 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, Spray Combustion. **(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 CI and SI engines - Octane rating - Gasoline direct injection - CRDI, GDI, GDCI, , EDICI, Microwave Ignition - Cetane rating - Homogeneous charge compression ignition engine(HCCI) - 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.*
4. *https://nptel.ac.in/courses/112/104/112104033/*
5. *https://nptel.ac.in/courses/112/106/112106299/*

19MEE24 - ENERGY CONSERVATION AND WASTE HEAT RECOVERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of this 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 : *Apply energy conservation techniques in thermal systems*

CO4 : *Apply energy conservation techniques in electrical systems*

CO5 : *Implement waste heat recovery technologies in the industries*

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 hysteresis. 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 - Cooling Tower. **(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, 2nd edition, 2019.*
2. *Sengupta Subrata, Lee SS, EDS, "Waste Heat Utilization and Management", Hemisphere, Washington, 1983.*

REFERENCES

1. *Rajan G.G., "Energy Efficiency Optimization", Productivity & Quality Pub. P. Ltd, 2019.*
2. *Meenu Agrawal, "Energy Conservation & Energy Security in India", Kunal Books (Publishers & Dist.), 2013.*
3. *Smith C.B., "Energy Management Principles", Pergamon Press, NewYork, 2nd edition, 2015.*
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).*
7. *https://nptel.ac.in/courses/112/105/112105221/*

19MEE25 - DESIGN OF HEAT EXCHANGERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Apply knowledge of mathematics, science, and engineering principles relevant to area of fluid/ thermal*

CO2 : *Select and apply appropriate models or simulations of the real world and analyze output of models/simulations to provide information for design decisions.*

CO3 : *Perform feasibility analysis and use results to choose candidate solutions and evaluate quality of solutions to select the best once.*

CO4 : *Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, and sustainability*

CO5 : *Select proper models to solve problems 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 **(7)**

ANALYSIS OF HEAT EXCHANGER

Introduction - Arrangement of flow paths in Heat Exchangers - Overall heat transfer coefficient - LMTD and - NTU Method for heat exchanger analysis - Heat exchanger design methodology - Variable overall heat Transfer coefficient - Heat exchanger design calculation. **(8)**

FORCED CONVECTION CORRELATIONS FOR SINGLE-PHASE HEAT EXCHANGERS

Introduction - Hydro dynamically developed & Thermally developing laminar flow in smooth circular ducts effect of variable physical properties - laminar flow of liquids and gases in ducts -Turbulent forced convection - Turbulent flow in smooth straight non- circular ducts - Turbulent flow liquid and gases in ducts. **(8)**

SHELL-AND-TUBE HEAT EXCHANGERS

Introduction - Basic components - Basic design procedure of a heat exchanger - Preliminary estimation of unit size -Rating of the preliminary design - Shell and tube -Side heat transfer, pressure drop, heat transfer coefficient -Bell-Delaware method- Design of heat exchanger subject to fouling. **(7)**

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 **(8)**

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. **(7)**

TOTAL: 45

TEXT BOOKS

1. *Ramesh K, Shah and Dusan P. Sekulic, "Fundamental of Heat Exchangers Design", John Wiley & Sons, Inc., 2003.*
2. *Sadik Kakaç, Hongtan Liu , Anchasa Pramuanjaroenkij, "Heat Exchangers: Selection, Rating, and Thermal Design", CRC Press, 2012.*

REFERENCES

1. *Arthur P. Frass, "Heat Exchanger Design ", Second Edition, John Wiley & Sons, New York, 1996.*
2. *T.Taborek, G.F.Hewitt and N.Afgan "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.*
5. *https://nptel.ac.in/courses/112/105/112105248/*

19MEE26 - TURBO MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Explain the working principle of turbo machines and apply it to various types of machines.*

CO2 *: Analyze energy transfer through velocity triangles.*

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

CO4 *: Construct and interpret the performance curves of turbo machines.*

INTRODUCTION

Introduction to Turbo machines - Classification of Turbomachines - Comparison with positive displacement machine - Second Law of Thermodynamics - turbine/compressor work, Nozzle/diffuser work - Fluid equations - continuity, Euler's turbine equation and its components ,Bernoulli's equation and its applications - Dimensionless parameters and their significance - Expansion and compression processes, overall isentropic efficiency, stage efficiency - Reheat Factor, Preheat Factor. **(9)**

ENERGY TRANSFER IN TURBOMACHINES

General analysis of turbomachines - Centrifugal compressor - Axial compressor - Effect of blade discharge - Degree of reaction - velocity triangle for different values of degree of reaction - Analysis of Axial/Radial turbines - Utilization factor. **(8)**

CENTRIFUGAL COMPRESSOR AND PUMPS

Centrifugal Compressor: classification, overall pressure ratio, blade angles, with slip and without slip factor - related problems , diffuser and surging - Centrifugal pumps: Manometric head, suction head, delivery head, and pressure rise, efficiency, slip, priming, cavitations and NPSH. **(7)**

AXIAL FLOW COMPRESSOR

Introduction - Velocity triangle - work done - work done factor - flow coefficient - pressure coefficient - overall pressure ratio - degree of reaction - related problems **(7)**

STEAM TURBINES

Classification - single stage impulse turbine, blade efficiency, stage efficiency, compounding - need for compounding, impulse staging, maximum utilization factor for multistage with equiangular blades, effects of blades and nozzle losses. Reaction turbine, maximum blade efficiency. **(8)**

HYDRAULIC TURBINES

Classification - Pelton, Francis and Kaplan turbines - unit quantities, Velocity triangles, power, efficiency, design parameters, different blade speeds. **(6)**

TOTAL : 45

TEXT BOOKS

1. *S.M. Yahya, Turbines, Compressors and Fans,4th Edition, Tata Mcgraw Hill, 2017.*
2. *Venkanna B.K., "Fundamental of Turbomachinery", PHI Learning, 2009*

REFERENCES

1. *Dennis G. Shepherd , "Principles of Turbomachinery", Macmillan Pub Co ,1961*
2. *Brunoeck, "Fans; design and operation of centrifugal, axial-flow, and cross-flow fans", Pergamon Press, 1973.*
3. *https://nptel.ac.in/courses/101/101/101101058/*
4. *https://nptel.ac.in/courses/112/106/112106200/*

19MEE27 - POWER PLANT ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Identify a suitable hydro-electric power plant from the run-off details available.*

CO2 : *Select suitable components for a thermal power plant based on the requirements specified.*

CO3 : *Compare different power plants and choose the relevant one based on the environment and available resources.*

CO4 : *Sketch hydrographs, flow duration curves and load curves for the details specified.*

HYDROLOGY & HYDRO-ELECTRIC POWER PLANT

Rainfall & Run - off measurements - Hydrographs - Flow duration curves - Mass curves and storage - Hydro-electric power plant - classification - Site selection considerations - Selection and Governing of Turbines **(9)**

THERMAL POWER PLANT

General Layout - Site selection considerations - Coal handling and storage - Stokers - Burners - Ash handling and dust collection systems - mechanical dust collectors - electrostatic precipitators - Draught and its types - Chimneys. **(9)**

NUCLEAR & DIESEL POWER PLANT

Nuclear energy - Isotopes - Radioactivity - Radioactive decay - Nuclear fission and fusion - Nuclear reactors - Types - Site selection considerations - Nuclear waste - effects - radioactive waste disposal system. Diesel Power Plant - Layout and components - comparison of diesel with thermal power plants. **(9)**

POWER PLANT ECONOMICS

Terms and Factors - Tariffs - Economics of Power Generation -Load curves - Ideal and Realized load curves - Effect of variable loads - Energy economics - Total and net energy - EROEI - Metrics for energy economics - Payback period - return on investment - net present value - levelized cost of energy - input output analysis. **(9)**

ENERGY STORAGE & NON-CONVENTIONAL POWER GENERATION

Energy Storage - Pumped Hydro - Compressed Air Energy Storage - Flywheels - electrochemical - magnetic - thermal - chemical energy storage. Non Conventional Power Generation - MHD - Thermionic Power Generation - Thermoelectric Power Generation - Fuel Cells - Geothermal energy - Hydrogen energy**(9)**

TOTAL : 45

TEXTBOOKS

1. *Domkundwar S, "Power Plant Engineering", Dhanpat Rai and Sons, 2016.*
2. *Sharma P C, "Power Plant Engineering", S K Kataria and Sons, 2019.*

REFERENCES

1. *Nag P K, "Power Plant Engineering", 4th Edition, Tata McGraw Hills Publications, 2017.*
2. *Nagpal G R, "Power Plant Engineering", Khanna Publishers, 2002.*
3. *Morse F P, "Power Plant Engineering", Affiliated East West Press Ltd, 2003.*
4. *https://nptel.ac.in/courses/112/107/112107291/*

COURSE CONTENTS FOR ELECTIVES
IN MANUFACTURING AND MANAGEMENT STREAM

19MEE28 - INDUSTRIAL PSYCHOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Analyze the behavior of individuals and groups in organizations in terms of the key factors that influence organizational behavior.*

CO2 : *Assess the potential effects of organizational level factors (such as structure, culture and change) on organizational behavior.*

CO3 : *Critically evaluate the potential effects of important developments in the external environment (such as globalization and advances in technology) on organizational behavior.*

CO4 : *Analyze organizational behavioral issues in the context of organizational behavior theories, models and concepts.*

INTRODUCTION TO INDUSTRIAL PSYCHOLOGY

Definitions & Scope. Major influences on industrial Psychology- Scientific management and human relations schools Hawthorne Experiments **(9)**

INDIVIDUAL IN WORKPLACE MOTIVATION AND JOB SATISFACTION

Stress management. Organizational culture, Leadership & group dynamics. Work Environment & Engineering Psychology-fatigue. Boredom, accidents and safety. Job Analysis, Recruitment and Selection. **(9)**

DECISION MAKING BY INDIVIDUALS & GROUPS

Decision making process, individual influences, group decision process. **(9)**

ORGANIZATIONAL CULTURE

Functions of organizational culture, Organizational Socialization, Assessing Cultural Values and Fit, Cross Cultural issues **(9)**

PERSONALITY AND ORGANIZATION

Meaning, Application of Personality theory in organization, traits, Common personality measurement tools **(9)**

TOTAL : 45

TEXTBOOKS

1. *Nelson, Quick and Khandelwal, ORGB: An innovative approach to learning and teaching Organizational Behaviour. A South Asian Perspective, Cengage Learning, 2012*
2. *Luthans, Fred, Organizational Behavior, McGraw Hill 2008*

REFERENCES

1. *Udai Pareek, Understanding Organizational Behavior, Oxford University Press*
2. *Robbins, Stephen, Organizational Behavior, Prentice Hall, India*
3. *https://nptel.ac.in/courses/109/104/109104105/*

19MEE29 - WORK SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 - Manand 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, 2013.*
2. *Niebel, B. and Freivalds, A. Methods, Standards, and Work Design, 13th 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 Human Factors and Ergonomics" CRC Press 4th Edition, 2017*
3. *"Introduction to work study", ILO, 3rd edition, Oxford & IBH publishing, 2015.*
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. *Prem Vrat, "Productivity Management- A systems approach", Narosa publishing, 1998.*
7. *Sanders Mark, S. and McCormick Ernert, J. "Human Factors in Engineering and Design", McGraw-Hill Inc, 1993.*
8. *https://nptel.ac.in/courses/112/107/112107249/*

19MEE30 - TOTAL PRODUCTIVITY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 :

INTRODUCTION OF TPM

Introduction, What is TPM?, From PM To TPM, What is Productive Maintenance, History of TPM, Development of TPM in Japan, Definition of TPM, JIPM and TPM definition, Input/output, 6 Major losses, 5 's' Housekeeping, Reasons for TPM popularity, Eight pillar of TPM, TPM in India, Pitfalls and Cautions before implementing TPM **(9)**

TPM OBJECTIVE : INCREASING OEE

Need for improving Production Efficiency, Need for OEE, Bottlenecks for Equipment Effectiveness, Measuring Equipment Effectiveness, Evaluation of Availability, Performance and Quality Rates, Overall Equipment Effectiveness, OEE for different 106 types of Equipment, 12 Steps for improving OEE, OEE improvement plans, Ideas for OEE improvement, Benefits from increased OEE **(9)**

METHODS OF PLANT MAINTENANCE

Planed, Preventive, Autonomous, Break Down, Replacement and Others Maintenance Methods **(5)**

TPM DEVELOPMENT PROGRAMS

Announcement about TPM launching, TPM Campaign and Education, Formation of TPM Organisation, Evidence of Commitment, Kick-Off of TPM, Improve Equipment and Quality Maintenance, Build Administrative Effectiveness through Office TPM, Safety and Environment, Sustaining TPM Implementation and raising levels, Application procedure for PM Prize **(9)**

EVALUATION OF VARIOUS MAINTENANCE STRATEGIES

Resources-Product, Development, Market, Development-Internal, Development and Expansion-External Diversification and Acquisition **(8)**

PRINCIPLES OF TOTAL PRODUCTIVE MAINTENANCE

Principle of TPM, Quality Maintenance, Research Problem Formulation Text Readings **(5)**

TOTAL : 45

TEXT BOOKS

1. *Masaji Tajiri, Fumio Gotoh, TPM Implementation: A Japanese Approach, 1st Edition, 2014*
2. *Steve Borris, Total Productive Maintenance: Proven Strategies and Techniques to Keep Equipment Running at Maximum Efficiency, McGraw-Hill Education,2006*

REFERENCES

1. *David J. Sumanth, "Total Productivity Management" CRC Press, 1998.*
2. *Campbell, John D. and Reyes-Picknell, James, 2nd Edition: Strategies for Excellence in Maintenance Management, Productivity Press, 2006.*
3. *Leflar, James, Practical TPM: Successful Equipment Management at Agilent Technologies, Productivity Press , 2001.*
4. *Seiichi Nakajima, "Introduction to TPM" ,1989*
5. *Seiichi Nakajima, "TPM Development Program" ,1993.*
6. *Japan Institute of Plant Maintenance, "TPM for Every Operator", Productivity Press,1996.*
7. *Yoshikazi Takahashi, "TPM - Total Productive Maintenance"*
8. *Productivity Management: A Systems Approach - Prem Vrat, G. D. Sardana, B. S. Sahay - Narosa Publishing House, 1998.*

19MEE31 - PLANT LAYOUT AND MATERIAL HANDLING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 : *Understand the scope and importance of material handling systems and Suggest appropriate material handling strategies in the industries.*

CO5 : *Identify, analyze, solve technical problems and successfully complete a comprehensive design project related to material handling in 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 equipment and analysis of handling problems. **(8)**

MATERIAL HANDLING SYSTEMS

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

TOTAL : 45

TEXT BOOK

1. *Siddhartha Ray, "Introduction to Materials Handling", New Age International Publishers,2017.*

REFERENCES

1. *Muthur,"Practical Plant Layout", McGraw Hill, New York, 1976.*
2. *Moor, "Plant Layout and Design", McMillan India Ltd., 1978.*
3. *S. C. Sharma, "Plant layout and material handling", Khanna publishers, 2000.*
4. *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.*
5. *Choudary.R.B. and Tagore.G.R.N., "Plant Layout and Material Handling", Khanna Publishers, New Delhi, 2005.*
6. *https://www.youtube.com/watch?v=IhGBUcMM-rE*

19MEE32 - PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 projects.*

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 BOOK

1. *Kerzner H., "Project Management: A Systems Approach to Planning, Scheduling and Controlling", John Wiley & Sons, 11th Edition, 2013.*

REFERENCES

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. *Murthy P.R., "Production and Operations Management", New Age International (P) Ltd. Publishers, 2nd Edition, 2006.*
4. *Mayer R.R., "Production Management", McGraw-Hill, 1968.*
5. *Harding H.A., "Production Management", Macdonald and Evans Ltd, 1974.*
6. *https://nptel.ac.in/courses/110/104/110104073/*

19MEE33 - RAPID PROTOTYPING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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- Software for AM- Geometric Modelling techniques- Data interfacing - part orientation and support generation Support structure design - Model slicing and Tool path generation - STL 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 - PolyJet Technology - Laminated Object Manufacturing - Electron Beam Melting Process- Laser Engineered Net Shaping (LENS) - History -Operation - Materials - Products - Advantages- Limitations - 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 - Bio Additive Manufacturing (BAM)- Case Studies on Current Applications of RP- Novel Application of RP Systems - Future Trends of RP Systems. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Chua, Chee Kai & K F Leong, Rapid Prototyping: 3D Printing And Additive Manufacturing Principles And Applications 5th Edition, Bio-Green Books, 2019*
2. *Chua, C.K, Leong, K. F, and Lim C.S., Rapid Prototyping: Principles and Applications, World Scientific 2010.*

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, Wiley Julia A McDonald, Chris J Ryall, David I Wimpenny (2001), Rapid Prototyping case book, Wiley.*
3. *Pham. D.T., and Dimov. S.S., "Rapid Manufacturing", Springer Verlag 2001.*
4. *N.Hopkinson, R.J.M, Hauge, P M, Dickens, "Rapid Manufacturing - An Industrial revolution for the digital age", Wiley, 2006*
5. *Cooper, G.K, Rapid Prototyping Technology Selection and Application, Marcel Dekker Inc, USA, 2001.*
6. *Liou, W.F., Rapid Prototyping and Engineering Applications, A toolbox for prototype development, CRC Press, Taylor & Francis Group LLC, USA, 2008.*

19MEE34 - ADVANCED WELDING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 components.*

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 - Laser beam welding including hybrid processes - Double pulsed variable polarity GTAW, Ultrasonic welding, Explosion Welding, Electroslag and Electro gas welding, Cold pressure welding, Friction welding processes, Friction stir welding, Dual rotation bobbin tool 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, preheat 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 - Blueprint 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 firecracker welding, underwater welding - wet and dry and micro joining. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Yadav,K.S. Advance Welding Technology, Standard book house, 2018*
2. *Islam Nawaz Ali Hasan, Advanced Welding Technology, Scitech Publications, 2015*

REFERENCES

1. *Parmar.R.S, "Welding Processes and Technology", 3rd Edition, Khanna Publishers, 2013.*
2. *Parmar.R.S, "Welding Engineering and Technology", 2nd Edition, Khanna Publishers, 2013.*
3. *Davis A C, "Welding", Cambridge University Press, 10th Edition, 1996.*
4. *Larry, "Welding - Principles and Applications", Delmar Publisher, New York, 4th Edition, 2007.*
5. *American Welding Society, Welding Handbook - Welding Processes Part 2, Vol. 3, AWS, 2004.*
6. *Zhou Y N, "Microjoining and Nanojoining", Woodhead publishing, 2008.*
7. *Steen W, "Laser Material Processing", Springer-Verlag, 1991.*
8. *Linnert G E, "Welding Metallurgy", Vol. I and II, 4th Edition, AWS, 1994.*
9. *Mishra R S and Mahoney MW, "Friction Stir Welding and Processing", ASM, 2007.*

19MEE35 - ADVANCED FOUNDRY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Outline the use of foundry in the 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. Various aspects of advances in foundry technology, Classification of casting techniques - 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, CO2 moulding, no bake moulding, shell moulding, Investment casting, permanent moulding, die casting and centrifugal casting, Cold box and Hot box. No bake processes. **(9)**

GATING AND RISERING SYSTEM

Principles of Gating and risers -their functions - Improvement of yield efficiency - Types - Design principles, design of gating and risering for steels and cast irons. Simple problems in gating and risering for steels and cast irons. **(9)**

MELTING FURNACES

Classification of 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

Casting defects - Identification, analysis and remedies - Composition control and temperature control. Simple problems in composition control for steels and cast irons, Sand reclamation, moulding machines, foundry layout and mechanization. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ramana Rao T V., "Metal Casting: Principles and Practice", New Age International Publishing Co., New Delhi, 2020.*
2. *Beeley Peter, Foundry Technology, Elsevier Science & Technology, 2015*

REFERENCES

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, 2009.*
3. *Srinivasan N K., "Foundry Engineering", Khanna Tech Publications, New Delhi, 2001.*
4. *ASM Metals Hand Book, Vol 15, "Casting" ASM International, 10th edition, 2008.*
5. *Albert E Barrington, "High Vacuum Engineering", Prentice Hall, 1964. Suggested open source Software Packages - iCAST, Foundry ERP*

19MEE36 - SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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)**

IT IN SUPPLY CHAIN

Lean Supply Chain, agile supply chain, Dynamic supply chain design, Impact of technology on SCM, Key trends in SCM, IT in supply chain coordination, IT in supply chain design - MRP, ERP, CRM, ISCM - Performance metrics. Discussion on supply chain adopted by primary industrial sectors and case studies. **(9)**

TOTAL : 45

TEXT BOOK

1. *Ayers J., "Handbook of Supply Chain Management", The St. Lencie Press/ APICS Series on Resource Management, 2000.*

REFERENCES

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.*
8. *https://nptel.ac.in/courses/110/106/110106045/*

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. *Kulkarni S and Sharma A., "Supply Chain Management", Tata McGraw Hill Publishing Company Limited, 2008.*

19MEE37 - QUANTITY PRODUCTION METHODS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 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 with respect to process, productivity, product quality and economy automobile parts; engine block, piston, connecting rod and crankshaft. 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. *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. *Chary S N, "Production and Operations Management", Tata McGraw Hill Publishing Company Limited, 2004.*

19MEE38 - PRODUCTION PLANNING AND CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of this 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) **(7)**

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. **(6)**

AGGREGATE PLANNING

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

DISAGGREGATE PLANNING

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

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

LOT SIZING RULES

Fixed order quantity (FOQ) - Economic Order Quantity (EOQ) - lot for lot. Fixed period requirements (FPR), Periodic Ordering Quantity (POQ), Least Unit Cost , least total cost, part period balancing, Wagner - Whitin Algorithm. **(6)**

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 **(6)**

CASE STUDIES (only classroom 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)**

TOTAL : 45

TEXT BOOKS

1. *Mukhopadhyay SK., "Production Planning and Control: Text and Cases", Phi Learning, 2nd Edition, 2007.*
2. *D.R. Kiran, "Production planning and control", First Edition, Butterworth-Heinemann - an imprint of Elsevier, 2019*
3. *Stephen N. Chapman, "The Fundamentals of Production Planning and Control", Pearson, 2005.*

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.*
6. *https://www.youtube.com/watch?v=9qBZyzjoqAo*

19MEE39 - LEAN AND AGILE MANUFACTURING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of the course the students would

CO1 *: Learn the concepts of Lean, Flexibility, and Agility as applied in automotive manufacturing and supply chain management.*

CO2 *: Acquire the ability to apply tools like Production Line Diagnostics and Value Stream Mapping.*

CO3 *: Understand the best business practices in supply chain management.*

CO4 *: Apply various tools such as 5S, Kanban, JIT and poke yoke in production system*

INTRODUCTION TO LEAN MANUFACTURING

Objectives of lean manufacturing -Key principles and implications of lean manufacturing - Traditional Vs lean manufacturing. **(5)**

LEAN MANUFACTURING CONCEPTS

Value creation and waste elimination- main kinds of waste. Pull production-different models of pull production. Continuous flow-continuous improvement. Kaizen- worker involvement - cellular layout-administrative lean. Toyota Production System. **(8)**

LEAN MANUFACTURING TOOLS AND METHODOLOGIES

5S, Poka Yoke. Team work and team engagement · ABCXYZ method of supply management. JIT, JIS principles and Kanban. Kanban circles. DFMA (Design for Manufacturing and Assembly). Production layout, process and logistic approach. Layout of production cell. Warehouse layout. TOC (Theory of Constraints) principle and DBR (Drum-Buffer-Rope) methods. SMED (Single Minute Exchange of Die) principles. TPM (Total Productive Maintenance) principles. Takt Time, Cycle Time, Target Cycle Time. DTD (Dock to Dock Time). **(12)**

AGILE MANUFACTURING

Definition, business need, conceptual framework, characteristics, and generic features. CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing. Cellular manufacturing, concepts, examples. Robust design approach, Approaches to enhance agility in manufacturing. Role of QFD, Managing people in Agile organization, Approaches. Applications of multimedia to improve agility in manufacturing. **(12)**

AGILE SUPPLY CHAIN MANAGEMENT

Principles, IT/IS concepts in supply chain management. Enterprise integration and management in agile manufacturing concepts. Agility, Adaptability. Strategic options in Agile manufacturing. **(8)**

REFERENCES

1. *S N Chary, Production and Operations Management, Tata McGraw-Hill,5th edition, 2012.*
2. *R Panneerselvam, Production and Operations Management, PHI Learning pvt Ltd, 2012.*
3. *Ohio Seichi, Toyota production System, McGraw Hill, 2001.*
4. *Korgaonkar, Just in Time Manufacturing, PHI, 1998.*
5. *Yam Guichi, Total Productive Maintenance, Japanese Institute of Plant Maintenance, Oxford Press, 1994.*
6. *https://nptel.ac.in/courses/112/104/112104188/*
7. *https://www.youtube.com/watch?v=G_0bl6FHo_c*

19MEE40 - PRODUCTION AND OPERATIONS MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Identify the elements of operations management and various transformation processes to enhance productivity and competitiveness.*

CO2 : *Plan and implement suitable materials handling principles and practices in the operations.*

CO3 : *Identify, study, compare, and evaluate alternatives, select and relate with a good supplier by adopting various purchasing methods and inventory controlling techniques.*

CO4 : *Apply various techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level or performance.*

CO5 : *Demonstrate various maintenance schedule techniques for real time applications and 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)**

MATERIAL HANDLING

Introduction - Objectives - Principles - Selection of material handling equipment - Evaluation of material handling equipment - Guidelines for effective utilization of material handling equipments - Relationship between plant layout and material handling. **(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)**

WORK STUDY (Time and Motion study)

Introduction - Productivity - factors influencing productivity, TPM, PPM, Improvement techniques - Work study - Method study - Objectives, procedure involved, selection of the job, techniques - Motion study - Principles and techniques - Work measurement - Objectives and techniques - Time study - steps involves and computation of motion study. **(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)**

TOTAL : 45

TEXT BOOKS

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

REFERENCES

1. *K. C. Jain, P. L. Verma, Prabhat Kartikey, "Production and Operations management", Dreamtech press, 2018.*
2. *Jay Heizer, Barry Render, Chuck Munson, Amit Sachan, "Operations Management",12th Edition, 2017.*
3. *Chary S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 3rd Edition, 2008.*
4. *R. Panneerselvam., "Production Planning and Control", PHI Learning, 3rd Edition, 2012.*
5. *Kanishka Bedi, "Production and Operations Management", Oxford University Press, 2nd Edition, 2007.*
6. *https://nptel.ac.in/courses/110/107/110107141/*

19MEE41 - SMART MANUFACTURING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Illustrate the basic concepts of industrial revolution.*

CO2 : *Analyze impact of industry 4.0 in manufacturing system.*

CO3 : *Learn components of the industrial internet of things and apply it to control the various things of industry.*

CO4 : *Implement IOT in process automation*

INDUSTRIAL REVOLUTION

Industry 1.0- Industry 2.0 -Industry 3.0 Industry 4.0, Outcomes of the Industrial Revolution. **(3)**

INDUSTRY 4.0

Industry 4.0- Additive Manufacturing Possible -Use Case of 3D Printing -Simulation and Digital Twin - Augmented Reality - Autonomous Robots - Blockchain -Big Data - Cloud. **(7)**

MACHINE2MACHINE (M2M)

M2M Working Business Scenario-Business Challenge -M2M in Aviation - M2M versus IoT -M2M Enhances IIoT. **(5)**

INTERNET OF THINGS (IOT)/INDUSTRIAL INTERNET OF THINGS (IIOT)

Evolution of Internet-Internet of Boffins -Internet of Geeks -Internet of Masses -Mobile Internet -Internet of Things -Some Definitions of IoT-Why IoT - SMART Light Control in Home Using IoT -SMART Soilless Farming in Home Using IoT - Industrial Internet of Things -SMART Light and Temperature Control in Industrial Buildings Using IoT - IoT Versus IIoT -Challenges of IoT - benefits **(7)**

MAJOR COMPONENTS OF IIOT

Components of IIoT -Hardware -Standard Tools -Software Application -Communication Technology - Processing Unit - Cloud - IoT Platforms **(7)**

IIOT STRATEGY AND IMPLEMENTATION

IIoT Strategy Planning - IIoT Implementation Methodology-Layers of IIoT Architecture -Choosing the Correct IIoT Platform. **(7)**

PROCESS AUTOMATION AND LEAN IIOT

Process Automation -Process Automation Importance in Manufacturing Industry- Robotic Process Automation -Simple Use Case of a Process Automation - Simple Process Automation in Shop floor - Lean IIoT - How Lean is Value Added to Business via IIoT **(9)**

TOTAL : 45

TEXTBOOK

1. *Uthayan Elangovan , "Smart Automation to Smart Manufacturing: Industrial Internet of Things" , Momentum press, LLC, New York ,2019.*
2. *Shoukat Ali, "Smart manufacturing", LAP Lambert Academic Publishing, 2016.*

19MEE42 - MANUFACTURING PLANNING AND COST ESTIMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

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

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

CO3 : *Calculate and analyse various elements of cost like material cost, labour cost and overhead expenses for different products in the 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; Estimation also estimation of losses in forging shops.*

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 (overheads), 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)**

TOTAL : 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. *Peter Scalon, "Process planning, Design/Manufacture Interface", Butterworth-Heinemann, 2003.*
2. *Gupta C.B., "Fundamentals of Business Accounting", Sultan Chand and Co., New Delhi, 2003.*
3. *A.K.Gupta, "product design and manufacturing" PHI, 2014.*
4. *Buffa, E.S., "Modern Production/Operations Management", 8th edition, John Wiley sons, 2003.*

19MEE43 - MANUFACTURING SYSTEMS MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

At the end of this 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 synthesize the many interrelationships inherent in complex socio-economic productive systems.*

ESSENTIALS OF A MANUFACTURING SYSTEM

Production and Manufacturing - input and output of a 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 BOOKS

1. *Katsundo Hitomi, "Manufacturing Systems Engineering", Viva, Low Priced Student Edition, 2nd Edition, 2004.*
2. *G. Srinivasan, IIT Madras, Lecture on Manufacturing systems management, NPTEL course.*

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.*
3. *https://nptel.ac.in/courses/110/106/110106044/*

ONE CREDIT COURSES

19MEOC01 - MATLAB PROGRAMMING

L	T	P	C
1	0	0	1

COURSE OUTCOMES

The students will be able to do

CO1 *: Themes of data analysis*

CO2 *: Visualization and modeling for engineering problems*

CO3 *: Programs for various mechanical engineering problems.*

MATLAB FUNDAMENTALS

Working with the MATLAB user interface, Entering commands and creating variables **(2)**

VECTORS AND MATRICES

Analyzing vectors and matrices, Visualizing vector and matrix data **(3)**

DATA FILES

Working with data files, Working with data types **(3)**

SCRIPTS AND LOOPS

Automating commands with scripts, Writing programs with branching and loops, Writing functions. **(3)**

APPLICATIONS

Engineering Mechanics, Theory of Machines and Robotics, Mechanical Vibrations and Control Systems using MATLAB. **(4)**

TEXT BOOKS

1. *MATLAB Onramp - MATLAB & Simulink Tutorial, https://in.mathworks.com/learn/tutorials/matlab-onramp.html*
2. *Dan B. Marghitu, Mechanisms and robot analysis with MATLAB, Springer, 2009.*
3. *Rao V. Dukkipati, MATLAB an introduction with applications, New age international private limited, 2010.*

19MEOC02 - NON-DESTRUCTIVE EVALUATION

L	T	P	C
1	0	0	1

ASSESSMENT: THEORY

COURSE OUTCOMES

On Completion of the course, the students should be able to:

CO1 *: Explain the need for Non-Destructive Tests*

CO2 *: List types of NDT and identify the appropriate one for a given sample of material*

INTRODUCTION TO NON-DESTRUCTIVE TESTS (NDT)

Introduction to NDT, Visual Optical methods, Dye penetrant testing, Basic principle, Types of dye and methods of application **(3)**

MAGNETIC PARTICLE TESTING

Magnetic particle testing, Basic theory of magnetism, Magnetization methods, Field indicators, Particle application, Inspection. **(3)**

EDDY CURRENT TESTING

Eddy current testing, Basic principle; Faraday's law, Inductance, Lenz's law, Self and Mutual Inductance. **(3)**

ULTRASONIC TESTING

Ultrasonic testing: Basics of ultrasonic waves, Pulse and beam shapes, Ultrasonic transducers. Test method, Distance and Area calibration Acoustic emission testing: Basic principle, Sources of acoustic emission, Source parameters **(3)**

RADIOGRAPHY

Radiography: X-rays and their properties, X-ray generation, X-ray absorption and atomic scattering. Image formation, Image quality, Digital Radiography, Image interpretation, Radiation Shielding **(3)**

TOTAL : 15

TEXT BOOK

1. *X. P. V. Maldague, Nondestructive evaluation of materials by infrared thermography, Springer-Verlag, 1st edition, (1993).*

REFERENCES

1. *X. P.V. Maldague, Non-Destructive Testing Handbook; Infrared and Thermal Testing, Vol-3, series III, American Society for Non-Destructive Testing, 3rd edition (2001).*
2. *C. N. Jackson and N.Sherlock, Non-Destructive Testing Handbook; Leak Testing , Vol-1, series VI, American Society for Non-Destructive Testing, 3rd edition, (1998).*
3. *R. K.Miller and V.K.Hill, Non-Destructive Testing Handbook; Acoustic Emission Testing, Vol-6, series V, American Society for Non-Destructive Testing, 3rd edition, (2005).*

19MEOC03 - ADVANCED INDUSTRIAL AUTOMATION SYSTEMS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

The students will be able to

CO1 *: Understand various components in an automated system.*

CO2 *: Understand the principle of operation and construction of mechanisms, hydraulic and pneumatic systems*

CO3 *: Understand the microprocessor technology, programming and CNC technology.*

AUTOMATION IN MANUFACTURING

Introduction : Importance of automation in the manufacturing industry. Use of mechatronics. Systems required.

Design of an automated system : Building blocks of an automated system, working principle and examples. **(4)**

MECHANISMS

Electronic cams, indexing mechanisms, tool magazines, and transfer systems. **(2)**

HYDRAULICS AND PNEUMATICS SYSTEMS

Hydraulic systems: hydraulic power pack, pumps, valves. Hydraulic systems: designing of hydraulic circuits.

Pneumatic systems: configurations, compressors, valves, distribution and conditioning. **(4)**

MICROPROCESSOR TECHNOLOGY AND CNC

Microprocessor Technology: signal conditioning and data acquisition, use of microprocessor or microcontroller. Configurations, Working.

CNC technology: basic elements, interpolators and programming. **(5)**

BOOKS AND REFERENCES

1. *HMT Ltd. Mechatronics, Tata McGraw Hill, New Delhi, 1988.*
2. *Bolton, W., "Mechatronics: E lectronic Control Systems in Mechanical and Electrical Engineering", Longman, Singapore,1999.*
3. *Gaonkar, R. S., Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing (India), Delhi, 2000.*
4. *Bradley, D. A., Dawson D., Burd, N. C. and Loader A. J., Mechatronics: Electronics in products and processes, CRC Press, Florida, USA, 2010.*
5. *Parr, A. A., Hydraulics and Pneumatics, Elsevier, 1999.*
6. *Smid, P., CNC Programming Handbook, Industrial Press, New York, USA, 2008.*

19MEOC04 - RECENT TRENDS IN QUALITY

L	T	P	C
1	0	0	1

ASSESSMENT: THEORY

COURSE OUTCOMES

On Completion of the course, the students should be able to:

CO1 *: Explain concepts of Quality and identify Customer requirements*

CO2 *: Explain and apply concepts of Six Sigma for manufacturing/service organization*

INTRODUCTION TO QUALITY

Quality concepts - ISO 9001 - Customer requirements, Quality Tools, Deming awards, TQM **(3)**

QUALITY CONCEPTS IN MANUFACTURING

Just in time (JIT) Concept, Lean Manufacturing, Agile Manufacturing, World Class Manufacturing, Total Productive Maintenance (TPM), Bench Marking, Business Process Re-engineering (BPR) **(6)**

SIX SIGMA - CONCEPT AND IMPLEMENTATION

Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitation **(6)**

TOTAL : 15

TEXT BOOK

1. *Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000), K C Jain and A K Chitale, Khanna Publishers*

REFERENCES

1. *Quality Control & Application, B L Hanson & P M Ghare, Prentice Hall of India.*
2. *Total Quality Management, S. Kumar, Laxmi Publication.*
3. *Statistical Quality Control, M. Mahajan, Dhanpat Rai & Co.*

19MEOC05 - FOUNDRY PRACTICE AND PROCEDURES

L	T	P	C
0	0	2	1

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Demonstrate process variables for molding process and to design gating system for sound casting components.*

CO2 : *Select the variables involved in the casting of ferrous and non-ferrous alloys.*

CO3 : *Explain the inspection techniques for assessing casting quality.*

GATING

Gating system design for pattern design - Method of calculation. **(4)**

MOULDING

Moulding Process set - Alpha set **(1)**

MELTING

Melting process - carbon steel and stainless steel (ASTM A216 and ASTM A351). **(3)**

HEAT TREATMENT

Heat Treatment - for carbon steel and stainless steel **(2)**

QUALITY

Quality - for Carbon steel and stainless steel - Destructive testing - NDT - Final Inspection **(4)**

RECENT DEVELOPMENTS

Recent developments in casting processes **(1)**

TOTAL : 15

NAME OF THE INDUSTRY

KOSO INDIA PRIVATE LIMITED

1/80, Telungalayam Road, Pillayappampalayam, Annur, Coimbatore - 641697

NUMBER OF STUDENTS PER BATCH : 15

19MEOC06 - BASICS OF AUTOMOTIVE ELECTRICAL SYSTEMS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Know the importance of Electrical standards in automobiles.*

CO2 : *Understand the electronic fuel injection/ignition components and their function.*

CO3 : *Choose and use sensors and equipment for measuring mechanical quantities, temperature and appropriate actuators.*

CO4 : *Diagnose electronic engine control systems problems with appropriate diagnostic tools.*

CO5 : *Analyses the chassis and vehicle safety system*

INTRODUCTION

Evolution of electronics in automobiles. Charging systems: Working and design of charging circuit diagram - Alternators - Requirements of starting system - Starter motors and starter circuits. **(2)**

IGNITION AND INJECTION SYSTEMS

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition - Distribution less ignition - Direct ignition - Spark Plugs. Electronic fuel Control, Petrol fuel injection - Diesel fuel injection. **(4)**

SENSOR AND ACTUATORS IN AUTOMOTIVES

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors - study of fuel injector, exhaust gas recirculation actuators. **(3)**

ENGINE CONTROL SYSTEMS

Control modes for fuel control-engine control subsystems - ignition control methodologies - different ECU's used in the engine management. **(3)**

CHASSIS AND SAFETY SYSTEMS

Traction control system - Cruise control system - electronic control of automatic transmission - antilock braking system - electronic suspension system - working of airbag and role of MEMS in airbag systems - centralized door locking system - climate control of cars. **(3)**

TOTAL : 15

TEXT BOOK

1. *Ribbens, "Understanding Automotive Electronics", 8th Edition, Elsevier, Indian Reprint, 2018*

REFERENCES

1. *Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 2015.*
2. *Richard K. Dupuy "Fuel System and Emission controls", Check Chart Publication, 2015.*
3. *Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 2020.*
4. *Tom Denton, "Automobile Electrical and Electronics Systems", Edward Arnold Publishers, 2016*

19MEOC09 - INSPECTION AND QUALITY CONTROL IN MANUFACTURING

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

To know about basic aspects and tools related to inspection and quality control in manufacturing.

INSPECTION

Introduction, Fundamental Concept of Quality, Role of Inspection and Measurement for Quality Control in Manufacturing, Need of Inspection, Inspection types and Principles, Design for Inspection, Destructive Inspection, Testing of Composite Materials. **(3)**

NON-DESTRUCTIVE INSPECTION-I

Visual Inspection, Dye Penetrant Inspection, Magnetic Particle Inspection, Eddy Current Inspection, Ultrasonic Testing. **(3)**

NON-DESTRUCTIVE INSPECTION-II

Acoustic Emission Inspection, Radiography, Leak Testing, Thermographic Non-destructive Testing, Advanced, Non-destructive Techniques, NDT Standards, Safety in NDT. **(3)**

QUALITY CONTROL

Introduction, Aim and functions of quality control, Kaizen and innovation - the Kaizen management practices - Total Quality Control (TQC). **(2)**

QUALITY CONTROL TOOLS

Small group activities - quality circles - Comparison of kaizen and Deming's approach. Affinity diagram - brainstorming - cause and effect analysis -checklist- flow charts - Pareto analysis - quality costing - Quality Function Deployment (QFD) - Training of quality - self managing teams. **(4)**

TOTAL : 15

TEXT BOOKS

1. *"Nondestructive Evaluation and Quality Control", ASM Handbook, Vol. 17 of 9th Edition Metals Handbook.*
2. *Winchell William, "Inspection and Measurement in Manufacturing", Society of Manufacturing Engineers.*
3. *Juran J.M & Gryna F.M., ?Quality Planning and Analysis - From Product development through use, Tata McGrawHill Publishing Limited, new Delhi, 3rd Edition, 1995*
4. *Pyzdek T and Berger R W, "Quality Engineering Handbook", Tata-McGraw Hill, New Delhi, 1996.*

REFERENCES

1. *Taguchi G, Elsayed E A and Hsiang, T.C., "Quality Engineering in Production Systems", Mc-Graw-Hill Book company, Singapore, 1989.*
2. *"Welding Inspection", 3rd Edition, American Welding Society.*
3. *Logothetics N ., Managing for total quality - From Deming to Taguchi and SPC, Prentice hall Ltd, New Delhi, 1997.*
4. *Kaniska Bedi, "Quality Management" Oxford University Press, Chennai, 2007.*

19MEOC10 - CONSTITUTION OF INDIA

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

On Completion of the course, the students should be able to:

CO1 : *Explain the meaning of constitution and salient features of Indian Constitution*

CO2 : *Explain Fundamental Rights, Duties and Discuss Historical Perspectives of Constitutional Amendments.*

CO3 : *Examine Provisions for Emergency*

INTRODUCTION TO CONSTITUTION

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947, Enforcement of the Constitution, Indian Constitution and its Salient Features, The Preamble of the Constitution **(5)**

FUNDAMENTALS, AMENDMENTS AND HISTORICAL PERSPECTIVES

Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India **(5)**

EMERGENCY SITUATIONS

Emergency Provisions : National Emergency, President Rule, Financial Emergency, and Local Self-Government - Constitutional Scheme in India. **(5)**

TOTAL : 15

TEXT BOOKS

1. *Brij Kishore Sharma: Introduction to the Indian Constitution, 8th Edition, PHI Learning Pvt. Ltd.*

19MEOC12 - HUMAN VALUES

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OBJECTIVE

1 To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence.

COURSE OUTCOMES

On Completion of the course, the students should be able to:

CO1 *: Explain the need for harmony within self and fellow humans.*

CO2 *: Justify the need for harmony with nature for sustainability.*

HARMONY WITH SELF AND OTHER HUMANS

Harmony in the Human Being - Harmony in Myself - Harmony in the Family and Society- Harmony in Human Relationship **(6)**

HARMONY WITH SELF AND NATURE

Harmony in the Nature and Existence - Whole existence as Co-existence - Implications of the above Holistic Understanding of Harmony on Professional Ethics **(9)**

TOTAL : 15

TEXT BOOKS

1. *B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.*
2. *PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.*

19MEOC13 - E-COMMERCE SECURITY

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OBJECTIVE

- *To understand, implement and defend against canonical attacks on web security.*

COURSE OUTCOMES

On Completion of the course, the students should be able to:

CO1 *: Explain the need for Web Security, Defense against Web attacks and Security Certificates*

CO2 *: Discuss the protocols for security in web payments*

CO3 *: Explain cryptocurrencies, security threats and regulations.*

INTRODUCTION TO WEB SECURITY

Harmony Web Security - Basic web security model - Web attacks (e.g., SQL injection, XSS, CSRF) and defenses - Session management and user authentication - Certificates and PKI - HTTPS: Design and pitfalls **(6)**

SECURITY IN WEB PAYMENTS

Payments - Legacy payment systems EMV protocol Attacks on EMV Securing CNP transactions and PCI compliance Tokenization **(4)**

CRYPTOCURRENCIES

Cryptocurrencies Early digital currencies Building blocks - The Bitcoin blockchain - Bitcoin mechanics - Bitcoin storage and use - Bitcoin security threats - Regulating cryptocurrencies **(5)**

TOTAL : 15

TEXT BOOK

1. *Bryan Sullivan and Vincent Liu. Web Application Security, A Beginner's Guide. McGraw Hill Education, 1st Edition.*

REFERENCES

1. *Narayanan, Bonneau, Felten, Miller, Goldfeder. Bitcoin and Cryptocurrency Technologies : A Comprehensive Introduction, Princeton University Press, 1st Edition.*

19MEOC14 - INNOVATION AND ENTREPRENEURSHIP

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

The students will be able to

CO1 : *Discuss the relationship between innovation and entrepreneurship.*

CO2 : *Recognize societal and environmental needs and propose innovative solutions*

CO3 : *Distinguish between Intrapreneurship, Business and Entrepreneurship and explain the various stages of entrepreneurship.*

INTRODUCTION

Innovation and its Need - Entrepreneurial Stages **(3)**

INNOVATION

Principles of Innovation, Do's and Don'ts - Sources for Innovation, unexpected success and failure, demographics and perception - Motivation for Innovation, Societal and Environmental Needs, Incongruities between perceived and actual customer values and expectations - High-risk High-return Innovation **(6)**

ENTREPRENEURSHIP

Intrapreneurship vs Entrepreneurship - Business vs Entrepreneurship- Entrepreneurial Processes **(6)**

TOTAL : 15

TEXT BOOK

1. *Peter F Drucker, "Innovation and Entrepreneurship", Harper and Row Publishers Inc, USA, 2009.*

REFERENCE

1. *Robert D Hisrich, Michael P Peters and Dean A Shepherd, "Entrepreneurship", Tata Mc Graw Hill, 10th Edition, 2017.*

19MEOC15 - 3-D SCANNING TECHNOLOGY

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 *: Apply the 3-D scanning process in any industrial environment*

CO2 *: Demonstrate the postprocessing skills in 3-D scanning process*

INTRODUCTION OF 3-D SCANNING TECHNOLOGY AND SCANNING DEMONSTRATION

3-D scanner working principle - types of 3-D scanners - technical specification - scanning software interface - applications - scanning demonstration. **(3)**

SOFTWARE INTERFACE

Three zones of software interface - workspace panel - scanned model - 3-D window - control panel - functional menu - new project - open project - save project - file format - scan folder - snapshots or frames of object - solid polygonal model - model parameters - number of polygons - number of vertices - size of model in random access memory - visibility of scanned object on workspace - tool panel - scan - scanning mode - edit - registration algorithms - fusion algorithm - post processing algorithms - align - edges - repair - measures - multi-scan - texture - publish. **(2)**

BASIC PROCESSING

Continuous scanning (auto-align) mode - manual alignment - global registration algorithms - geometry registration algorithm - polygonal modelling - sharp fusion algorithm - small object filter algorithm - mesh simplification algorithm - file formats for exporting model. **(2)**

PRACTICE ON POST-PROCESSING OF SCANNED IMAGE FILES **(8)**

TOTAL : 15

REFERENCES

1. *https://artecgroup.zendesk.com/hc/en-us/articles/201926472-Lesson-1-Installing-Artec-Studio*
2. *https://artecgroup.zendesk.com/hc/en-us/articles/201926482-Lesson-2-Artec-Studio-interface*
3. *https://artecgroup.zendesk.com/hc/en-us/articles/202051201-Lesson-3-Basic-processing*
4. *https://artecgroup.zendesk.com/hc/en-us/articles/201837081-How-to-3D-body-scan-with-Artec-Eva*

OPEN ELECTIVES

19CEOE01 - TOWN PLANNING AND ARCHITECTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : interpret the geometric forms and aesthetic qualities of Architecture

CO2 : integrate the various elements of architecture and orientation of buildings

CO3 : describe the development plans and planning regulations

CO4 : incorporate the development control rules in town and country planning

PRINCIPLES OF TOWN PLANNING

Evaluation of planning - Objects of town planning - principles of town planning- origin of towns - growth of towns - origin - direction - various forms of planning **(9)**

ELEMENTS OF ARCHITECTURE

Introduction of architecture - definition - Evaluation of geometric forms - function and history - Sphere, Cube, Pyramid, Cylinder and Cone - aesthetic qualities of Architecture - Proportion, Scale, Balance, Symmetry, Rhythm and axis - Contrast in Form - Harmony. **(9)**

PRINCIPLES OF ORIENTATION AND PLANNING OF BUILDINGS

Factors affecting orientation - Sun-Wind-Rain - Orientation criteria for Indian conditions - Principles governing the theory of planning - Planning of residential buildings. **(7)**

DEVELOPMENT PLAN

Principles of city planning - levels of planning- scope and contents of regional plan, master plan, detailed development plan and structure plan - preparation and implementation - planning of new towns - slum clearance and urban renewal. **(9)**

PLANNING LEGISLATION AND DEVELOPMENT CONTROL RULES

Planning legislation and administration - Tamil Nadu Town and Country Planning Act, Tamil Nadu Housing Board Act, Tamil Nadu slum clearance and Improvement Act. Zoning regulations - sub division regulations - building regulations - Floor Space Index - minimum plot sizes - open spaces - minimum standard dimensions **(11)**

TOTAL : 45

TEXT BOOKS

1. *RangwalaS.C., "Town Planning", Charotar Publishing House, Anand, 2013.*
2. *Francis D.K., Ching, "Architecture Form, Space and Order", Oxford University Press, 2014.*

ONLINE RESOURCES

1. *https://nptel.ac.in/courses/124/107/124107001/*
2. *https://nptel.ac.in/content/storage2/courses/109104047/pdf/lecture40.pdf*

19CEOE02 - CLIMATE CHANGE AND ADAPTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Outline the earth's system which influences the climatic factors of the earth.

CO2 : Infer the evidences and observed changes in the climate and environment on a global scale and in India.

CO3 : Analyse the impacts of climate change on various sectors and the uncertainties over the projected impacts of climate change.

CO4 : Investigate the various adaptation and mitigation options in various sectors and examine the mitigation efforts made in India.

CO5 : Correlate future clean technology and alternate energy options inferred in clean development mechanism.

EARTH'S CLIMATE SYSTEM

Introduction-Climate in the spotlight-The Earth's Climate Machine - Climate Classification - Global wind systems - Trade Wind Systems - Trade Winds and the Hadley Cell - The Weserlies - Cloud formation and Monsoon Rains - Storms and Hurricanes - The Hydrological Cycle - Global Ocean Circulation - EI Nino and its Effect - Green House Gases and Global Warming - Carbon Cycle. **(9)**

OBSERVED CLIMATE CHANGE AND ITS CAUSES

Observation of Climate Change - Changes in pattern of temperature, precipitation and sea level rise - Observed effects of Climate Changes - Patterns of Large Scale Variability - Drivers of Climate Change - Feedbacks - The Montreal Protocol - UNFCCC - IPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India. **(9)**

IMPACTS OF CLIMATE CHANGE

Impacts of Climate Change on various sectors - Agriculture, Forestry and Ecosystem - Water resources - Human Health - Industry, Settlement and Society - Methods and Scenarios - Projected Impacts for different regions - Uncertainties in the Projected Impacts of Climate Change. **(9)**

CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES

Adaptation Strategy/options in various sectors - Water - Agriculture - Infrastructure and Settlement including coastal zones - Human Health - Tourism - Transport - Energy - Key Mitigation Technologies and practices - Energy supply - Transport - Buildings - Industry - Agriculture - Forestry - Carbon sequestration - Carbon Capture and Storage (CCS) - Mitigation Efforts in India and Adaptation funding. **(9)**

CLEAN TECHNOLOGY AND ENERGY

Clean Development Mechanism - Carbon Trading - Examples of future Clean Technology - Biodiesel - Natural Compost - Eco-friendly Plastic - Alternate Energy - Hydrogen - Bio-fuels - Solar Energy - Wind - Hydroelectric Power. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.*
2. *UNIPCC Fifth Assessment Report, 2014.*
3. *Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2003.*

REFERENCES

1. *Anil Markandya, Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge, 2002.*
2. *Heal, G. M., Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Kluwer Academic Publ., 1998.*
3. *Jepma, C.J., and Munasinghe, M., Climate Change Policy - Facts, Issues and Analysis, Cambridge University Press, 1998.*
4. *Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.*

ONLINE RESOURCES

1. *"An Inconvenient truth (2006)"- video*
2. *https://climate.nasa.gov*
3. *https://unfccc.int*
4. *https://environment .gov.au*

19CEOEO3 - METRO SYSTEMS AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Integrate the basic elements of MRTS, BRTS, LRTS and other transportation systems

CO2 : Illustrate the components of metro rail systems

CO3 : Apply the concepts of ITS in the field of Transportation Engineering

PRINCIPLES OF TRANSPORTATION SYSTEMS

Transportation systems in India - various modes of transport - public transport - Intermediate public transport - types - characteristics - other urban transportation modes - drawbacks- various transit systems **(9)**

MRTS

Definition - Mass Rapid Transit System - History of MRTS - Need for MRTS - connectivity in Indian conditions - cities having MRTS - infrastructure - operations - fares and ticketing - case study. **(8)**

BRTS and LRTS

Bus Rapid Transit System - terminology - history -features - performance - cost - drawbacks - Light Rail Transit System - necessity - types - gauge- capacity integration with cycles - comparison to other rail modes **(9)**

METRO RAIL SYSTEMS

History of Metro trains - Need for Metro rail - connectivity in Indian conditions - cities having Metro - construction techniques adopted in Metro Rail stations - Case study - Delhi Metro (DMRC) - Chennai Metro (CMRL) **(10)**

ITS

Definition - Intelligent Transport System - Principles - Application of ITS technologies in various countries - smart transportation - case studies **(9)**

TOTAL : 45

TEXT BOOKS

1. *Pradip Kumar Sarkar, Vinay Maitri, G. J. Joshi ·"Transportation Planning Principles, Practices and Policies", Prentice Hall India Pvt., Limited 2017*
2. *D. Johnson Victor, S. Ponnuswamy, "Urban Transportation Planning, Operation and Management" Tata McGraw-Hill Education, 2012*
3. *Mashrur A. Chowdhury, Adel Wadid Sadek "Fundamentals of Intelligent Transportation Systems Planning" Artech House · 2003*
4. *Sumit Ghosh, Tony S. Lee, "Intelligent Transportation Systems Smart and Green Infrastructure Design, Second Edition" CRC Press · 2010*

ONLINE RESOURCES

1. *https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_48.pdf*

19CEOE04 - RENEWABLE ENERGY RESOURCES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Infer the current energy scenario and future energy usage in India.

CO2 : Interpret 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 : Correlate 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 BOOKS

1. *Sukathme, S.P, Nayak J.K., "Solar Energy", Tata McGraw-Hill Book Co., New Delhi, 2017.*
2. *Rai, G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2010.*
3. *P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.*
4. *Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.*

REFERENCES

1. *Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.*
2. *Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.*
3. *Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015.*

ONLINE RESOURCES

1. *https://swayam.gov.in/nd1_noc20_ge06/preview*
2. *https://swayam.gov.in/nd2_nou20_cs09/preview*

19CEOE05 - PRINCIPLES OF SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Identify the components, factors and environmental issues affecting Sustainable development.

CO2 : Assess the role of International summits, conventions and Environmental aspects on Sustainable development.

CO3 : Interpret the necessity and importance of Indian and International Socio -economical and legal aspects in Sustainability.

CO4 : Illustrate the different strategies to achieve Sustainable development.

CO5 : Assess the role of Life cycle Assessment, Cleaner Production and Sustainable Chemistry to achieve sustainable development.

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 **(9)**

ENVIRONMENTAL ASPECTS

International Environmental summits, conventions and agreements-Tiwari committee recommendation - Role of Pollution Control Board - Transboundary issues - Ecological indicators- Ecological foot print- Carbon foot print - Basic concept of Environmental impact assessment **(9)**

SOCIO ECONOMIC AND JUDICIAL ASPECTS

UN Sustainable development policies through trade- World Trade Organization-International monetary fund and World bank - Circular Economy and Sustainable Development - Socio economic policies for sustainable Development- Role of Judiciary in Sustainable Development - Major Environmental Cases in India - Development of Environmental Policies in India - Environment Protection Act, 1986 - EIA notification 2006 - National Conservation Strategy and Policy Statement on Environment and Development, 1992 - Policy Statement for the Abatement of Pollution, 1992 - National Environment Policy, 2006. SDG India Index - Baseline Report 2018 **(9)**

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Economic growth and Sustainable Development - Resource depletion and resource protection- - Internet of things and Sustainable Development - Sustainable Management of Forest, Land, water- Natural Disaster management- case studies. **(9)**

CLEANER PRODUCTION, LIFE CYCLE ASSESSMENT - GREEN/SUSTAINABLE CHEMISTRY

Cleaner Production, definition, aim, application-Generic process of Cleaner Production Assessment- Life cycle Assessment - definition, necessity and elements- ISO Environmental standards- Environmental Audit -Green Chemistry - twelve Principles of Green Chemistry - case studies. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ramakrishnan, P. S., "Ecology and Sustainable Development", National Book Trust, New Delhi, 2001*
2. *Paul Robbins, John Hintz, and Sarah A. Moore, "Environment and Society: A Critical Introduction", Wiley-Blackwell, 2014*
3. *Bimal N. Patel and Ranita Nagar, "Sustainable Development and India", Oxford University Press, 2018.*

REFERENCES

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. *Kirkby, J.O., Keefe, P., and Timberlake, "Sustainable Development", Earthsean Pub., London, 2001*

ONLINE RESOURCES

1. *https://nptel.ac.in/courses/107/103/107103081/*

19CEOE06 - DISASTER MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, 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 - Role of Engineers in Disaster Management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *R. Subramanian, “Disaster Management” Vikas Publishing House Pvt. Ltd, New Delhi, 2018.*
2. *Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2017.*

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.*
4. *Singhal J.P. "Disaster Management”, Laxmi Publications, 2010.*

5. *Khanna BK, "All You Wanted To Know About Disasters", New India Publishing Agency, New Delhi, 2005.*
6. *Ramana Murthy, "Disaster Management", Dominant, New Delhi, 2004.*
7. *Rajdeep Dasgupta, "Disaster Management and Rehabilitation", Mittal Publishers, New Delhi, 2007.*

19MEOE01 - DESIGN OF EXPERIMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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, analyse 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 : Analyse the nature of variables, statistical inference, influence parameter selection, factorial concepts, Conduct Design of experiments; interpret the direct and interaction effects using RSM.

INTRODUCTION

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. **(7)**

BASIC STATISTICAL CONCEPTS

Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples. **(9)**

EXPERIMENTAL DESIGN

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples. **(11)**

ANALYSIS AND INTERPRETATION METHODS

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples. **(9)**

EXPERIMENT DESIGN USING TAGUCHI'S ORTHOGONAL ARRAYS

Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples. **(9)**

TOTAL :45

TEXT BOOKS

1. *C.F. Jeff Wu & Michael Hamada, "Experiments-Panning, Analysis, and Optimization", 3rd Edition, John Wiley & Sons. Inc., 2021.*
2. *D.C. Montgomery, "Design and Analysis of Experiments", 10th Edition, John Wiley & Sons. Inc. 2019.*

REFERENCES

1. *T.B. Barker, Andrew Milivojevich, "Quality by Experimental Design", 4th Edition, CRC Press, 2021*
2. *https://nptel.ac.in/courses/110/105/110105087/*
3. *https://nptel.ac.in/courses/111/104/111104075/*

19MEOE02 - ENGINEERING OPTIMIZATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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.

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. **(11)**

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. **(10)**

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. **(12)**

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 function along a direction - steepest descent (Cauchy) method. **(12)**

TOTAL : 45

TEXT BOOKS

1. *S. S. Rao, "Engineering Optimization: Theory and Practice", 5th Edition, John Wiley & Sons, 2019.*
2. *K. Deb, "Optimization for Engineering Design - Algorithms and Examples", 2nd Edition, Prentice Hall India, 2013.*

REFERENCES

1. *J. S. Arora, "Introduction to Optimum Design", 4th Edition, Academic Press, 2016.*
2. *Ashok D. Belegundu &Tirupathi R. Chandrupatla, "Optimization Concepts and Applications in Engineering", 3rd Edition, Kindle Edition, Cambridge University Press, 2019.*

3. *A. Ravindran, K. M. Ragsdell, Reklaitis G.V., "Engineering Optimization: Methods and Applications", John Wiley & Sons, Inc., 2006.*
4. *https://nptel.ac.in/courses/112/105/112105235/*
5. *https://nptel.ac.in/courses/105/108/105108127/*
6. *https://nptel.ac.in/courses/112/101/112101298/*

19MEOE03 - ENGINEERING POLYMERS, COMPOSITES AND ALLIED MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 moulding - compression and transfer moulding - blow moulding and rotational moulding - 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 NANOMATERIALS

Nano structured materials, low-dimensional structures: quantum wells, quantum wires, and quantum dots, Nano clusters & Nanocrystals, electronic and optical properties of Nano crystallites, metallic and semiconducting superlattices, 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., & Braun P. V, "Nano composite 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.*

19MEOE04 - INDUSTRIAL ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 an appropriate vision system for the robot and then extract these images to get the desired output.

CO5 : Write a 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., & 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, Mitchell Weiss, Tooger. N. Nager, & Nicholas G. Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill International, 2004.*
2. *Richard. D. Klafter, Thomas. A. Chmielewski, & Michaelnegin, "Robotic Engineering - An Integral Approach", Prentice Hall of India, 2002.*
3. *https://nptel.ac.in/courses/112/105/112105249/*

19MEOE05 - BUSINESS PROCESS REENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 the same in the 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 keeping 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 Life Cycle 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 implementation; Re-organizing 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. Workflow 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. *Henry J Johansson, Patrick McHugh, John Pendlebury & William A. Wheeler, "Business Process Reengineering: Break Point 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.*
5. *Walford, R.B., "Business Process Implementation for IT Professionals and Managers" Artech Business Process Reengineering" Prentice Hall, New Delhi, 1993.*

19MEOE06 - ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 the short run concept.

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 - Phillips 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*

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 & Smrit Kaur, "Micro Economics", Cengage Learning, 2013.*
4. *William A McEachern & Indira A., "Macro Economics", Cengage Learning, 2014.*
5. *Lipsey & Chrystal, "Economics", Oxford University Press, 2010.*
6. *https://nptel.ac.in/courses/112/107/112107209/*

19EEOE01 - ENERGY AUDITING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Exhibit Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing

CO2 : Compute the thermal efficiency of various thermal utilities and use the energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure.

CO3 : Analyse the cost- benefit of various investment alternatives for meeting the energy needs of productive processes through energy conservation study.

CO4 : Illustrate the energy saving techniques to reduce power consumption of the non- productive loads

CO5 : Advocacy of strategic and policy recommendations on energy conservation and energy auditing.

ENERGY AUDIT

Global energy scenario - Heat and Electrical energy - Role of energy managers in industries - Energy auditing -Types of energy audit- Data to be collected in auditing - Needs, methodology and types of energy audits - Simple payback period - Net present value of saving- Energy audit report **(9)**

ELECTRICAL ENERGY CONSERVATION

Basic Industrial electrical distribution- energy saving and energy efficiency with Transformers, reactive power correction and cable loss reduction- Energy saving in lighting systems -Specific Energy Consumption (SEC) - Load management - Demand Side Management (DSM). **(9)**

HEAT ENERGY CONSERVATION

Energy Audit - Losses in Boiler - Waste heat recovery - Sources of waste heat - High temperature heat recovery - Medium temperature heat recovery - Waste heat recovery applications- Cogeneration- Heating, ventilation and air conditioning systems (HVAC) :Types - energy conservation in cooling towers and Spray ponds. **(9)**

BUILDING, TRANSPORT AND UTILITY ENERGY CONSERVATION

Real buildings systems: Consumption - Cost versus lifecycle cost - Building design - Water supply systems Real Transportation Systems: Energy conservation in transportation - New technologies - Progress in clean diesel technology. Energy conservation inpumps, and fan and blowers - Energy efficient motors. **(9)**

ENERGY AUDIT PLANNING AND MONITORING

Energy Action Planning: Energy management system - Management commitment and Energy conservation policy - Energy performance assessment - Data collection and management - Analysis of data, baseline and benchmarking - Estimation of energy savings potential - Action planning and Training planning.

Monitoring and Targeting: Defining monitoring & targeting, Elements of monitoring & targeting - Data and information, various techniques - Energy consumption, Production and Cumulative sum of differences (CUSUM). **(9)**

TOTAL : 45

TEXT BOOKS

1. *D. P. Sen Gupta, K. R. Padiyar, IndranilSen, M.A, "Recent Advances in Control and Management of Energy Systems", Interline Publishers, Bangalore, 1993.*

2. *AmlanChakrabarti, "Energy Engineering and Management", PHI Learning, New Delhi 2012.*
3. *YP.Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, 2006.*
4. *Frank Krieth and D Yogi Goswami, "Energy Management and Conservation Handbook", CRC Press, 2007.*
5. *C.B. Smith, "Energy Management Principles", Pergamon Press, New York, 1981.*

REFERENCES

1. *"General Aspects of Energy Management and Energy Audit-Unit- 1,2,3,4", BEE Guide book, 2010.*
2. *Hamies, "Energy Auditing and Conservation: Methods, Measurements, Management & case study", Hemisphere, Washington, 1980.*
3. *Diamant R.M, "Total Energy", Pergamon Press, Oxford Press, 1970.*
4. *Albert Thumann, "Fundamentals of Energy Engineering", Prentice Hall, May 1984*
5. *Larry C Whit et.al, "Industrial Energy Management & Utilization", 1st Edition, Springer, 1988.*

19EEOE02 - SOLAR AND WIND ENERGY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Summarize the solar radiation, measurements and characteristics of solar PV cell.

CO2 : Develop the model of a PV system and its applications.

CO3 : Illustrate the basic types, mechanical characteristics and model of wind turbine.

CO4 : Analyse the electrical characteristics and operation of various wind-driven electrical generators.

CO5 : Utilize 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 pyranometer - 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 by -pass 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 in the 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, 3rd Edition, 2015.*

REFERENCES

1. *Roger A. Messenger and Jerry Ventre, "Photovoltaic systems engineering", Taylor and Francis Group Publications, 2020.*

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, 2015.*

19EEOE03 - ELECTRICAL SAFETY PROCEDURES AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify and analyze the precautions and protection of electrical hazards

CO2 : Select and use the suitable personal protective equipment according to the working environment

CO3 : Interpret the safety procedures for the specific work place

CO4 : Analyze and apply the various grounding techniques

CO5 : Infer the electrical safety against low voltage and high voltage and to manage the medical equipments

INTRODUCTION AND HAZARDS OF ELECTRICITY

Electrical Safety 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 - Tagout - 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 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 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 BOOK

1. *John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", 4th edition, Mc Grew Hill, 2012*

REFERENCE S

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. *Electrical Safety booklets issued by Government bodies*

19EEOE04 - ENERGY EFFICIENT ILLUMINATION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Understand the properties of light, importance of lighting in various fields, types of light sources and methods of lighting.

CO2 : Perform the calculation of luminance parameters in various applications.

CO3 : Identify the criteria for selection of lighting equipment's and control systems in various applications.

CO4 : Impart design and technology for Interior lighting and Exterior lighting applications

CO5 : Review the various technologies used in Smart lighting systems.

INTRODUCTION : BASICS OF LIGHTING

Lighting Physics - Optical Radiation - Concept of Color - Biological Factors : Human eye and brain response - Different entities of illuminating systems. Properties of Lighting - Natural and Artificial lighting - Good and Bad Lighting - Challenges in Lighting - Good Practices in Lighting - Types of Lighting. **(7)**

LIGHTING CALCULATIONS AND LIGHT SOURCES

Basic Terms in Lighting System - Luminance measurement - Laws of Illumination - Polar Curves - Rousseau's construction - Concept of Photometry - Introduction of lighting software.

Lamps: Incandescent Lamps: Halogen lamps - Discharge Lamps: MV and SV Lamps, Fluorescent Lamps: FTL, CFL - Arc lamps - Special Lamps: LED: Surface Mounted Devices (SMD-LEDs), Chip on Board (COB-LEDs) - Neon lamps - Lasers - Comparison of Lamps - Life Cycle Cost (LCC) Analysis - Efficacy. **(12)**

LIGHTING EQUIPMENTS AND STANDARDS

Luminaries, Wiring, Control gears, Switching boards, Reflectors and Control circuits - Heating, Harmonics and EMI Suppression techniques from lighting equipment - Switching and Dimming control algorithm - Recommendation of Illumination Levels for Various Tasks / Activities / Locations - Role of 3D printing technology for designing luminaries - International Standards and codes of lighting system. **(9)**

LIGHTING APPLICATIONS

Interior lighting: Industrial, Residential, Indoor stadium and Hospitals. Exterior lighting: Flood, Street, Aviation and Transport lighting - Sign and display Board Lighting - Lighting in Agriculture - Lighting in Automobiles. **(8)**

SMART LIGHTING SYSTEMS

Intelligent lighting system - Smart LED lighting systems - LED Smart Projector system - Solar Street Lighting Systems - Role of IoT in lighting system - Concept of Light Fidelity (Li-Fi) - Significance of UV-C lighting in medical - Concept of Artificial Moon for street lighting. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to the Laser", Visions Communications, Washington DC, USA, 2nd Edition, 1994.*
2. *Jack L. Lindsey, "Applied Illumination Engineering", Prentice Hall of India, New Delhi, 3rd Edition, 2008*

3. *Leon Gaster, John Stewart Dow, "Modern Illuminants and Illuminating Engineering", Nabu Press, Washington DC, 1st Edition, 2010.*
4. *Philip Gordon., "Principles and Practices of Lighting Design: The Art of Lighting Composition", Blue Matrix Productions, 2011.*

REFERENCES

1. *Lighting Engineering: Practical Hand Book, INDALUX 2002*
2. *IES Lighting Handbook, 10th Edition, 2011.*
3. *NPTEL Course: Illumination Engineering*
4. *Lighting - Research paper reference from Philips - Lighting Academy and Signify Lighting University.*

19EEOE05 - ELECTRIC VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Apprehend the fundamentals and importance of electric vehicles and its components

CO2 : Select the suitable drive scheme based on the motor and topology for the given specification and applications

CO3 : Design and categorize the battery system for electric vehicles and hybrid electric vehicles

CO4 : Recognize the suitable battery charging scheme for different environments and applications.

CO5 : Describe the significance of E-mobility and its various business opportunities

ELECTRIC VEHICLES

An Overview of Conventional, Battery, Hybrid and Fuel Cell Electric Systems - Conventional IC Engine Vehicle - BEVs - HEVs - Series HEV - Parallel HEV - Series-Parallel HEV - FCEV - EV subsystems - Vehicle Dynamics: Vehicle Load Forces - Basic Power, Energy, and Speed Relationships - Aerodynamic Drag - Aerodynamic Drag and Fuel Consumption - Rolling Resistance - Gradability **(9)**

ELECTRIC PROPULSION

Electric Motors in EVs - Configuration and control of DC motor drives - Induction motor drives- Permanent Magnet motor drives - Switched reluctance motor drives - Transmission configuration, Components - gears, differential, clutch, brakes - regenerative braking - types - Motor sizing.- Matching the electric machine and the internal - combustion engine (ICE), Sizing the propulsion motor, sizing the power - electronics, selecting the energy storage technology, Communications- supporting subsystems **(9)**

BATTERIES

Introduction to Batteries - Energy Storage Requirements in Electric Vehicles: Batteries Types: Lead-Acid Battery - Nickel-Metal Hydride - Lithium-Ion - Battery Operation - Battery Parameters and Comparisons - Battery Packs - Battery Sizing - Battery based energy storage and its analysis - Fuel Cells - Fuel Cell based energy storage and its analysis - Super capacitors- Hybridization of different energy storage devices **(9)**

BATTERY CHARGING

Charging methods for battery- Fast charging - Battery Charging, Protection, and Management System - Termination methods - Charging from grid - Isolated and Non-isolated DC - DC Converters - Bidirectional DC-DC converter - High-frequency transformer based isolatedcharger topology - Transformer less topologies. **(9)**

E-MOBILITY

Energy Management Strategies - Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H - E-mobility business - Electrification challenges - Connected Mobility and Autonomous Mobility- Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). **(9)**

TOTAL : 45

TEXT BOOKS

1. *Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition CRC Press, 2018.*
2. *Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021*

REFERENCES

1. *James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd edition, Wiley, 2012*
2. *Soylu "Electric Vehicles - The Benefits and Barriers", InTech Publishers, Croatia, 2011.*
3. *J.M. Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), 2nd edition, London, UK, 2010.*
4. *R. Stone and J.K. Bell, "Automotive Engineering Fundamentals", SAE International, Warrendale, PA, 2004.*
5. *Viswanathan B. and Scibioh Aulice M, "Fuel cells: Principles and Applications", University Press, 2008.*

19EEOE06 - ENERGY EFFICIENCY IN THERMAL AND ELECTRICAL UTILITIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Preaudit the energy

CO2 : Analyse the possibility of energy savings

CO3 : Analyze the methods of energy savings

CO4 : Design the solutions

CO5 : Identify and perform appropriate energy management

ENERGY EFFICIENCY IN THERMAL UTILITIES - I

- Fuels and Combustion: Introduction to fuels, properties of fuel oil, coal and gas, storage, handling and preparation of fuels, principles of combustion, combustion of oil, coal, and gas.
- Boilers: Types, combustion in boilers, performance evaluation, analysis of losses, feedwater treatment, blowdown, energy conservation opportunities..
- Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.
- Insulation and Refractories: Insulation-types and application, the economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractories, heat loss.
- FBC boilers: Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, Retrofitting FBC system to conventional boilers, saving potential. **(9)**

ENERGY EFFICIENCY IN THERMAL UTILITIES - II

- Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate, and flash steam recovery system, identifying opportunities for energy savings
- Cogeneration: Definition, need, application, advantages, classification and saving potentials.
- Waste Heat Recovery: Classification, advantages, and applications, commercially viable waste heat recovery devices, saving potential.
- Energy Management & Audit: Definition, need and types of an energy audit. Energy management (audit) approach-understanding energy costs, benchmarking, energy performance, matching energy use to the requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.
- Material and Energy balance: Facility as an energy system, methods for preparing process flow, material, and energy balance diagrams. **(9)**

ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

- Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.
- Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy-saving opportunities with energy- efficient motors.

- Energy-Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy-efficient motors, soft starters with energy savers, variable speed drives, energy-efficient transformers, electronic ballasts, occupancy sensors, energy-efficient lighting controls. **(9)**

ENERGY EFFICIENCY IN THERMO ELECTRIC UTILITIES - I

- Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities
- HVAC and Refrigeration System: Vapor compression refrigeration cycle, refrigerants, the coefficient of performance, capacity, and factors affecting Refrigeration and Air conditioning system performance and savings opportunities.
- Vapor absorption refrigeration system: Working principle, types and comparison with vapor compression system, saving potentially
- Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.
- Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. **(9)**

ENERGY EFFICIENCY IN THERMO ELECTRIC UTILITIES - II

- Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy-saving opportunities assessment of cooling towers.
- Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation avenues.
- Diesel Generating system: Factors affecting the selection, energy performance assessment of diesel conservation avenues **(9)**

TOTAL : 45

ENERGY PERFORMANCE ASSESSMENT FOR EQUIPMENT AND UTILITY SYSTEMS

Open Book examination on the following energy performance assessments for equipment and utility systems:

- Boilers, Furnaces
- Cogeneration, Turbines (gas, steam)
- Heat Exchangers
- Electric Motors, Variable Speed Drives
- Fans and Blowers, Water Pumps, Compressors
- HVAC systems
- Lighting Systems
- Performing Financial Analysis.
- Applications of Non-conventional & Renewable Energy Sources (NRES)
- Waste minimization and resource conservation

TEXT BOOKS

1. *Mehmet Kanolu, Yunus A. Çengel, "Energy efficiency and management for engineers", McGraw- Hill Education, 2020*
2. *Stephen A. Roosa, Steve Doty, Wayne C. Turner, "Energy Management Handbook", 9th edition, River Publishers, Taylore and Francis Group, 2020*
3. *Energy Efficiency in Thermal Utilities, Bureau of Energy Efficiency (BEE), Guide books*
4. *Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency (BEE), Guide books*

REFERENCES

1. *Rajiv Shankar, "Energy Auditing in Electrical Utilities", Viva Books, 2017*
2. *Wayne C. Turner," Energy Management Handbook", Eighth Edition, 2012*
3. *Stephen A. Roosa, Steve Doty, "Energy Management Handbook", 2018*
4. *General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency (BEE), Guide books*
5. *Energy Performance Assistance for Equipment and Utility Systems, Bureau of Energy Efficiency (BEE), Guide books*

19ECEOE01 - SIGNAL PROCESSING AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 Blocks 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, 3rd Edition, 2011.*
2. *Simon Haykin, "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*

19ECEOE02 - SMART SENSORS AND IoT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the classification ,types,packaging and testing of smart sensors

CO2 : Interpret the construction and working principles of Electronic sensors

CO3 : Exemplify the working of different types of light radiation sensors .

CO4 : Illustrate the key concepts of temperature ,gas and airquality sensors used to measure the parameters.

CO5 : Interpret the characteristics, functional blocks and architecture of IoT to develop an IoT based applications.

SMART SENSORS BASICS

Sensor Classification, Performance and Types, Error Analysis characteristics- Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications-Testing Smart Sensors- HVAC Sensor Chip- Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control-MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration. **(9)**

ELECTRONIC SENSORS

Resistance strain gauge - piezoelectric pressure gauge - characteristics- load cells-torque sensor- Piezo-resistive and capacitive pressure sensor- optoelectronic pressure sensors- vacuum sensors- Capacitor plate sensor, Inductive sensors, LVDT- Hall effect- Doppler detectors- liquid level detectors, flow sensors - ultrasonic sensor- flow sensors. **(9)**

GHT RADIATION SENSORS

Electronic and Optical properties of semiconductor as sensors - LED - Semiconductor lasers- Fiber optic sensors- Thermal detectors - Photo multipliers- photoconductive detectors- Photo diodes- Avalanche photodiodes - CCDs - Intensity sensor - Interferometers-Phase sensor: Phase detection, Polarization maintaining fibers. **(9)**

TEMPERATURE, GAS AND AIR QUALITY SENSORS

Bimetallic strip- Bourdon temperature gauge- thermocouples- Resistance thermometers- thermistors- bolometer- Pyroelectric detector-Engine combustion process- Catalytic exhaust after treatment, Emission limits- Exhaust sensors and Engine control - Exhaust sensors for OBD- Hydro-Carbon Sensors- NOx-Sensors-Oxygen Sensors- Measurement of oxides of sulphur,oxides of nitrogen unburnt hydrocarbons, carbonmonoxide, dust mist and fog- smoke sensors. **(9)**

IoT AND ITS APPLICATIONS

IoT Definition - Characteristics - IoT Functional Blocks -IoT Architecture -Physical design of IoT - Logical design of IoT- Sensing & Actuation -Basics of Networking - Communication Protocols- Machine-to-Machine - Communication models & APIs.

Domain specific applications of IoT: Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture, Smart Traffic Control and Smart water management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Jacob Fraden," Handbook of modern sensors: physics, designs, and applications", 5th Edition, Springer, 2016.*
2. *Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, Boston, 2011.*

REFERENCES

1. *Arshdeep Bahga, Vijay Madisetti, "Internet of Things - A hands-on approach", Universities Press, 2015.*
2. *Jon. S. Wilson, "Sensor Technology Hand Book", Elsevier, 1st Edition, Netherland, 2011.*
3. *John G Webster, "Measurement, Instrumentation and sensor Handbook", CRC Press, 2nd Edition, Florida, 2017.*
4. *John P. Bentley," Principles of Measurement systems", 3rd Edition, Pearson Education Asia Pvt. Ltd, 2009.*
5. *D. Patranabis," Sensors and Transducers", 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2006.*
6. *Ernest O Doebelin, Dhanesh N Manik, "Measurement Systems, Application and Design", McGraw Hill, 6th Edition, 2007.*

19ECEOE03 - CONSUMER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Understand the various types of microphones and loudspeaker.

CO2 : Explain the principle and working of Monochrome TV.

CO3 : Describe the Colour TV scanning process and camera tube.

CO4 : Illustrate LCD, LED TV, working of cable TV and DTH.

CO5 : Interpret the significant technical considerations using a broad systems perspective.

AUDIO SYSTEMS

Microphones Carbon, moving coil, wireless microphone; Loudspeakers - Direct radiating Electrostatic and horn loudspeaker; Multi-speaker system; Sound Recording - Magnetic Recording, Digital Recording, Optical Recording (CD system and DVD). **(9)**

MONOCHROME TV

Elements of TV communication system, Scanning process, Scanning methods and Aspect Ratio, Need of synchronizing and blanking pulses, Composite Video Signal, Camera Tube: Vidicon. **(9)**

COLOUR TELEVISION

Primary, secondary colours, Concept of Mixing, Colour Triangle, Camera tube, PAL TV Receiver, Concept of Compatibility with Monochrome Receiver, NTSC, PAL, SECAM. **(9)**

LCD AND LED TELEVISION

Basic principle and working of LCD & LED TV, Cable Television: Working of Cable TV, DTH **(9)**

DOMESTIC & CONSUMER APPLIANCES

Operation of Microwave Oven, Automatic Washing Machine, Photostat Machine, Digital Camera, Vacuum cleaner, Food Processors, Scanner. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Bali S.P., "Consumer Electronics" Pearson Education, 2017.*
2. *Bali R and Bali S.P. "Audio video systems: principle practices & troubleshooting", Khanna Book Publishing Co. (P) Ltd., 2010.*

REFERENCES

1. *Gulati R.R., "Modern Television practices" New Age International Publication (P) Ltd.2011.*
2. *Gupta R.G, "Audio video systems" Tata Mc graw Hill, 2nd Edition, 2010.*
3. *Whitaker Jerry & Benson Blair, "Standard Handbook of Audio engineering" McGraw-Hill Professional, 3rd Edition, 2010.*
4. *Amit Dhir, "The Digital Consumer Technology Handbook", Elsevier Science, 2004.*

19ECEOE04 - ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

Upon completion of this course, students will be able to demonstrate an ability to

CO1 : Describe the concepts of robotics, safety measures and homogeneous transformation.

CO2 : Formulate the concepts of mechanical drives and sensors in robotics.

CO3 : Describe the types of sensors and Robotic Vision

CO4 : Develop robotics programming, classifications and its applications.

CO5 : Exemplify the concepts of artificial intelligence.

ROBOT KINEMATICS

Introduction - Robotics and programmable automation - Historical background - Laws of Robotics - Robot definitions - Robotics system and Robot anatomy - Specifications of Robots - Safety measures in Robotics. **(10)**

ROBOTIC DRIVERS AND CONTROLS

Robot drives, actuators and control - Functions of drive systems - General types of fluids - Pump classification - Pneumatic systems - Electrical drives - DC motors - Stepper motors - Drive mechanism. **(9)**

SENSORS AND MACHINE VISION

Need for sensing systems- Principles and Applications of the following types of sensors- Position and displacement sensors - Potentiometers, Encoders, Linear Variable Differential Transformer, Force and Torque sensors- Wrist sensor, Joint sensor, Tactile array sensor, Slip sensors- Proximity sensors- Range finders- Imaging sensors- Inductive Proximity switch- Acoustic sensors- Opto-electronic sensors- Lighting Techniques, Robot Vision- Sensing and Digitizing, Image Processing and analysis- Preprocessing, Segmentation, Description, Recognition, Interpretation and Applications of robot vision system **(9)**

ROBOTIC LANGUAGE AND PROGRAMMING

Robot language and programming. Robot language - Classification of Robot languages - Computer control and robot software - VAL system and language. Applications of Robots: Capabilities of Robots - Robotics applications - Obstacle avoidance. **(8)**

ARTIFICIAL INTELLIGENCE IN ROBOTICS

The history of Artificial Intelligence- Artificial and Natural Intelligence- Artificial Intelligence and Automated manufacturing- The application domains of Artificial Algorithms- Risks and Benefits of AI- Agents and Environments- Knowledge representation.

(9)

TOTAL : 45

TEXT BOOKS

1. *Satya Ranjan Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill, 2nd Edition, 2012.*
2. *Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 2014.*

REFERENCES

1. *Robin.R.Murphy, "Introduction to AI Robotics", The MIT Press, Canbridge, Massachusetts, London, England, Second Edition, 2019.*
2. *Jadran Lenarcic, Jean-Pierre Merlet, "Advances in Robot Kinematics 2016", Springer International Publishing AG, 2018.*

3. *Peter McKinnon, "Robotics", CreateSpace Independent Publishing Platform, 2016.*
4. *Ritu Tiwari, Anupam Shukla, Rahul Kala, "Intelligent Planning for Mobile Robotics: Algorithmic Approaches", Information science reference, United states of America, 2013.*
5. *David. L. Pool and Alan. K. Mackworth, "Artificial Intelligence: Foundations of Computational agents", Cambridge University, 2011.*

19ECEOE05 - INFORMATION THEORY AND CODING TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the information content in a discrete memoryless source through parameters such as entropy and mutual information.

CO2 : Estimate a channel's capacity based on Shannon's channel capacity theorem

CO3 : Analyze various channel encoding and decoding methods

CO4 : Design and develop an error control coding methods for random error and burst error detection and correction techniques

CO5 : Understand different applications in coding techniques

INFORMATION THEORY AND SCHEMES FOR SOURCE CODING

Uncertainty Information and Entropy - Basic Properties of entropy - Information rate - Conditional entropy - Joint Entropy - Mutual Information - Channel capacity of a Gaussian channel

SOURCE CODING : Prefix codes - Necessary conditions for source coding - Kraft Mcmillan Inequality- Huffman Coding- Shannon Fano Coding Efficiency calculations. **(9)**

MEMORYLESS FINITE SCHEMES FOR CHANNEL CODING

Discrete Memoryless Channel - Channel models - BSC and BEC channels - Cascaded channels - Channel capacity of discrete and analog channels - Channel capacity of a Gaussian channel-Bandwidth-S/N trade-off-Channel coding theorem - Information capacity theorem - Code rate and redundancy-Parity check codes - Rate Distortion Theory. **(9)**

LINEAR BLOCK CODES AND CYCLIC CODES

Rationale for coding - Types of codes - Matrix description of linear block codes - Syndrome decoding - Minimum distance considerations -Repetition codes - Dual codes- Cyclic codes :Generator polynomial - Parity check polynomial - Encoder of cyclic codes - Calculation of syndrome - Cyclic codes for error correction. **(10)**

CONVOLUTIONAL CODES

Convolutional codes : Tree codes- Trellis codes- Viterbi decoding of convolutional codes - Catastrophic Error Propagation in Convolutional Codes -Performance Bounds for Convolutional Codes - Coding Gain - Convolutional Code Trade off - Soft Decision Viterbi Decoding -Feedback Decoding - Sequential Decoding **(9)**

CODING TECHNIQUES IN DATA COMPRESSION

Static and Dynamic Huffman coding - Arithmetic coding - Run length encoding- Lempel-Ziv coding -Image compression techniques -JPEG standard for Lossy and Lossless compression- Video compression standards. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003.*
2. *Ranjan Bose, "Information Theory Coding and Cryptography", Tata McGraw Hill, 3rd Edition 2016.*

REFERENCES

1. *Richard B.Wells, "Applied Coding and Information Theory for Engineers", Pearson Education, 1st Edition Indian reprint, 2009.*
2. *Khalid Sayood, "Introduction to Data Compression", 4th Edition, Elsevier, 2012.*
3. *Bernard Sklar, "Digital Communications: Fundamentals and Applications", Pearson Education, 2nd Edition, 2009.*
4. *Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", John Wiley & Sons, 2nd Edition, 2006.*
5. *Reza F M, "An Introduction to Information theory", McGraw Hill, 2000.*
6. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 1st Edition, 2021.*

19ECEOE06 - WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Outline the challenges & issues in the wireless sensor network and its subsystems and interpret network architecture and its components

CO2 : Describe the essential principles of the MAC protocols for Wireless Sensor Networks

CO3 : Elucidate the Routing & localization tracking inWireless Sensor Networks

CO4 : Discuss the features of WSN Operating systems

CO5 : Illustrate the methodologies to provide WSN based solution for various critical issues.

SENSOR NETWORKS - INTRODUCTION & ARCHITECTURES

Challenges for Wireless Sensor Networks-Enabling Technologies for Wireless Sensor Networks- Characteristic requirements for WSN - WSN architecture - Commercially available sensor nodes -Imote, IRIS, Sunspot -Physical layer and transceiver design considerations in WSNs-Single Node Architecture -Energy Consumption of Sensor Nodes- Sensor Network Scenarios- Optimization Goals and Figures of Merit. **(9)**

DATA LINK LAYER

Fundamentals of MAC protocols- Issues in designing a MAC Protocol for WSN - Low duty cycle protocols and wakeup concepts - Contention based protocols:PAMAS - Schedule-based protocols:LEACH - Sensor MAC - Berkeley MAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4- Link Layer protocols - fundamentals task and requirements, error control, framing, link management, Address and Name Management, Assignment of MAC Addresses, Unique,Content-based and geographical addressing. **(10)**

ROUTING AND TRACKING

Routing Challenges and Design Issues in Wireless Sensor Networks- Taxonomy :Data-centric routing SPIN - Energy aware routing, Gradient-based routing -Hierarchical Routing LEACH -Location Based Routing GAF, Data aggregation - Various aggregation techniques

A Tracking Scenario - Problem formulation - Distributed representation and inference of states- Tracking multiple objects - Sensor models - Topology control - Clustering - Time synchronization - Localization and Localization Services **(10)**

EMBEDDED OPERATING SYSTEMS FOR WSNs

Embedded Operating Systems: Operating Systems for WSNs - Introduction - Operating System Design Issues- Introduction to Tiny OS - NesC - Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM. **(7)**

APPLICATIONS OF WSN

WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications - Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling **(9)**

TOTAL : 45

TEXT BOOKS

1. *Kazem Sohraby, Daniel Minoli and Taieb Znati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, First Edition, 2007.*
2. *Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.*

REFERENCES

1. *Anna Hac, "Wireless Sensor Network Design", John Wiley & Sons, First Edition, 2003.*
2. *C.S.Raghavendra Krishna, M.Sivalingam and Taribznati, "Wireless Sensor Networks", Springer Publication, 2004.*
3. *Paolo Santi, "Topology Control in Wireless Adhoc and Sensor Networks", John Wiley & Sons, 2005.*
4. *Philip Levis, David Gay,"TinyOS Programming", Cambridge University Press, 2009 Contiki - Open Source Operating System for IoT - http://www.contiki-os.org/*

19ECEOE07 - AUTOMOTIVE EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Design modules for hybrid vehicle using automotive system components.

CO2 : Design control system in automotives by appropriate choice of Microcontrollers, Sensors and actuators.

CO3 : Examine the communication protocols for real time applications

CO4 : Understand the safety and comfort in Automobiles as per the government test procedures.

CO5 : Understand the communication and diagnostic protocols

AUTOMOTIVE SYSTEMS

Overview of Automotive industry - Tools and Processes - Introduction to modern automotive systems -Spark and Compression Ignition Engines - Automotive Transmissions - Vehicle braking fundamentals -Steering Control - Overview of Hybrid Vehicles - Analog and Digital Systems - Basic measurements systems. **(9)**

SENSORS AND ACTUATORS

Sensors: Characteristics, response and modeling - Actuators - Microcontroller and Digital Signal Processors used for automotive applications. **(9)**

EMBEDDED COMMUNICATION

Embedded Automotive Protocols: CAN, LIN, FLEXRAY, MOST **(9)**

SAFETY SYSTEMS

Active Safety Systems: ABS, TCS, ESP, brake assist - Passive Safety Systems: Airbag systems, Advance Driver Assistance system (ADAS) -Computer vision techniques - Connected cars technology - Trends towards Autonomous vehicles. **(9)**

FUNDAMENTALS OF DIAGNOSTICS

Basic wiring system and Multiplex wiring system, Self-Diagnostic system - various On board and off board diagnostics in Automobiles - Diagnostics tools - Diagnostics Protocols: KWP20000 and UDS. **(9)**

TOTAL : 45

TEXT BOOK

Ronald K Jurgen, "Automotive Electronics Hand Book", McGraw- Hill, 2nd Edition 1999.

REFERENCES

1. *William B. Ribbens, Ph.D, "Understanding Automotive Electronics", Elsevier Publications, 7th Edition, 2012.*
2. *Tom Denton, "Advance Automotive Diagnosis", 2nd Edition, Elsevier 2006.*
3. *BOSCH Automotive Handbook, 8th Edition.*
4. *Denton. T, "Automobile Electrical and Electronics Systems", SAE (Society for Automobile Engineers) International, 3rd Edition, 2004.*
5. *Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5th Edition, 2009.*

19ECEOE08 - 5G TECHNOLOGIES AND APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : describe the evolution of cellular systems from 2G to 4G

CO2 : explain the motivation, targets of 5G technology and its standardization

CO3 : elaborate the 3GPP releases and 5G radio access network architecture

CO4 : discuss the services offered by 5G deployment and its design approaches

CO5 : understand the role between 5G and emerging next generation wireless technologies

EVOLUTION OF CELLULAR SYSTEMS

Evolution from 2G to 3G and 3G to 4G - Circuit Switch to Packet Switch - ITU Standardization Process- - Evolution of LTE and releases. **(9)**

INTRODUCTION TO 5G

Motivation for 5G - 5G targets - Technology components - Spectrum - capabilities - The role of 3GPP in standardization - use cases - 5GPPP (Public-Private Partnership) **(9)**

5G RADIO ACCESS NETWORK

Radio access - 3GPP Releases - 5G New Radio (NR) - Requirements - 3GPP phases for IMT-2020 - NR air interface - 5G RAN architecture **(9)**

5G SERVICES

Enhanced Mobile Broadband (eMBB) systems - Massive Machine Type Communication (MMTC) system - Ultra Reliable and Low Latency Communication (URLLC) systems - Design approaches **(9)**

EMERGING TECHNOLOGIES IN 5G

Massive MIMO - Network Function Virtualization - Software Defined Networking - Cognitive radio -Millimetre Wave - Heterogeneous network - Internet of Things **(9)**

TOTAL : 45

TEXT BOOKS

1. *Saad Asif, "5G mobile Communications Concepts and Technologies", CRC Press,2018*
2. *Biljana Badic, Christian Drewes, Ingolf karls, Markus Mueck, "Rolling out 5G Use cases, Applications and Technology Solutions", Apress, 2016*

REFERENCES

1. *Antti Toskala, Harri Holma, Takehiro Nakamura, "5G Technology 3GPP New Radio", Wiley & Sons Ltd. 2020.*
2. *Devaki Chandramouli, Juho Pirskanen, Rainer Liebhart, "5G for the Connected World", Wiley,2019*
3. *Haesik Kim, "Design and Optimization for 5G Wireless Communications", Wiley, 2020*
4. *Ramjee Prasad, "5G Outlook Innovations and Applications", River Publications, 2016*
5. *Anwer Al-Dulaimi, "5G Networks Fundamental Requirements, Enabling Technologies, and Operations Management", Wiley, 2018*
6. *Mauro Boldi, Olav Queseth, Patrick Marsch, Ömer Bulakci, "5G System Design Architectural and Functional Considerations and Long Term Research", Wiley,2018*

19ECEOE09 - VEHICULAR COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Understand basic principles, technologies, and system architecture of vehicular ad-hoc networks (VANET)

CO2 : Analyze Physical Layer and MAC Layer for signal propagation for vehicular communication

CO3 : Describe the various routing mechanisms and protocols to fulfill vehicular networking requirements.

CO4 : Explain the challenges and issues in establishing cellular V2X connection and mobility management.

CO5 : outline vehicular communication platforms for various emerging applications

INTRODUCTION TO VEHICULAR RADIO NETWORKS

Basic principles and challenges-Mobile Wireless Communications and Networks-Need for Vehicular Communications-VANET activities- Network Architecture for Vehicular Communications. **(9)**

PHYSICAL LAYER AND MAC LAYER

Signal Propagation-Doppler spread and its impact on OFDM Systems-Proposed MAC approaches and standards, Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC **(10)**

VANET ROUTING PROTOCOLS

Opportunistic packet forwarding-topology based routing- geographic routing **(8)**

VEHICULAR MOBILITY MANAGEMENT

Connected Vehicles& Connected Autonomous Vehicles- Dedicated Short Range Communication-flow and traffic models-Standards and Regulations- DSRC Protocol Stack, Cellular V2X **(9)**

EMERGING VANET APPLICATIONS

Vehicle to Infrastructure Safety Applications-communication paradigms-message coding and composition-data aggregation-Security and Privacy **(9)**

TOTAL : 45

TEXT BOOKS

1. *H. Hartenstein and K. P. Laberteaux, VANET: Vehicular Applications and Inter-Networking Technologies, John Wiley & Sons Ltd., 1st Edition 2010.*
2. *Luca Delgrossi, Tao Zhang, "Vehicle Safety Communications: Protocols, Security, and Privacy", John Wiley & Sons Ltd 1st Edition 2012.*

REFERENCES

1. *P. H.-J. Chong, I. W.-H. Ho, Vehicular Networks: Applications, Performance Analysis and Challenges, Nova Science Publishers, 2019.*
2. *C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2015.*
3. *Popescu-Zeletin R, Radusch I and Rigani M.A, "Vehicular-2-X Communication",Springer,2010.*
4. *M. Watfa, Advances in Vehicular Ad-Hoc Networks: Development and Challenges, Information Science Reference, 2010.*
5. *H. Moustafa, Y. Zhang, Vehicular Networks: Techniques, Standards, and Applications, CRC Press, 2009.*
6. *Xiang W, "Wireless Access in Vehicular Environments Technology", Springer, 2015*

19ECEOE10 - SENSING FOR AUTOMOTIVE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Acquaint with the basic automotive system components and need for automotive sensors.

CO2 : Discuss the fundamentals of various Power train sensors in automotive systems.

CO3 : Comprehend various sensors for chassis management.

CO4 : Understand the sensors for vehicle management & security systems in Automobiles.

CO5 : Examine the vehicle communication protocols standards in automotive applications.

AUTOMOTIVE SYSTEMS

Introduction to Modern Automotive Systems- Electronics in Automobiles - Combustion Engines- Power-train- braking systems - Transmission- Applications and Challenges in the automotive. **(9)**

POWERTRAIN AUTOMOTIVE SENSORS

Exhaust temperature sensor - λ sensors - PM sensor - NOx sensor - fuel quality sensor- level sensor- torque sensor-speed sensor- manifold pressure sensor - mass flow sensor. **(9)**

CHASSSIS SENSORS

Wheel speed sensors/direction sensors- steering position sensor (multi turn)- acceleration sensor (inertia measurement)- brake pneumatic pressure sensor- ABS sensor- electronic stability sensor. **(9)**

SENSORS FOR VEHICLE MANAGEMENT & SECURITY SYSTEMS

Gas sensors (CO2)- Temperature/humidity sensor- air bag sensor- key less entering sensor- radar sensors. Tire pressure monitoring systems- Two wheeler and Four wheeler security systems. **(9)**

VEHICLE COMMUNICATION STANDARDS

Automotive Protocols : CAN, LIN, FLEXRAY, MOST **(9)**

TOTAL : 45

TEXT BOOK

John Turner, Automotive Sensors, 2010, Momentum Press, 1st Edition, New York.

REFERENCES

1. *Automotive Electrics, Automotive Electronics: Systems & Components, 2014, 5th Edition, BOSCH.*
2. *Ronald K Jurgen, "Automotive Electronics Hand Book", McGraw- Hill, 2nd Edition 1999.*
3. *Automotive Sensors Handbook, 8th Edition, 2011, BOSCH*
4. *Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, Iwao Yokomori, "Sensors for Automotive Technology", 4th Edition, Wiley, New York, 2010.*
5. *Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5th Edition, 2009.*

19CSOE01 - CUSTOMER RELATIONSHIP MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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.

CO3 : Understand the type of collecting and connecting the customer data with proper guidelines for privacy.

CO4 : Demonstrate the scoring process and apply the various CRM optimization techniques to optimize the CRM process in order to improve customer profitability.

CO5 : 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 -Data mining tool: WEKA -CRM tools - Next generation for CRM. **(10)**

TOTAL : 45

TEXT BOOKS

1. *Alex Berson, Stephen Smith, Kurt Thearling, "Building Data mining Applications for CRM", Tata McGraw Hill, Fifteenth Reprint, 2008.*
2. *Ian H.Witten ,Eibe Frank, Mark A.Hall, "Data Mining Practical Machine Learning Tools and Techniques", Morgan Kaufmann, Fourth Edition, 2016*

REFERENCES

1. *Francis Buttle, Stan Maklan "Customer Relationship Management: Concepts and Technologies", Routledge, Fourth Edition, 2019.*
2. *Roger J. Baran, Robert J. Galka, "CRM: The Foundation of Contemporary Marketing Strategy", S.Chand (G/L) & Company Ltd, Second Edition, 2017.*

19CSOE02 - FUNDAMENTALS OF SOFTWARE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 BOOKS

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)*

REFERENCES

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*

19CSOE03 - INTERNET PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Gain knowledge in overview of www and web based applications.

CO2 : Design and develop dynamic and Interactive web page 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.*

REFERENCES

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.*

19CSOE04 - INTRODUCTION TO DATA WAREHOUSING AND DATA MINING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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. Association 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.*

REFERENCES

1. *Arun K Pujari, "Data Mining Techniques" Universities Press India Ltd., Third Edition, 2012.*
2. *Dunham, "Data Mining- Introductory and Advanced Topics", Pearson Education, New Delhi, First Edition, 2006.*
3. *Sam Anahory, Dennis Murray, "Data Warehousing in the Real World ", Pearson Education, Seventh Indian Reprint New Delhi,2003.*
4. *George M. Marakas, "Modern Data Warehousing, Mining, & Visualization Core concepts", Pearson Education, First Edition, 2003*
5. *Paulraj Ponnaiah, "Data Warehousing Fundamentals", Wiley Publishers, Singapore, First Edition, 2001.*

19CSOE05 - INTRODUCTION TO EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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*

REFERENCES

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.*

19ITOE01 - DIGITAL COMPUTER BASICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 **(9)**

COMBINATIONAL CIRCUITS

Adder : Half Adder - Full Adder - Binary Parallel Adder - BCD Adder. Subtractor : Half Subtractor - Full Subtractor. Code Conversion. Decoders - De-Multiplexer - Encoders - Multiplexers. **(10)**

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 - Up down 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. Cieti,"Digital Design with an Introduction to the Verilog HDL, Pearson Education, Fifth Edition, 2013.*

REFERENCES

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.*

19ITOE02 - PROGRAMMING IN JAVA

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 references ", Tata McGraw Hill, ftinth Edition, McGraw Hill Education, 2014.*

REFERENCE

1. *Deitel H.M and Deitel P.J, "Java - How to Program", Prentice Hall of India, Ninth Edition, 2012.*

19ITOE03 - FUNDAMENTALS OF DATABASE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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, Coras M.Colonel, "Database Systems: Design, Implementation and Management", Thompson Learning Course Technology, Tenth Edition, 2012.*

REFERENCES

1. *Abraham Silberschatz, Henry F.Korth,S.Sudharshan,"Database System Concepts", McGraw-Hill, Sixth Edition, 2013.*
2. *Ramez Elmasri, Shamkant B. tJavathe, "Fundamentals ofDatabase Systems", Pearson Education, Sixth Edition, 2013.*
3. *Raghu Ramakrishnan, Johannes Gehrke, "Database ManagementSystems", 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, 2004.*

19ITOE04 - CLOUD COMPUTING FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 / 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 tool **(9)**

CLOUD SECURITY

Security Overview - Cloud SecurityChallenges - 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

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, 2002.*
3. *Kai Hwang, Geoffrey C Fox,Jack GDongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2002.*

19ITOE05 - INFORMATION SECURITY FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Identify and analyze the security threats and attacks and applydevice 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. **(9)**

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. **(9)**

POLICIES, STANDARDS, PRACTICES AND BUSINESS CONTINUITY

Introduction - Information Security Policy, Standards and Practices -The Information Security Blueprint: ISO 17799/BS 7799, ISO 27001and itscontrols, NIST SecurityModels, 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 **(6)**

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 ITAct - 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)*

REFERENCES

1. *Thomas R.Pettier, "Information Security Fundamentals", Auerbach Publications, Second Edition, 2013.*
2. *Vicki 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.*

19ITOE06 - INTRODUCTION TO HUMAN COMPUTER INTERACTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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. **(9)**

WINDOWS & COMPONENTS

Windows: New Navigation Schemes - Selection of Window - Selection of DevicesBased on Screen Based Controls. Components: Text and Messages - Icons and Increases - Multimedia - Colors - Uses -Problems - Choosing colors. **(11)**

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

1. *Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition*

19ITOE07 - ENTERPRISE RESOURCE PLANNING CONCEPTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 in order to define the functionality of various departments in a company.

CO4 : Analyze the ERP market place 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)*

REFERENCES

1. *Ellen F.Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Course Technology Ptr, Fourth Edition, 2011.*
2. *Vinod Kumar Garg and Venkitakrishnan N.K., "Enterprise Resource Planning - Concepts and Practice", Prentice Hall of India, New Delhi, Second Edition, 2012.*

19CHOE01 - INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 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 protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe - drilling - boring - milling - grinding - shaping - sawing- shearing presses - forge hammer - flywheels - shafts - couplings -gears - sprockets wheels and chains pulleys and belts - authorized entry to 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 equipment and instruments - safety in generation, distribution and handling of industrial 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-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills - hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production 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 leak test, 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.*

19CHOE02 - RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

1. *Daniel A Crowl., Louvar J.F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, New Jersey, 2002.*

19CHOE03 - GREEN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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 : Analyse 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.*

19CHOE04 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are 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 : Analyse 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-H2O 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.*

REFERENCE

1. *Banarjee.S.N., An introduction to corrosion and corrosion inhibitors, Oxonian Press Ltd., New Delhi, 1985.*

19CHOE05 - INTRODUCTION TO CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are 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 equipment for transport and separation processes.

CO4 : Apply material and Energy balance to precisely calculate material required for a process.

CO5 : Apply steady state balances to develop process flow sheets.

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.*

19CHOE06 - NANOMATERIAL SYNTHESIS AND CHARACTERIZATION LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : To synthesize several nanomaterials in different methods in lab scale.

CO2 : To understand and operate the instruments for material characterization.

CO3 : To interpret the properties of synthesized nanomaterials by analyzing the results

EXPERIMENTS

1. Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidal sol.
2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap estimation from the band edge.
3. Synthesis of ceria nanofibres by Solvothermal method.
4. Synthesis of silica nanoparticles using Stober method.
5. Synthesis of Au nanoparticles by simple chemical method.
6. Synthesis of Fe_3O_4 nanoparticles by simple reduction method.
7. Effect of reducing agent on the synthesis of metal nanoparticles.
8. Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by UV-Visible absorption.
9. Effect of concentration on the synthesis of silver nanoparticles.
10. Effect of reducing agent on gold nanoparticles.
11. Fabrication of silver nanofilms.
12. Synthesis of polyvinyl alcohol fibres by electrospinning method.
13. Synthesis of Au and Ag nanoparticles at aqueous-organic liquid interface; UV-visible spectroscopy of the colloidal film; comparison with the corresponding colloidal sol.
14. Sol gel synthesis of $ZnO/TiO_2/CdO$ nanoparticles.
15. A bioroute to Au nanoparticles.
16. Sol-gel spin coating route to SnO_2 nanothin films: surface roughness measurement by AFM.
17. Hydrothermal synthesis of ZnS Nanorods: Nanorods formation by SEM analysis.
18. Fabrication and wettability characterization of nanostructured soft polymer surfaces.
19. Preparation of nanofluids.
20. Determination of viscosity of nanofluids.
21. Evaporation studies of nanofluids.
22. Measurement of stability of nanofluids.
23. Optical properties of nanofluids.
24. Measurement of onset of natural convection in nanofluids.
25. Thermal conductivity measurement of nanofluids.

TOTAL : 60

REFERENCES

1. *Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, Nanofluids: Science and Technology, Wiley, 2007.*
2. *Vincenzo Bianco, Oronzio Manca, Sergio Nardini, Kambiz Vafai, Heat Transfer Enhancement with Nanofluids, CRC Press, 2017.*
3. *Amy S., Thermal Energy Storage Using Phase Change Materials: Fundamentals and Applications Fleischer, Springer, 2015.*
4. *Mohsen Sheikholeslami and Davood Domairry Ganji, Applications of Nanofluid for Heat Transfer Enhancement, Elsevier, 2017.*
5. *S.M. Sohel Murshed, Carlos Nieto de Castro, Nanofluids: Synthesis, Properties and Applications, Nova Science Publishers, 2014.*
6. *T. Pradeep, A Textbook of Nanoscience and Nanotechnology. Tata McGraw-Hill Education, 2003.*
7. *P.R. Chandran, M. Naseer, N. Udupa, N. Sandhyarani. Size controlled synthesis of biocompatible gold nanoparticles and their activity in the oxidation of NADH. Nanotechnology. 8, 23(1), 2011.*
8. *I.A. Ibrahim, A.A. Zikry, M.A. Sharaf. Preparation of spherical silica nanoparticles: Stober silica. J. Am. Sci. 6(11), 985-9, 2010.*
9. *X. Chen, S.S. Mao. Titanium dioxide nanomaterials: synthesis, properties, modifications, and applications. Chemical reviews. 11, 107(7), 2891-959, 2007.*
10. *Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, Nanofluids: Science and Technology, Wiley, 2007.*

19CHOE07 - MULTIVARIATE STATISTICS LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Design experiments to obtain statistical principles of Univariate examples.

CO2 : Apply the concepts of statistics to draw conclusions from data

CO3 : Assess practical knowledge to carry out meaningful interpretation of data from real life

CO4 : Conduct experiments to solve complex engineering problems effectively as an individual or team work.

CO5 : Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.

LIST OF EXPERIMENTS

1. Point and Interval Estimation for Normal and Chi-Square Distribution using Excel and R.
2. Point and Interval Estimation for T-Distribution and F-Distribution using Excel and R.
3. K-means Clustering.
4. One-way ANOVA Model in Excel and R.
5. Linear Regression
6. Logistic Regression
7. Naive Bayesian Classifier
8. Decision Trees
9. Simulation of Principal component analysis using Excel and R.
10. Simulation of Fischer Discriminant Analysis using Excel and R.
11. Modeling the Change by Differential Equations using R and Excel.
12. Modeling the Change by Difference Equations using R and Excel.
13. Multivariate Normal & Hoteling's T2 Distribution.
14. Multivariate Analysis of Variance (MANOVA).
15. Correspondence Analysis using R.

TOTAL : 60

REFERENCES

1. *Apostol T.M. (1985) Mathematical Analysis, Narosa,Indian Ed.*
2. *Courant R. And John F. (1965) Introduction to Calculas and Analysis, Wiley.*
3. *Miller K.S. (1957) Advanced Real Calculas, Harper, New York.*
4. *Rudin, Walter (1976) Principles of Mathematical Analysis,McGraw Hill.*
5. *Malik S.C. (2005) Principles of Real Analysis, New Age International (p)Ltd.*
6. *Bartle R.G. (1976) Elements of Real Analysis*

19MOE01 - GRAPH THEORY AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE 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 the irrespective mainstream.

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 ANDSUB GRAPHS

Graph-Standard Concepts in Graphs - Sub graphs - Complete Graph - Bipartite Graph - Isomorphism - Adjacency Matrix and Incidence Matrix-Walk, Trail and Path - Bipartite Graph - Connectedness - The Shortest Path Problem - Dijkstra'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)**

TOTAL : 45

TEXT BOOKS

1. *Gary Chatrand and Ping Zhang, Introduction to Graph Theory, Mc Graw Hill Education (India), 2017.*
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" Second Edition, Prentice Hall of India Private Limited, 2001.*
2. *Balakrishnan. R, Ranganathan. K , "A Text book of GraphTheory", Second Edition, Springer Newyork, 2012.*
3. *Clark. J. and Holton. D.A, "A First Look at GraphTheory", Allied Publishers,1995.*
4. *Frank Harary, Graph Theory, 10th Edition, Narosa Publishing House, 2001.*

19MOE02 - METHODS OF APPLIED MATHEMATICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE 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 Bei functions. **(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 - Bessel and Legendre Series **(9)**

PARTIAL DIFFERENTITAL EQUATIONS

Linear and quasi - linear equations of the first and second order. Characteristics of first and second order linear equations. Heat flow equations. Problems in one, two and three dimensions - Fourier method. **(9)**

INTEGRAL TRANSFORM METHODS

Calculus of variations - Variational notation, Constraints and Lagarangian multipliers, variable and points, Rayleigh - Ritz method. **(9)**

TOTAL : 45

TEXT BOOKS

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 Edition (EEE).Prentice Hall of India P.Ltd., 2014.*

REFERENCES

1. *F.B. Hildebrand - Methods of Applied Mathematics, Second Edition. Prentice Hall of India P.Ltd., 2012.*
2. *David Borthwick : An introduction to partial differential equation Springer International Publishing 2017.*
3. *Mattias Blennow: Mathematical methods in Physics and Engineering, CRC Press, 2018.*

19MOE03 - LINEAR AND NON - LINEAR PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE 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 - Vogel'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 Sales man 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 2016, New Delhi.*
2. *Resource management techniques by V.Sundaresan, Tenth Edition, 2016, A.R Publications, Chennai.*

REFERENCES

1. *Kanti Swarup, P.K. Gupta and Man Mohan, " Operations Research", Sultan Chand & Sons, Educational publishers, New Delhi. 20th Edition, 2019.*
2. *Frederick S. Hillier, Gerald J. Lieberman, "Introduction to Operations Research", Mc Graw Hill, (India) Private Limited, India, 11th Edition, 2021.*

19MOE04 - PROBABILITY AND RANDOM PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will be able to understand the basic 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

Discrete distributions : Binomial, Poisson and Geometric - Properties and Simple problems

Continuous distributions : Normal, Uniform Exponential - Properties and Simple problems. **(9)**

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 FUNCTIONS AND POWER 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, 2020.*
2. *T. Veerarajan, Probability, Statistics and Random Processes, Second Edition, Tata Mc Graw - Hill 2017.*

REFERENCS

1. *Robert Hogg & Joseph McKean: Introduction to Mathematical Statistics, Pearson 8th Edition 2018.*
2. *Bhat, B. R.: Modern Probability Theory - An Introductory Text Book, Third Edition, New Age International 2015.*

3. *Cochran,W.G: Sampling Techniques, Wiley Eastern Private Limited, 2007.*
4. *Sukhatme, P.V. and Sukhatme, B.V.(1977) : Sampling Theory of Survey with Applications, Asia publishing House.*
5. *Rakesh Dube, "Higher mathematics for Engineering and Science" Manakin Press, 2018.*
6. *Ibe,O.C.,"Fundamentals of Applied Probability and Random processes", 2nd Edition, Elsevier, 2019.*
7. *Peyton Peebles, "Probability Random Variables and Random Signal Principles", Tata Mc Graw Hill, 4th Edition, NewDelhi, 2017.*

19POE01 - INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

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 - Structual, 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 (buckyballs, 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. *Nano technology: Basic Science and Emerging technologies, Mick Wilson, Kamali Kannargare., Geoff Smith Overseas Press (2005)*
2. *A Text book of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw Hill Education Pvt. Ltd., 2012.*
3. *Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, 2002.*
4. *Introduction to Nanotechnology, Charles P.Poole,Frank J.Owens, Wiley Interscience (2003)*

5. *Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, Baldev Raj, B B Rath, 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*

19POE02 - PHYSICS AND TECHNOLOGY OF THIN FILMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

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 abalation 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. *Kiyotaka Wasa, Makoto Kitabatake, Hideaki Adachi, Thin Films Material Technology, Springer-Verlag Berlin Heidelberg, 2004.*

19POE03 - SOLAR CELL FUNDAMENTALS AND MATERIALS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

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

EVOLUTION 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.*

19POE04 - ADVANCED MATERIAL PROCESSING TECHNOLOGIES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

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

INTRODUCTION AND 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, 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. **(10)**

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. **(8)**

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. *Betzalel Avitzu, "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", Mc Graw Hill Publishing Co., INC, 1997*
2. *Gowariker V R, Viswanathan N V, Jayadev Sreedhar, "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.*

19COE01 - 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. *George W. 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*

REFERENCES

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.*

19COE02 - ADVANCED DRUG DELIVERY SYSTEMS

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

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)**

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)**

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 antibodybioconjugates. **(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.*

19COE03 - 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 microporous 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.*

19COE04 - 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 Veprek (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*

19COE05 - 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; trichoderma 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.*

REFERENCES

1. *Martin Kaltschmitt; Hermann Hofbauer. "Biomass Conversion and Biorefinery", Springer Publishing, 2008.*

19HOE01 - PRINCIPLES OF MANAGEMENT

COURSE OUTCOMES

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

Unit I - Introduction to Management: Meaning, Definition and Significance of Management-Basic functions of Management-Development of Management Thought **(9)**

Unit II - Management Concepts: Planning, Organizing, Staffing, Directing and Controlling- MBO-Six sigma **(9)**

Unit III - Organizational Behavior: Significance of OB, Role of Leadership, Personality and Motivation, Stress, Attitudes, Values and Perceptions at work **(9)**

Unit IV - Business Process Reengineering: Need for BPR, Various phases of BPR, Production and Productivity-Factors influencing Productivity **(8)**

Unit V - 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 BOOKS

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.*

REFERENCES

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.*

19HOE02 : CURRENT TRENDS IN INDIAN ECONOMY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

Unit - 1 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)**

Unit - II 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)**

Unit - III 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)**

Unit - IV Service sector: Service sector in India-Banking-Insurance-Telecommunication-IT sector-Software exports-BPO-Contribution to GDP **(9)**

Unit - V 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 BOOKS

1. *Ruddar Datt and Sundaram, KPM, Indian Economy, S.Chand and company, New Delhi-2015*
2. *Ramesh Singh Indian Economy, McGraw hill Education 7th edition, 2015*

References: www.jagranjosh.com

19H0E03 - MONETARY ECONOMICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

Unit I 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)**

Unit II 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)**

Unit III 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)**

Unit IV 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)**

Unit V 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.*

REFERENCES

1. *Sethi TT, "Monetary Economic Theory", S Chand & Co, New Delhi, 1996.*
2. *Mithani DN, "Money Banking and International Trade", Himalaya, Mumbai, 2013.*

19HOE04 - ENGLISH FOR ACADEMIC PURPOSE

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : Write a description and apply grammatical rules.

CO2 : Analyse a passage and enhance vocabulary.

CO3 : Formulate a research paper

CO4 : Listen to a lecture and prepare a summary.

CO5 : Construct dialogues using appropriate expressions.

FOCUS ON LANGUAGE

Sentence construction- types of clauses- sequence- co ordination- subordination- paragraphing information - describing a system & procedure **(9)**

READING

Understand a writer's purpose - Use strategies to ascertain meaning from unfamiliar vocabulary encountered in context - Recall and use vocabulary regarding urbanization and megacities - 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. **(13)**

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 - 6. The Methodology - The Results - The Discussion - The Conclusion - Citing Sources - Proofreading.

LISTENING

Listening to conversation - lectures - topics - discussions - listening comprehension on specific topics - listening to recognize formal and informal spoken English **(11)**

SPEAKING

Seminar skills - Engage in verbal role playing in Formal and Informal situation. - 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 **(12)**

TOTAL : 45

REFERENCES

1. *Wisniewska, I., Riggenbach, H.,& Samuda, V. (2007). Grammar dimensions*
2. *Form, meaning, and use (4th Ed.). Boston, MA: Heinele Cengage Learning Longman Introductory Course for the TOFEL Test*
3. *Original publications and web- based resources will be reviewed as necessary.*

19HOE05 - ENGLISH FOR COMPETITIVE EXAMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : Listen to TOEFL 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 question.

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 a 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

REFERENCES

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.*
2. *Sharpe J.Pamela. Barron's TOEFL iBT Internet- Based Test. 12th Edition, Galgotia publications Pvt.Ltd: New Delhi, 2009.*

19HOE06 - LIFE AND LITERATURE

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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 the fiction

Unit - 1 : 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)**

Unit - 2 : Poems

Stopping By Woods on a Snowy Evening by Robert Frost

The Ballad of Father Gilligan by W.B. Yeats **(9)**

Unit - 3 : 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

Albert Einstein and Steve Jobs **(11)**

Unit - 4 : 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

REFERENCES

1. *Xavier. ed. An Anthology of Popular Essays and Poems. Macmillan: New Delhi, 2009.*
2. *Kumara Pillai. ed. A Book of Modern Short Stories. Macmillan: New Delhi, 2009.*
3. *Colleen and Darius Krishnaraj. ed. Convergence , A Book of Short Stories. Macmillan: New Delhi, 2009.*
4. *Ernest Hemmingway. The Old Man and the Sea. Arrow: Warwickshire, 2000.*
5. *Baroness Emma Orczy, The Scarlet Pimpernel. Hutchinson : 1995.*

COIMBATORE INSTITUTE OF TECHNOLOGY

(Autonomous Institution affiliated to Anna University Chennai)

COIMBATORE - 641 014

DIAMOND JUBILEE

(1956 - 2016)

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF MECHANICAL ENGINEERING

CURRICULUM & SYLLABI

THIRD TO EIGHTH SEMESTER

Under Choice Based Credit System

(For the students admitted during the academic year 2019 - 2020 and onwards)

INDEX