DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instructions

and

Syllabi of

B.E VII and VIII SEMESTER

2018-2019

UNIVERSITY COLLEGE OF ENGINEERING
(AUTONOMOUS)

OSMANIA UNIVERSITY

HYDERABAD-500 007, TELANGANA

UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY

VISION OF THE INSTITUTE

The Vision of the Institute is to generate and disseminate knowledge through a harmonious blending of Science, Engineering and Technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

MISSION OF THE INSTITUTE

- To achieve excellence in Teaching and Research.
- To generate, disseminate and preserve knowledge.
- To enable empowerment through knowledge and information.
- Advancement of knowledge in Engineering, Science and Technology.
- Promote learning in free thinking and innovative environment.
- Cultivate skills, attitudes to promote knowledge creation.
- Rendering socially relevant technical services for the community.
- To impart new skills of technology development.
- To inculcate entrepreneurial talents and technology appreciation programmes.
- Technology transfer and incubation.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION OF THE DEPARTMENT

To generate and disseminate knowledge in Mechanical Engineering and nurture professional, technical and scientific temper for serving the needs of the industry, research organizations and society.

MISSION OF THE DEPARTMENT

- Create technically competent mechanical engineers to suit the changing needs of global industry and society.
- To cultivate skills, attitudes to promote knowledge creation and technology development.
- Interact with prominent educational institutions and R&D organizations for enhancing teaching, research and consultancy services.

DEPARTMENT OF MECHANICAL ENGINEERING

B.E (Mechanical Engineering)

PROGRAM EDUCATIONAL OBJECTIVES

PEO 1	To provide the requisite fundamentals of varied subjects related to Mechanical Engineering to conceive, plan, model, design, construct, maintain and improve systems to enhance human comfort.
PEO 2	To provide knowledge of experimental, computational, analytical, simulation tools and techniques require to address the challenges in Mechanical Engineering and other allied fields.
PEO 3	To provide knowledge to apply Mechanical Engineering Fundamentals to design and implement cost effective systems in manufacturing.
PEO 4	To provide effective communication skills, creative methods, ethics and continuous learning techniques to fulfill their professional requirements and societal needs.

PROGRAM ARTICULATION MATRIX

S.No.	PEO Statement	M1	M2	M3
PEO 1	To provide the requisite fundamentals of varied subjects related to Mechanical Engineering to conceive, plan, model, design, construct, maintain and improve systems to enhance human comfort.	3	3	3
PEO 2	To provide knowledge of experimental, computational, analytical, simulation tools and techniques require to address the challenges in Mechanical Engineering and other allied fields.	3	3	3
PEO 3	To provide knowledge to apply Mechanical Engineering Fundamentals to design and implement cost effective systems in manufacturing.	3	3	3
PEO 4	To provide effective communication skills, creative methods, ethics and continuous learning techniques to fulfill their professional requirements and societal needs.	2	2	2

PROGRAM OUTCOMES (POs):

At the end of the program, the student will be able to:

POs	
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an mechanical engineering to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems related to mechanical engineering and allied fields reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**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.
PO4	**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.
PO5	**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.
PO6	**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 Mechanical engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the mechanical engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the mechanical 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.
PO12	**Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
Program Specific Outcomes	
PS01	Apply the principles of collaborative and multi disciplinary approach for solving problems
PS02	Able to interact with industry and R&D institutions leading to start-ups/ budding entrepreneurs.

SCHEME OF INSTRUCTION & EXAMINATION
B.E VII Semester (Mechanical Engineering)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P	Contact Hrs/wk	CIE	SEE	
1	PC701ME	Thermal Turbo Machines	3	-	-	3	30	70	3
2	PC702ME	CAD/CAM	3	-	-	3	30	70	3
3	PC703ME	Management and Information system	3	-	-	3	30	70	3
4	HS901MB	Managerial Economics & Accountancy	3	-	-	3	30	70	3
5	PC704ME	Finite Element Analysis	3	-	-	3	30	70	3
6	PE *	Professional Elective - III	3	-	-	3	30	70	3
7	OE **	Open Elective-II	3	-	-	3	30	70	3
PRACTICALS									
8.	PC751ME	Thermal Engineering Lab	-	-	2	2	25	50	1
9.	PC752ME	CAD/CAM Lab	-	-	2	2	25	50	1
10.	PW761ME	Summer Internship	-	-	-	-	50	-	2
11.	PW762ME	Project Work-I	-	-	2	2	100	-	4
		Total	21	00	06	27	410	590	29

*PROFESSIONAL ELECTIVE-III	
PE701ME	Design of Solar Energy Systems
PE702ME	Non-conventional Methods of Machining & Forming
PE703ME	Additive Manufacturing Technologies
PE704ME	Aerodynamic Design of Thermal Turbines
PE707ME	Entrepreunership

**OPEN ELECTIVE-II	
OE701BM	Human Factor Engineering
OE702BM	Basic Medical Engineering
OE701CE	Optimization Techniques
OE701CS	Data Base Management Systems
OE702CS	Information Security
OE701EC	Principles of electronic communication
OE702EC	Fundamentals of IOT
OE701EE	Non-conventional Energy Sources
OE701ME	Startup Entrepreunership
#OE702ME	Finite Element Methods

OE702ME not applicable for Mechanical and Civil Engineering students.

Department of Mechanical Engineering
University College of Engineering (A), Osmania University, Hyderabad-500 007

List of NPTL course approved for the academic year 2018-19

Professional Elective-IV

S. No	Name of Course	Registration Last Date	Start Date	End Date	Exam Date	Course Duration
1.	Design for Quality, Manufacturing and Assembly	August 06, 2018 till 5:00pm	August 06, 2018	September 28, 2018	October 07, 2018	8 weeks
2.	Processing of Polymers and Polymer Composites	August 06, 2018 till 5:00pm	August 06, 2018	September 28, 2018	October 07, 2018	8 weeks
3.	Engineering Fracture Mechanics	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
4.	Energy Conservation and Waste heat recovery	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
5.	Mechanics of Human Movement	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
6.	Fundamentals of surface Engineering: Mechanisms, Process and Characterization	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks

Professional Elective-V

S. No	Name of Course	Registration Last Date	Start Date	End Date	Exam Date	Course Duration
1.	Introduction to Abrasive Machining and Finishing Process	August 06, 2018 till 5:00pm	August 06, 2018	September 28, 2018	October 07, 2018	8 weeks
2.	Heat Exchangers: Fundamentals and Design Analysis	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
3.	Work System Design	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
4.	Noise Management and Control	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
5.	Advanced Composites	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks

Open Elective-III

S. No	Name of Course	Registration Last Date	Start Date	End Date	Exam Date	Course Duration
1.	Integrated Waste Management for Smart City	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
2.	Waste water Treatment and Recycling	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
3.	Introduction to Internet of Things	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
4.	Introduction to R software	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
5.	Fabrication Techniques for MEMS based sensors: Clinical Perspective	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
6.	Digital Image Processing	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
7.	Controls Engineering	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
8.	Ecology and Environment	August 06, 2018 till 5:00pm	August 06, 2018	September 28, 2018	October 07, 2018	8 weeks
9.	Total Quality Management-I	August 06, 2018 till 5:00pm	August 06, 2018	September 28, 2018	October 07, 2018	8 weeks
10.	Ethics in Engineering Practice	August 06, 2018 till 5:00pm	August 06, 2018	September 28, 2018	October 07, 2018	8 weeks
11.	Structural Health Monitoring	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
12.	Transform Techniques for Engineers	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks
13.	System Design for Sustainability	July 30, 2018 till 5:00pm	July 30, 2018	October 19,2018	October 28, 2018	12 weeks

PC701ME

THERMAL TURBO MACHINES

Credits: 3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn about formulation of governing equations for compressible fluid flows
- To understand the design concepts of mechanical devices handling compressible fluids
- To learn about the functioning of turbomachines and related performance parameters.

Course Outcomes:

- The Students will be able to
- The Students are expected to formulate governing equations of compressible flows and derive relations among fluid flow properties.
- The Students are expected to be able to predict the compressible flow properties behaviour with friction, heat transfer and shock waves.
- The Students are expected to be able to classify turbomachines and explain working principle of rotodynamic compressors and calculate performance parameters.
- The Students are expected to explain classification and working principles of steam turbines. They must be able to draw velocity diagrams and calculate performance parameters.
- The Students are expected to be able to explain working principles of gas turbine cycles and understand methods to improve their efficiency. They should be able to understand working principles and performance parameters of Jet and Rocket Propulsion Systems

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PS O1	PS O2
CO1	3	3	3	3	1	1	-	-	-	1	1	-	1	1
CO2	3	3	3	3	3	-	-	-	-	1	1	1	1	-
CO3	3	3	3	3	2	-	-	-	-	1	2	2	2	2
CO4	3	3	3	3	3	2	2	-	-	2	1	1	-	-
CO5	3	3	3	3	3	2	2	-	-	2	1	1	-	-

Unit-I

Introduction to compressible flows: bulk modulus and coefficient of compressibility, acoustic velocity, mach number, pressure field created by a point disturbance, mach cone and mach angle.
Isentropic flow through variable area devices: Energy equation for flow through nozzles and diffusers, Relations connecting stagnation and static properties-enthalpy, temperature, pressure and density. Various regimes of flow-adiabatic steady flc.v ellipse. Effect of back pressure on nozzle performance.

Unit-II

Flow through constant area ducts with friction (Fanno flow): Governing equation, Fanno line, Fanno relations for perfect gas, maximum length of a duct.
Flow through constant area ducts with heat transfer (Rayleigh flow): Governing equation, Rayleigh line, Rayleigh relations for perfect gas, choking due to heat transfer.
Types of shocks-normal, oblique and expansion.
Normal shock waves : Governing equations, Prandtl-Meyer equation, Rankine-Hugoniot relations.
Oblique shock waves: Relation between deflection angle and wave angle.

Unit-III

Definition and classification of turbo machines, Euler's equation for energy transfer.
Rotodynamic compressors: General classification, comparison with positive displacement compressors. Concept of shape number-selection of impeller.
Axial flow compressors: Stage velocity triangles, enthalpy-entropy diagram, Euler's work input, flow coefficient, blade loading coefficient, relations for static pressure rise in rotor,

stator and stage. Stage and polytropic efficiency. Factors affecting stage pressure ratio. Degree of reaction. Surging, stalling and choking.

Centrifugal compressors: Elements of a centrifugal stage, stage velocity triangles, performance of different types of impellers- forward, radial and backward swept blades. Enthalpy-entropy diagram, degree of reaction. Slip factor, actual work and stage and polytropic efficiency.

Unit-IV

Steam Turbines: Classification, flow over blades, impulse and reaction turbines, Pressure and velocity compounding of steam turbines.

Impulse steam turbines: Velocity triangles-single and multistage De Laval turbine, effect of blade friction, axial thrust, effect of blade speed ratio on stage and blade efficiency. Partial Admission, height of turbine blades.

Parson's reaction turbine: Reaction stage analysis, degree of reaction, maximum blade efficiency, representation on enthalpy-entropy diagram. Height of turbine blades.

Unit-V

Gas turbines : Classification and comparison of open and closed cycles. Thermodynamic Analysis of Brayton/Joule cycle. Methods to improve thermal efficiency of gas turbine cycles: inter cooling, reheat and regeneration.

Jet Propulsion : Aircraft propulsion turbo engines: Turbo jet, turboprop, turbofan, ramjet and pulse jet engines. Propulsion performance parameters: Thrust force, thrust power and thrust specific fuel consumption. Thrust, propulsion, transmission and overall efficiencies

Rocket Propulsion: Working principle, propulsion efficiency.

Types of Rocket engines: Solid propellant and liquid propellant engines.

Suggested Reading:

1. Yahya S M, " Fundamentals of compressible flow", Wiley eastern Ltd., 2003.
2. Balachnadran P, "Fundamentals of Compressible fluid dynamics", Prentice Hall of India, New Delhi, 2006.
3. Rathakrishnan E, "Gas Dynamics", Prentice Hall of India, New Delhi, 2003.
4. Mathur M L & Mehta F S, " Thermal Engineering", Jain Brothers(New Delhi), 1996.
5. Gopalakrishnan G, Prithvi Raj D, "A treatise on Turbomachines", Scitech Publications, Chennai, 2002.

PC702ME

CAD/CAM

Credits: 3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To introduce the concepts of CAD and advanced modeling techniques
- To help the students in understanding the functioning of computer numerical control machine tools and also in writing programs for operating this machines.
- To help the student in understanding advanced manufacturing concepts like Group technology, flexible manufacturing systems, Computer aided Process Planning, Computer aided quality control, Artificial Intelligence etc.

Course Outcomes:

The Students will be able to

- Understand the fundamental applications of computer in design, manufacturing and geometric transformation techniques in CAD
- Develop mathematical Model for curves, surfaces, solid models and understand the fundamental concepts of Finite Element Analysis
- Write CNC Part program for manufacturing components
- Understand the concepts of Machining Centres, adaptive control and as well as fundamentals knowledge of robotics
- Understand the working of various components of an modern manufacturing systems

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS O1	PS O2
CO1	3	2	1	1	2	1	-	-	-	-	-	1	-	1
CO2	3	2	1	2	3	1	--	--	--	--	--	1	1	3
CO3	2	2	1	2	3	1	-	-	-	-	-	1	-	3
CO4	2	2	1	2	3	2	-	-	-	-	-	1	-	2
CO5	2	2	1	2	3	2	-	-	-	-	-	1	-	2

Unit-I

CAD Fundamentals, Product life cycle in conventional and computer based manufacturing system, Hardware integration and networking. CAD Software: Definitions of system software and application software. Graphic Standards and Exchange Formats. CAD database and structure. Automatic 2-D facilities such as Fillets, Chamfers, Hatching, Dimensioning, Editing, Windowing & Zooming. 2-D & 3-D Geometric Transformations.

Unit-II

Geometric modeling: 3-D wire frame modeling: wire frame entities and their definitions, Interpolation and approximation of curves, synthetic curves and curve fitting. Definitions of cubic, Bezier, and B-spline curves.

Surface modeling: Definitions of basic surfaces, surface of revolution, blends, intersection, and Cubic, Bezier, B-spline surfaces.

Solid Modeling: Solid entities, Boolean operations, B-rep and C-rep approaches. Feature based modeling: Concepts and applications, Assembly modeling.

Finite element modeling: Introduction, modeling, Meshing, Characteristics of different elements, different solvers and post processing.

Unit-III

Numerical Control of machine Tools: Features and elements of NC. Positional, paraxial and contouring types. Definitions of axes, punched type, formats of tape preparation. Definitions of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components. Programming with MACROS.

Unit-IV

Computer Control in NC and Robots: Machining centers, CMC, DNC and adaptive control systems. Their types, typical configurations and relative features. Industrial Robots: Classification based on manipulator configurations, relative characteristics, Online and offline programming methods, controls and drives, applications.

Unit-V

Group Technology: Organization, G.T. layout, part classification and coding, CAPP: Variant and Generative approaches and their relative features. Computer Aided Quality Control: Computer in quality control, Contact and non contact inspection, optical and non optical computer aided testing. Basic concepts of FMS, Experts systems. Artificial intelligence, CAD/CAM integration, Introduction to 3D Printing: Process chain, Classification , description about SLA, SLS and FDM processes.

Suggested Reading:

1. Ibrahim Zeid, "CAD/CAM, theory and practice", McGraw Hill Inc, N.Y.1991.
2. Grover, MP and Zimmers E.W., "CAD/CAM", Prenctice Hall of India 1989.
3. Rao P.N., Tiwari N.K., Kundra T.K., "Computer Aided Manufacturing", Tata McGraw Hill, New Delhi, 1993.
4. Radhakrishnan. P, Subramanyan. S, Raju. V, "CAD/CAM/CIM", New Age international (P) Ltd., 2nd Edn., 2004.

PC703ME

MANGEMENT AND INFORMATION SYSTEM

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the concept of method study, ergonomics, forecasting and their role in Management.
- To know the important components of management like marketing, financial and maintenance management.
- To understand the role of information system in implementing modern management concepts.

Course Outcomes: The Students will be able to

- To understand the concept of motion study, ergonomics , forecasting and their role of management
- Understand the concept of forecasting and its types using different techniques along with cost analysis
- To understand the marketing concepts and strategies with financial and time management
- To understand maintenance management and cost associated evaluation of life testing of products using reliability testings
- To understand the role of information systems and in implementing modern management concepts

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		1		1	3	1	1			2		2	1	2
CO2		2	1	1	2		2		1	2	3	2	1	
CO3	1	1			1			1		1	2	1	1	2
CO4	1	1	2	1				1			1	1	2	
CO5		2	2		2					2	2	2	1	2

Unit-I

Method Study: Introduction and Definition, Objectives of Method Study, Steps involved in method study, Selection of the job for method study, Recording Techniques, Micro-Motion Study, Memo Motion Study, Cycle Graph and Chronocycle Graph, Principles of Motion Economy.
Ergonomics: Introduction and Definition, Objectives of Human Engineering, Ergonomics as Multidisciplinary, Ergonomic Productivity and Working Environment, Study of Human Engineering Areas, Man-Machine Systems, Three Aspects of a Man-Machine Systems, Display Design, Design of Controls, Environmental Factors, Anthropometry, Manual Material Handling, Physiological Aspects of Muscular Work, Workplace Design.

Unit-II
Forecasting : Introduction, Need for forecasting, Long-term and Short-term forecasts, Classification of Forecasting Methods, Judgment Techniques, Time-Series Analysis: Least Square Method of Forecasting (Regression Analysis), Moving Average Forecasting, Exponential Smoothing Method, Casual Forecasting Method, Forecast Error, Costs and Accuracy of Forecasts.

Unit-III
Marketing Management; Marketing concepts -4P components of marketing mix management, product life cycle and its forecasting strategies. Marketing Research Techniques and different sales promotion methods.
Financial Management: Elements of cost – establishing selling price of a product of a product, overheads and its distribution. Nature of financial management. Time value of money, Techniques of capital budgeting.

`Unit-IV

Maintenance management : Introduction, Objectives, Maintenance Costs, Benefits and Limitations of Failure Statistics, Types of Maintenance, Preventive Maintenance System, Break down Maintenance, Condition Based Maintenance System.

Reliability. Introduction, Reliability in terms of hazard rate, failure density function. Bath tub curve. Reliability calculation for series, parallel and parallel- series systems. Relationship between reliability, maintainability and availability. Introduction to life testing and estimation of parameters for exponential distribution.

Unit-V

Information System: Definition of Information System (IS), Organizational Need for Information System, Impact of IT on Organization Structure, Operating Elements of an IS, Main Functions of IS, Information Flows in organization, Information users and their information needs, Characteristics of the information systems, Information System at operational, tactical and strategic levels, Model of an information system, strategic uses of information technology. Categories of computers, input/ output devices, primary and secondary storage, introduction to operating system.

Suggested Reading:

1. Everett E.ADAM, Jr and Ronald J. Ebert, Production and Operation Management- concepts, models and behavior", 5 ed. 1988, (EEE), Prentice- Hall of India (P) LTD., New Delhi.
2. Robert Schultheis, Mary Sumner, "Management Information System": Irvin Mc Graw Hill,1998
3. S.K. Hazara Chowdary, "Production Management", Media Promoters & Publishers LTD., Calcutta.
4. Harold Amrine, "Manufacturing Organization & Management", Eastern Economy Edition.
5. Martand Telsang, "Industrial Engineering and Production Management", S.Chand & Company Ltd., 1998.
6. S.A.Kelkar, "Management Information Systems- A Concise Study", PHI, New Delhi- 2008.

HS901MB

MANAGERIAL ECONOMICS & ACCOUNTANCY

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand responsibilities of a manager of a business undertaking.
- To analyze various factors influencing demand elasticity
- To Forecast & compute the future sales level.
- To determine Break Even Point (BEP) of an enterprise
- To understand the features, steps, merits, uses & limitations of Pay Back, ARR, NPV, PI & IRR methods of Capital Budgeting
- To understand the principles of accounting and prepare Journal, Ledger, Trial Balance, Manufacturing A/c, Trading A/c., Profit & Loss A/c. and Balance Sheet of an enterprise.

Course Outcomes:

- Understand the responsibilities of a manager of a business undertaking
- Able to Forecast & compute the future sales level
- Outline the features, steps, merits, uses & limitations of Pay Back, ARR, NPV, PI & IRR methods of Capital Budgeting
- Assess various factors influencing demand elasticity and determine Break Even Point (BEP) of an enterprise
- Understands the principles of accounting and prepare Journal, Ledger, Trial Balance, Manufacturing A/c, Trading A/c., Profit & Loss A/c. and Balance Sheet of an enterprise.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1					1	1	2	1	1	1	1	1	
CO2	1	1			1	1	1				1	1	1	
CO3	1	1			1	1		2			1	1	1	
CO4	1	1				1					1	1	1	
CO5	1	1			2	1					1	1	1	

UNIT-I

Introduction to economics and its evolution: Managerial Economics its Scope, Importance and relation to other sciences, its usefulness to engineers-Basic concepts of Managerial Economics.

UNIT-II

Demands: Analysis-concept of demand, determinants, law of demand, its assumptions, elasticity of demand, price, income and cross elasticity, demand forecasting-markets competitive structure, price- output determination under perfect competition and Monopoly. (Theory questions and small numerical problems can be asked).

UNIT-III

Theory of Production: Firm and industry-production function-input-output relations-laws of returns- internal and external economics of scale. Cost analysis-Cost concepts-fixed and variable costs-explicitly and implicitly costs-out pocket of costs and imputed costs-opportunity cost-cost output relation- ship-break even analysis. (Theory and Problems).

UNIT-IV

Capital management: Significance, determinates and estimation of fixed and working capital require- ments, sources of capital. Introduction to capital budgeting, methods of payback and discounted cash flow methods with problems. (Theory questions and numerical problems on estimating working capital requirements and evaluation of capital budgeting opportunities can be asked)

UNIT V

Book-keeping: Principles and significance of double entry book keeping, journal, subsidiary books,

ledger accounts, trial balance concepts and preparation of final accounts with simple adjustments-analysis and interpretation of financial statements through ratios.
(Theory questions and numerical problems on preparation of final accounts, cash book, petty cash book, bank reconciliation statement, calculation of some ratios)

Suggested Readings:

1. Varshney RL and KI Maheswari, Managerial Economics, Sultan Chand.
2. JC Pappas and EF Grigham, Managerial Economics.
3. Grawal T.S. Introduction to Accountancv.
4. Maheswari S.N. Introduction to Accountancy.
5. Panday I.M. Financial Management.

PC704ME

FINITE ELEMENT ANALYSIS

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the theory and application of the finite element method for analyzing structural systems.
- To learn Approximation theory for structural problems as the basis for finite element methods
- To learn formulations for a variety of elements in one, two, and three dimensions. Implementations of element formulations will be examined using Matlab.
- To understand modeling and analysis of structures using planar, solid, and plate elements

Course Outcomes:

Unit-I

Introduction to Finite Element Method, solution method using FEM, descretisation, Boundary conditions, load application, types of elements comparison, Stress and Equilibrium, Boundary conditions. Strain-Displacement relations. Stress-strain relations.
One Dimensionla problems: Finite element modeling, coordinates and shape functions.
Potential Energy approach: Assembly of Gloabal stiffness matrix and load vector. Finite elemtn equations, Treatment of boundary conditions. Quadratic shape functions.

Unit-II

Analysis of trusses and frames: Element stiffness matrix for a truss member. Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node.
Analysis of Beams: Element stiffness matrix for two nodded, two degrees of freedom per node beam element.

Unit-III

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions.
Finite element modeling of Axisymmetirc solids subjected to Axisymmetric loading with triangular elements.

Unit-IV

Two dimensional four nodded isoparametric elements and numerical integration.
Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional analysis of thin palate. Analysis of uniform shaft subjected to torsion.

Unit-V

Dynamic Analysis: Formulation of finite element mode, element matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam.
Time dependent field problems: Application to one dimensional heat flow in a rod. Finite element formation to three dimensional problems in stress analysis. Types of elements used.
Convergence requirements and geometric isotropy. Local, natural and global coordinates. Introduction to Finite Element Analysis Software.

Suggested Reading:

1. Tirupathi R. Chandraputla and Ashok, D. Belgundu" Introduction to Finite Elements in Engineering", pearson Education, 2002, 3rd Edition.
2. Rao S.S., "The Finite Element Methods in Engineering", pergamon Press, 1989.
3. Segerlind, L.J. "Applied Finite Element Analysis", Wiley Publication, 1984.
4. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill Company, 1984.

PC751ME

THERMAL ENGINEERING LABORATORY

Credits:1

Instructions: (2P) hrs per week *Duration of SEE: 3hours*
CIE: 25 Marks *SEE: 50 Marks*

Objectives:

- To understand working principles of heat transfer equipment
- To understand the flow phenomena on cascade blades.
- Understand the fundamental applications of measuring instruments in equipment
- Able to find the performance of compressors, blowers
- Understand the working and determine the performance various turbines
- Able to estimate the heat transfer in various types of heat exchangers
- Able to find out conductivity of solids and liquids and convection in liquids

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	2						1	1		1
CO2	2	2	2	1	1						1	1		1
CO3	2	2	2	1	1						1	1		1
CO4	2	2	2	1	1						1	1		1
CO5	2	2	1	1	1						1	1		1

- **A representative list of experiments to be conducted is as follows:**

1. Determination of static pressure distribution on a turbine blade surface at midspan on low speed wind tunnel.
2. Study on downstream wake profile of a turbine cascade at midspan on low speed wind tunnel.
3. Study on downstream wake profile of a compressor cascade at midspan on low speed wind tunnel.
4. Study of Double pipe Heat Exchanger: Determination of Overall heat transfer coefficient in Parallel and counter flow modes of operation.
5. Study of Finned Tube Heat Exchanger: Determination of Overall heat transfer coefficient in Parallel and counter flow modes of operation.
6. Study of Shell and Tube Heat Exchanger: Determination of Overall heat transfer coefficient in Parallel and counter flow modes of operation.
7. Study of Cross flow Heat Exchanger: Determination of Overall heat transfer coefficient.
8. Study on Thermal conductivity of metal rod.
9. Study on Thermal conductivity of liquid.
10. Study on Thermal conductivity of insulating powder
11. Study on performance of Centrifugal blower with forward swept blades.
12. Study on performance of Centrifugal blower with backward swept blades.
13. Heat transfer in Forced Convection.
14. Heat transfer in Natural Convection.

15. Critical Heat flux apparatus (Boiling Heat Transfer)
16. Unsteady State of Heat Transfer.
17. Study on heat pipe demonstrator
18. Study on Stefan Boltzmann apparatus
19. Pressure distribution in convergent air nozzle

PC752ME

CAD/CAM LAB

Credits:1

Instructions: (2P) hrs per week *Duration of SEE: 3hours*
CIE: 25 Marks *SEE: 50 Marks*

Objectives:

- To understand the various features of geometric modeling packages like Creo(Pro-E) /CATIA/Solid Works like 2d-Sketching, Part Modeling and Assembly
- To understand the application of Finite Element Analysis packages like ANSYS/ NASTRAN/ADINA in solving structural and thermal problems
- To develop NC part program, simulate and manufacture components on CNC machine
- Understand the Various Features of Geometric Modeling Package Creo(Pro-E) like 2d-Sketching, Extrude, revolve, sweep, surface of revolution, blend etc.
- Apply the knowledge of Finite Element analysis in solving structural and thermal problems using Ansys software.
- Write NC Part program, simulate and manufacture components on CNC machine

Course Outcomes:

- Apply the Various Features of Geometric Modeling Package like 2d-Sketching, Extrude, revolve, sweep, blend etc. For modelling Three Dimensional parts.
- Apply the knowledge of Finite Element analysis in solving structural and thermal problems using standard FEA software.
- Write NC Part program and generate tool path simulation using CAM Software

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	--	2	--	--	---	---	2	1	1	---	---
CO2	2	2	2	1	2	--	---	----	----	1	---	1	--	--
CO3	--	1	--	2	1	--	---	--	1	---	1	---	--	--

List of Experiments :

1. Introduction to 2D Sketching & Extrude
2. Modelling of parts using Revolve Feature
3. Modelling of parts using Sweep feature
4. Modelling of parts using blend Feature
5. Analysis of Two Dimensional Truss
6. Analysis of Plane Stress Bracket
7. Analysis of Flat rectangular plate
8. Analysis of a Cantilever Beam
9. Analysis of Simple Conduction problem
10. Analysis of Thermal - Mixed Boundary problem

11. Writing Manual Part program & generate tool path simulation for basic turning operations on CAM Software.
12. Writing Manual Part program & generate tool path simulation for basic turning operations using Box turning / Multiple Turning Cycle and demo of Manufacturing of Simple parts on CNC lathe machine

PW761ME

SUMMER INTERNSHIP

Credits: 2

Instructions:NIL *CIE:50 Marks*

Course Objectives:

- To give an experience to the students in solving real life practical problems with all its constraints.
- To give an opportunity to integrate different aspects of learning with reference to real life problems.
- To enhance the confidence of the students while communicating with industry engineers and give an opportunity for useful interaction with them and familiarize with work culture and ethics of the industry.

Course Outcomes: Student will be

- Able to design/develop a small and simple product in hardware or software.
- Able to complete the task or realize a prespecified target, with limited scope, rather than taking up a complex task and leave it.
- Able to learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to prespecified criteria.
- Able to implement the selected solution and document the same.
- Able to write a technical report and present it to appropriate audience

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1		1	2			1	2	2	1	1		
CO2	2	1		1	2			1	2	2	1	1		
CO3	2	1		1	2			1	2	2	1	1		
CO4	2	1		1	2			1	2	2	1	1		
CO5	2	1		1	2			1	2	2	1	1		

Summer Internship is introduced as part of the curricula for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Industry / R & D Organization / National Laboratory for a period of 8 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide. After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the department. Award of sessional marks are based on the performance of the student at the work place and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will coordinate the overall activity of Summer Internship.

***Students after undergoing summer internship of 6 Weeks duration at the end of semester VI the credits will be awarded after evaluation in VII semester.**

PW762ME

PROJECT WORK-I

Credits:4

Instructions: 2Hrs per week *CIE:50 Marks*

Objective:

The project seminar is to actively involve the students in preparation of the final year projectwith regard to following components:

- Problem definition and specification
- Literature survey, familiarity with research journals
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of graphs, bar (activity) charts and analyzing the results.
- Presentation - oral and written.

Project work

Prerequisites:

- Able to define Problem with specifications
- Relevant Literature survey, familiarity with research journals
- Critically evaluate various available techniques to solve a particular problem
- Able to Plan the work, prepare required graphs, bar (activity) charts and analyse the results and arrive at a solution
- Prepare and present results in a scientific manner (Presentation - oral and written)

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				1	2			1	2	2	2	1		
CO2				1	2			1	2	2	2	1		
CO3				1	2			1	2	2	2	1	1	1
CO4				1	3			1	2	2	2	1	1	1
CO5				1	3			1	2	2	2	1	1	1

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

First 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R & D institutions. The objective of these preliminary talks will be to expose the students to real life practical problems and methodology to solve the technical problems.

Seminar schedule will be prepared by the co-ordinator for all the students from 5^{th} week to the last week of the semester which should be strictly adhered to.

Each student will be required to:

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 20 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

PE701ME

DESIGN OF SOLAR ENERGY SYSTEMS

(Professional Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn concepts of solar energy conversion
- To understand the design principles of solar energy systems, their utilization and performance evaluation
- To understand the applications of solar photovoltaic systems

Course Outcomes:

- Understand the basic principle and Estimation solar radiation
- Analyze the coversion of solar radiation into heat also methods of reducing heat loss
- Design and analyze the solar energy systems
- Study the methods of performance and testing of solar collector
- Study the design and applications of Solar Photovoltaic Systems

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	-	2	-	-	-	2	2	-	-
CO2	3	3	3	2	2	2	-	-	-	-	2	-	-	-
CO3	3	3	3	1	-	-	-	-	-	-	2	2	-	-
CO4	3	3	1	3	2	-	-	-	-	-	2	-	-	-
CO5	3	2	3	1	2	-	2	-	-	-	2	2	-	-

Unit-I

Hour angle, Sun's declination, Determination of Solar time, Solar angle, Day length. Energy measuring equipment - Pyrheliometers, Pyranometers. Sunshine recorder, Estimation of Average Solar radiation, Direct & diffused radiation. Ratio of beam and total radiation on horizontal and titled surfaces.

Unit-II

Principles of Solar Energy Utilization:
Principles of conversion of solar radiation into heat. Conduction, Convection and Radiation heat transfer. Heat exchanger. Methods of reducing heat loss. Energy storage - sensible and latent heat. Water storage and pebble bed storage.

Unit-III

Design of Solar Energy Systems:
Equipment to collect solar energy - Flat plate, liquid collectors, Air heating collectors, Focusing type collectors - Solar disc, theoretical solar image, solar concentrators, Receiver geometries. Orientation and Sun tracking system. Evaluation of overall heat transfer coefficient. Thermal analysis - Natural and forced convection heat transfer.

Unit-IV

Performance Testing of Solar Collectors:
Governing equations for evaluation of performance. Methods of testing, testing procedures, testing of liquid and air flat plate collectors. Cylindrical, parabolic concentrators. Overall performance of heating panels. Selection of materials - Absorbing heat transfer fluids.

Unit-V

Design and Application of Solar Photovoltaic Systems:
Solar photovoltaics - Photovoltaic conversion, Photon energy, p-n junction, Solar cells, efficiency of solar cells, Silicone crystal cells, Photovoltaic applications for refrigeration, street lights, water pumps and power generation.

Suggested Reading:

1. Sukhatme S.P.," Solar Energy", 2 Edition, Tata McGraw Hill Publishing Co. Ltd., 2nd ed, 1996.
2. Garg H.P. and Prakash J., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., 1997.
3. Magal B.S. "Solar Power Engineering", Tata McGraw Hill Publishing Co. Ltd., 1994.

PE702ME

NON-CONVENTIONAL METHODS OF MACHINING & FORMING
(Professional Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:
- To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications
- To understand the basics of various forming operations and machining techniques.

Course Outcomes: The student will be able to
- Differentiate between conventional and non-conventional machining and forming processes.
- Understand working principles of Non-conventional machining and forming processes
- Match the material and tool with respect to process
- Study the parametric influences during process
- Select the suitable process for processing a component.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1					1		1		
CO2	3	1	1	1	1					1		1		
CO3	3	3	1	1	1					1		1	1	1
CO4	3	3	1	3	1					1		1		
CO5	3	3	3	1	3					1		1	2	2

Unit-I

Ultrasonic Machining (USM): Process description, abrasive slurry, Abrasive materials and their characteristics. Functions of liquid medium in slurry. Types of Transducers, effect of process parameters, applications and limitations. Abrasive Jet Machining (AJM): Principle of operation, process details, process variables and their effect on MRR and accuracy. Equation for MRR. Advantages, disadvantages and applications.

Water Jet Machining (WJM): Schematic diagram, equipment used, advantages and applications.

Unit-II

Electro Discharge Machining (EDM): Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, over cut and side taper Flushing, Mechanism of metal removal, crater volume, types of power supply circuits, mathematical analysis of metal removal rate (MRR), characteristics of spark eroded surfaces, advantages, disadvantages and applications, wire electro-discharge machining principles and description.

Electro-Chemical Machining (ECM): Schematic of the process, process parameters, function and characteristics of electrolyte, chemistry of the process. Equation for specific MRR and electrode feed rate, advantages, limitations and applications.

Rotary Machining, Hot machining, high speed machining, description of each process, process parameters, advantages and applications.

Unit-III

LASER Beam Machining (LBM): Principle of LASER Beam production, materials used, thermal analysis of the process, process parameters, equations for power density and machining rate, advantages, limitations and applications.

Plasma Arc Machining (RAM): Equipment used, process description and parameters, types of

plasma arc: Transferred arc and non-transferred arc and process applications.
Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production of Electron beam, equipment used, Advantages, disadvantages and applications. ION Etching: Process description and applications.
Hybrid Machining Processes: Principle and applications of Electro chemical discharge machining, electro chemical abrasive finishing, electro discharge abrasive grinding.

Unit-IV

Rubber Pad Forming: Principle of the process, process details, process variants - Guerin, wheelon, Marforming and Hydro forming processes and applications.
High Energy Rate Forming (HERF): Advantages of high energy rate forming, Explosive forming: Explosive materials, standoff operation and contact operation, advantages and applications.Electro-Hydraulic Forming (EHF): Schematic of the process, description and its applications. Electro-Magnetic
Forming (EMF): Process details and parameters, materials used and applications. HERF hammers.

Unit- V

Stretch Forming: Introduction, types of stretch forming: stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming. Stretch forming equipment and accessories, accuracy and surface finish, process variables and limitations.
Tube spinning: Introduction, methods of tube spinning, Backward spinning, Forward spinning, machines and tools used. Machine variables, speeds and feeds, effect of tube spinning on work metal properties and applications.
Hydrostatic Forming: Process principle description and applications.
Water Hammer Forming (WHF): Schematic diagram of the process, principle of operation, process variable, work materials, process limitations and applications.

Suggested Reading:

1. Pandey PC. and Shan H.S., *"Modern Machining Process",* Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980
2. Bhattacharya A., *"New Technology",* The Institution of Engineers, India, 1984.
3. Davies and Austin, *"Developments in High Speed Metal Forming".* The Machinery Publishing Co. Ltd., 1985
4. Mikell. P. Groover *"Fundamentals of Modern Manufacturing".* Prentice Hall Inc., NewJerry

PE703ME

ADDITIVE MANUFACTURING TECHNOLOGIES
(Professional Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives*:**
- To learn the fundamental concepts of Additive Manufacturing (i.e. Rapid Prototyping) and 3-D printing, its advantages and limitations.
- To classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc.
- To have a holistic view of various applications of these technologies in relevant fields such as mechanical, Bio-medical, Aerospace, electronics etc.

Course Outcomes: The student will be able to
- Comprehend the importance, historical background and fundamentals of additive manufacturing(AM)
- Build the prototypes using AM technologies like Stereo Lithography Apparatus (SLA), Solid Ground Curing (SGC), Laminated Object Manufacturing (LOM), and Fused Deposition Modelling (FDM)
- Construct prototypes using powder based AM technologies like Selective Laser Sintering (SLS), Three Dimensional Printing (3DP), and classify, evaluate Rapid Tooling Processes
- Preparation of CAD data, evaluation of STL file problems and features of various AM software
- Apply AM processes for Mechanical, Bio-medical, Aerospace, Automotive, Medical etc. industries

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							1		
CO2	2	2	2	2	2							1		
CO3	2	2	2	2	2							1		
CO4	2	2	2	2	3							1		
CO5	2	2	2	2	3							1		

Unit-I
Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RPprocess, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

Unit-II
Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid- based Rapid Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Unit-III
Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification;

Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling : Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

Unit-IV

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

Unit-V

RP Applications : Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

Suggested Reading:

1. Chua C.K., Leong K.F. and LIM C.S, Rapid prototyping; Principles and Applications, World Scientific Publications , Third Edition, 2010.
2. D.T. Pham and S.S. Dimov, Rapid Manufacturing, Springer, 2001.
3. TerryWohlers, Wholers Report 2000, Wohlers Associates, 2000.
4. PaulF.Jacobs, Rapid Prototyping & Manufacturing ASME Press, 1996.

PE704ME

AERODYNAMICS DESIGN OF THERMAL TURBINES
(Professional Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives*:**
- To learn design concepts of thermal turbines
- To understand the analysis of flow past a turbine cascade
- To understand turbine blade design methods

Course Outcomes: The student will be able to
- The Students are expected to be explain the Euler's Turbine equations application and Concepts of 1D 2D and 3D Flows in Turbines
- The Students are expected to be able to understand Aerodynamics of flow over turbine cascades and relevant performance parameters,
- The Students are expected to be use 1D and 2D Blade Design Methods and solve problems on Axial turbine stages cascades.
- The Students are expected to understand 3D Blading design methods and use Radial equilibrium and Actuated Disc theories of Axial flow turbine cascades.
- The Students are expected to understand the performance maps of Axial turbines and estimate losses in turbine cascades. They are also expected to understand wind tunnel experimental test procedures and related instrumentation.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1				1	1	1	1		1
CO2	3	3	3	2	2	1					1	1	1	1
CO3	3	3	3	3	3	2	1			1	1	1	1	1
CO4	3	3	3	2	2	1					1	1	1	1
CO5	3	3	3	3	3	1					2	2	1	1

Unit-I

Introduction: Definition of a turbine stage. Enthalpy - Entropy diagram for a Turbine stage. Definition of Euler work, specific work and isentropic work. Euler's trubine equation and Energy transfer equation. Definitions of shape No, stage efficiency, stage reaction, work done factor, utilization factor and coupling power.

Concepts of ID, 2D and 3D flows; Vortices; Circulation; Potential and Viscous flow theories. Definitions of subsonic, transonic and supersonic flows. Single Aerofoil theory and its limitations. Boundary layer parameters and flow separation.

Unit-II

Aerodynamics of turbine cascades: Definition of a cascade. Classification of turbine Cascades. Blade and cascade geometric parameters. Blade and cascade angles and relation ships. Flow parameters and their significance. Cascade flow model for turbines. Wake flow NACA and other cascade blade data specification methods.

1 D Analysis: Cascade aerofoil blade forces. Force coefficients Lift and Drag Coefficients. Equations for blade forces with cascade blade parameters and angles. Stagnation pressure loss for a turbine cascade. Cascade efficiency.

Unit-III

1 D and 2D Blade Design Methods:

1 D methods: Pitch-line design method. Velocity diagrams at hub, tip and mean radii. Definition of mean flow terms. Kulta condition and Zweifel's criterion for axial turbine cascade design. Problems on axial turbine stage cascades.

2 D methods: Concepts of singularities, simple relations. Schlichting Method - equations for induced velocity,

Camber line and thickness distribution for an arbitrary aerofoil shape - Direct and indirect design

problems. Channel flow approach - Stanitz I and I approximation methods.

Unit-IV

3D Blading Design Methods:

Radial Equilibrium theory: Fundamental equation and approaches for the vortex design of axial turbine cascades; Simple problems on Radial equilibrium theory.

Actuator Disc theory: Concept and application to simple design problems on axial flow turbine cascades.

Unit-V

Performance Evaluation:

Dimensionless groups and performance maps for axial turbines. Distribution of static pressure over a blade profile losses in turbine cascades. Profile, Annulus, Secondary, Tip clearance and over all loss estimation -Soderberg and Ainley - Malhieson methods. Loss model for a turbine cascade.

Description of wind tunnel test rig for experimental investigations of turbine cascades. Types of pressure probes, Hotwire anemometer, LDV principles and their calibration techniques. Concepts of flow visualization and its sinificance.

Suggested Reading:

1. J.P. Gostelow, " Cascade Aerodynamics" -, Pergamoa Press, USA.
2. S.M. Yahya, " Fans, Turbines and Compressors", Tata Mc-Graw Hill Pub; Delhi.
3. S.L. Dixon, "Fluid Mechanics and Thermodynamics of Turbomachinary" Pergamon Press, USA.
4. Gopalakrishnan G, Prithvi Raj D, "A treatise on Turboniachincs?', Scitech Publications. Chennai, 2002

PE707ME

ENTREPRENEURSHIP
(Professional Elective-III)
Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise & project management
- To understand the design principles of solar energy systems, their utilization and performance evaluation
- To understand the behavioral aspects of entrepreneurs and time management

Course Outcomes:

Student will be able to

- Understand the Indian industrial environment
- Able to identify the characteristics of Entrepreneurs, and conception and evaluation of ideas
- Able to carry out Project formulation and project and financial profitability analysis
- Understand project planning and control using CPM -PERT techniques
- Identify Behavioral aspects of entrepreneurs

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2				2	2	1	
CO2	1					1	1				1	2	1	
CO3	1	1	1		1	1	1		1		1	1	1	
CO4	1	1	1		1				1		1	1	1	
CO5						1	1	1			1	1		

Unit I:
Indian Industrial Environment – Competence; Opportunities and Challenges, Entrepreneurship and Economic growth, Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

Unit II:
Identification and characteristics of entrepreneurs, Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas, their sources and decision making. Choice of Technology – Collaborative interaction for Technology development.

Unit III:
Project formulation, analysis of marked demand, demand supply gap, financial and profitability analysis, technical analysis and risk analysis. Project financing in India.

Unit IV:
Project Management during construction phase, project organization, project planning and control using CPM -PERT techniques. Humana aspects of project management. Assessment of tax burden.

Unit V:
Behavioral aspects of entrepreneurs: Personality – determinats, attributes and models, leadership concepts and models. Values and attitudes. Motivation aspects, change behavior. Corporate social responsibility. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

Suggested Readings:

1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "Project – Planning , Analysis, Selection, Implementation and Review", Tata McGraw-Hill Publishing Company Ltd., 1995.
3. B. Badhai, "Entrepreneurship for Engineers", Dhanpath Rai & Co., Delhi, 2001.
4. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster, 2002.
5. Robert D. Hisrich and Michael P.Peters, " Entrepreneurship", Tata McGRaw Hill Edition, 2002.

OE701BM

HUMAN FACTOR ENGINEERING

(Open Elective-II)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives*:**

- Provide a broad based introduction to ergonomic principles and their application in the design of work, equipment and the workplace.
- Consideration is given to musculo-skeletal disorders, manual handling, ergonomic aspects of the environment as well as to the social and legal aspects.

Course Outcomes:

- Apply ergonomic principles to the creation of safer, healthier and more efficient and effective activities in the workplace
- Conduct ergonomic risk assessments and develop appropriate control measures for ergonomic risk factors
- Describe work-related causes of musculo-skeletal disorders
- Design a workplace according to good ergonomic principles
- Assess ergonomic aspects of the working environment and work organization

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

Unit-I Overview of Ergonomics (20%)

General Principles -Aims, objectives and benefits of ergonomics , Definition and scope of ergonomics and systems of work , The role of the ergonomist , Fitting the job to the person and the person to the job , Human characteristics, capabilities and limitations , Human error , Teamwork and ageing , Interfaces between job, person and environment , Human computer interaction. **Biological Ergonomics**- Body systems - musculo-skeletal and nervous , Anatomy, static and dynamic anthropometry . Biomechanics . Applying work physiology - body metabolism, work capacity and fatigue, Static and dynamic postures. **Psychology**-Perception of risk , Motivation and behaviour , Memory , Signal Detection Theory and vigilance , 'Work 'Stress' - causes, preventative and protective measures , Work organisation - shift working and overtime. **Developing an Ergonomics Strategy at Work**- Culture of an organisation - commitment and decision-making , 'Macro-ergonomics' and participatory ergonomic teams , Ergonomics at the design stage , Developing ergonomics, professional ergonomists and competence

Unit-II

Ergonomics Methods and Techniques (20%)

Work Design -Task analysis and allocation of functions , User trials , Problem solving - scientific method. **Ergonomics Risk Assessment-** Definitions of hazard and risk , Priorities , Risk evaluation quantity and quality of risk , Assessment systems , Overall ergonomics approach , Control measures monitoring and feedback . **Measurements and Information Gathering**- Ergonomics standards , Observational techniques , Rating scales, questionnaires and check lists , Use of models and simulation

Unit-III Musculo-Skeletal Disorder (20%)

Manual Handling-The nature and causes of manual handling disorders , Risk assessment , Job design and training , Principles of handling and preventative and protective measures

Work Related Upper Limb Disorders (WRULD)- The nature and causes of WRULD/ 'Repetitive Strain Injuries'/Cumulative Disorders , Risk assessment , Principles of control, preventive and protective measures

Unit-IV Workplace, Job and Product Design (20%)

Workplace Layout and Equipment Design- Principles of workstation and system design , Space and workstation design principles , Risks to health: Musculoskeletal problems, Visual fatigue, Mental stress, Requirements for eye tests, Design considerations for Visual Display Unit (VDU) Stations: Ergonomic factors, Work stations, Design of work and practice, Carrying out assessments of risk at VDU workstations

Controls, Displays and Information-Visual, auditory and other displays , Quantitative and qualitative information , Compatibility and population stereotypes , Warnings, signs and labels , Sources and selection of data , Principles of software ergonomics

Unit-V Relevant Physical Factors of the Work Environment (10%) & **Standards and Social Aspects (10%). Lighting** - Visual acuity and colour vision , Lighting levels, contrast and glare , Reflections and flicker fusion . **Noise** - Noise induced hearing loss, Distraction, annoyance and emergency signals. **Thermal Environment-** Body temperature regulation and acclimatisation ,Subjective assessments - thermal comfort and discomfort. **Other Considerations**- Smell, taste and tactile senses , Vibration - effects and subjective assessment

Clothing and Protective Equipment- Objective and subjective effects , Risk perception, and wearability , Design, style and fit. **Standards** - ISO standards , Sources of other standards

Selection and Training- Training Needs Analysis , Testing and interview techniques

Instruction and Supervision- Health information, legal requirements , Supervision and records , Measuring health and illness

Suggested Reading:

1. Introduction to Human factors and Ergonomics, 4th edition by Gariel Salvendy, John & Willey & Son's.
2. Introduction to Human Factors and Ergonomics, 4th Edition by Robert Bridger, CRC Press.
3. An Introduction to Human factors Engineering by 2nd Edition, Christopher D. Wickens, Sallie E. Gardon, Yili Liv, PHI series.
4. Stephen Konz and Steve Johnson 2007 Work Design: Occupational Ergonomics 7th Edition Holcomb Hathway.
5. Dul & Weerdmeester 2003 Ergonomics for Beginners Taylor & Francis.
6. R.S.Bridger 2003 Introduction to Ergonomics Taylor & Francis

OE702BM

BASIC MEDICAL ENGINEERING

(Open Elective-II)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives*:**

- State the Physiological reasons for using a particular piece of Biomedical Equipment.
- Describe the operating principles of a wide range of biomedical equipment.
- To familiarize the latest technologies of modern medicine
- To make learners able to use new and updated diagnostic methodologies
- To make learners capable enough of adopting the methods of recovery and improving health with a service approach

Course Outcomes: At the end of the course the student will be able to

- Understand Physiological reasons for using a particular piece of Biomedical Equipment and familiarise operating principles of a wide range of biomedical equipment
- Use latest technology and updated diagnostic tools
- Analyse and Evaluate various diagnostic methodologies
- Use and maintenance of biomedical equipment for critical care and therapeutic care
- Evaluate and Analyse various equipment for critical care and therapeutic care

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

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Unit-I Medical Monitoring and recording: Patient monitoring: System concepts, bedside monitoring systems, central monitors, heart rate and pulse rate measurement. Temperature measurement Blood pressure measurement: Direct and indirect methods. Respiration rate measurement: Impedance pneumograph, Apnoea detectors. Ambulatory monitoring: Arrhythmia monitor, data recording, replay and analysis, Telemetry.

Unit-II Physiotherapy and Electrotherapy Equipment: Diathermy machines: Short wave diathermy, Microwave diathermy and ultrasonic diathermy Electro diagnostic/Therapeutic apparatus: Nerve muscle stimulator, Functional electrical stimulator etc.

Unit-III Medical Imaging Equipment:

X-Ray machines: Properties and production of X-Rays, X-ray machine, Image Intensifier. X-ray computed tomography: basic principle and construction of the components. Ultrasonic Imaging: Physics of ultrasonic waves, medical ultrasound, basic pulse echo apparatus. Magnetic Resonance Imaging: Principle, Image reconstruction techniques, Basic NMR components, Biological effects, Merits.

Unit-IV Critical care Equipment:

Ventilators: Mechanics of respiration, artificial ventilators, Positive pressure ventilator, Types and classification of ventilators. Drug delivery system: Infusion pumps, basic components, implantable infusion system, closed loop control in infusion pump. Cardiac Defibrillators: Need for defibrillators, DC defibrillator, Implantable defibrillators, Defibrillator analyzer.

Unit-V Therapeutic Equipment:

Cardiac pacemakers: Need for cardiac pacemakers, External and implantable pacemakers, types. Dialysis Machine: Function of kidney, artificial kidney, Dialyzers, Membranes, Hemodialysis

machine. Lithotripters: The stone diseases problem, Modern Lithotripter systems, extra corporeal shockwave therapy.

Suggested Reading:

1. R.S.Khandpur, Hand Book of Biomedical Instrumentation, Tata McGrawHill, Second Edition, 2014.
2. John G.Webster, Medical Instrumentation Application and design, Wiley India Edition, 2009.

OE701CE

OPTIMIZATION TECHNIQUES

(Open Elective-II)

Credits: 3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the basic concepts of operations research.
- To study about the linear programming and non linear programming.
- To gain knowledge on various gradient search methods.

Course Outcomes: Student will acquire the

- Familiarize the basic concepts of operations research
- Classify and contrast linear programming and non linear programming
- Solve problems of L.P. by graphical and Simplex methods
- Evaluate various gradient search methods
- Solve problems based on Integer Programming

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

Unit I:

Introduction: Definitions, Characteristics, Objective function, Classification of optimization problems, Engineering applications and limitations. Construction of L.P. Models, Slack and surplus variables, Standard form, Canonical form and matrix form of LP Problems.

Unit II:

Linear Programming: Definitions and Formulation of the LPP, Graphical methods, numerical problems by graphical method, Simplex algorithm, Numerical problems using Simplex method.

Unit III:

Artificial Variables, solution by the Big-M method, Two-Phase method, special cases in Simplex method viz. Degeneracy, alternate optima, unbound solutions and infeasible solutions and numerical problems. Duality principle, Dual problems and numerical problems.

Unit IV:

Non-Linear Programming:

Introduction, local and global optima, concave and convex functions, Kuhn-Tucker conditions, graphical solutions. Direct search method, Gradient method, Quadratic programming problems.

Unit V:

Integer Linear Programming

Importance of Integer Linear Programming, Necessity, Definitions, Gomory's cutting plane method, Branch and bound method, zero-one programming, numerical problems.

Suggested Readings:

1. Hillier, F. S. and Lieberman, G. J. (2009). "Introduction to Operations Research." Ninth Edition, McGraw-Hill, Holden-Day.
2. Taha, H.A. (2008). "Operations Research, Pearson Education India." New Delhi, India
3. Anand Sharma. (2014). "Quantitative Techniques for Decision Making."Himalaya Publishers.
4. **Srinivasa Raju, K. and** Nagesh Kumar**, D. (2014). "**Multicriterion Analysis in Engineering and Management." Prentice Hall of India (PHI) Learning Pvt. Ltd, New Delhi.
5. Rao, S.S. (2009). "Engineering Optimization: Theory and Practice." John Wiley.
6. Sharma J.K. (2013). "Operation Research: Theory and Applications." Fifth Edition, Macmillan Publishers, New Delhi, India.

OE701CS

DATA BASE MANAGEMENT SYSTEMS

(Open Elective-II)

Credits: 3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To introduce three schema architecture and DBMS functional components
- To learn formal and commercial query languages of RDBMS
- To understand the principles of ER modeling and theory of normalization
- To study different file organization and indexing techniques
- To familiarize theory of serializablity and implementation of concurrency control, and recovery

Course Outcomes : Student will be able to:

- Understand the mathematical foundations on which RDBMS are built
- Model a set of requirements using the Extended Entity Relationship Model (EER), transform an EER model into a relational model ,and refine the relational model using theory of Normalization
- Develop Database application using SQL and Embedded SQL
- Use the knowledge of file organization and indexing to improve database application performance
- Evaluate working of concurrency control and recovery mechanisms in RDBMS

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

UNIT – I

Introduction: Database System Applications, Purpose of Database Systems, View of Values, Nested Sub-queries, Complex Queries, Views, Modification of the Database, Joined Relations Data, Database Languages, Relational Databases, Database Design, Object–based and Semi-structured Databases, Data Storage and Querying, Transaction Management, Data Mining and Analysis, Database Architecture, Database Users and Administrators.

Database Design and the E-R Model: Overview of the Design Process, The Entity-Relationship Model, Constraints, Entity-Relationship Diagrams, Entity – Relationship Design Issues, Weak Entity Sets, Extended E-R Features, Database Design for Banking Enterprise, Reduction to Relational Schemas, Other Aspects of Database Design

UNIT – II

Relational Model: Structure of Relational Databases, Fundamental Relational-Algebra Operations, Additional Relational – Algebra Operations, Extended Relational - Algebra Operations, Null Values, Modification of the Databases.

Structured Query Language: Data Definition, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Null

UNIT – III

Advanced SQL: SQL Data Types and Schemas, Integrity Constraints, Authorization, Embedded SQL, Dynamic SQL, Functions and Procedural Constructs, Recursive Queries, Advanced SQL Features. Relational Database Design: Features of Good Relational Design, Atomic Domains

and First Normal Form, Functional-Dependency Theory, Decomposition using Functional Dependencies.

UNIT – IV

Indexing and Hashing: Basic Concepts, Ordered Indices, B^+-tree Index Files, B-tree Index Files, Multiple-Key Access, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices.

Index Definition in SQL Transactions: Transaction Concepts, Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability

UNIT – V

Concurrency Control: Lock-based Protocols, Timestamp-based Protocols, Validation-based Protocols, Multiple Granularity, Multi-version Schemes, Deadlock Handling, Insert and Delete Operations, Weak Levels of Consistency, Concurrency of Index Structures.

Recovery System: Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery, Recovery with Concurrent Transactions, Buffer Management, Failure with Loss of Nonvolatile Storage, Advanced Recovery Techniques, Remote Backup Systems

Suggested Readings:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, Database System Concepts, McGraw-Hill International Edition, 6th Edition, 2010
2. Ramakrishnan, Gehrke, Database Management Systems, McGraw-Hill International Edition, 3rd Edition, 2003
3. Elmasri, Navathe, Somayajulu, Fundamentals of Database Systems, Pearson Education,4th Edition, 2004

OE702CS

INFORMATION SECURITY

(Open Elective-II)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn legal and technical issues in building secure information systems
- To provide an understanding of network security
- To expose the students to security standards and practices

Course Outcomes: On completion of this course student should be able to:

- Describe the steps in Security Systems development life cycle(SecSDLC)
- Understand the common threats and attack to information systems
- Understand the legal and ethical issues of information technology
- Identify security needs using risk management and choose the appropriate risk control strategy based on business needs
- Use the basic knowledge of security frameworks in preparing security blue print for the organization

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	1									
CO2	2	2	2	2	1									
CO3	2	2	2	2	1									
CO4	2	2	2	2	1									
CO5	2	2	2	2	1									

UNIT-I

Introduction: History, Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access, The SDLC, The Security SDLC.
Need for Security: Business Needs, Threats, Attacks, and Secure Software Development

UNIT-II

Legal, Ethical and Professional Issues: Law and ethics in Information Security, Relevant U.S. Laws, International Laws and Legal Bodies, Ethics and Information Security.
Risk Management: Overview, Risk Identification, Risk Assessment, Risk Control Strategies, Selecting a Risk Control Strategy, Quantitative versus Qualitative Risk Control Practices, Risk Management discussion Points, Recommended Risk Control Practices.

UNIT-III

Planning for Security: Security policy, Standards and Practices, Security Blue Print, Security Education, Continuity strategies.
Security Technology: Firewalls and VPNs: Physical Design, Firewalls, Protecting Remote connections.

UNIT-IV

Security Technology: Intrusion Detection, Access Control, and other Security Tools: Intrusion Detection and Prevention Systems-Scanning, and Analysis Tools- Access Control Devices.
Cryptography: Foundations of Cryptology, Cipher methods, Cryptographic Algorithms, Cryptographic Tools, Protocols for Secure Communications, Attacks on Cryptosystems

UNIT-V

Implementing Information Security: Information security project management, Technical topics of implementation, Non Technical Aspects of implementation, Security Certification and

Accreditation. Security and Personnel: Positioning and staffing security function, Employment Policies and Practices, and Internal control Strategies.
Information Security Maintenance: Security management models, Maintenance model, and Digital Forensics.

Suggested Reading:

1. Michael E Whitman and Herbert J Mattord, "*Principles of Information Security*", Cengage Learning, 2011.
2. Thomas R Peltier, Justin Peltier, John Blackley, "*Information Security Fundamentals*", Auerbach Publications, 2010.
3. Detmar W Straub, Seymour Goodman, Richard L Baskerville, "*Information Security, Policy, Processes, and Practices",* PHI, 2008.
4. Mark Merkow and Jim Breithaupt " *Information Security Principle and Practices"*, Pearson Education, 2007

OE701EC

Principles of Electronic Communications

Credits:3

Instruction : (3L) hrs per week

Duration of SEE : 3 hours

CIE : 30 Marks *SEE : 70 Marks*

Course Objectives:

- Provide an introduction to fundamental concepts in the understanding of communications systems.
- Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transport layer.
- Provide an introduction to the evolution of wireless systems and current wireless technologies.

Course Outcomes: *Student will be Able to*

- Familiarise fundamental concepts of communications systems
- Compare and contrast working of analog and digital communication systems
- Evaluate the OSI network model and the working of data transmission
- Analyse the working of telecommunication systems
- Analyse the working of wireless communication systems.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

UNIT- I

Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels, **Signal Transmission Concepts-**Baseband transmission and Broadband transmission, **Communication parameters**-Transmitted power, Channel bandwidth and Noise, Need for modulation **Signal Radiation and Propagation**-Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

UNIT- II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

UNIT- III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet , Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

UNIT- IV

Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony.

Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

UNIT- V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

Suggested Readings:

1. *Principles of Electronic Communication Systems*, Louis E. Frenzel, 3e, McGraw Hill publications, 2008.
2. *Data Communications and Networking,* Behrouz A. Forouzan, 5e TMH, 2012.
3. Kennady, Davis, *Electronic Communications systems*, 4e, TMH, 1999.

PE 702 EC

Fundamentals of IOT

Credits:3

Instruction : (3L) hrs per week *Duration of SEE : 3 hours*
CIE : 30 Marks *SEE : 70 Marks*

Course Objectives:

- Discuss fundamentals of IoT and its applications and requisite infrastructure
- Describe Internet principles and communication technologies relevant to IoT
- Discuss hardware and software aspects of designing an IoT system
- Describe concepts of cloud computing and Data Analytics
- Discuss business models and manufacturing strategies of IoT products

Course Outcomes: *Student will be able to*

- Understand the various applications of IoT and other enabling technologies
- Comprehend various protocols and communication technologies used in IoT
- Design simple IoT systems with requisite hardware and C programming software
- Relevance and Importance of cloud computing and data analytics to IoT
- Comprehend the business model of IoT from developing a prototype to launching a product .

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

Unit- I

Introduction to Internet of Things

IOT vision, Strategic research and innnovation directions, Iot Applications, Related future technologies, Infrastructure, Networks and communications, Processes, Data Management, Security, Device level energy issues.

Unit- II

Internet Principles and communication technology

Internet Communications: An Overview – IP,TCP,IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addressess, TCP and UDP Ports, Application Layer Protocols – HTTP,HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source.

Unit- III

Prototyping and programming for IoT

Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping, Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling.

Techniques for writing embedded C code: Integer data types in C, Manipulating bits - AND,OR,XOR,NOT, Reading and writing from I/ O ports. Simple Embedded C programs for LED Blinking, Control of motor using switch and temperature sensor for arduino board.

Unit- IV

Cloud computing and Data analytics

Introduction to Cloud storage models -SAAS, PAAS, IAAS. Communication APIs, Amazon webservices for IoT, Skynet IoT Messaging Platform.

Introduction to Data Analytics for IoT - Apache hadoop- Map reduce job execution workflow.

Unit- V

IoT Product Manufacturing - From prototype to reality

Business model for IoT product manufacturing, Business models canvas, Funding an IoT Startup, Mass manufacturing - designing kits, designing PCB,3D printing, certification, Scaling up software, Ethical issues in IoT- Privacy, Control, Environment, solutions to ethical issues.

Suggested Readings:

1. Internet of Things - Converging Technologies for smart environments and Integrated ecosystems, River Publishers.
2. Designing the Internet of Things , Adrian McEwen, Hakim Cassimally. Wiley India Publishers
3. Fundamentals of embedded software**:** where C meets assembly by Daneil W lewies, Pearson.
4. Internet of things **-**A hands on Approach, Arshdeep Bahga, Universities press.

OE701EE

NON CONVENTIONAL ENERGY SOURCES

(Open Elective-II)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn the importance of various non-conventional energy sources and its principles
- To learn solar energy applications and its concepts
- To learn the basics of wind energy, ocean thermal electric conversion and tidal energy
- To learn the biomass process and generation of energy through biomass

Course Outcomes: The student will be able to

- Understand the principles of energy extraction
- Differentiate between conventional and non conventional energy systems
- Classify and compare various non conventional energy systems like biomass, wind, solar and oceanic energy
- Analyse and Evaluate various non conventional energy systems
- Design suitable non conventional energy systems for specific applications

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

Unit I:

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells — Polarization - Conversion efficiency and Applications of Fuel Cells.

Unit II:

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

Unit III:

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind- Basic components of WECS -Classification of WECS -Site selection considerations -Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

Unit IV:

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-thermal Energy - Types of Geo-thermal Energy Systems - Applications of Geo-thermal Energy.

Unit V:

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of

Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass -Biomass gasifies.

Suggested Reading:

1. Rai G.D, *Non-Conventional Sources of Energy,* Khandala Publishers, New Delhi, 1999.
2. M.M.El-Wakil, *Power Plant Technology.* McGraw Hill, 1984.

OE701ME

STARTUP ENTREPRENEURSHIP

(Open Elective-II)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise & project management
- To understand the behavioral aspects of entrepreneurs and time management

Course Outcomes: Student will

- Understand the behavioural aspects of entrepreneurs and time management
- Creative thinking and transform ideas into reality
- Importance of innovation in new business opportunities
- Create a complete business plan and workout the budget plan.
- write a project proposal with budget statement

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2					1	1		1	1	1	1		2
CO2	2					1	1		1	1	1	1		2
CO3	2					1	1		1	1	2	1		2
CO4	2					1	1		1	1	2	1		2
CO5	2					1	1		1	1	2	1		2

Unit I: Creativity & Discovery

Definition of Creativity, self test creativity, discovery and delivery skills, The imagination threshold, Building creativity ladder, Collection of wild ideas, Bench marking the ideas, Innovative to borrow or adopt, choosing the best of many ideas, management of tradeoff between discovery and delivery, Sharpening observation skills, reinventing self, Inspire and aspire through success stories

Unit II: From Idea to Startup

Introduction to think ahead backward, Validation of ideas using cost and strategy, visualizing the business through value profile, activity mapping, Risks as opportunities, building your own road map

Unit III: Innovation career lessons

Growing & Sharing Knowledge, The Role of Failure In Achieving Success, Creating vision, Strategy, Action & Resistance: Differentiated Market Transforming Strategy; Dare to Take Action; Fighting Resistance; All About the startup Ecosystem; Building a Team; Keeping it Simple and Working Hard.

Unit IV: Action driven business plan

Creating a completed non-business plan (a series of actions each of which moves your idea toward implementation), including a list of the activities to be undertaken, with degrees of importance (scale of 1 to 3, where 1 is 'most important'). A revision of the original product or service idea, in light of information gathered in the process, beginning to design the business or organization that will successfully implement your creative idea. Preparing an activity map.

Unit V: Startup financing cycle

Preparing an initial cash flow statement, showing money flowing out (operations; capital) and flowing in. Estimate your capital needs realistically. Prepare a bootstrapping option (self

financing). Prepare a risk map. Prepare a business plan comprising five sections: The Need; The Product; Unique Features; The Market; Future Developments. Include a Gantt chart (project plan – detailed activities and starting and ending dates); and a project budget.

Suggested Readings:

1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "Project – Planning , Analysis, Selection, Implementation and Review", Tata McGraw-Hill Publishing Company Ltd., 1995.
3. B. Badhai, "Entrepreneurship for Engineers", Dhanpath Rai & Co., Delhi, 2001.
4. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster, 2002.
5. Robert D. Hisrich and Michael P.Peters, " Entrepreneurship", Tata McGRaw Hill Edition, 2002.

OE702ME

FINITE ELEMENT METHODS

(Open Elective-II)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the theory and application of the finite element method for analyzing structural systems.
- To learn Approximation theory for structural problems as the basis for finite element methods
- To learn formulations for a variety of elements in one, two, and three dimensions. Implementations of
- element formulations will be examined using Matlab.
- To understand modeling and analysis of structures using planar, solid, and plate elements

Course Outcomes: Student will be able to

- Understands the concept of Finite Element Method and realize its limitations
- formulate 1D, 2D and 3D element and distinguish between linear and higher order elements
- Applying 1D , 2D and 3D elements to solve different static problems
- Applying 1D , 2D and 3D elements to solve dynamic problems
- Use of Finite element software.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							1	1	
CO2	2	3	2	2	2							1	1	
CO3	2	3	3	2	2							1	1	
CO4	2	3	2	2	2							1	1	
CO5	2	2	2	2	3							1	1	

Unit I:

Introduction to Finite Element Method, solution method using FEM, descretisation, Boundary conditions, load application, types of elements comparison, Stress and Equilibrium, Boundary conditions. Strain-Displacement relations. Stress-strain relations.

One Dimensionla problems: Finite element modeling, coordinates and shape functions.

Potential Energy approach: Assembly of Gloabal stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions. Quadratic shape functions.

Unit II:

Analysis of trusses and frames: Element stiffness matrix for a truss member. Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node.

Analysis of Beams: Element stiffness matrix for two nodded, two degrees of freedom per node beam element.

Unit III:

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions.

Finite element modeling of Axisymmetirc solids subjected to Axisymmetric loading with triangular elements.

Unit IV:

Two dimensional four nodded isoprarametric elements and numerical integration.

Steady state heat transfer analysis: Ond dimensional analysis of a find and two dimensional analysis of thin palate. Analysis of uniform shaft subjected to torsion.

Unit V:

Dynamic Analysis: Formulation of finite element mode, element matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam.

Time dependent field problems: Application to one dimensional heat flow in a rod. Finite element formation to three dimensional problems in stress analysis. Types of elements used.
Convergence requirements and geometric isotropy. Local, natural and global coordinates. Introduction to Finite Element Analysis Software.

Suggested Readings:

1. Tirupathi R. Chandraputla and Ashok, D. Belgundu" Introduction to Finite Elements in Engineering", pearson Education, 2002, 3rd Edition.
2. Rao S.S., "The Finite Element Methods in Engineering", pergamon Press, 1989.
3. Segerlind, L.J. "Applied Finite Element Analysis", Wiley Publication, 1984.
4. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill Company, 1984.

SCHEME OF INSTRUCTION & EXAMINATION
B.E VIII Semester (Mechanical Engineering)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P	Contact Hrs/wk	CIE	SEE	
1.	PE *	Professional Elective-IV	3	-	-	3	30	70	3
2.	PE **	Professional Elective-V	3	-	-	3	30	70	3
3.	OE ***	Open Elective-III	3	-	-	3	30	70	3
PRACTICALS									
3.	PW861ME	Project Work-II/ Internship	-	-	4	4	50	100	8
		Total	9	-	4	13	140	310	17

*PROFESSIONAL ELECTIVE-IV	
PE801ME	Waste Heat Recovery & Co-Generation
PE802ME	Mechanics of Composite Materials
PE803ME	Machine Tool Engineering & Design
PE804ME	Advanced Propulsion & Space Science

**PROFESSIONAL ELECTIVE-V	
PE807ME	Energy Conservation & Management
PE808ME	Tool Design
PE809ME	Non-Destructive Testing

***OPEN ELECTIVE-III	
OE801MT	Statistical Applications in Engineering
OE801BM	Human Machine Interface
OE802BM	Instrumentation Engineering
OE801CE	Road Safety Engineering
OE802CE	Green Building Technology
OE801CS	Data Science using R
OE801EC	Global and Regional Satellite Navigation System
OE801EE	Illumination and Electric Traction System
OE801ME	Composite Materials
OE802 ME	Industrial Administration and Financial Management
OE803ME	3D Printing Technology

PE801ME

WASTE HEAT RECOVERY & CO-GENERATION

(Professional Elective-IV)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn concepts of waste heat recovery
- To learn the applications of heat exchangers & recuperators in heat recovery
- To understand cogeneration methods

Course Outcomes: Student will be

- Understand the concept of waste heat recovery
- Distinguish heat exchangers and recuperators
- Acquire knowledge about various cogeneration methods
- Understand the cogeneration concept and thermodynamic advantages

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1	1	
CO2	2	2	2	2								2	1	
CO3	1	1	1	1								1	1	
CO4	2	2	2	1								1	1	
CO5	1	1	1									1	1	

Unit I:

Definition, Sources, Quantity and quality of waste heat. Technologies for waste heat recovery and utilization.

Need of storage systems for waste heat.

Utilization of Waste Heat - Continuous and Intermittent. Energy requirements of industry. Various forms of waste heat available.

Unit II:

Overview of heat exchangers. Gas to gas. Gas to liquid and liquid to liquid heat exchangers. Calculation of effectiveness and design of heat exchanger for number of tubes. Pressure drop considerations LMTD and effectiveness -NTU methods.

Unit III:

First and Second law of thermodynamics, and it's effect on design of recuperators. Recuperators-Ceramic, metallic and reradiant recuperators, high temperature recuperators. Concept of porosity, Peclet number superficial velocity, pressure drop, and selection of material for heat storage and recovery.

Unit IV:

Cogeneration - Definition, Two basic cogeneration concepts, thermodynamic advantage, Cogeneration efficiency, potential benefits and costs of cogeneration. Cogeneration-Over view, Industrial application of cogeneration.

Unit V:

Source of waste heat and methods of utilization. Application of Cogeneration to a steam power plant. Identifying the possibilities of extracting energy to run a gas turbine. Integration of Steam turbine and Gas turbine - Power calculations, various types and their applications towards power generation. Quality of steam and its effect on performance. Legislation - Power plant and Industrial fuel use act (FUA) Potential nation wide

benefits of Cogeneration, Impact of Cogeneration on fuel use patterns. Legislative, Environment and Institutional Constraints for use of waste heat.

Suggested Readings:

1. Donald Q. Kern, "Process Heat Transfer", McGraw Hill International Editions, Chemical Engineering Series, 1965.
2. Wylen V. and Sonntag, "Fundamentals of Classical Thermodynamics" - SI Version, Wiley Eastern Ltd., 1993.
3. David Hu S., "Handbook of Industrial Energy Conservation", Van Nostrand Reinhold Co., 1983.

PE802ME

MECHANICS OF COMPOSITE MATERIALS

(Professional Elective-IV)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To know the properties of fiber and matrix materials used in composites, as well as some common manufacturing techniques.
- To know how to analyze a laminated plate in bending, including finding laminate properties from lamina properties.
- To understand the strength of an orthotropic lamina and measurement of basic composite properties.

Course Outcomes: The students will be able to

- Understand the concept of composites its advantages and applications
- Compare and contrast different manufacturing methods of composites
- Analysis and evaluation of laminate composites using micromechanics
- Analysis and evaluation of laminate composites using macromechanics
- Estimate the properties of composites using micormechnics and macromechanics

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							1	1	
CO2	2	2	2	2	2							1	1	
CO3	2	2	2	2	2							1	1	
CO4	2	2	2	2	2							1	1	
CO5	2	2	2	2	2							1	1	

Unit I:

Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fibre composites.

Unit II:

Micromechanics of Composites:

Mechanical properties: Production of Elastic constant, micromechanical approach, Halpin-Tsal equations, Transverse stresses.

Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

Unit III:

Macromechanics of Composites:

Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation.

Unit IV:

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

Unit V:

Strength of an orthotropic lamina: Maximum stress theory, maximum strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials. Measurement of constituent material properties: Fibre tests, Matrix tests. Measurement of basic composite properties: Tensile test, compressive test, a plane shear test, interlaminar shear test,

flexure test.

Suggested Reading:

1. Jones, R.M., "Mechanics of Composite Materials", McGraw Hill Co., 1967.
2. Ronald F. Gibson, "Principles of Composite Materials Mechanics", McGraw-Hill, Inc., 1994.
3. Krishan, K. Chewla, "Composite Material", Springer - verlag, 1987.
4. Carl. T. Herakovich, "Mechanics of Fibrous Composites", John Wiley Sons Inc., 1998.

PE803ME

MACHINE TOOL ENGINEERING & DESIGN

(Professional Elective-IV)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn and applications of the basics and working principles of different types of machine tools
- To grasp the knowledge of critical functional and operational requirements of different types of machine tools
- To learn the knowledge of design of different types of machine tools to meet varied functional and operational requirements.

Course Outcomes: Student will be able to

- Understand the basic working principles of different machine tools with kinematic mechanisms.
- Distinguish the functional and operational requirements of different machine tools
- Design speed and feed gear boxes for a particular configuration.
- Design machine tool structures for strength and rigidity
- Understand various controls used in machine tools

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		1		2	1	1	1		1		1	2	
CO2	2		2	3		2	1		1	1			2	
CO3	3	3	3	2	3		1	1	2		2	1	3	3
CO4	2	2	2	1	2		1	1	2	1		1	2	2
CO5	2	2	1	1	1	1	1			1	1	1	2	2

Unit I:

Basic features: Classification of machine tools-Basic features of construction and fundamental kinematic mechanisms of general purpose, special purpose machine tools, transfer machines, Automatic and N.C. machines. Mechanisms used for converting rotary to linear motion: Mechanisms for intermittent motion.

Unit II:

Kinematics, Drives of Machine tools: Selection of range of speeds and feeds. Layout in G.P., A.P. and Logarithmic progression, standardization of speeds and feeds. Productivity loss. Selection of highest and lowest speeds, range ratio. Design of ray diagram" and structural diagrams for machine tool gear boxes. Sliding, clustered and clutched drives, Rupport drive.

Unit III:

Feed gear boxes: Norton and Meander drives pre-selection of speed, stepped and stepless regulation. Strength, rigidity and design analysis: Analysis of beds, frames, columns. Materials for structures. Methods to improve
the rigidity of structures. Types of Guide ways-overall compliance of machine tool. Thermal effects-functional accuracy of machine tool.

Unit IV:

Spindle units: Spindle units of lathe, drilling, milling and grinding machines, materials for spindles. Spindle design. Effect of clearance on the rigidity of spindle. Hydrodynamic, hydrostatic, rolling bearings. Selection of
bearings.

Unit V:

Hydraulic controls: Various controls used in machine tools. Hydraulic and pneumatic systems

used in machine tools-positive displacement pumps - properties of fluids — relief valves, check valves, flow control valves, multi-position valves, filters, accumulators. Hydraulic circuit for surface grinding machine, hydro-copying system.

Suggested Reading:

1. Sen G.S., & Battacharya, "Principles of Machine Tools", New Central Book Agency, Calcutta, 1986.
2. Basu S.K., "Design of Machine Tools", Allied Publishers, 1980.
3. Russe W. Henke, "Introduction to Fluid Power Circuits and Systems", Addison Wesley, 1970.
4. Mehta, "Machine Tool Design", Central Publishers, 2004.

PE804ME

ADVANCED PROPULSION & SPACE SCIENCE

(Professional Elective-IV)

Credits: 3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn about gas dynamic concepts of rocket propulsion system
- To learn rocket engine system.
- To learn celestial sphere and its parameters
- To learn about Satellites & Remote Sensing

Course Outcomes: Student will be able to

- Classify different rocket propulsion systems and understand the concept of gas dynamics
- understand the working principle of rocket engine system
- understand celestial sphere and its parameters

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

Unit I:

Advanced Gas Dynamics: Normal shock waves, pitot tubes, moving shock waves, oblique shock waves, reflected shock waves, conical shock waves, hypersonic flow, Newtonian theory, high temperature flows, low density flows.

Unit II:

Advanced Propulsion: Rocket engines - Operation and performance of rocket engines, design and operating parameters - total impulse, thrust, energy and efficiencies, Typical performance values, overview of monopropellant, bipropellant liquid, solid and hybrid rocket propulsion systems, combined cycle propulsion, Electric / Ion propulsion.

Unit III:

Rocket Technology: Flight mechanics, application thrust profiles. Acceleration -staging of rockets, feed systems, injectors and expansion nozzles, typical nozzle designs (cone, bell, plug). Rocket heat transfer and ablative cooling. Testing and Instrumentation. Nuclear thermal rockets, pulsed detonation engines, Solar sails.

Unit IV:

Celestial Sphere: Spherical trigonometry, celestial coordinate systems, Astronomical triangle, Time-Sidereal, apparent and mean solar time. Equation of Time.

Two Body Problem: Formulation, relative motion and solution, Kepler's equation, motions of r ockets and artificial satellites, transfer orbits, minimum energy interplanetary transfer orbits, use of parking orbits, Perturbations of artificial satellites due to atmospheric drag and flattening of earth.

Unit V:

Nuclear Processes in the Sun, Solar wind, interaction of solar Wind and Earth's magnetic field, Van Allen radiation belts.

Satellites & Remote Sensing: Orbits, earth segment, space segment, earth station, satellite subsystems, working details of communication and navigational satellites - components, operation and maintenance, meteorological satellites. Principles of remote sensing.

Suggested Reading:

1. Shapiro, "The dynamics and thermodynamics of compressible flow", 1953.
2. Thomas, D. Daman, "Introduction to space: The Science of space flight", Orbit book Co., 3rd ed., Malabar, FL, 2001.
3. K.D. Abhyankar, "Astrophysics of the solar systems", University Press (India) Ltd., 1999.
4. Timothy Pratt and Charles, W. Bostian, "Satellite Communications", John Wiley, 1986.

PE805ME

ENERGY CONSERVATION AND MANAGEMENT

(Professional Elective-V)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn about energy conservation
- To understand sources of loss of power in energy conversion
- To understand Procedure for Comprehensive Energy Conservation Planning
- To understand Industrial energy conservation methods

Course Outcomes: Student will be

- Student will able to understand different forms of energy
- Student will be able to calculate the amount of heat energy available
- Students able to understand the industry energy conservation modeling
- Students able to understand methodology for forecasting industrial energy supply and demand.
- Understand the energy storage techniques

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1							1	1	1	
CO2	2	2	1	1							1	1	1	
CO3	1	2	2	1	1						1	1	1	
CO4	1	2	1	1	1						1	1	1	
CO5	2	1	1								1	1	1	

Unit I:

Definition, Principles of Energy Conservation - Maximum Thermodynamic efficiency. Maximum Cost - effectiveness in energy use. Various forms of energy - Heat Mechanical. Electrical energy and Chemical energy. Identification of potential sources of energy losses - Transportion, operation and conversion from one from to another.

Unit II:

Heat energy and storage - Media of transport of heat energy - steam, oil and flue gases. Calculation of steam quality. Calculation of amount of heat energy available. Recuperators. Constructional details, Selection of materials to store heat energy. Concept of power. Modes of mechanical energy transport - Gears, pulleys, belts, shafts etc., Calculation of power. Sources of loss of power in energy conversion into electricity, potential energy (i.e., pumps).

Unit III:

Chemical energy - combustion of fuels - petrol, diesel and coal. Loss due to quality of fuel, conversion into other form of energy - boilers, I.C. engines. Calculation related to losses. Electrical energy - Working principle of motors and generators. Calculation of efficiency of generators. Losses during transmission and energy conversion - into mechanical energy, thermal energy. Calculation of effecting parameters.

Unit IV:

Procedure for Comprehensive Energy Conservation Planning (CECP) -Specifying targets, identifying energy in-efficient facilities. Synthesize evaluation and optimization of alternative conservation measures in view of organization costs. Flow chart of organization's functions. Collection of accountable data. Application of CECP method. An example.

Unit V:

Industrial energy conservation modeling - Methodology - Definition of production system - A primary copper production system, Model construction - Mathematical Programming. Market penetration, Structure of energy conservation model. Data preparation - coefficients needed in a model, Unit production cost and unit energy requirements. Model exercise, verification and validation. Methodology for forecasting Industrial Energy Supply and Demand.

Suggested Reading:

1. Gottschalk C.M., "Industrial Energy Conservation", John Wiley & Sons, 1996.
2. Chaturvedi P., and Joshi S., "Strategy for Energy Conservation in India", Concept PublishingCo., New Delhi, 1997.

PE806ME

TOOL DESIGN

(Professional Elective-V)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the basic knowledge of select appropriate materials for tooling applications
- To grasp the Design, develop, and evaluate cutting tools and work holders for a manufactured product
- To comprehend the basic knowledge of press tools for sheet metal working.

Course Outcomes:

- Understand ASA and ORS systems of tool geometry .
- Design a single point or multi point cutting tool to machine a required job.
- Design a die and punch for blanking, piercing, drawing and bending operations.
- Discriminate the knowledge of Jigs and Fixtures design
- Apply the concepts and design a GO and NO GO guage.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2	3			1								1	1	1
CO3	3	2	3			1			2				2	1
CO4	2			2					2					1
CO5	3	2	3			2						1	1	1

Unit I:

Cutting tool materials and single point cutting tools:

Cutting tool materials, desired properties. Types, major Constituent, relative characteristics, latest development: ISO; classification and coding of carbides.

Geometry of single point cutting tool. Influence of each geometrical parameters on the cutting tool performance. Factors involved in their selection. Tool signature and geometry in MRS, ORS, NRS. Cutting forces and design features of HSS and carbide tipped tools.

Feature of high production cutting tools. Chipbreakers and their types.

Unit II:

Form tools and multi point cutting tools:

Form tools: Radial and tangential: flat and circular. Form correction and tool holding methods.

Drills Geometry: Variation of rake and clearance angles along tips, effect of geometrical parameters on thrust and torque effect of feed rate on rake and clearance, web thinning. Types of drill points, Grinding of drills. **Milling Cutters:** Major types, geometry of peripheral, end and face milling cutters. Profile sharpened and form relieved expression for minimum number of teeth. Design features, forces and power estimation, Grinding of milling cutters.

Reamers: Types, geometry, Reaming allowance, design features tolerance disposition.

Broachers: Pull and push types. Internal and External broaches, geometry and design features. Pull force

estimation. Keyway, spline, round, square broaches.

Unit III:

Press tools for sheet metal working:

Blanking and piercing. Diet set elements. Simple and progressive dies. Estimation of punch load, clearances, centre of pressure, strip layout, methods of reducing punch load.

Bending dies: Spring back and bending allowance estimation of punch load.

Drawing Dies: Punch load, blank size, number of draws, methods of retaining metal in draw dies. Metal flow during drawing.

Metal spinning: Configuration and design features of metal spinning, shear forming and flow forming.

Unit IV:

Jigs & Fixtures: Design principles and construction features. Locating methods associated with flat, cylindrical internal and external surface. Types of locating pins. Requirements and choice of locating systems. Redundant location, fool proofing. Setting blocks, types of clamping devices and their basic elements. Quick action clamps and nuts. Equalising and multiple clamping pneumatics. Hydraulic, magnetic and vacuum clamping. Types of drill jig and their classification. Types of jig bushes, jig feet. Indexing jigs. Economic analysis of Jigs and Fixtures. Economic tool life for minimum cost maximum production and max profit rate.

Unit V:

Miscellaneous tools: Cam design for single spindle automatics for simple components. Tool layout estimation

of cycle time. Gauge design: Taylor's principle, limit gauges for holes and shafts. Estimation of limits on Go and No Go gauges. Forgoing dies: Draft, parting line, filters. Allowances, sequence in multiple impression forging. Flashing, Trimming.

Plastic Tools: Application of plastic as a tooling material viz., for Gauges, Surface plates, jigs and fixtures. Forming dies.

Suggested Readings:

1. Surendra kenav and Umesh Chandra, "Production Engineering Design (Tool Design)", Satyaprakashan, New Delhi, 1994.
2. Donaldson, Leain and Goold, "Tool Design", Tata McGraw Hill, New Delhi, 1983.
3. Amitabha Battacharya and Inyong Ham, "Design of Cutting Tools, Use of Metal Cutting Theory", ASTME publication Michigan USA, 1969.

PE807ME

NON-DESTRUCTIVE TESTING

(Professional Elective-V)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives**:*

- To learn the basic principles, techniques, equipment, applications and limitations of basic NDT methods.
- To learn the selection of appropriate NDT methods.
- To grasp the standards and specifications related to NDT technology.
- To know the developments and future trends in NDT.

Course Outcomes:

- After study of the course, the learner should be able to:
- Able to understand the basic principles ,techniques and equipment of NDT methods
- Able to analyse and interpret the results from NDT TESTS
- Able to apply the codes, standards and specifications used in NDT
- Able to select proper NDT method for inspection of industrial products
- Able to know the developments and future trends in NDT

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	3	3	3		2	1		1	1	1
CO2	2	3	2	3	3	3	3		2	3		1	1	1
CO3	2	3	2	3	3	3	3		2	3		1	1	1
CO4	2	3	2	3	3	3	2		2	3		1	1	2
CO5	3	2	1	1	3		2		1	2		2	1	1

-

Unit I:

Liquid Penetrant Inspection: Principles of penetrant inspection, characteristics of a penetrant, water –washable system, post-emulsification system, solvent-removable system, surface preparation and cleaning, Penetrant application, Development, Advantages limitations, and applications.

Magnetic Particle Inspection: Principle, Magnetisation methods, continuous and residual methods, sensitivities, Demagnetisation, Magnetic particles, Applications, Advantages and limitations.

Unit II:

Eddy Current Testing: Principle, Lift-off factor, and edge effects, Skin effect, Inspection frequency, coil arrangements, inspection probes, types of circuit, reference pieces, phase analysis, display methods and applications.

Unit III:

Ultrasonic Testing: Generation of ultra sound, characteristics of an ultrasonic beam, sound waves at interfaces, sound attenuation, Display systems, Probe construction, type of display, Inspection techniques, Identification of

defects, Immersion testing, Sensitivity & calibration. Reference standards. Surface condition, Applications.

Unit IV:

Radiography: Principle and uses of Radiography, limitations, Principle, Radiation sources, Production of X-rays, x-ray spectra, Attenuation of radiation, Radiographic equivalence, Shadow formation, enlargement and distortion, Radiographic film and paper, Xeroradiography, fluoroscopy, Exposure factors, Radiographic screens, identification markers and image quality indicators, Inspection of simple shapes, inspection of complex shapes, viewing and interpretation of radiographs, Radiation hazard, Protection against radiation, measurement of radiation received by personnel.

Unit V:

Acoustic Emission: Physical Principles, Sources of emission, instrumentation and applications. Other NDT Techniques: Neutron radiography, Laser induced Ultrasonics, Surface analysis, Thermography.

Suggested References:

1. Barry Hull & Vernon John, "Non Destructive Testing", 1988.
2. HJ.Frissell (Editorial Co-Ordinator) - "Non-Destructive Evaluation and Quality Control" - ASM Hand Book - International Publication, USA, 1989.
3. Dove and Adams, "Experimental stress analysis and motion measurement", Prentice Hall of India, Delhi.

OE801MT

STATISTICAL APPLICATIONS IN ENGINEERING

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives**:*

- Introduce the basics of Probability
- To provide the knowledge of various distributions like Normal Weibull, Log normal etc
- To provide the knowledge of tests of significance like F-test, t-test and Chi-square test

Course Outcomes: At the end of this course student is expected reach the following outcomes

- Importance of statistics and its sampling distribution
- Classify and compare various probability distributions
- Apply various probability distributions to solve practical problems
- Estimate unknown parameters of populations and apply the tests of hypothesis
- Judge the independence of attributes of given data

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1								1		
CO2	2	2	2	2	1							1		
CO3	2	2	2	2	2							1		
CO4	2	2	2	2	1							1		
CO5	2	2	2	2								1		

Unit I: Basic Probability: Introduction- Random experiments and events, Mutually exclusive events, Probability of an event, Addition law of Probability, Conditional Probability, Independent events and Independent experiments, Baye's theorem .
Random Variables-One dimensional Random Variable, Discrete Random Variable, Continuous Random Variable.

Unit II: Basic Statistics : Measures of Central tendency (Mean, Median, Mode), Moments, Skewness, Kurtosis.
Probability distributions, Binomial, Poisson-Evaluation of statistical parameters for these two distributions.

Unit III: Continuous Distributions: Exponential, Gamma, Normal distribution, Wei-bull distribution, χ^2- distribution, t-distribution, F-distribution,Lognormal distribution , Evaluation of statistical parameters for these distributions.

Unit IV: Applied Statistics: Sampling, Standard Error, Test of significance for large samples, Null hypothesis, Alternate hypothesis, Critical region, Critical values, Level of significance, Confidence interval, Test of significance, Large sample test for single proportion, Difference of proportions, Single mean, Difference of means, Difference of standard deviations.

Unit V: Test of Significance for Small samples : Tests of Significane for small samples Test for single mean, Difference of means, Test for ratio of variances (F- test, t-test), Chi-square test for goodness of fit and independence of attributes

Suggested Reading:

1. R.K.Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5th Edition, 2016.
2. S. Ross," A First Course in Probability" , Pearson Education India, 2002.
3. S.C. Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand& Sons, 2014.
4. Peter V. O' Neil., Advanced Engineering Mathematics 7th Edition, Cengage Learning.
5. Kanti B. Dutta., Mathematical Methods of Science and Engineering Cengage Learning.
6. N.P . Bali and M. Goyal, " A text book of Engineering Mathematics", Laxmi Publications, 2010.
7. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons ,9th Edition, 2012.
8. P.N. Arora,Sumeet Arora, S. Arora, Comprehensive Statistical Methods, S.Chand & Company Ltd, 2008.

OE801BM

HUMAN MACINE INTERFACE

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives**:*

- To stress the importance of a good interface design.
- To understand the importance of human psychology in designing good interfaces.
- To motivate students to apply HMI in their day – to – day activities.
- To bring out the creativity in each student – build innovative applications that are user friendly.
- To encourage students to indulge into research in Machine Interface Design.

Course Outcomes: At the end of this course student is expected reach the following outcomes.

- Design user centric interfaces
- Design innovative and user friendly interfaces
- Apply HMI in their day-to-day activities
- Critical evaluation of existing interface designs, and suggestions to improve them
- Design application for social and technical task
-

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1									
CO2	2	2	2	2	1							1	1	
CO3	2	2	2	2	1							1	1	
CO4	2	2	2	2	1							1	1	
CO5	2	2	2	2	1							1	1	

UNIT-I:
Introduction - Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields.
The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction; Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error

UNIT-II:
Understanding goal directed design - Goal directed design; Implementation models and mental models; Beginners, experts and intermediates – designing for different experience levels; Understanding users; Modeling users – personas and goals.

UNIT-III:
GUI - benefits of a good UI; popularity of graphics; concept of direct manipulation; advantages and disadvantages; characteristics of GUI; characteristics of Web UI; General design principles.

UNIT-IV:
Design guidelines - perception, Gesalt principles, visual structure, reading is unnatural, color, vision, memory, six behavioral patterns, recognition and recall, learning, factors affecting learning, time.

UNIT-V:
Interaction styles - menus; windows; device based controls, screen based controls.
Communication - text messages; feedback and guidance; graphics, icons and images; colours.

Suggested Reading:

1. Alan Dix, J. E. Finlay, G. D. Abowd, R. Beale “Human Computer Interaction”, Prentice Hall.
2. Wilbert O. Galitz, “The Essential Guide to User Interface Design”, Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, “About Face3: Essentials of Interaction design”, Wiley publication.
4. Jeff Johnson, “Designing with the mind in mind”, Morgan Kaufmann Publication.
5. Donald A. Normann, “Design of everyday things”, Basic Books; Reprint edition 2002.

OE802BM

INSTRUMENTATION ENGINEERING

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives**:*

- to understand the need of instrument
- understand the principle of operation of different sensors
- to design signal conditioning circuits for different industrial sensors
- to design the instruments.

Course Outcomes: At the end of this course student is expected reach the following outcomes.

- Characteristics of an ideal sensor
- Understand the principles of operation of various sensors
- Classify and compare various sensors
- Analyse and evaluate various sensors for specified applications
- Design and develop sensors for specified applications

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1									
CO2	2	2	2	2	1							1	1	
CO3	2	2	2	2	1							1	1	
CO4	2	2	2	2	1							1	1	
CO5	2	2	2	2	1							1	1	

UNIT I

Instrument, block diagram of an instrument, Principles of transduction and measurement, Sensor Classification, Functional specifications of sensors; static and dynamic characteristics of measurement systems. Primary sensors, bimetals, Bellows, Bourdon tube, capsule, diaphragm, applications.

UNIT – II

Resistive sensors. Potentiometers, Strain gages, RTDs, Thermistors, LDR. Signal conditioning. Wheatstone bridge, balance and deflection measurements. Instrumentation amplifier. Interference types and reduction. Shield grounding. Isolation amplifiers, Applications.

UNIT-III

Reaction variation and electromagnetic sensors. Capacitive sensors, inductive sensors, LVDT, electromagnetic sensors. Signal conditioning, AC bridges, AC amplifiers, electrostatic shields, carrier amplifiers, phase-sensitive detectors, Applications.

UNIT-IV

Self-generating sensors. Thermoelectric sensors, thermocouples, piezoelectric sensors, photovoltaic sensors. Signal conditioning. chopper and low-drift amplifiers, Noise in op-amps. Digital sensors. Telemetry and data acquisition, Applications.

UNIT-V

Other sensors: Accelerometer transducers, Gyroscopes, Ph sensors, measurement of Conductivity, viscosity, conductivity, flow meters, Humidity, signal conditioning and Applications.

Suggested Reading:

1. Ramon Pallas-Areny and John G.Webster, *Sensors and signal conditioning*, John Wiley and Sons, 1991.
2. Principles of measurements by J P Bentely
3. Electronic measurements and instrumentation by A K Sawhany

OE801CE

ROAD SAFETY ENGINEERING

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives**:*

- Introduction to various factors considered for road safety and management
- Explain the road safety appurtenances and design elements
- Discuss the various traffic management techniques

Course Outcomes: At the end of this course student is expected reach the following outcomes.

- Familiarise with various factors considered for road safety and management
- Understand road safety appurtenances and critically evaluate various traffic management techniques
- Prepare accident investigation reports and database
- Apply design principles for roadway geometrics improvement with various types of traffic safety appurtenances/tools
- Manage traffic including incident management

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1									
CO2	2	2	2	2	1							1	1	
CO3	2	2	2	2	1							1	1	
CO4	2	2	2	2	1							1	1	
CO5	2	2	2	2	1							1	1	

UNIT - I

Road accidents: Causes, scientific investigations and data collection, Analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of Road accident statistics, Safety performance function: The empirical Bayes method Identification of Hazards road location. Application of computer analysis of accident data.

UNIT-II

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & Driver characteristics influencing road safety.

UNIT - III

Road Signs and Traffic Signals: Classification, Location of Signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols. Road Marking: Role of Road markings, Classification, visibility. Traffic Signals: Need, Signal face. Illumination and location of Signals, Factors affecting signal design, pedestrians' safety, fixed and vehicle actuated signals. Design of signa1s, Area Traffic control. Delineators, Traffic Impact Attenuators, Road side rest areas, Safety Barriers, Traffic Aid Posts.

UNIT-IV

Traffic Management Techniques: Integrated safety improvement and Traffic Calming Schemes, Speed and load limit, Traffic lights, Safety cameras, Tests on driver and vehicles, pedestrian safety issues, Parking, Parking enforcement and its influence on Accidents. Travel Demand Management; Methods of Traffic management measures: Restriction of Turning Movements, Oneway streets, Tidal Flow Operation Methods, Exclusive Bus Lanes and Closing Side-streets; Latest tools and

techniques used for Road safety and traffic management. Road safety issues and various measures for road safety; Legislation, Enforcement, Education and Propaganda, Air quality, Noise and Energy Impacts; Cost of Road Accidents.

UNIT-V

Incident Management: Introduction, Characteristics of Traffic Incidents, Types of Incidents, Impacts, Incident management process, Incident traffic management; Applications of ITS: Motorist information, Equipment used; Planning effective Incident management program, Best practice in Incident management programs. National importance of survival of Transportation systems during and after all natural disasters especially cyclones, earthquakes, floods etc and manmade disasters like sabotage, terrorism etc.

Suggested Reading

1. Guidelines on Design and Installation of Road Traffic Signals,IRC:93.
2. Specification for Road Traffic Signals, IS: 7537-1974.
3. Principles and Practice of Highway Engineering by L.R. Kadiyali andN.B.Lal.
4. Hand book of T.E. Myer Kutz, Editor McGraw Hill, 2004.

OE801CE

GREEN BUILDING TECHNOLOGY

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- Exposure to the green building technologies and their significance.
- Understand the judicial use of energy and its management.
- Educate about the Sun-earth relationship and its effect on climate.
- Enhance awareness of end-use energy requirements in the society.
- Develop suitable technologies for energy management.

Course Outcomes:

- Understand the fundamentals of energy use and energy processes in building
- Identify the energy requirement and its management
- Know the Sun-earth relationship vis-a-vis its effect on climate
- Be acquainted with the end-use energy requirements
- Be familiar with the audit procedures of energy

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2					1	3				1	1		
CO2	2					1	3				1	1		
CO3	2					1	3				1	1		
CO4	2					1	3				1	1		
CO5	2					1	3				1	1		

UNIT I

Overview of the significance of energy use and energy processes in building: Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT II

Indoor environmental requirement and management: Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

UNIT III

Climate, solar radiation and their influences: Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT IV

End-use, energy utilization and requirements: Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building - Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer

UNIT V

Energy management options: Energy audit and energy targeting - Technological options for energy management.

Suggested Reading:

1. Michael Bauer, Peter Mösle and Michael Schwarz, "Green Building – Guidebook for Sustainable Architecture", Springer, Heidelberg, Germany, 2010.
2. Norbert Lechner, *"Heating, Cooling, Lighting - Sustainable Design Methods for Architects"*, Wiley, New York, 2015.

3. Mike Montoya*, "Green Building Fundamentals*", Pearson, USA, 2010.
4. Charles J. Kibert*, "Sustainable Construction - Green Building Design and Delivery*", John Wiley & Sons, New York, 2008.
5. Regina Leffers*, "Sustainable Construction and Design*", Pearson / Prentice Hall, USA, 2009.
6. James Kachadorian, *"The Passive Solar House: Using Solar Design to Heat and Cool Your Home",* Chelsea Green Publishing Co., USA, 1997.

OE801CS

DATA SCIENCE USING R

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives**:*

- To learn basics of R Programming environment : R language , R- studio and R packages
- To learn various statistical concepts like linear and logistic regression , cluster analysis , time series forecasting
- To learn Decision tree induction, association rule mining and text mining

Course Outcomes: At the end of this course student is expected reach the following outcomes.

- Understand the basics of R Programming environment : R language , R- studio and R packages
- Use various statistical concepts like linear and logistic regression , cluster analysis , time series forecasting for solving problems
- Use various data structures and packages in R for data visualization and summarization
- Use linear , non-linear regression models, and classification techniques for data analysis
- Use clustering methods including K-means and CURE algorithm

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2		2									
CO2	2	2	2	2	3									
CO3	2	2	2	2	3									
CO4	2	2	2	2	3									
CO5	2	2	2	2	3									

UNIT-I

Introduction To R: Introduction, Downloading and Installing R, IDE and Text Editors, Handling Packages in R.

Getting Started With R: Introduction, Working with Directory, Data Types In R, Few Commands for Data Exploration.

Loading and Handling Data In R: Introduction, Challenges of Analytical Data Processing, Expression, Variables, Functions, Missing Values Treatment In R, Using 'As' Operator To Change The Structure Of The Data, Victors, Matrices, Factors, List, Few Common Analytical Tasks, Aggregation And Group Processing Of A Variable, Simple Analysis Using R, Methods For Reading Data, Comparison Of R GUI's For Data Input, Using R With Databases And Business Intelligence Systems.

UNIT-II

Exploring Data In R: Introduction, Data Frames, R Functions for Understanding Data in Data Frames, Load Data Frames, Exploring Data, Data Summary, Finding the Missing Values, Invalid Values And Outliers, Descriptive Statistics, Spotting Problems In Data with Visualization.

UNIT- III

Linear Regression Using R: Introduction, Model Fitting, Linear Regression, Assumptions of Linear Regression, Validating Linear Assumption.

Logistic Regression: Introduction, What Is Regression?, Introduction To Generalized Linear Model, Logistic Regression, Binary Logistic Regression, Diagnosing Logistic Regression, Multinomial Logistic Regression Model.

UNIT IV

Decision Tree: Introduction, What Is A Decision Tree?,Decision Tree Representation In R, Appropriate Problems For Decision Tree Learning, Basic Decision Tree Learning Algorithm, Measuring Features, Hypothesis Space Search In Decision Tree Learning, Inductive Bias In Decision Tree Learning, Why Prefer Short Hypotheses, Issues In Decision Tree Learning.

Time Series In R: Introduction, What Is Time Series Data, Reading Time Series Data, Decomposing Time Series Data, Forecasts Using Exponential Smoothing, ARIMA Models.

UNIT-V

Clustering: Introduction, What Is Clustering, Basic Concepts in Clustering, Hierarchical Clustering, K-Means Algorithm, CURE Algorithm, Clustering in Non-Euclidean Space, Clustering for Streams and Parallelism.

Association Rules: Introduction, Frequent Itemset, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating SyntheticTransaction Data, Additional Measures of Interestingness, Distance Based Clustering Transaction and Association.

Text Mining: Introduction, Definition of Text Mining, A Few Challenges in Text Mining, Text Mining Verses Data Mining, Text Mining In R, General Architectures of Text Mining Systems, Pre-Processing of Documents In R, Core Text Mining Operations, Using Background Knowledge for Text Mining, Text Mining Query Languages.

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods.

Frequent Itemset, Closed Itemset And Association Rules.

Frequent Itemset: Mining Methods, Pattern Evaluation Methods, Sentiment Analysis

Suggested Reading:

1. Data Analytics using R by Seema Acharya. McGraw Hill education.
2. Practical Data Science with R, Nina Zumel and John Mount, Manning Shelter Island.
3. The R book, Crawley, Michael J. John Wiley & Sons, Ltd

OE801EC

GLOBAL AND REGIONAL SATELLITE NAVIGATION SYSTEM

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To explain the basic principle of GPS and its operation.
- To make the students to understand signal structure.
- To make the students understand the GPS errors.
- Highlight the importance of integrating GPS with other systems.
- To make the students understand about various GRNSS.

Course Outcomes: Student will be

- Understand the principle and operation of GPS
- Critically evaluate GPS Signal structure and services
- Probable causes of GPS errors and methods of rectification
- Applications of GPS in various fields such as navigation, GIS etc
- Operate GRNSS

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1									
CO2	2	2	2	2	1									
CO3	2	2	2	2	1									
CO4	2	2	2	2	1									
CO5	2	2	2	2	1									

Unit I:

Introduction to Satellites, their properties, Orbits and Launch vehicles, Kepler's Laws, GPS fundamentals: Principle of Trilaiteration, Transit, GPS Operating Principle, Architecture: Space, Control and User Segments and its Frequencies.

Unit II:

GPS Signal structure: C/A and P-Codes, SPS and PPS services, GPS Coordinate Systems: Significance, Types of GPS receivers, Selective Availability, Spoofing and Anti-spoofing.

Unit III:

GPS Errors: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Multipath; Dilution of Precision (DOP).

Unit IV:

GPS Modernization: Future GPS satellites, New signals and their benefits, New Control Segment, Principle of operation of DGPS, architecture and limitations, GPS Applications: Surveying Mapping Marine, air and land Navigation, Military and Space Application.GPS Integration with Geographic Information System (GIS), Inertial Navigation System (INS), Pseudolite and Cellular.

Unit V:

Other GRNSS: GLONASS, GALILEO, QZNSS, CNSS and IRNSS System: Principle of Operation, Features and their Current Status.

Suggested Reading:

1. Ahmed El-Rabbany, "*Introduction to GPS"*, Artech House Publishers, 2/e, Boston 2006.
2. Elliot D Kaplan and Christopher J Hegarty," *Understanding GPS principles and applications*", Artech House Publishers, 2/e Boston & London 2005.
3. B.Hofmann-Wellenhof, H.Lichtenegger, and J.Collins, "*GPS Theory and Practice,"* Springer Verlog, 5/e, 2008.

OE801EE

ILLUMINATION AND ELECTRIC TRACTION SYSTEM

(Open Elective-III)

Credits: 3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives**:*

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc.,
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electrification of traction system.

Course Outcomes: At the end of this course student is expected reach the following outcomes.

- Understand Utilization of electrical energy for various applications like industrial heating, welding etc.
- Compare and contrast different methods of electric heating
- Different control techniques used in the operation of three phase induction motors
- Decide the type and ratings of lights used for different purposes like residential, street lighting, factories etc
- Analyse and Evaluate electric traction system, type of motors and their speed control

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2										
CO2	2	2	1	1										
CO3	2	2	1	1										
CO4	2	2	1	1										
CO5	2	2	1	1										

Unit I:

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens — Design of elements. Core type, Coreless type furnaces, High frequency eddy current heating, Dielectric heating. Arc furnace. Electric welding, Resistance welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Unit II:

Schematic Utilization and Connection Diagrams for Motor Control:

Two supply sources for 3 phase Induction motors. Direct reversing, remote control operation, and jogging operating of Induction motor. Contactor control circuit. Push button control stations. Over load relays, limit switches, float switches. Interlocking methods for reversing control.

Unit III:

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations — Determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps — Fluorescent lamp, Starting and power factor corrections, Stroboscopic effects — Neon signs, Application to factory lighting, Street lighting and Flood lighting.

Unit IV:

Electric Traction: System of Electric Traction — Transmission of drive — Systems of track electrification — Traction mechanics — Speed time curves — Tractive effort — Power of Traction motor — Specific energy consumption — Mechanics of train movement— Coefficient of adhesion.
Traction Motors: Desirable characteristics, d.c series motors, a.c series motors 3-phase induction motors, d.c motor series & parallel control, Energy saving.

Unit V:

Train Lighting: Systems of train lighting — Special requirements of train lighting — Methods of obtaining unidirectional polarity — Methods of obtaining constant output — Single battery system — Double battery parallel block system — Principal equipment of double battery system — Coach wiring — Dynamo. **Batteries:** Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

Suggested Reading:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating
1. and Costing, Wiley Eastern Ltd., 1991.
2. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
3. B.L.Theraja, A Text Book of Electrical Technology, S.Chand & Company Ltd, Vol —I.

OE801ME

COMPOSITE MATERIALS

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives**:*

- To know the properties of fiber and matrix materials used in composites, as well as some common manufacturing techniques.
- To know the various moulding process and architecture of composite laminates
- To know how to estimate the laminate properties from lamina properties.
- To understand the strength of an orthotropic lamina and measurement of basic composite properties.

Course Outcomes: At the end of this course student is expected reach the following outcomes.

- Understand the concept of composites its advantages and applications
- Compare and contrast different manufacturing methods of composites
- Analysis and evaluation of laminate composites using micromechanics
- Analysis and evaluation of laminate composites using macromechanics
- Estimate the properties of composites using micormechnics and macromechanics

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							1	1	
CO2	2	2	2	2	2							1	1	
CO3	2	2	2	2	2							1	1	
CO4	2	2	2	2	2							1	1	
CO5	2	2	2	2	2							1	1	

Unit I: Introduction to composite materials, general characteristics, Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fibre composites

Unit II: Molding Processes: hand layup, vacuum molding, compression molding, pultrusion molding, centrifugal molding, filament winding, prepegs and molding compounds and architecture of composite materials: laminates, sandwich composites and other achitectures.

Unit III: Micromechanics of Composites: Mechanical properties: Production of Elastic constant, micromechanical approach, Halpin-Tsal equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

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Unit IV: Macromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation.

Unit V: Strength of an orthotropic lamina: Maximum stress theory, maximum strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials. Measurement of constituent material properties: Fibre tests, Matrix tests. Measurement of basic composite properties: Tensile test, compressive test, a plane shear test, interlaminar shear test, flexure test.

Suggested Reading:

1. Jones, R.M., "Mechanics of Composite Materials", McGraw Hill Co., 1967.
2. Ronald F. Gibson, "Principles of Composite Materials Mechanics", McGraw-Hill, Inc., 1994.

3. Krishan, K. Chewla, "Composite Material", Springer - verlag, 1987.
4. Carl. T. Herakovich, "Mechanics of Fibrous Composites", John Wiley Sons Inc., 1998.

OE802ME
INDUSTRIAL ADMINISTRATION AND FINANCIAL MANAGEMENT
(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand various types of organizational structures, manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources
- To understand the importance of quality, inventory control and concepts like MRP I and MRP II
- To understand the nature of financial management and concepts like breakeven analysis, depreciation and replacement analysis

Course Outcomes: At the end of this course student is expected reach the following outcomes.

- Understand the different phases of product life cycle, types of manufacturing systems, plant layout optimization problems
- Role of scheduling function in better utilization of resources
- Fundamental concepts of quality control, process control, material control and appreciate the importance of MRP-I and MRP –II.
- Know the different terminology used in financial management and apply different techniques of capital budgeting
- Analyse and various types of costs involved in running an industrial organization

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2							1			
CO2	2	2	1	1							2			
CO3	2	2	1	1							2			
CO4	2	2	1	1							2			
CO5	2	2	1	1							2			

Unit-I

Types of organizations, organizational structures. Designing Products, Services and Processes: New product design and development. Product life cycle: phasing multiple products. Manufacturing process Technology: Product, job shop, batch, assembly line and continuous process technology; flexible manufacturing systems. Design of Services, service process technology operations capacity; capacity planning decisions, measuring capacity; estimating future capacity needs.

Unit-II

Locating production and services facilities, effects of location and costs and revenues, factor rating, simple median model (linear programming) Layout planning; process layout; product layout — Assembly lines; line balancing manufacturing cellular layout. Scheduling systems and aggregate planning for production and services; loading assignment algorithm; priority sequencing and other criteria.

Unit-III

Quality planning and Control: basic concepts, definitions and history of quality control. Quality function and concept of quality cycle. Quality policy and objectives. Economics of quality and measurement of the cost of quality. Quality considerations in design.

Process control: machine and process capability analysis. Use of control charts and process engineering techniques for implementing the quality plan. Acceptance sampling: single, double and multiple sampling, operating characteristic Curve - calculation of producers risk and consumers risk.

Unit-IV

Inventory control: deterministic and stochastic inventory models; variable demand; lead time, specific service level, perishable products and service.

Inventory control in application; concepts for the practioners; saving money in inventory

systems; ABC classifications. Inventory control procedures; Quantity - reorders versus periodic inventory systems; material requirement planning (MRP); MRP as a scheduling and ordering system; MRP system components; MRP computational procedure; Detailed capacity planning; MRP - limitation and advantages; Manufacturing Resources Planning (MRP-II).

Unit-V

Elements of cost, overheads, breakeven analysis, depreciation, replacement analysis. Nature of financial management-time value of money, techniques of capital budgeting and method, cost of capital, financial leverage.

Suggested Reading

1. Buifa and Sarin, "Production and operations management" - Wiley Publications.
2. I.M. Pandey, "Elements of Financial Management" Vikas Publications, New Delhi, 1994.
3. James C. Van Home & John, M. Wachowicz, Jr., "Fundamentals of Financial Management", Pearson Education Asia, 11^{th} ed. 2001.

OE803ME

3D PRINTING TECHNOLOGY

(Open Elective-III)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the fundamental concepts of 3D Printing, its advantages and limitations.
- To classify various types of 3D Printing Processes and know their working principle, advantages, limitations etc.
- To have a holistic view of various applications of these technologies in relevant fields such as Mechanical, Bio-medical, Aerospace, electronics etc.

Course Outcomes: Upon competition of this course the student will be able to:

- Understand the fundamentals of 3D Printing Technology, its process chain and classify various types of 3D Printing process
- Learn about the working principle, advantages, limitations and applications of various types of liquid and solid based 3D Printing Systems
- Understand the various types of Powder based 3D Printing systems, their advantages, limitations and applications.
- Understand the various types of 3D Printing Data formats, STL file errors and features of the 3D Printing Softwares
- Learn the versatile applications of 3D Printing Technology in various fields like automobile, aerospace, biomedical, Electronic industries etc

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1	1	
CO2	2	2	1	1								1	2	
CO3	2	2	1	1								1	2	1
CO4	2	2	1	1								1	2	1
CO5	2	2	1	1								1	2	1

UNIT-I

Introduction: Prototyping fund3D Printingentals, Historical development, Fund3D Printingentals of 3D PRINTING, Advantages and Limitations of 3D PRINTING , Commonly used Terms, Classification of 3D PRINTING process, 3D PRINTING Process Chain: Fund3D Printingental Automated Processes, Process Chain.

UNIT-II

Liquid-based 3D Printing Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

Solid-based 3D Printing Systems: L3D Printinginated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT-III

Powder Based 3D Printing Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Laser Engineered Net Shaping (LENS), Electron Be3D Printing Melting.

UNIT-IV

3D Printing Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

UNIT-V

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewellery Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Printed electronics, Biopolymers, Packaging

Suggested Reading:

1. Chua C.K., Leong K.F. and LIM C.S, Rapid prototyping; Principles and Applications, World Scientific Publications , Third Edition, 2010.
2. D.T. Ph3D Printing and S.S. Dimov, Rapid Manufacturing, Springer, 2001.
3. TerryWohlers, Wholers Report 2000, Wohlers Associates, 2000.
4. PaulF.Jacobs, Rapid Prototyping & Manufacturing ASME Press, 1996