With effect from the Academic year 2021-22

DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction
and
Syllabi of

B.E. VII & VIII Semesters

2021-2022

AICTE MODEL CURRICULUM

UNIVERSITY COLLEGE OF ENGINEERING

(AUTONOMOUS)

OSMANIA UNIVERSITY

HYDERABAD – 500 007 TELANGANA

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

S. No.	Code	Name of the Course	No of Hours				Scheme of Examination		Credits
			L	T	P	Contact Hrs/wk	CIE	SEE	
1.	PC701ME	Thermal Turbo Machinery	3	-	-	3	30	70	3
2.	PC702ME	Automation in Manufacturing	3	-	-	3	30	70	3
3.	PC703ME	Operation Research	3	-	-	3	30	70	3
4.	PE	**Professional Elective-IV**	3	-	-	3	30	70	3
5.	PE	**Professional Elective-V**	3	-	-	3	30	70	3
6	OE	**Open Elective-II**	3	-	-	3	30	70	3
PRACTICALS									
7.	PC751ME	CAM and Automation Lab	-	-	3	3	25	50	1.5
8.	PC752ME	Thermal Engineering Lab-II	-	-	3	3	25	50	1
9.	PW654ME	Summer Internship-II	-	-	2	2	50	-	1
10.	PW751ME	Major Project Phase -I	-	-	2	2	50	-	1
		Total	18	-	10	28			22.5

Code	**Professional Elective-IV**	Code	**Professional Elective-V**
PE741ME	Heating Ventilation and Air Conditioning	PE751 ME	Waste Heat recovery and Co generation
PE742ME	Fuel Cell Technology	PE752ME	Energy conservation and Management
PE743ME	Total quality Management	PE753ME	Design for Manufacturing
PE744ME	Entrepreneurship	PE754 ME	Machine tool Engineering and Design
PE745ME	Microprocessor in automation	PE755ME	Mechanical Vibrations
PE746ME	Machine Learning application	PE756ME	Industrial Robotics
PE747ME	Virtual Reality and Augmented Reality	PE757ME	Design of Transmission systems

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Code	**Open Elective Course-II**
OE701BM	Micro Electro-Mechanical Systems
OE702CE	Green Building Technology
OE703CS	Information Security
OE704CS	Data Base Management Systems
OE705EC	Embedded Systems
OE706EC	Verilog HDL
OE707EC	Satellite Communication and Applications
OE708EE	Optimization Techniques
OE709EE	Non-Conventional Energy Sources
OE710 ME	Start up Entrepreneurship
OE711 ME	Nano Technology

PC701ME

THERMAL TURBO MACHINERY

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

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 turbo machines and related performance parameters.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. The Students are expected to formulate governing equations of compressible flows and derive relations among fluid flow properties.
2. The Students are expected to be able to predict the compressible flow properties behaviour with friction, heat transfer and shock waves.
3. The Students are expected to be able to classify turbo machines and explain working principle of Rotodynamic compressors and calculate performance parameters.
4. The Students are expected to explain classification and working principles of steam turbines.
5. They must be able to draw velocity diagrams and calculate performance parameters.
6. 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

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 bladefriction, 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

AUTOMATION IN MANUFACTURING

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

Course Objectives:

- To understand the importance of automation in the of field machine tool based manufacturing
- To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC
- To understand the basics of product design and the role of manufacturing automation

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Understand the fundamental concepts of automation, its importance and classify various types of automation.
2. Interpret the fundamental applications of computer in design, manufacturing and solve Problems using geometric transformation techniques in CAD
3. Illustrate the architecture of a CNC Machine tool and Write CNC Part programs for manufacturing components
4. Describe the working of various automated material handling systems like AGV, AS/RS/ Robots
5. Understand the basic working principles of low cost automation like pneumatic, hydraulic, plc and also gain knowledge on the importance of modelling and simulation

UNIT I

Introduction: Importance of automation, Current trends, CAD, CAM, CIM; Automation in production Systems, Automation Principles and Strategies, Basic elements of an Automated System, Types of automation systems: Fixed or Rigid Automation, Programmable Automation, Flexible Automation
Levels of Automation

UNIT II

Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software: CAD Software: System software, Application Software, Graphic Standards & Exchange formats, CAD database and structure, 2D Geometric Transformations, 3D Geometric Transformation, Geometric modelling: Bezier Curve, Spline curves, NURBS, Surface: Plane surface, ruled surface, Surface of revolution, Tabulated Cylinder, Bezier surface, B-spline surface and solid modelling: CSG and B-Representation.

UNIT III

Computer Aided Manufacturing: Introduction – Features & Elements of NC, Types of input media and NC Classification, CNC Hardware, NC and NC part programming, Machining Centers, CNC-Adaptive Control systems, FMS: Definition, components of FMS and FMS layouts.

UNIT IV

Automated Material Handling Systems: Overview 01 Material Handling Equipment, Principles of material handling, Introduction to working of Automated Guided Vehicles, Automated Storage retrieval systems, Robotics: Definition, classification and types of robot programming.

UNIT V

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies, Basic structure of PLC and Micro-controllers.

Introduction to Modelling and Simulation: Product design, process route modelling, Introduction to Product Life Cycle Management, PLM Software's, Components of PLM Software

Suggested Reading:

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition, Pearson.
3. YoramKoren, Computer control of manufacturing system, 1st edition
4. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.
5. Radhakrishnan, P. Sbramanyam, S.Raju.v, "CAD/CAM/CIM", New Age International (P) Ltd, 2nd Edition,

PC703ME

OPERATION RESEARCH

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

Course Objectives:

- To understand the terms used in OR, model the given problem
- To learn various types OR models to solve different problems
- To learn various network models and how to use them
- To understand the concepts of Inventory models and sequencing models and develop them
- To solve queuing problems and understand concepts of Integer programming and goal programming.

Course Outcomes: Upon successful completion of this course, the student will be able to

1. To understand the basics of OR, including mathematical modeling, feasible solutions and optimization using LPP
2. To formulate and solve transportation and assignment problems
3. To develop network models and solve for industrial projects
4. To apply Inventory models , sequencing models in industry
5. To model and solve queuing problems.

UNIT- I

Introduction : Operations Research models : Characteristics, applications and limitations.

Linear Programming Problem: Introduction, Basic Assumptions, Formulation, graphical method, simplex method Big M and Two Phase method. Duality principle, Primal and Dual Problems, Sensitivity Analysis and Economic Interpretation.

UNIT- II

Transportation and Assignment models:

Transportation Problems : Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Unbalanced problems, Optimal solution.

Assignment problem – Formulation – Optimal solution – Variants of Assignment Problem; Traveling Salesman problem.

UNIT- III

Network Models: Shortest route, minimal spanning tree, maximum flow models–

Project networks: Introduction to PERT and CPM, critical Path calculation, float calculation and its importance.

UNIT- IV

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – discount models – Inventory control models in practice.

Sequencing Models: Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines, processing 2 jobs through m machines.

Game Theory:

Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods.

UNIT -V

Queuing models - Queuing systems and structures – Notation parameter – Single server and multi server models – Poisson arrivals – Exponential service times – with finite population – Infinite population.

Integer programming: Introduction, Types of Integer programming, Branch and bound methods

Goal programming: Introduction, types and solution

Suggested Reading:

1. Hamdy, A. Taha, *Operations Research – An Introduction*, Seventh Edition, Prentice Hall of India Pvt. Ltd., 2002.
2. Ronald L. Rardin, *Optimization in Operations Research*, First Indian Reprint 2002, Pearson Education Asia.
3. R. Paneerselvam, *Operations Research*, Prentice Hall of India Private Ltd., 2002.
4. Singiresu S. Rao, *Engineering Optimization Theory of Practice*, 3rd edition, New Age International (P) Ltd. Publishers.
5. S.C. Sharma, *Operations Research*, Discovery Publishing House, 2006.

PE741ME

HEATING VENTILATION AND AIR CONDITIONING
(Professional Elective – IV)

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

Course Objectives:

- To impart basic concepts used in the heating ventilation and air conditioning.
- To get basic knowledge of various heating and cooling methods adopted in industry.
- To know the design aspects of duct and duct design
- To understand the working of various components used in the Air conditioning.
- To know the various applications of air conditioning systems.

Course Outcomes:

1. Identify the different heating and ventilation system
2. Estimate and analyze the cooling load from different heat source.
3. Design the various ducts for different arrangements.
4. Explain the various air conditioning accessories and helping devices.
5. Describe the industrial and commercial applications of air conditioning systems.

UNIT-I

Air Heating System: Classification- gravity warm heating system, forced warm heating system. Balancing warm air heating system. Advantages and disadvantages of air heating system.

Hot water (Hydronic) heating system: Classification- gravity and forced hot water heating system. Gas boiler, Circulating pump, Radiant heating system.

Fundamentals of good indoor quality need for building ventilation. Type of ventilation system-supply and exhaust. Commercial, Residential and Kitchen ventilation system.

UNIT-II

Cooling Load Estimation: Different heat sources, Sensible heat gain through building structure by conduction, Heat gain from solar radiation, Solar heat gain through outside walls and roofs, Sol air temperature, Solar heat gain through glass areas, Heat gain due to infiltration, ventilation, occupants and appliances. Heat gain from products, lighting and power equipments. Heat gain through ducts. Concepts of heating load calculations.

UNIT-III

Air Distribution System: Classification of duct and duct materials, Pressure in Ducts, Continuity and Bernoulli's equation for Ducts, pressure loss in ducts, pressure loss due to friction in ducts, Friction factor for ducts, Rectangular sections equivalent to circular section, Equivalent length system for representing the other loss. Duct design and Arrangement Systems. Noise and noise control.

UNIT-IV

Air Conditioning Equipments: Air cleaning and Air-Filters, Humidifiers, Dehumidifiers, Fans and Blowers - types of fans- fan characteristic- Centrifugal fans, Axial fans, Static pressure calculation for selection of motor and fan, Grills and Registers. Chilled water piping, Supply and Return pipe sizing. Chilled water pumps.

UNIT-V

Commercial and Industrial Applications: Air conditioning of Houses, Offices, Hotels, Restaurants, Departmental stores, Theatres, Auditorium, and Hospitals.

Transport air conditioning: Automobile, railways, Marine and air craft.

Special applications: Computers, storage of medicine and vaccine, cold storages, printing, textiles, leather industries and various products and process industries.

Suggested Reading:

1. *HVAC Fundamentals Volume-I –James.E Brumbough, Wiley Publications.*
2. Ventilation ASHRAE Hand Book
3. A Course in Refrigeration and Air conditioning by Arora & Domkundwar, Dhanpatrai & Co
4. Refrigeration and air Conditioning by R.S. Khurmi & J.K. Gupta , S Chand & Co
5. Jordon & Priester, *Principles of Refrigeration and Air Conditioning*, Prentice Hall, India.

e-Resources:

1. http://nptel.ac.in/

PE742ME

FUEL CELL TECHNOLOGY

(Professional Elective – IV)

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

Course Objectives:

- To introduce the fundamental knowledge fuel cell working principle and their utilizations.
- To learn performance analysis of fuel cell through thermodynamics and electrochemistry.
- To understand the design concept of the fuel cell subsystems.

Course Outcomes:

1. Upon successful completion of this course, the student will be able to:
2. Describe the fundamental concept of fuel cell system and their relative merits and demerits and also compare with other systems
3. Understand the various types of fuel cells working mechanisms.
4. Execute appropriate fuel cell technology for a given application.
5. Evaluate the performance of fuel cells under different operating conditions and also know the fuel cell heat management
6. Develop enough skills to design and require subsystems of the fuel cell system.

UNIT-I

Fundamentals: Brief history, working principles of fuel cell, components, and relative merits and demerits, classifications of fuel cells: low, intermediate and high temperature fuel cells, comparison of fuel cells with battery and heat engines.

UNIT-II

Fuel Cell Types: Polymer Electrolyte Membrane Fuel Cells (PEMFCs), Alkaline Fuel Cells (AFCs), Phosphoric Acid Fuel Cells (PAFCs), Solid Oxide Fuel Cells (SOFCs), Molten-Carbonate Fuel Cells (MCFCs), Direct Methanol Fuel Cells (DMFCs), Zinc Air Fuel Cells (ZAFCs), Protonic Ceramic Fuel Cells (PCFCs), Biological Fuel Cells (BFCs)

UNIT-III

Fuel Cells Applications: Portable Power, Backup Power, Transportation Applications: Automobiles, Buses, Utility vehicles, Scooters and bicycles, Stationary Power Applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells, and hybrid electric vehicle

UNIT-IV

Fuel Cell Analysis: Fuel cell thermodynamics, and electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Volmer equation, performance evaluation of fuel cells: current/voltage, voltage efficiency and power density, Fuel cell: charge transport, mass transport, energy balance mass. fuel cell stack, fuel cell heat management..

UNIT-V

Fuel Cell System Design: Fuel Subsystem, Electrical Subsystem, System Efficiency. Fuel Types, Delivery, and Processing, Fuel Cell Operating Conditions, Fuel Cell Testing Setup, Verification of the Assembly, Fuel Cell Conditioning, Fuel Cell Hybrid Power Systems.

Suggested Reading:

1. Ryan O'Hayre, Suk-Won Cha, Whitney G.Colella, Fritz B.Prinz, "*Fuel Cell Fundamentals*", John Wiley & Sons, Inc., 2016.
2. Andrei A Kulikovsky, "*Analytical Modelling of Fuel Cells*", Elsevier, 2010,
3. Vladimir S. Bagotsky, "*Fuel Cells Problems and Solutions"*, John Wiley & Sons, Inc., 2009
4. Michael Gasik,"*Materials for fuel cells*", Woodhead Publishing Limited, 2008
5. Colleen Spiegel, "*Designing and Building Fuel Cells*", The McGraw-Hill Companies, 2007

PE743ME

TOTAL QUALITY MANAGEMENT
(Professional Elective – IV)

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

Course Objectives:

- Develop quality environment to the organization.
- Describe the TQM approach for manufacturing/service organization in length.
- Categorise various Quality terms like Tolerance and Variability, PDCA cycle,Crosby's10 points and Deming's14Points.
- Identify international and national Quality awards

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Understand the significance of quality in manufacturing
2. Rectify the deviations in quality in manufacturing
3. Practice the quality standards in the organization

UNIT-I

Evolution of Quality-Historical Perspective, Basic Concepts of Quality, Vision, Mission and Objectives of an Organization, Corporate Structure in an Organization and Role of Quality. Quality Planning, Quality by Design, Quality Costs and Cost of Failure, Waste Control, How Quality Benefits Business.

UNIT-II

Quality and Competitiveness in Business, Zero Defects and Continuous Improvement, Role of Leadership and Commitment in Quality Deployment, Team Building, Motivation and Rewards, Total Employee Empowerment, Quality Functions-Measurement, Inspection, Testing, Calibration and Assurance.

UNIT-III

Design Control and Conformity, Tolerance and Variability, PDCA Cycle, Juran Trilogy, Crosby's 10 points and Deming's14Points Customers Requirements, Customer-Supplier and Chain Links, Establishing Customer Focus-Customer, Satisfaction, Measurement and Customer Retention.

UNIT-IV

Product Liability, Total Quality Concepts and CWQC, Difference in Western And Japanese Approach of TQM, Basic Philosophy and Fundamental Models of TQM, Total Quality and Ethics.

UNIT-V

Internal Politics and Total Quality Management, Quality Culture, Education and Training Implementing Total Quality Management- An Integrated System Approach Total Preventive Maintenance. Self-Assessment, International/National Quality Awards: Malcolm Baldridge Award, Deming Prize, European Award, Rajeev Gandhi Award, CII Exim Award, Jamna Lal Bajaj Award, Golden Peacock Award.

Suggested Reading:

1. Total Quality Management by N.V.RNaidu, G. Rajendra New Age International, First Edition, Jan2006.
2. Total Quality Management by R.S Naagarazan, New Age international,3e,2015.
3. Quality Control & Application by B. L.Hanson &P. M. Ghare, Prentice Hall of India,2004.
4. Total Quality Management by V.S Bagad Technical Publications, First Edition,Jan2008.
5. Total Quality Management by S. Rajaram Dreamtech Press, First Edition,Jan2008.

PE744ME

ENTREPRENEURSHIP
(Professional Elective – IV)

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

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:

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

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

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.

PE745ME

MICROPROCESSORS IN AUTOMATION
(Professional Elective – IV)

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

Course Objectives:

- Understand internal architecture of 8051 and Microprocessors
- To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller
- Learn to interface different peripheral devices with Microprocessors
- Learn to write basic programs in Microprocessors (8051 & ARM)
- Learn to design simple embedded systems
- Understand the importance of role of embedded systems in industry

Course outcomes: After completion of the course student will be able to

1. Understand the internal architecture and interfacing of different peripheral devices with Microprocessors
2. Write the programs for Microprocessors
3. Understand the role of Microprocessors in industry.
4. Understand the design concept of embedded systems.
5. Develop real time interface systems for industrial applications

UNIT-I

Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers.
Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals.

UNIT-II

Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing. Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller; Interfacing peripherals:

UNIT-III

Programmable peripheral interface (8255). Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features,

UNIT-IV

Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z Transform, Digital Filters, Implementation of Digital Algorithm.

UNIT-V

Microprocessors in Control Systems, Self-Tuning and Adaptive Control by Microprocessor, Microprocessor-Based AC Motor Control, Control of DC Motors, Direct Numerical Control.

Text Books:

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private ltd
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino,Tata McGraw-Hill Publishing Company Ltd.
3. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
4. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition,2007).
5. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall
6. Mohammad Ali Mazidi, Rolin D McKinley, Janice G Mazidi, The 8051 Microcontroller and Embedded Systems, Second Edition, Prentice Hall
7. Andrew N.Sloss, Domnic Symes, Chris Wright, ARM system developers guide, Elsevier publications.

PE746ME

MACHINE LEARNING APPLICATIONS
(Professional Elective – IV)

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

Course Objectives:

- Understand the importance of data preparation & management in Machine learning applications
- Learn the basics of various statistical tools required in machine learning
- Learn to solve using regression and clustering techniques
- Learn to use concept of ANN and CNN for solving problems
- Learn to use ML and DL for mechanical applications

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

1. Distinguish between supervised and unsupervised problem statements
2. Compare and contrast various Machine Learning and Deep Learning algorithms
3. Apply the concepts of Supervised & Unsupervised Learning to obtain the required results
4. Evaluate the importance of different algorithms used for Machine & Deep learning
5. Apply the concepts of ML and DL to the real-time data for mechanical applications and arrive at the required results.

UNIT I

Data Preparation: Introduction, types of data, Data preparation -Data selection, Data Pre-processing-Formatting, cleaning and sampling, Data Transformation-Scaling, Decomposition and Aggregation. **Regression:** Linear regression, Logistic regression, Multiple regression, Stepwise, overfitting, Regularization

UNIT II

Supervised Learning: Gradient Descent, Bias and Variance, Support Vector Machine: Hyperplanes, Kernels, Regularization, Large margin classification

UNIT III

Unsupervised learning: Clustering, k-means algorithm, Principal Component Analysis, Missing Data, choosing clusters

UNIT IV

Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, Overfitting, learning network structure. Shallow neural networks, problems with shallow networks, importance of Deep Learning, key concepts in Deep Learning, Practical Considerations of Deep neural networks: hyper parameter tuning, initialisation, regularisation, gradient checking, optimisation algorithms, Convolutional Neural Networks, step by step procedure, Recurrent Neural Networks- step by step procedure, ALEXNET, Autoencoders

UNIT V

Mechanical Applications of Machine Learning: ANOVA Analysis of manufacturing processes like forming, welding, Abrasive machining, Condition Monitoring of rotary and reciprocating equipment, Condition monitoring of wind turbine, bearing fault diagnostics, Automatic car detection,

Suggested Readings:

1. Tom Mitchell, *Machine Learning*, McGraw Hill
2. Ian Goodfellow, YoshuaBengio, and Aaron Courville, Deep Learning
3. Christopher M. Bishop, Pattern Recognition and Machine Learning
4. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning
5. Kevin Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press
6. Richard Sutton and Andrew Barto, *Reinforcement Learning: An Introduction*, MIT Press.
7. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems

PE747ME

VIRTUAL REALITY AND AUGMENTED REALITY
(Professional Elective – IV)

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

Course Objectives:

- Learn the basics of VR and AR
- Learn how to build objects in Unity IDE
- Learn to build controllers in Unity IDE
- Learn to build environment in Unity IDE
- Learn to generate animated walk in Unity IDE

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

1. Differentiate Virtual and Augmented Realities
2. Understand Virtual reality concepts
3. Develop VR applications using Unity3D
4. Move around the 3D world
5. Run Unity 3D application in VR on a smart phone

UNIT-I

Introduction To Virtual Reality : Virtual Reality – Types – Virtual Reality Vs Augmented Reality – Applications – Technical skills required

UNIT-II

Building Simple Scenes: Introduction to Unity IDE – Objects and Scale – Creating a simple diorama – VR Device integration

UNIT-III

Gaze Based Control: First person Controller – Third person controller – Navigation in VR application – World space User Interface

UNIT-IV

Physics & Environment: Physics component – physics materials – Raycast – particle effects

UNIT -V

Walk-Throughs: Assembling scenes – Adding photos – Animated walkthrough – optimizing for performance – Using all 360 degrees

Suggested Textbooks:

1. Tony Parisi, Learning Virtual Reality, O'Reilly Media, 2016
2. Jason Jerald, The VR Book – Human Centered Design for Virtual Reality, Morgan & Claypool, 2015
3. John Williamson, Charles Palmer, Virtual Reality Blueprints: Create compelling VR experiences for mobile and desktop, Packt Publishing, 2018

PE751ME

WASTE HEAT RECOVERY AND CO-GENERATION
(Professional Elective – V)

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

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

1. Understand the concept of waste heat recovery
2. Distinguish heat exchangers and recuperators
3. Acquire knowledge about various cogeneration methods
4. Understand the cogeneration concept and thermodynamic advantages

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 Reading:

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.

PE752ME

ENERGY CONSERVATION AND MANAGEMENT
(Professional Elective – V)

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

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

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

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.

PE753ME

DESIGN FOR MANUFACTURING
(Professional Elective – V)

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

Course Objectives:

- The candidate should be able to design the product for any manufacturing activity
- The student should be able design the process for manufacturing
- The student should be able design any part

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Design for manufacturing any part geometry
2. Design for functionality and performance
3. Design for utility

UNIT-I

Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization.
Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.

UNIT-II

Metallic Components Design: Metal extrusion, metal stamping, fine blanking, four slide parts, spring and wire forms, spun metal parts, cold headed parts, extruded parts, tube and section bends, rolled formed parts, power metal parts, forging electro forming parts, specialized forming methods, turned parts, machined round holes, drilled parts, milled parts.

UNIT-III

Metallic Components Design: Planned shaped and slotted parts, screw threaded contoured and internal Ground parts, center less ground, electrical discharged, rolled furnished parts, electro chemical and Advanced machine parts. Sand cast, die cast, investment cast and other cast products.

UNIT-IV

Non Metallic Components Design: Thermosetting plastic, injection moulded and rotational moulded parts, Blow moulded, welded plastic articles, ceramics. Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, Bearing assembly.

UNIT-V

Assembled Parts Design: Retension, bolted connection, screwed connections, flanged connections, centred connections, press fitted connections, surface finishing, plated parts, heat treated parts, NC machining, group technology, low cost automation, computer aided manufacture, product design requirements.
Case Studies: Identification of economical design and redesign for manufacture.

Suggested Reading:

1. James G. Bralla, “Hand book of product design for manufacturing” McGraw Hill Co., 1986
2. K.G. Swift “Knowledge based design for Manufacture”, Kogan page Limited, 1987

PE754ME

MACHINE TOOL ENGINEERING AND DESIGN
(Professional Elective – V)

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

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

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

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

PE755ME

MECHANICAL VIBRATIONS
(Professional Elective – V)

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

Course Objectives:

- To gain the knowledge of mathematical modelling of a physical system and applying
- The principles of Newton's Second Law and conservation of energy to derive the equations of motion.
- To familiarize with linear systems with degrees of freedom.
- To study the response of a vibrating system with periodic excitation and understand the principle of vibration isolation.

Course Outcomes:

1. Develop a mathematical model for a physical system and derive the governing differential equations.
2. Determine the natural frequencies of single and two degrees of freedom systems.
3. Determine the effect of damping in real time systems.
4. Determine and analyze the response of machine members or structures in forced vibration with different excitation frequencies.
5. Solve the eigen value problems to identify mode shapes.

UNIT-I

Fundamentals of Vibrations Analysis- Introduction; Elements of vibration; vibration analysis procedure; spring elements-equivalent stiffness; Mass or inertia elements; Damping elements-equivalent damping-Types of damping, Definitions and Terminology, Simple harmonic motion.

Free Vibration Analysis-Single Degree of Freedom Systems Undamped Vibrations: Different methods for equation of motion-Newton's Second Law, D'Alembert's Principle. Principle of Conservation of Energy, Rayleigh's method.

Damped Vibrations: Differential equation of motion, critical damping coefficient and damping ratio; Damped natural frequency; Logarithmic decrement; Energy dissipated in viscous damping.

UNIT-II

Forced Vibration Analysis (Single Degree of Freedom System):Response of damped and undamped systems to harmonic excitation; frequency response curve; magnification factor; Harmonic excitation of the base, vibration isolation, transmissibility, force transmission to foundation; response of a damped system under rotating unbalance. Vibration measuring instruments-working principle of Seismic mass, Vibrometer, Accelerometer.

UNIT-III

Damped and Undamped Vibrations: Free and forced vibration analysis of two degree of freedom system-different methods for the formulation of equations of motion, natural frequencies, Principal modes-physical interpretation and orthogonality.

UNIT-IV

Torsional Vibrations: Torsional vibration of one, two and three rotor system, Equivalent shafting, Torsional vibration of a geared system, Coordinate coupling-static and dynamic coupling.

UNIT-V

Numerical methods: Characteristic equation, Eigen values, identification of node and mode shapes. Eigen value method, Influence coefficients.

Suggested Readings:

1. G.S. Grover & Nigam, Mechanical Vibrations, Nem Chand & Bros, 6th edn,1998
2. S.S. Rao, Mechanical vibration, 4th edn, Pearson, 2009
3. Thomson , William T, Theory of Vibration with Application,4th edn, Pearson Education, 2007
4. V.P. Singh , Mechanical vibration, Dhanpath Rai &Co., 3rd edn,2006
5. Graham Kelley,S., Mechanical vibration – Schaums Outline Series, TMH
6. F.S. Tse, Morse & Hinkle ,Mechanical vibration, Allyn and Bacon, 1978

With effect from the Academic year 2021-22

PE756ME

INDUSTRIAL ROBOTICS
(Professional Elective – V)

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

Course Objectives:

- The student should be able to learn
- Various types of industrial robots
- Industrial robots operations
- Understand and control the programming of robots

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Undertake the design of the motion planning of the robot
2. Undertake repair and maintenance and rectify mechanical operations
3. Plan the motion design for each particular activity

UNIT-I

Safety, introduction to industrial robotics, components of the robot, controller/logic function, teach pendant/interface, manipulator, degrees of freedom, and axis numbering, base types. **Classification of robots:** power source, geometry of the work envelope, drive systems: classification and operation, so classification, **end-of-arm tooling:** multiple tooling, positioning of EOAT,

UNIT-II

Programming and file management: planning, subroutines, writing the program, testing and verifying, normal operation, file maintenance, **automation sensors:** limit switches, proximity switches, tactile and impact sensors, temperature sensors, fluid sensors, position sensors, sound sensors, connection to the robot, sensor selection criteria; **vision systems:** components of a vision system, image analysis, lighting,

UNIT-III

Integration and networking: types of networks, communication protocols,, integration,**; programmable logic controllers (PLCS) and human-machine interfaces (HMIS)L** basic components of the PLC, operation of the PLC, human–machine interfaces, **maintenance and troubleshooting:** preventive maintenance, arc flash, troubleshooting, crash recovery, repair tips, parts swapping versus fixing the problem, precautions before running the robot

UNIT-IV

Robot handling: The handling task, Robot characteristics for handling.- **Robot assembly.-case studies** Application characteristics., **Robot welding :** The spot welding process - 6.3 Robot spot welding- 6.4. The robot task- The arc welding process - Robot MIG welding- **Machining with robots :** Application characteristics - **Spray painting applications:** The spray painting process - Spray painting robot anatomy and characteristics - Programming techniques - **Innovative robot applications** in the automation of manufacturing processes, assembly automation - applications in inspection.

UNIT-V

Lean Manufacturing With Robotics for Low Volume, Small Batch Runs: Changeover for Small Batches, the Design of a Robotic Work-Cell, Automating the machining process, Automating the welding process and Automating the material removal process for small batch runs,

Automating small batch runs for press tending and palletizing, automating the palletizing process for small batch runs, Tools for small batch and high changeover production
Lean Manufacturing with Robotics for High Volume: Large Batch Runs, Robotic Machine Tending for High Production, Robotic Cellular Manufacturing

Suggested Reading:

1. Keith Dinwiddie Industrial Robotics / Edition 1 by , Publisher: Cengage Learning
2. Rex Miller, Mark R. Miller Robots and Robotics: Principles, Systems, and Industrial Applications,
3. Groover M P (Author) Industrial Robotics Technology, Programming &Application, Tata McGraw Hill Education
4. Larry T. Ross, Stephen W. Fardo, and Michael F. Walach Industrial Robotics Fundamentals: Theory and Applications, 3rd Edition
5. Andrew Glaser, Industrial Robotics, Industrial Press publisher , ---add Year ALSO--

PE757ME

DESIGN OF TRANSMISSION SYSTEMS
(Professional Elective – V)

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

Course Objectives:

- The mechanical motions elements
- Understand the configuration and design
- Manufacturability of mechanical element

Course Outcomes: Upon completing this course the students will be able to design transmission systems for engines and machines.

1. Determine the motion for various applications
2. Design a requirement motion most efficiently
3. Solve the motion design of various mechanisms

UNIT-I

Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets

UNIT-II

Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears.

UNIT-III

Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears;
Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears**.**

UNIT-IV

Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine tool applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications**.**

UNIT-V

Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; **Design of plate clutches**, axial clutches, cone clutches, internal expanding rim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes, internal expanding shoe brake.

REFERANCES :

1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
2. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
3. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001.

OE 701BM

MICRO ELECTRO-MECHANICAL SYSTEMS

(OPEN ELECTIVE-II)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To introduce to basics of Micro-electro-mechanical systems
- To understand properties of materials involved in MEMS
- To pertain fabrication methods involved in MEMS manufacturing
- To apply the concepts for various applications

Course Outcomes: Upon completion of the course, the student will be able to

1. Elucidate basic concepts involved in MEMS technologies
2. Realize the properties of various materials involved in MEMS technologies
3. Apply the concepts and technologies involved in designing of MEMS
4. Relate different manufacturing processes involved in fabrication of MEMS
5. Recognize micro sensors, micro actuators and their applications in various fields.

UNIT I

Introduction to MEMS: What is MEMS, Historical Background, classification, Micro-engineering, importance of micro-engineering. Technological advancements in MEMS, advantages and disadvantages of MEMS.

UNIT II

MEMS materials: Materials used in MEMS. Material properties: electrical, mechanical, thermal, chemical, biological, optical and processing. Reliability issues of materials

UNIT III

Designing of MEMS: Design and analysis process for MEMS. Initial design process, structured design process. Commonly used design flow, structured design flow. Design flow for MEMS cad design. Design and verification flow for integrated MEMS.

UNIT IV

MEMS fabrication Techniques: Photolithography, materials for micromachining, bulk micromachining Surface micromachining, High aspect-ration-micromachining, assembly and system integration.

UNIT V

MEMS structures and devices: Mechanical sensors, mechanical actuators, micro-fluidic devices, optical/photonic micro-systems, biological transducers.

Suggested Readings:

1. Adams TM, Layton RA., *"Introductory MEMS: Fabrication and applications"*, 2010.
2. Tobergte DR, Curtis S., *"An Introduction to Micro-electro-mechanical Systems Engineering"* Second Edition. vol. 53. 2013.
3. Kreith F, Kreider JF., *"The MEMS Handbook*" CRC Press 2002.
4. Reza Ghodssi, Pinyen Lin, *"MEMS Materials and Processes Handbook"* Springer 2013
5. Gad-el-Hak M, *"MEMS applications"* 2nd edition, CRC press 2006.

OE 702CE

GREEN BUILDING TECHNOLOGY

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

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: Student will be

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

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 - Auditoryrequirement.

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 Readings:

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.

With effect from the Academic year 2021-22

OE 703CS

INFORMATION SECURITY

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

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: Student will be

1. Describe the steps in Security Systems development life cycle(SecSDLC)
2. Understand the common threats and attack to information systems
3. Understand the legal and ethical issues of information technology
4. Identify security needs using risk management and choose the appropriate risk control strategy based on business needs
5. Use the basic knowledge of security frameworks in preparing security blue print for the organization
6. Usage of reactive solutions, network perimeter solution tools such as firewalls, host solutions such as antivirus software and Intrusion Detection techniques and knowledge of ethical hacking tools
7. Use ethical hacking tools to study attack patterns and cryptography and secure communication protocols
8. Understand the technical and non-technical aspects of security project implementation andaccreditation

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, and Risk Control Strategies, Selecting a Risk Control Strategy, Quantitative versus Qualitative Risk Control Practices, Risk Management discussion Points, and 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, And 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 DigitalForensics.

Suggested Readings:

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

With effect from the Academic year 2021-22

OE 704CS

DATA BASE MANAGEMENT SYSTEMS

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

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, andrecovery.

Course Outcomes: Student will be

1. Understand the mathematical foundations on which RDBMS are built.
2. 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.
3. Develop Database application using SQL and Embedded SQL.
4. Use the knowledge of file organization and indexing to improve database application performance.
5. Understand the working of concurrency control and recovery mechanisms in RDBMS.

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, Implementationof 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 InternationalEdition, 3rd Edition, 2003.
3. Elmasri, Navathe, Somayajulu, "*Fundamentals of Database Systems"*, Pearson Education,4th Edition, 2004.

OE 705EC

EMBEDDED SYSTEMS

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To gain knowledge to design embedded systems.
- To understand the processor selection criteria for Embedded System Design.
- To gain the knowledge of ARM Cortex on Zynq for embedded systems.
- To gain the knowledge of tool chain for embedded systems.
- To understand the importance of RTOS in building real time systems

Course Outcomes: Student will be

1. Design an embedded system.
2. Distinguish between RISC and CISC
3. Use the ARM Cortex for design of embedded system
4. Use Embedded Software Development Tools for Designing Embedded System applications
5. Apply their understanding in building real time systems

UNIT-I

Introduction To Embedded Systems: The Embedded Design Life Cycle - Product Specification, Hardware/Software Partitioning, Iteration and Implementation, Detailed Hardware (selection fo processor) and Software Design, Hardware/Software Integration, Product Testing And Release, Maintenance and Up gradation.

UNIT-II

ARM Embedded Systems: The RISC design philosophy, The ARM design philosophy, ARM processor fundamentals, registers, current program status register, pipeline, exceptions, interrupts, and vector table, core extensions, architecture revisions, ARM processor families.

UNIT-III

Embedded processing with ARM CORTEX on Zynq: Fundamentals of FPGA, types of FPGA, case study of Xilinx FPGA, Processing System, programmable logic, programmable logic interfaces, security, Zynq 7000 family members, Zynq versus standard FPGA, Zynq versus standard processor.

UNIT-IV

Embedded Software Development Tools: Host and Target Machines, Cross Compilers, Cross Assemblers, Tool Chains, Linkers/Locators for Embedded Software, Address Resolution, and Locator Maps. Getting Embedded Software into Target System: PROM programmer, ROM emulator, In Circuit- Emulators, Monitors, Testing on Your Host Machine - Instruction Set Simulators, Logic Analyzers.

UNIT-V

Introduction to Real Time Operating Systems: Tasks and task states, tasks and Data, Semaphores and shared data. Operating system services: Message queues, mailboxes and pipes, timer functions, events, memory management, Interrupt routines in an RTOS environment.

Suggested Readings:

1. Arnold S Berger, "*Embedded Systems Design"*, South Asian edition, CMP Books, 2005.
2. Andrew Sloss, Dominic Symes, Chris Wright, *ARM "System Developer's Guide: Designingand Optimizing System Software",* Elsevier, 2004.
3. Louise H Crockett, Ross. A. Elliot et al "*The Zynq Book*", Edition 1, Strathclyde academicmedia, July 2014.
4. David E Simon, "*An Embedded software primer*", Pearson, 2012

With effect from the Academic year 2021-22

OE 706EC

VERILOG HDL

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL.
- To develop combinational and sequential circuits using various modeling styles of Verilog HDL
- To design and develop Verilog HDL models of data path and control units of Central Processing Unit (CPU)
- To learn Synthesis and FPGA design flow.
- To design and develop real time applications: Booth's multiplier, Divider, hardwired control for basic CPU, FIR filter.

Course Outcomes: Student will be

1. Implement and distinguish different Verilog HDL modeling styles
2. Construct and analyze Verilog HDL models of combinational and sequential circuits
3. Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications
4. Outline FPGA design flow and timing analysis

UNIT - I

Introduction to HDL: Overview and Importance of HDLs, Differences between HLL, HDL and ALP. Design methodologies, Modules, Lexical Conventions, Number Specifications, Strings, Identifiers and Keywords Data types, System task and compiler Directives, Port declaration and port connection rules

UNIT - II

Structural and Dataflow modeling: gate-level modeling, delays, hazards, dataflow modeling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples

UNIT - III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules Simulation: Types of Simulation, Event driven Simulation and Cycle Based Simulation; design examples.

UNIT - IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions, Tasks and Functions. Verilog HDL synthesis, synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT - V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Reading:

1. Samir Palnitkar, *"Verilog HDL A Guide to Digital Design and Synthesis,"* 2nd Edition, Pearson Education, 2006.
2. Ming-Bo Lin, "*Digital System Designs and Practices: Using Verilog HDL and FPGA,"* Wiley India Edition, 2008.
3. J. Bhasker, *"A Verilog HDL Primer*," 2nd Edition, BS Publications, 2001.

OE 707EC

SATELLITE COMMUNICATION AND APPLICATIONS

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To familiarize with basic concepts related to satellite Communication.
- To understand Sub-Systems of Satellites and Launches.
- To design the Earth Station antennas.
- To know about the parameters affecting the Satellite System Performance.
- To understand the applications of satellites.

Course Outcomes: *Student will be*

1. Able to have knowledge about the Satellite communications Principles and Properties.
2. Able to know about the Space craft subsystems and Launch vehicles.
3. Able to design the Satellite Earth station antennas
4. Able to analyze the effects of various parameters on Satellite System performance.
5. Able to understand the applications of Satellite Communication.

UNIT–I

Origin of Satellite communications, A Brief History of Satellite Communication, Basic principles and properties of satellite communication. Earth segment, Space segment, Interpretation of Kepler's Laws. Orbital Mechanics: The Equation of the Orbit, Describing the Orbit, Locating the Satellite in the Orbit, Orbital effects in communication system Performance: Doppler shift, Range variation, Eclipse and Sun-Transit Outage.

UNIT– II

Space craft sub systems, Equipment Reliability and Space Qualification: Space Qualification, Reliability, and Redundancy, Satellite launch and launch vehicles and Mechanics of Launching a Synchronous Satellite.

UNIT– III

Earth Stations: Earth Station Design for Low System Noise Temperature, Design of large antennas and small earth station antennas. Low noise amplifiers and High power Amplifiers for Satellite communication.

UNIT– IV

Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T ratio: Noise Temperature, calculation of System Noise Temperature, Noise Figure and Noise Temperature, Propagation on Satellite-Earth paths: Attenuation, depolarization, atmospheric absorption, Tropospheric Multipath effects and Land and Sea Multipath, Multipath Effects in System Design, Faraday rotation in the Ionosphere, Ionospheric scintillations, Rain and ice effects.

UNIT– V

Satellite Navigation Applications: Global and Regional Satellite Navigation Systems- Operating Principles, Advantages, Limitations, Current Status and Applications, Remote Sensing Satellites.

Suggested Readings:

1. Wilbur L. Pitchand and Henri G. Suyderhoud, Robert A. Nelson, "*Satellite Communication Systems Engineering",* 2nd edn.3rd Impression, Pearson Education.2008.
2. Timothy Pratt and Charles Nestian. W, "*Satellite Communication",* John Wiley and Sons, 1988.
3. Tri T. Ha, "*Digital Satellite Communication"*, Tata McGraw- Hill, Special Indian Edition2009.

With effect from the Academic year 2021-22

OE 708EE

OPTIMIZATION TECHNIQUES

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand the need and basic concepts of operations research and classify the optimization problems.
- To study about the linear programming and non-linear programming concepts and their applications
- To understand various constrained and un-constrained optimization techniques and their applications.
- To understand the concepts and implementation of Genetic Algorithms to get the optimum solutions
- To study the concepts of Metaheuristics Optimization techniques

Course Outcomes: Student will be

1. Analyze any problem of optimization in an engineering system and able to formulate a mathematical model to the problem and solving it by the techniques that are presented.
2. Solve problems of L.P. by graphical and Simplex methods.
3. Apply various constrained and un-constrained optimization techniques for the specific problems.
4. Could able to implement the Genetic Algorithms to solve the for optimum solution.
5. Understands the concepts to use the Metaheuristics Optimization techniques

UNIT – I

Introduction: Definitions, Characteristics, Objective function, Classification of optimization problems, Engineering applications and limitations. Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints and Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Condition

UNIT – II

Linear Programming: Definitions and Formulation of the LPP, Construction of L.P. Models, Slack and surplus variables, Standard form, Canonical form and matrix form of LP Problems. Artificial Variables, solution by the Big-M method, Duality principle, Dual problems and numerical problems.

UNIT – III

Random Search Methods concepts: Direct Search Methods - Univariate Method, Gradient of a Function, Indirect Search Methods - Gradient of a Function, Steepest Descent (Cauchy) Method, Newton's Method.

UNIT – IV

Binary Genetic Algorithm: Genetic Algorithms Natural Selection on a Computer, Components of a Binary Genetic Algorithm. Selecting the Variables and the Cost Function. Variable Encoding and Decoding, the Population, Natural Selection, Selection, Mating. Mutations, the Next Generation and Convergence, Components of a Continuous Genetic Algorithm.

UNIT – V

Metaheuristics Optimization: Concepts of Simulated Annealing, Theoretical approaches, Advantages and disadvantages, applications, Ant Colony Algorithms - Introduction, Collective behavior of social insects, Formalization and properties of ant colony optimization.

Suggested Readings:

1. Rao, S.S., *"Engineering Optimization: Theory and Practice",* John Wiley & Sons, Inc., 2009
2. Taha, H.A., *"Operations Research, Pearson Education India",* New Delhi, India, 2008.
3. Randy L. Haupt and Sue Ellen Haupt, *"Practical genetic algorithms"* second edition, a John Wiley & sons, inc., publication -2004.
4. Sharma J.K., "*Operation Research: Theory and Applications"* Fifth Edition, Macmillan Publishers, New Delhi, India, 2013.
5. J. Dreo A. Petrowski, P. Siarry E. Taillard, *"Metaheuristics for Hard Optimization"* Springer.

With effect from the Academic year 2021-22

OE 709EE

NON-CONVENTIONAL ENERGY SOURCES

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand the different types of energy sources
- To Understand the need of non-conventional energy sources and their principles
- To understand the limitations of non-conventional energy sources
- To outline division aspects and utilization of renewable energy sources for diriment application
- To analyze the environmental aspects of renewable energy resources

Course Outcomes: Student will be able to

1. Know the different energy resources and need of renewable energy resources
2. Understand the concepts of working of fuel cell systems along with their applications
3. Describe the use of solar energy and the various components and measuring devices used in the energy production and their applications
4. Appreciate the need of Wind Energy and their classification and various components used in energy generation and working of different electrical wind energy system
5. Understand the concept of OTEC technology, Biomass energy resources and different types of biogas Plants used in India

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 H2O2 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 Readings:

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.

OE710ME

START UP ENTREPRENEURSHIP
(Open Elective-II)

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

Course Objectives:

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

Course Outcomes: Student will

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

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", TataMcGraw-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.

OE711ME

NANO TECHNOLOGY
(OPEN ELECTIVE –II)

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

Course Objectives:

- To familiarize Nano materials and technology.
- To understand Nano structures, fabrication and special Nano materials.
- Understand the processing of nano materials

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Apply the nano materials to different industrial applications
2. Explore the nano materials various human applications
3. Design and manufacture nanomaterial processes

UNIT-I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nano Technology, Bottom-up and Top-down approaches, challenges in Nano Technology.

UNIT-II

Materials of Nano Technology: Introduction-Si-based materials, Ge-based materials, Smart materials, metals, Ferroelectric materials, Polymer materials, GaAs & InP (III-V) group materials, Nano tribology and Materials, Principles and analytical techniques of XRD, SEM, TEM and STM/AFM.

UNIT-III

Nano Structures: Zero dimensional Nano structure (Nano Particles)- Synthesis procedure, characterization techniques, properties and applications of Nano Particles

One dimensional Nano structures (Nano Wires, Nano Tubes)- Various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes.

UNIT-IV

Nano Fabrication: Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping) MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques).

UNIT-V

Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal- ceramics and polymer-Ceramics), Characterization procedures, applications. Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications.

Suggested Reading:

1. A.K.Bandyopadyay, Nano Materials, New Age Publications, 2007.
2. T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnolgy, Tata McGraw-Hill, 2008.
3. Carl. C. Koch, Nano Materials Synthesis, Properties and Applications, Jaico Publishing House, 2008.
4. Willia Illsey Atkinson, NanoTechnology, Jaico Publishing House, 2009.

PC751ME

CAM AND AUTOMATION LAB

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

Course Objectives:

- To write CNC part programs and simulate using CAM Simulation Software's like CADEM/MASTER CAM or any equivalent software's.
- To write and execute robot programming using simulation tools for performing pick and place and stacking of objects etc.
- To conduct basic experiments on Pneumatics, Hydraulics and Electro-Pneumatic systems

Course Outcomes:

The students will be able to

1. Gain working knowledge in writing CNC part Program, simulate using CAM software's and understand the manufacture components on CNC machines
2. Develop robot programs for simulating various tasks like pick and place, stacking etc., using standard robot simulation software's like Robotstudio, Microsoft Robotics Developer Studio or any equivalent software's
3. Gain working knowledge in simulation of Pneumatic, Hydraulic and PLC simulator.

List of Experiments

1. Generate tool path simulation for basic Step turning/Face turning operation.
2. Generate tool path simulation for basic taper turning operation.
3. Generate tool path simulation for thread cutting operation.
4. Generate tool path simulation for combined drilling and grooving operations
5. Generate tool path simulation for Multiple operations
6. Generate tool path simulation for Milling operations
7. Robot Program simulation for stacking the objects in a palletizer
8. Robot programming for a pick & place.
9. Robot Program for perform a spray painting or any other similar operation using any programming method.
10. Hydraulic equipment simulation using H-Simulator
11. Pneumatic equipment simulation using P-Simulator
12. PLC simulator

Note: At least 10 experiments have to be completed with minimum two experiments from CAM, Robotics, Pneumatic, hydraulic and PLC simulators

PC752ME

THERMAL ENGINEERING LAB-II

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

Outcomes:

1. Able to find the performance of compressors, blowers
2. Understand the working and determine the performance various turbines
3. Able to estimate the heat transfer in various types of heat exchangers
4. Able to find out conductivity of solids and liquids and convection in liquids

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
20. To conduct experiments on aero foil of NACA specification

PW654ME

SUMMER INTERNSHIP-II

Instructions: NIL
Credits: - CIE: 25 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

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

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 grades Excellent, Good, Average will be allotted after evaluation in VII semester

PW751ME

MAJOR PROJECT PHASE -I

Instructions: 2Hrs per week SEE 25 marks
CIE: 50 Marks Credits: 2

Course Objectives:

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic Literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:

1. demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems
2. evaluate different solutions based on economic and technical feasibility
3. effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

Project work

Pre requisites:

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)

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 5th 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

With effect from the Academic year 2021-22

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

S. No.	Code	Name of the Course	No of Hours				Scheme of Examination		Credits
			L	T	P	Contact Hrs/wk	CIE	SEE	
1.	PC801ME	**Professional Elective-VI**	3	-	-	3	30	70	3
2.	PC802ME	Principles of Management	3	-	-	3	30	70	3
3.	PC803ME	**Open Elective-III**	3	-	-	3	30	70	3
PRACTICALS									
9.	PW851ME	Major Project Phase - II	-	-	12	12	50	100	6
		Total	9	-	4	21			15

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code	**Professional Elective-VI**
PE861 ME	Advanced Propulsion and Space Science
PE862ME	Hybrid vehicle Technology
PE863ME	Cryogenic Engineering
PE864ME	Bio Mechanics
PE865ME	Sustainable Manufacturing
PE866ME	Non Destructive Testing
PE867ME	Tool Design
PE868ME	Design of Mechatronics Systems
PE869ME	Design for Additive Manufacturing

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code	**Open Elective Course-III**
OE801BM	Basic Medical Equipment
OE802CS	Data Science Using R
OE803EC	Mobile Communication
OE804EC	Internet of Things and Applications
OE805EC	Global and Regional Satellite Navigation System
OE806EE	Applications of Electrical Energy
OE807 ME	Composite materials
OE808 ME	Industrial Administration and Financial Management
OE809CS	Software Engineering
OE810CS	Python Programming
OE811CS	Cyber Securities

PE861ME

ADVANCED PROPULSION AND SPACE SCIENCE
(Professional Elective – VI)

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

Course Objectives:

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

Course Outcomes: Student will be able to

1. Classify different rocket propulsion systems and understand the concept of gas dynamics
2. Understand the working principle of rocket engine system
3. Understand celestial sphere and its parameters

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 rockets 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., 3 Rd 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, 198

PE862ME

HYBRID VEHICLE TECHNOLOGY
(Professional Elective – VI)

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

Course Objectives:
At the end of the program, the students shall be able to understand:

- Electric vehicle subsystems and components
- Purpose and working principle of the various subsystems
- Electric vehicle performance and costs
- Electric vehicle applications and benefits

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Understand and design various aspect of hybrid vehicle
2. Undertake to maintain the operation and performance of the vehicle
3. Evaluate the hybrid vehicle performance.

UNIT-I
ICE (Internal Combustion Engine) limitations, Understanding of the electric vehicle (EV) and hybrid electric vehicle (HEV);E-Mobility vs. ICE vehicle - Performance, efficiency, emissions, energy, power, cost, convenient ; Vehicle tractive effort vs. torque developed by EV, HEV & ICE ; EV & hybrid vehicle classification and their basic features, characteristics, applications.

UNIT-II
EV Components' purpose, working principle, features, types, performance-Clutch, Torque converter, Automatic transmission, planetary gear, CVT, gear ratio calculation; Driveline & differential - FWD, RWD, 4WD, AWD (Front wheel drive, rear wheel drive, 4 wheel drive, all-wheel drive); Braking system - regenerative braking, mechanical brake, braking force distribution, Architecture examples

UNIT-III
Energy storage devices – Purpose of battery, working principle, features, types, performance-Battery, Ultra capacitor / Super capacitor, Flywheel, Fuel cell,
Hybridization of energy sources

UNIT-IV
Power converter: DC to DC converter - Resistor, transistor, chopper; AC to DC converter - Thyristor, rectifier; DC to AC converter – Inverter

UNIT-V
Electric motor: Classification, their basic understanding; Motor properties, motor losses, a good motor; Working principle, performance characteristics, controls, applications DC motor, BLDC motor (Brushless DC motor), Induction motor, PMSM (Permanent magnet synchronous motor).

Suggested Reading:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC, Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
4. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000 http://nptel.ac.in/courses/108103009.

PE863ME

CRYOGENIC ENGINEERING
(Professional Elective – VI)

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

Course Objectives:

- To provide the knowledge of evolution of low temperature science.
- To learn the technology of refrigeration and gas liquefaction.
- To know various equipments used for cryogenic systems.
- To understand the methods of separation and purification systems.
- To familiarize the cryogenic instruments.

Course Outcomes:

1. Identify the cryogenic application and understand material properties.
2. Estimate and analyze the refrigeration and liquefaction for minimum work.
3. Design the various heat exchangers and other components.
4. Describe the methods of separation and purification.
5. Explain about cryogenic i**nstrumentation and Safety** aspects.

UNIT–I

Introduction to Cryogenics: Historical development, Applications of cryogenics (Space Technology, Food Processing, Super Conductivity, Electrical Power, Cryobiology, Medicine, Cryo-metallurgy), nuclear, chemical and rocket propulsions.

Properties of Engineering Materials: Solids (Mechanical, Thermal, Electrical and Magnetic properties), Properties of Cryogenic fluids.

UNIT-II

Refrigeration and Liquefaction: Refrigeration and liquefaction principles, Joule-Thomson expansion, Isentropic expansion, Linde- Hampson cycle, Claude cycle and Cascade systems. Magnetic cooling, Striling cycle, Cryocoolers, Philip refrigerators, Solvay refrigerator, Gifford – McMahon refrigerator, pulse tube refrigerator.

UNIT-III

Cryogenic Equipments: Heat exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization. Various insulations and storage equipment for cryogenic fluids. Industrial storage and Transfer of cryogenic fluids.

UNIT-IV

Separation and Purification Systems: Ideal separation of gases, Characteristics of mixtures, Temperature-Composition diagrams, Enthalpy-Concentration diagrams. Principles of gas separation, Air separation systems, Hydrogen separation systems, Helium separation systems. Gas purification methods.

UNIT-V

Cryogenic Instrumentation and Safety: Properties characterizing cryogenic instrumentation. Temperature measurements, Pressure, flow-rate, Liquid-level. Safety in cryogenic fluid handling, Precautions and Protection measures.

Suggested Reading:

1. Randal F. Barron, Cryogenic Systems, Oxford University Press, New York, 1999
2. T.M Flynn, Cryogenic Engineering, Maxwell Dekker, 1997.
3. Scoot, Cryogenic Engineering, Van Nostrand Co. Inc. 1985.
4. R W Yance and WM Duke, Applied Cryogenic Engineering, John Willey.
5. Klaus D. Timmerhaus, Richard Palmer Reed, Cryogenic Engineering: 50 years of progress, Springer, 2007
6. Fundamentals of Cryogenic Engineering. Mamata Mukhopadhyay
7. Theory and design of cryogenic systems : A.Arkherov
8. Cryogenic Engineering Edit / B.A. Hands/ Academic Press, 1986
9. Hand Book of Cryogenic Engineering – J.G. Weisend –II, Taylor and Francis, 1998

e-Resources:

1. http://nptel.ac.in/

PE864ME

BIO MECHANICS
(Professional Elective – VI)

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

Objectives:

- Understand the importance of composition & properties with respect to structure of bones
- Learn to develop viscoelastic models of soft tissues
- Learn to determine the mechanical behavior of passive muscles
- Understand the behavior of muscle force production and transmission
- Learn to optimse the production of muscle force and transmission

Course outcomes: After completion of the course student will be able to

1. Identify various bones with their composition & elastic properties and understand their importance with respect to structural strength of human skeleton
2. Determine the viscoelastic constitutive models of soft tissues and further modifying the muscle models as fibre composite materials
3. Determine the mechanical properties of muscles and tendons
4. Develop functional relationships between force applied and length & velocity developed in muscles
5. Optimise the muscle force production & transmission

UNIT-I

Introduction to Biomechanics – Terminology – Anthropometry – Skeletal Mechanics – Structure of bones – Composition and properties of bones and relationship to structure – Elasticproperties of bones – Characterizing elastic anisotropy – Modeling and Remodeling of bones(Wolfe's law of bone remodeling)

UNIT-II

Viscoelasticity of soft tissues – Models of viscoelasticity (Maxwell, Voigt, Kelvin)Muscle mechanics – Muscle architecture and mechanics – Muscle fascicles and theirarrangement – Fiber architecture in fascicles – Muscle as a fiber reinforced composite – Musclecentroids – Muscle Cross sectional areas (Physiological & Anatomical) –

UNIT-III

Properties of tendons and passive muscles – Viscoelastic behavior of tendons – Tendon interaction with surrounding tissues – Mechanical properties of passive muscles

UNIT-IV

Mechanics of Active muscle: Muscle force production and transmission – Functional relations (Force – length, Force – Velocity curves), History effects in muscle mechanics – Hill's model (derivation) – Sliding filament theory

UNIT-V

Muscle coordination – Problem of motor redundancy – Approach to studying muscle force production using optimization (forward and inverse)Exemplary behavior: Dynamics of Reaching – Inverse dynamic modeling

Suggested Readings:

1. Principles of Biomechanics by Robert L.Huston, CRC Press
2. Berne & Levy Physiology, 6th Updated Edition, Bruce M. Koeppen and Bruce A. Stanton, Mosby, 2009 edition.

PE865ME

SUSTAINABLE MANUFACTURING
(Professional Elective – VI)

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

Course Objectives:

- To understand the fundamentals of Sustainable Manufacturing and various tools and techniques of sustainability.
- To know the principles of sustainable design
- To understand the role of customer and user needs assessment for sustainability

Course Outcomes: After completion of the course student will be able to:

1. Summarize the basic concepts in sustainability
2. Apply sustainable engineering design tools for life cycle assessment (LCA) and examine the features of various LCA Software
3. Interpret the Principles of Sustainable Breakthrough Design
4. Summarize the various design concepts for sustainability
5. Identify Customer and User Needs Assessment for sustainable manufacturing

UNIT-I

Basic Concepts in Sustainability, Understanding the language of sustainable engineering design, construction and operation. .Natural resources terminology. Carrying capacity. Sustainable development, corporate responsibility, biophysical constraints, environmental management.

UNIT-II

Tools and Techniques of Sustainability, Sustainable Engineering Design Tools – Life cycle analysis, carbon foot printing. Life cycle assessment (LCA), Types of LCA's: baseline, comparative, streamlined .LCA inventory analysis: processor input- output. Hybrid inventory analysis. Sustainable Product Design. Whole systems design.Lightweightingandmaterialsreduction.Designingforalifetime.Designfordurability, Repair and upgrade, disassembly and recycling. Energy use in design. Reducing energy losses in design.

UNIT-III

Foundational Concepts &Principles for Sustainable Break through Design

Infrastructure for managing flows of materials, energy and activities; sustainable value creation approaches for all stake holders, environmental design characteristics; design changes & continual improvement; inclusivesustainabledesignprinciples,crowdsourcing,multiple-objectivedesigns; infrastructures that support system thinking; knowledge management for sustainable design,learning systems and experimentation; smart data systems, understanding variation.

UNIT-IV

Sustainable Design: Industrial ecology, multiple life cycle design, principles of design, green engineering, cradle to cradle design, The Natural Step, biomimicry, design for reuse, dematerialization, modularization, design for flexibility, design for disassembly, design for inverse manufacturing, design for the environment, etc.

UNIT-V

Customer and User Needs Assessment Identification &breakdown structures that describe customers & stakeholders, green marketing, socially conscious consumerism, sources of customer information, collecting information, analyzing customer behaviour, translating the voice of the customer, use analysis, structuring customer needs, service gap analysis, prioritizing customer needs, strategic design, Kano technique.

Suggested Readings:

1. Clarke, Abigail & John K.Gershenson, 2006.Design for the Life Cycle. Life-cycle Engineering Laboratory, Michigan Technological University.
2. Finster, MarkP., 2013. Sustainable Perspectives to Design and Innovation.
3. Ramaswamy, Rohit,1996.Design and Management of Service Processes: Keeping Customers for Life, Prentice Hall.
4. Schmitt, Brent, 2003. Customer Experience Management, Wiley and Sons

PE866ME

NON DESTRUCTIVE TESTING
(Professional Elective – VI)

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

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

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

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.

PE867ME

TOOL DESIGN
(Professional Elective – VI)

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

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:

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

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. Chip breakers 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**.**

PE868ME

DESIGN OF MECHATRONICS SYSTEMS
(Professional Elective – VI)

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

Course Objectives:

- Understand different mechanical elements of organization
- Understand the electronics in combination with mechanical elements
- Working and functional features of mechatronics systems

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Programme the mechanical system
2. Design of mechanical system with sensors
3. Functional design of mechatronic systems

UNIT-I

Microprocessors, Microcontrollers, Digital Signal Processors (DSP's) and Microcontroller Architecture, Microcontroller Math and Number Manipulation: Manipulating Individual Bits, Testing Individual Bits: Programming Languages: Interpreters, Compilers, Hybrid Compiler/Interpreters, Integrated Development Environments (IDEs), Choosing a Programming Language

Program Structures for Embedded Systems: Event Driven Programming, Event Checkers, Services, Building an Event Driven Program, State Machines

Software Design: Building as a Metaphor for Creating Software, Introducing Some Software Design Techniques, Software Design Process

Communications: Bit-Parallel and Bit-Serial Communications, Signaling Levels, Communicating Over Limited Bandwidth Channels, Telephones and Modems,, Communicating with Light, Communicating over a Radio,

UNIT-II

Microcontroller Peripherals: Accessing the Control Registers,: The Parallel Input/output Subsystem,

Timer Subsystems, : Pulse Width Modulation (PWM), : PWM Using the Output Compare System, The Analog-to-Digital (A/D) Converter Subsystem

Basic Circuit Analysis and Passive Components: Voltage, Current and Power, Circuits and Ground, Laying Down the Laws, Resistance, Thevenin Equivalents, Capacitors, Inductors

Inductors and Time-Varying Signals, Time and Frequency Domains, Circuit Analysis with Multiple Component Types, Simulation Tools, Limitations of Simulation Tools

Semiconductors: Diodes, MOSFETs, Multi-Transistor Circuits, Reading Transistor Data Sheets

Operational Amplifiers: The Ideal Op-Amp, Analyzing Op-Amp Circuits, Comparator

Real Operational Amplifiers and Comparators: Reading an Op-Amp Data Sheet, Reading a Comparator Data Sheet, Comparing Op-Amps

UNI-III

Sensors: Sensor Output & Microcontroller Inputs, Sensor Design, Fundamental Sensors and Interface Circuits: Light Sensors, Strain Sensors, Temperature Sensors, Magnetic Field Sensors; Proximity Sensors, Position Sensors, Acceleration Sensors

Programming Logic controller: switches, relays , timers, logic, input and output system ,Ladder programming process

UNIT-IV:

Drives and mechanisms of an automated system; drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.

Hydraulic system Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps.

Design of hydraulic circuits. Pneumatic system Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

UNIT-V

Introduction to Programmable Logic Controllers (PLCs) : Programmable Logic Control Overview

Industrial Process Control, PLC Terminology, PLC Hardware Components, PLC Applications, Sensors and Actuators, Implementing Automation with PLCs, Programming PLCs, Ladder Logic Terminology, Typical PLC Instruction Set, PLC Programming Process, PLC Program Simulation PLC Programming Example

References:

1. Devdas Shetty, Ph.D., P.E. and Richard A Kolk Mechatronic System Design ,Cengage Publisher
2. J. Edward Carryer Matthew Ohline Thomas Kenny Introduction to Mechatronic Design Pearson publications
3. Boucher, T. O., Computer automation in manufacturing - an Introduction, Chapman and Hall, 1996.
4. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988
5. Deb, S. R., Robotics technology and flexible automation, Tata McGraw-Hill, New Delhi, 1994.
6. Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman, Singapore, 1999.
7. Mechatronics: Bolton, W., Longman/div
8. Introduction to Mechatronics: D.G. Alciatore & Michael B. Histand; Tata Mc Graw Hill
9. Mechatronic handbook: Bishop; CRC press
10. Intelligent Mechatronic Systems: Modeling, Control and Diagnosis, R. Merzouki, A. K. Samantaray, P. M. Pathak, B. Ould Bouamama, Springer, London
11. Boukas K, Al-Sunni, Fouad M “Mechatronic,Systems Analysis, Design and Implementation,” Springer,
12. Sabri Cetinkunt, “Mechatronics with Experiments,” 2nd Edition, Wiley
13. Janschek, Klaus, “Mechatronic Systems Design,” Springer

PE869ME

DESIGN FOR ADDITIVE MANUFACTURING
(Professional Elective – VI)

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

Course Objectives:

- To understand the importance of additive manufacturing
- To get the knowledge of various types of additive manufacturing technologies and the role of CAD in AM
- To understand the concept of Design for AM, Computational Tools and the application of these concepts for Polymer AM and Metal AM Technologies

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Understand the fundamental concepts of AM
2. Interpret the working principles of various AM Technologies
3. Gain knowledge on the concept of Design for AM
4. Analyze the various computational tools for Design Analysis and Optimisation of AM Parts
5. Apply the knowledge of DFAM for polymer and metal based AM processes.

UNIT I

Introduction: Definition of AM, Process Chain of AM, Advantages of AM: Part Complexity, Instant Assemblies, Part Consolidation, Mass Customization, Freedom of Design, On-demand Manufacturing, Classification of various AM Technologies

UNIT II

AM Technologies: Working principle and applications of the following AM Technologies: Material Extrusion: Fused Deposition Modelling (FDM), Material Jetting: Polyjet, Binder Jetting: 3DPrinting, Sheet Lamination: Laminated Object Manufacturing (LOM), Vat Photopolymerization: Stereolithography (SLA), Direct Light Processing (DLP), Powder Bed Fusion: Selective Laser Sintering (SLS) and Selective Laser Melting (SLM), Direct Energy Deposition: Laser Engineered Net shaping (LENS).

CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL format, STL Fire errors, Error removal algorithms

UNIT III

Design For AM

Introduction to the concept of DFAM, Using AM to Add Value to Products, General Guidelines for Designing AM Parts: Design to Avoid Anisotropy, Design to Minimize Print Time, Design to Minimize Post-processing, Take Advantage of Design Complexity. Function First, Materials Second**.**

UNIT IV

Computational Tools for Design Analysis and Optimisation of AM Parts

Aims of Using Design Analysis for AM , Special Considerations for Analysis of AM Parts : Material Data, Surface Finish , Geometry., Simplifying Geometry, Mesh-Based Versus Parametric Models, Geometry Distortion. Mesh: Parametric Models , Mesh-Based Models, Boundary Conditions, Optimisation, Topology Optimisation, Build Process Simulation.

UNIT V

Design for Polymer AM: Anisotropy, Wall Thicknesses, Overhangs and Support Material, Holes, Ribs, Avoiding Superfluous Material, Font Sizes and Small Details

Design for Metal AM: Designing for Metal Powder Bed Fusion , The Basics of Powder Bed Fusion, Metal Powder Production, Powder Morphology, Powder Size Distribution, Metal AM Material Characteristics, The Metal AM Process : Energy Density, Topology Optimisation, Lattice Structures , Overhangs and Support Material, Residual Stress : Designing to Reduce Residual Stress, Stress Concentrations : Designing to Reduce Stress Concentrations , Setting up a Metal AM Print Job, General Part Positioning Guidelines.

Text Books:

1. Olaf Diegel, Axel Nordin, Damien Motte, "**A Practical Guide to Design for Additive Manufacturing**" Springer Series in Advanced Manufacturing, First Edition, 2019.
2. **Martin Leary, Design for Additive Manufacturing, 1st Edition, Elsevier, Publisher, 2019.**
3. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing- Ian Gibson, David W Rosen, Brent Stucker, Springer, Second Edition, 2010.
4. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific.
5. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
6. NPTEL Course on Rapid Manufacturing

PC802ME

PRINCIPLES OF MANAGEMENT

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

Course Objectives:

- To understand the principles of management and their application to the functioning of an organization
- Upon completion of this course, the students will get a clear understanding of management
- Functions in an organization
- Various activates of organisation with respective different objectives
- Understand organizational structures

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Able to organizational communications
2. Understand organizational objectives
3. Organizational human communications

UNIT-I

Definition of management, science or art, manager vs entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches

UNIT-II

Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.
Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.

UNIT-III

Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

UNIT-IV

Directing, individual and group behaviour, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.
Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

UNIT-V

Behavioural aspects of entrepreneurs: Personality – determinants, 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 Reading:

1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999**.**

OE 801BM

BASIC MEDICAL EQUIPMENT

(Open Elective - III)

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

Course Objectives:

- To make the students understand the need for several Biomedical Equipments.
- To make the students understand the operating principles of a wide range of Biomedical Equipment.

Course Outcomes: Upon completion of the course, the students will be able to:

1. Learn about various physiological parameters, monitoring and recording.
2. Assess the need and operating principle of equipment used in physiotherapy
3. Interpret the working principle and operating procedure and applications of Medical Imaging equipments.
4. Perceive the governing principles and functions of critical care equipments.
5. Learn about the various Therapeutic Equipment used for different applications

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, and 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 Readings:

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

With effect from the Academic year 2021-22

OE 802CS

DATA SCIENCE USING R

(Open Elective - III)

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

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: Student will be able to

1. Use various data structures and packages in R for data visualization and summarization
2. Use linear, non-linear regression models, and classification techniques for data analysis
3. Use clustering methods including K-means and CURE algorithm

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 Item set, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating Synthetic Transaction 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 Item set, Closed Item set And Association Rules.

Frequent Item set: Mining Methods, Pattern Evaluation Methods, and Sentiment Analysis

Suggested Readings:

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

With effect from the Academic year 2021-22

OE 803EC

MOBILE COMMUNICATION
(Open Elective - III)

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

Course Objectives:

- Understand basics of Cellular systems, their generations and Characteristics of Mobile Communications.
- Understand the Frequency reuse mechanism for Mobile operations and Co-Channel interference concepts
- Understand the Mobile signal Coverage in different terrains and Lee models
- Understand the working of Antennas at Cell-site and at Mobile units.
- Understand the various Handoff mechanisms and Concept of Dropped calls

Course Outcomes: Student will be

1. Able to analyze the various operational features of Mobile Communication Systems
2. Able to deal with the Mobile communication system designs of Frequency re-use and Interference Factors
3. Able to carry out the Design aspects of Mobile signal coverage over different terrains
4. Able to analyze the different Cell-site and Mobile antennas for different applications
5. Able to characterize the Handoffs mechanisms.

UNIT – I

Introduction to Cellular Mobile Communications:

History of Mobile cellular: AMPS system (First-generation systems), Second-generation System, 3G Systems, 4G Systems, 5G Systems, Other Cellular-like Systems, Spectrum allocation, Spectrum Efficiency Considerations.

Basic Cellular systems, Circuit-Switched and Packet-Switched Systems, Performance criteria, Voice quality, Data quality, Picture quality, Service quality and special features.

Uniqueness of Mobile Radio Environment, Description of Mobile Radio Transmission Medium, Model of Transmission Medium, Mobile Fading characteristics, The Radius of Active Scatter region, Delay spread and Coherence Bandwidth, Noise level in Cellular Frequency band

UNIT – II

Frequency Reuse Concept and Cellular system Components:

Concept of Frequency reuse channels, Frequency reuse schemes, Frequency reuse distance, Number of Customers in the System, Co-Channel Interference Reduction Factor, Desired C/I from a Normal case in an Omni-directional antenna System, Handoff mechanism, Cell splitting, Consideration of the Components of Cellular Systems, Antennas, Switching equipment and Data Links.

UNIT – III

Cell Coverage:

General Introduction, Ground Incident angle and Ground Elevation angle, Ground Reflection angle and Reflection point, Obtaining the Mobile Point-to-Point Model (Lee Model), A standard condition, Obtain Area-to-Area Prediction model, The Phase difference between a direct path and ground-reflected path, A general formula for Mobile Radio Propagation

Propagation over water or Flat open area, Between Fixed stations, Land-to-Mobile transmission over water, Foliage Loss, Propagation in Near-In distance, Long distance propagation, Obtain Path loss

from a Point-to-Point Prediction Model in Non-obstuctive condition and obstructive condition, Form of a Point-to-Point Model, General Formula and its Merit

UNIT – IV

Cell-Site and Mobile Antennas:

Antennas at Cell-site, Omnidirectional antennas, Directional antennas, Location antennas, Set-up Channel antennas, Space Diversity Antennas at cell site, Umbrella-Pattern Antennas, Interference reduction antennas, Unique Situations of Cell-Site antennas, Smart antennas, types and applications Mobile Antennas, Roof-mounted antenna, Glass-Mounted antenna, High-gain antenna, horizontally and vertically oriented Space-Diversity Antennas.

UNIT – V

Handoff and Dropped Calls:

Value of Implementing Handoffs, Types of Handoff, Initiation of Hard Handoff, Delaying a Handoff, Forced Handoffs. Queuing of handoffs, Power difference Handoffs, MAHO and Soft Handoff, Cell-site Handoff only, Intersystem Handoff. Introduction to Dropped Call Rate and Formula of Dropped Call Rate

Suggested Readings:

1. William C.Y.Lee, *"Wireless and Cellular Telecommunications*", 3rd International edition, McGraw Hill, 2006
2. Theodere S. Rappaport, *"Wireless Communications, Principles and Practice*", 2nd edition, Prentice Hall, 2003.
3. Gordon L. Stuber. "*Principles of Mobile Communications",* 3rd edition, Springer Publications, 2011.

With effect from the Academic year 2021-22

OE 804EC

INTERNET OF THINGS AND APPLICATIONS
(Open Elective - III)

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

Course Objectives:

- To introduce the concepts of automation in daily life.
- To familiarize the concepts of all IoT based communication systems.
- To understand the importance of cloud technologies in the field of IoT.
- To get familiar with standard embedded boards like Raspberry Pi.
- To study a real time system with a view of an application program interface (API).

Course Outcomes: Student will be

1. Able to design IoT based solutions for given problem statements.
2. Able to develop programs for Raspberry Pi.
3. Able to demonstrate the functionality of cloud communication.
4. Able to analyze the technologies used in IoT.
5. Able to incorporate multiple sensors to develop an IoT based system.

UNIT- I

Introduction to Internet of Things

Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT,IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling TEchnologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

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 Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source
Vs Closed Source. 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.

UNIT- III

API Development and Embedded programming

Getting started with API, Writing a new API, Real time Reactions, Other Protocols, Techniques
for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather Monitoring.

UNIT -IV

IoT Systems - Logical Design using Python

Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages,
File Hnadling, Date/Time Operations., Classes, and Python packages for IoT, IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT- V

Cloud computing and Data analytics and IoT Product Manufacturing

Introduction to Cloud storage models and Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation.(Ref 1) Business model for IoT product manufacturing, IoT Startups, Mass manufacturing, Ethical issues in IoT.

Suggested Readings:

1. Vijay Madisetti, Arshdeep Bahga, "*Internet of Things (A Hands-on-Approach)",* VPT Publisher, 1st Edition, 2014
2. Adrian McEwen (Author), Hakim Cassimally", *"Designing the Internet of Things",* Wiley India Publishers
3. Kenneth A Lambert and B.L. Juneja*, "Fundamentals of Python*", Cenage Learning

With effect from the Academic year 2021-22

OE 805EC

GLOBAL AND REGIONAL SATELLITE NAVIGATION SYSTEM
(Open Elective - III)

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

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

1. Able to understand the principle and operation of GPS.
2. Able to understand the GPS Signal structure and services.
3. Able to understand about various errors.
4. Able to use of GPS in various fields such as navigation, GIS etc.
5. Able to understand principle of Operation of various GRNSS.

UNIT- I

Introduction to Satellites, their properties, Orbits and Launch vehicles, Kepler's Laws, GPS fundamentals: Principle of Trilaiteration, Transit, GPS Operating Principle, And 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 Readings:

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.

OE 806EE

APPLICATIONS OF ELECTRICAL ENERGY

(Open Elective - III)

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

Course Objectives:

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating.
- To understand various techniques of electric welding and types of batteries.
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electric traction including speed – time curves of different traction services.
- To understand systems of train lighting.

Course Outcomes: Student will be

1. Identify a suitable heating scheme for a given application.
2. Identify proper welding technique and various characteristics of batteries.
3. Classify types of electric light sources based on nature and operation and their objectives, performance and reliability.
4. Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.
5. Select proper train lighting scheme.

UNIT-I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating. Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

UNIT- II

Electric welding: Classification of electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

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.

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.

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.
3. Partab H, "*Modern Electric Traction",* Dhanpat Rai & Sons, 2000.
4. B.L.Theraja, *"A Text Book of Electrical Technology",* S.Chand & Company Ltd, Vol-I.

OE807ME

COMPOSITE MATERIALS
(Open Elective – III)

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

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.

1. Understand the concept of composites its advantages and applications
2. Compare and contrast different manufacturing methods of composites
3. Analysis and evaluation of laminate composites using micromechanics
4. Analysis and evaluation of laminate composites using macromechanics
5. Estimate the properties of composites using micormechnics and macromechanics

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 architectures.

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.

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.

OE808ME

INDUSTRIAL ADMINISTRATION AND FINANCIAL MANAGEMENT
(Open Elective – III)

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

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.

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

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.

OE809CS

SOFTWARE ENGINEERING

(Open Elective - III)

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

Course Objectives:

- To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
- To impart knowledge on various phases , methodologies and practices of software development
- To understand the importance of testing in software development and study various testing strategies and software quality metrics

Course Outcomes:

Student will be able to

1. Acquire working knowledge of alternative approaches and techniques for each phase of software development
2. Acquire skills necessary for independently developing a complete software project
3. Understand the practical challenges associated with the development of a significant software system

UNIT-I

Introduction to Software Engineering:

A generic view of Process: Software Engineering, Process Framework, CMM Process Patterns, Process Assessment.

Process Models: Prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process.

An Agile view of Process: Introduction to Agility and Agile Process, Agile Process Models.

UNIT-II

Software Engineering Principles: SE Principles, Communication Principles, Planning Principles, Modeling Principles, Construction Principles, Deployment.

System Engineering: Computer-based Systems, The System Engineering Hierarchy, Business Process Engineering, Product Engineering, System Modeling.

Requirements Engineering: A Bridge to Design and Construction, Requirements Engineering Tasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, Building the Analysis Model, Negotiating Requirements, Validating Requirements.

UNIT-III

Building the Analysis Model: Requirements Analysis Modeling Approaches, Data Modeling Concepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-based Modeling, Creating a Behavioral Model.

Design Engineering: Design within the context of SE, Design Process and Design Quality, Design Concepts, The Design Model, Pattern-based Software Design.

UNIT-IV

Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design, Assessing Alternative Architectural Designs, Mapping Data Flow into a Software Architecture.

Modeling Component-Level Design: Definition of Component, Designing Class-based Components, Conducting Component-level Design, Object Constraint Language, Designing Conventional Components.

Performing User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT-V

Software Quality Assurance: Basic Elements, Tasks, Goals and Metrics, Formal Approaches, Statistical Software Quality Assurance, Software Reliability, ISO 9000 Quality Standards, SQA Plan.

Testing Strategies: A Strategic Approach to Software Testing, Strategic Issues, Test Strategies for O-O Software, Validation Testing, System Testing, The Art of Debugging.

Testing Tactics: Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing, Control Structure Testing, O-O Testing Methods, Testing Methods applicable on the Class Level, Inter Class Test Case Design, Testing for Specialized Environments, Architectures and Applications, Testing Patterns.

Product Metrics: Software Quality, A Framework for Product Metrics, Metrics for the Analysis Model, Metrics for the Design Model, Metrics for Source Code, Metrics for Testing, Metrics for Maintenance.

Suggested Readings:

1. Roger S.Pressman," *Software Enigneering: A Practitioner's Approach*", 7th Edition, McGraw Hill, 2009.
2. Ali Behforooz and Frederick J.Hudson, "*Software Engineering Fundamentals*", Oxford University Press, 1996.
3. Pankaj Jalote, "*An Integrated Approach to Software Engineering*", 3rd Edition, Narosa Publishing House, 2008.

OE810CS

PYTHON PROGRAMMING

(Open Elective - III)

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

Course Objectives:
The main objective is to teach Computational thinking using Python.

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.
- To construct Python programs as a set of objects.

Course Outcomes:
On completion of the course, students will be able to:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Develop simple Python programs for solving problems.
4. Structure a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries.
6. Read and write data from/to files in Python Programs

UNIT-I
Introduction to Computing and Problem Solving: Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms.
Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, The type() Function and Is Operator, Dynamic and Strongly Typed Language.
Control Flow Statements: The if, The if…else,The if…elif…else Decision Control Statements, Nested if Statement, The while Loop, The for Loop, The continue and break Statements.

UNIT-II
Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, Command Line Arguments.
Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT-III
Files and exception: text files, reading and writing files, format operator; command line arguments,errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings
Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT-IV
Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism.
Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT-V
GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Readings:

1. Richard L. Halterman, " *Learning To Program With Python*", Copyright © 2011.
2. Dr. Charles R , "*Python for Everybody*, *Exploring Data Using Python 3*", Severance. 2016.
3. Gowrishankar S., Veena A, "*Introduction to Python Programming*", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, ``*Think Python: How to Think Like a Computer Scientist*'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)

OE811CS

CYBER SECURITY

(Open Elective - III)

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

Course Objectives:

- Understand the threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and it applications.

Course Outcomes:

After Completion of the course, Student will be able to:

1. Understand the various network threats
2. Analyse the forensic tools for evidence collection
3. Apply the firewalls for threat analysis

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, searc and seizure of computer systems, password cracking

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrival, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act

Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems

Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings:

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

PW851ME

MAJOR PROJECT PHASE - II

Instructions: (3L) hrs per week
CIE: 50 Marks *SEE: 100 Marks*
Credits: 6

Course Objectives:

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic Literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:

1. demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems
2. evaluate different solutions based on economic and technical feasibility
3. effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

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)

The student 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 coordinator for all the students from 5th 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.