B.E. (Mechanical Engineering) - VII SEMESTER

S. No	Code No.	Subject	Scheme of Instructions				Scheme of Examination		Credits
			L	T	P/D	Duration in Hrs.	CIE	SEE	
Theory Courses									
1	6HS704HS	Operation Research	3	-	-	3	40	60	3
2	6PC714ME	Finite Element Analysis	3	-	-	3	40	60	3
3	*PE*	Professional Elective IV / MOOCs	3	-	-	3	40	60	3
4	*OE*	Open Elective III #	3	-	-	3	40	60	3
5	*OE*	Open Elective IV #	3	-	-	3	40	60	3
Practical / Laboratory									
6	6PC760ME	FEA Lab	-	-	2	2	40	60	1
7	6PC761ME	Automation & Robotics Lab	-	-	2	2	40	60	1
8	6PW752ME	Internship-II	-	-	4	4	40	60	2
Total			**15**	**-**	**8**	**23**	**320**	**480**	**19**

Professional Elective – 4		
S. No.	**Course Code**	**Course Title**
1	6PE713ME	Computational Fluid Dynamics **(MOOC's-3C)**
2	6PE714ME	Fundamentals of Robotics **(MOOC's-3C)**
3	6PE715ME	Mechatronics
4	6PE716ME	Product Design and Development **(MOOC's-1C)**

#Open Elective – 3		
S. No.	**Course Code**	**Course Title**
1	6OE703ME	Introduction to Robotics

offered by Mechanical Engineering Department to other departments.

B.E. (Mechanical Engineering) - VIII SEMESTER

S. No.	Code No.	Subject	Scheme of Instructions				Scheme of Examination		Credits
			L	T	P/D	Duration in Hrs.	CIE	SEE	
Theory Courses									
1	*PE*	Professional Elective V / MOOCs	3	-	-	3	40	60	3
2	*PE*	Professional Elective VI / MOOCs	3	-	-	3	40	60	3
3	6PW853ME	Project Work	-	-	16	16	50	100	8
Total			**6**	**-**	**16**	**22**	**130**	**220**	**14**

Professional Elective – 5			Professional Elective – 6		
S. No.	**PE Stream**	**Course Title**	**S. No.**	**PE Stream**	**Course Title**
1	6PE817ME	Gas Dynamics and Jet Propulsion	1	6PE821ME	Heating Ventilation and Air Conditioning
2	6PE818ME	Automation in Production Systems	2	6PE822ME	Operations and Supply Chain Management **(MOOC's-3C)**
3	6PE819ME	Business Analytics	3	6PE823ME	Electric Vehicle Technology
4	6PE820ME	Total Quality Management	4	6PE824ME	Non Destructive Techniques

#Open Elective – 4		
S. No.	**Course Code**	**Course Title**
1	6OE804ME	Industrial Engineering & Management

offered by Mechanical Engineering Department to other departments.

B.E. (Mechanical Engineering) - VII SEMESTER

S. No.	Code No.	Subject	Scheme of Instructions				Scheme of Examination		Credits
			L	T	P/D	Duration in Hrs.	CIE	SEE	
Theory Courses									
1	6HS704HS	Operation Research	3	-	-	3	40	60	3
2	6PC714ME	Finite Element Analysis	3	-	-	3	40	60	3
3	*PE*	Professional Elective IV / MOOCs	3	-	-	3	40	60	3
4	*OE*	Open Elective III #	3	-	-	3	40	60	3
5	*OE*	Open Elective IV #	3	-	-	3	40	60	3
Practical / Laboratory									
6	6PC760ME	FEA Lab	-	-	2	2	40	60	1
7	6PC761ME	Automation & Robotics Lab	-	-	2	2	40	60	1
8	6PW752ME	Internship-II	-	-	4	4	40	60	2
Total			**15**	**-**	**8**	**23**	**320**	**480**	**19**

Professional Elective – 4		
S. No.	**Course Code**	**Course Title**
1	6PE713ME	Computational Fluid Dynamics **(MOOC's-3C)**
2	6PE714ME	Fundamentals of Robotics **(MOOC's-3C)**
3	6PE715ME	Mechatronics
4	6PE716ME	Product Design and Development **(MOOC's-1C)**

#Open Elective – 3		
S. No.	**Course Code**	**Course Title**
1	6OE703ME	Introduction to Robotics

offered by Mechanical Engineering Department to other departments.

Course Code	Course Title						Core / Elective
6HS704HS	**OPERATION RESEARCH**						Core
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
Basic Mathematics	3	-	-	0	40	60	3

Course Objectives:
It is intended to make the students to :

- Formulate the variables into linear programming models/techniques.
- Understand the concept of post optimality and the techniques of CPM and PERT.
- Learn the mathematical tools needed to optimize the transportation and assignment problems.
- Understand the replacement model in money value and game theory in market strategies.
- Know the sequencing in job operation and queuing in different private and public sector organizations.

Course Outcomes:
After completing the course, student will be able to:

CO1. Formulate the linear programming models in operation research at different applications.

CO2. Convert the primal programming problem to dual programming problems and know the techniques of CPM and PERT.

CO3. Analyze the transportation and assignment models in various research activities.

CO4. Analyze the replacement model in real time scenario and game theory in decision making conflict.

CO5. Apply the sequencing in job scheduling and queuing model in waiting line cases.

Unit-I

Introduction: Definition and Scope of Operation Research: Linear programming, Formulation of linear programming problems, Graphical method of solving LP problem, Simplex method, maximization and minimization. Degeneracy in LPP, Unbounded and, Infeasible solutions.

Unit-II

Duality: Definition, Relationship between primal & dual solutions, Economic Interpretation, Post optimality sensitive analysis, Dual Simplex Method.

Project Management: Introduction to CPM and PERT, Critical path calculation, float calculation and its importance, Cost reduction by Crashing of activity.

Unit-III

Transportation Models: Finding an initial feasible solution - North West comer method, least cost method, Vogel's Approximation method, finding the optimal solution by stepping stone and MODI methods, Special cases in Transportation problems - Unbalanced Transportation problem.
Assignment Problems: Hungarian method of Assignment problem, Maximization in Assignment problem, unbalanced problem, problems with restrictions, travelling salesman problems.

Unit-IV

Replacement Models: Introduction, replacement of items that deteriorate ignoring change in money value, replacement of items that deteriorate considering change in money value with time, replacement of items that fail suddenly, Individual replacement policy, Group replacement policy.

Game Theory: Introduction, 2 person zero sum games, Maximin Minimax principle, Principle of Dominance, Solution for mixed strategy problems, Graphical method for 2 x n and m x 2 games.

Unit-V

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

Queuing Theory: Introduction, single channel - Poisson arrivals - exponential service times with infinite population & finite population, Multi channel - poison arrivals - Exponential service times with infinite population.

Text Books:

1. S.D. Sharma, - Operations Research, Kedarnath, Ramnath & Co., Meerut.
2. Hamdy, A. Taha, -Operations Research-An Introduction, Sixth Edition, Prentice Hall of India Pvt. Ltd.

Reference Books:-

1. Hrvey M. Wagner, -Principles of Operations Resear, Second Edition, Prentice Hall of India Ltd.
2. V.K. Kapoor, -Operations Research, S. Chand Publishers, New Delhi.
3. R. Paneer Selvam, -Operations Research, Second Edition, PHI Learning Pvt. Ltd., New Delhi.
4. Data Reconciliation by Prof. Shanker Narasimha.

Course Code	Course Title						Core/Elective
6PC714ME	FINITE ELEMENT ANALYSIS						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Strength of Material & Heat Transfer	3	-	-	-	40	60	3

Course Objectives:
It is intended to make the students to :

- Understand the theory and application of the finite element method for analyzing structural systems.
- Learn Approximation theory for structural problems as the basis for finite element methods.
- Learn formulations for a variety of elements in one, two, and three dimensions.
- Understand modeling and analysis of structures using solid, and plate elements.

Course Outcomes:
After completing the course, student will be able to:

CO1. Illustrate the concept of Finite Element Method and realize its limitations.
CO2. Construct shape functions for 1D, 2D and 3D linear and higher order elements.
CO3. Applying 1D, 2D and 3D elements to solve different static structural problems.
CO4. Solve 1D and 2D steady state heat transfer, and 1D Eigen value and Eigen-vector problems.
CO5. Analyze time dependent heat transfer problems.

Unit I
Introduction: Introduction to Finite Element Method for solving field problems, Stress and Equilibrium, Boundary conditions, Strain, Displacement, Stress-Strain relations. One dimensional problems: Finite element modelling coordinates and shapes functions, Potential Energy approach: Assembly of Global stiffness matrix and load vector, Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

Unit II
Analysis of trusses, Beams: Hermite function, Element stiffness matrix for a truss member, Analysis of plane truss with two DoF at each node. Analysis of Beams: Element stiffness matrix for two nodes.

Unit III
Finite element modelling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Finite element modelling of axi-symmetric solids subjected to axi-symmetric loading with triangular elements.

Unit IV
Two dimensional four noded iso-parametric elements and numerical integration. Steady state heat transfer analysis: One dimensional analysis of a slab and fin and two dimensional analysis of thin plate.

Unit V
Dynamic Analysis: Formulation of finite element model, element matrices, Evaluation of Eigen values and Eigen vectors for a stepped bar and a beam, Time dependent field problems, Application to one dimensional heat flow in a rod. Introduction to finite element formulation of three dimensional problems in stress analysis, Convergence requirements.

Text Books:

1. Tirupathi R. Chandraputla and Ashok, D. Belgundu" Introduction to Finite Elements in Engineering", PHI or Pearson Education.
2. Rao S.S., "The Finite Element Methods in Engineering", Pergamon Press.

Reference Books:

1. Segerlind, L.J. "Applied Finite Element Analysis", Wiley Publication.
2. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill Company.

Course Code	Course Title						Core/Elective
6PE713ME	COMPUTATIONAL FLUID DYNAMICS						PE-IV
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Fluid Mechanics	3	-	-	-	40	60	3

Course Objectives:

It is intended to make the students to :

- Understand the equations of fluid flow.
- Learn Finite difference method with heat transfer equations and grid generation.
- Understand forward, backward and central difference techniques.
- Learn Finite volume method and staggered grid.

Course Outcomes:

After completing the course, student will be able to:

CO1. Formulate the governing equations for different types of fluid flow systems.

CO2. Illustrate method of averaging of turbulent flow properties and classify second order partial differential equations.

CO3. List finite differential equations based on accuracy, type of differences and analyse their stability.

CO4. Solve equations using FDM and numerical methods on discretised domain.

CO5.Apply Finite volume method for basic equations of heat transfer and fluid flow problems.

Unit-I

Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations-Navier Stokes equations, Reynolds and Favre averaged N-S equations. Heat transfer conduction equations for steady and unsteady flows. Steady convection-diffusion equation. Jacobi, Gauss Seidel and ADI (Alternative direct implicit method) methods.

Unit-II

Concepts of Finite difference methods: Forward, backward and central difference. Finite difference Solution-Parabolic partial differential equations. Euler, Crank Nicholson, Implicit methods. Higher order difference methods. Errors, consistency. stability analysis- von Neumann analysis. Convergence criteria.

Unit-III

Introduction to turbulence, mixing length model, K-ε turbulence Model. Classification of PDEs-Elliptic, parabolic and hyperbolic equations. Initial and boundary value problems.

Unit-IV

Numerical Methods: 1D and 2D Elliptic partial differential equations problems. Viscous incompressible flow, Stream function- Vorticity method. Introduction to Grid Generation- Types of grid-O, H & C type.

Unit- V

Introduction to finite volume method: Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows, Staggered grid, SIMPLE Algorithm.

Text Books:

1. Patankar, S V, Numerical Heat transfer and Fluid flow, Hemisphere Publishing Company, New York.
2. Muralidhar K, Sundararjan T, Computational Fluid Flow and Heat transfer, Narosa Publishing House.

Reference Books:

1. John D Anderson, Computational Fluid Dynamics, Mc Graw Hill, Inc.
2. Pradip Niyogi, Chakrabartty S K, Laha M K, Introduction to Computational Fluid dynamics.
3. Chung, T J, Computational Fluid Dynamics, Cambridge University Press.

Course Code	Course Title						Core/Elective
6PE714ME	**FUNDAMENTALS OF ROBOTICS**						PE-IV
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
KOM	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:
It is intended to make the students to :

- Familiarize with basic terminologies of the robotic science and essential knowledge required to get started in the field of Robotics
- Learn different types of grippers and sensors used in robotics.
- Learn the concepts of forward and inverse kinematics, and understand their significance in robot motion planning
- Understand sensor selection criteria.
- Learn programming languages for robot programming.

Course Outcomes:
After completing the course, student will be able to:

CO1: Understand the principles and functions of robotic components.
CO2: Analyze the role of sensors, actuators, and controllers in robotic systems.
CO3: Apply kinematic principles to model and control robot movement.
CO4: Apply the basic concepts of robot dynamics.
CO5: Develop basic programming skills for robot control and simulation.

Unit-I
Introduction to robotics:
Brief History, Basic Concepts of Robotics such as Definition, Three laws, Types of robots, Elements of Robotic Systems , DOF, Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc .Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.

Unit-II
Grippers and Sensors for Robotics:
Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system.
Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Selections of sensors. Need for sensors and vision system in the working and control of a robot.

Unit III
Drives and Control for Robotics: Drive - Types of Drives, Types of transmission systems & Actuators.
Control Systems: Types of Controllers, Introduction to closed loop control.

Unit-IV

Robot Kinematics &Dynamics:

Basic Concepts of Robot Dynamics, Newton-Euler and Lagranzian Formulations, Dynamics of Serial and Parallel Manipulators, Dynamics and Control of Mobile Robots, Energy and Stability Analysis in Robotic Systems

Unit-V

Programming and Languages for Robotics: Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages, Generations of Robotic Languages, Introduction to VAL,RAIL, AML, Python, ROS etc., Development of languages since WAVE till ROS.

Text books:

1. “Robot Modelling & Control” by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, John Wiley & Sons, Inc.
2. "Introduction to Robotics: Mechanics and Control" by John J. Craig, Pearson.

Reference books:

1. "Robotics: Modelling, Planning and Control" by Bruno Siciliano, Springer.
2. "Robotics: Control, Sensing, Vision, and Intelligence" by C.S.G. Lee and K. S. Fu, McGraw-Hill Education.
3. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, Pearson.

Course Code	Course Title						Core/Elective
6PE715ME	**MECHATRONICS**						PE-IV
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:

It is intended to make the students to :

- Understand the interdisciplinary nature of Mechatronics and its applications in modern engineering.
- Learn the principles and applications of sensors and actuators in mechanical systems.
- Acquire skills in designing electronic circuits and interfacing them with mechanical systems.
- Develop competencies in programming microcontrollers for controlling mechatronic systems.
- Apply systems thinking for the design, analysis, and implementation of integrated mechatronic solutions

Course Outcomes:

After completing the course, student will be able to:

CO1. Explain the fundamental concepts of Mechatronics and its role in advancing mechanical engineering technologies.
CO2. Implement sensor and actuator systems for mechanical applications.
CO3. Create and troubleshoot electronic circuits that interface with mechanical systems.
CO4. Program microcontrollers for the control and automation of mechatronic systems.
CO5. Analyse and design complex mechatronic systems using an integrated approach.

Unit I

Introduction to Mechatronics: Definition and scope of Mechatronics, Historical perspective and evolution of Mechatronics, Mechatronics in manufacturing, automation, and product design. Interdisciplinary nature of Mechatronics: mechanical systems, electronic systems, and information technology.

Unit II

Sensors and Actuators: Overview of sensors and actuators used in mechatronic systems Principles and operation of various sensors (Temperature, Pressure, Velocity and Position). Principles and operation of actuators (Electric, Hydraulic and Pneumatic). Signal conditioning and conversion.

Unit III

Electronic Systems for Mechatronics: Basic electronic components and circuits, Introduction to digital electronics, logic gates, flip-flops, counters microcontrollers and microprocessor basics, architecture, programming, and applications. Interfacing microcontrollers with sensors and actuators.

Unit IV

Control Systems for Mechatronics: Fundamentals of control theory, Open-loop and closed-loop control systems, Introduction to PID (Proportional-Integral-Derivative) control. Implementation of algorithms in mechatronic systems.

Unit V

Mechatronic System Design and Applications: Systems approach to mechatronic design, Case studies of mechatronic systems: automotive systems, robotic systems, smart devices. Design tools and software for Mechatronics (e.g., CAD, MATLAB/Simulink), Future trends and challenges in Mechatronics.

Text Books:

1. "Mechatronics: An Integrated Approach" by Clarence W. de Silva.
2. "Introduction to Mechatronics and Measurement Systems" by David G. Alciatore and Michael B. Histand.

Reference Books:

1. "Mechatronics: Principles and Applications" by Godfrey C.
2. "Mechatronics Systems: Sensors and Actuators" by Robert H. Bishop.
3. "Mechatronics: A Multidisciplinary Approach" by W. Bolton.

Course Code	Course Title						Core/Elective
6PE716ME	**PRODUCT DESIGN AND DEVELOPMENT**						Professional Elective-IV
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
NIL	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:
It is intended to make the students to :

- Understand the fundamentals of designing products, their life cycle.
- Understand creativity techniques for effective product design and development.
- Understand Legal factors, social issues and Engineering ethics in product design.
- Understand the importance of value and value analysis job plan.
- Understand the product development process.

Course Outcomes:
After completing the course, student will be able to:

CO1. Understand the product design and development principles.
CO2. Apply anthropometric principles in product design.
CO3. Understand and navigate legal factors and social issues relevant to product design
CO4. Recognize the importance of value engineering in improving product performance and cost-effectiveness.
CO5. Understand the concept of modern product development process.

Unit-I
Introduction: Product design and development, product life cycle, Product development process, Essential factors of product design , Product strategies, Analysis of the product, Basic design considerations, Time to market, Role of aesthetics in product design, Innovative thinking, Morphology of design.

Unit-II
Industrial Ergonomics: Anthropometry, Man-Machine interaction. Concepts of size and texture colour. Comfort criteria. Psychological & Physiological considerations. Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.

Unit-III
Design for Manufacturing & Assembly: Methods of designing for Manufacturing & assembly. Design for maintainability. Design for environment. Legal factors and social issues. Engineering ethics and issues of society related to design of products.

Unit-IV
Value Engineering: Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, value analysis job plan, creativity, steps to problem solving, value analysis tests, value engineering idea generation check list, Cost reduction through value engineering-case study. Materials and process selection in value engineering.

Unit-V

Product Development: Modern product development process, Re-engineering and redesign product development process, product development teams, Product development planning, Manufacturing & economic aspects of product development. Basic concepts of Concurrent Engineering, Tools for product design – Drafting / Modelling software QFD, CAM Interface. Overview of Patents & IP Acts. Report generation.

Text Books:

1. Karl T Ulrich, Steven D Eppinger , " Product Design & Development." Tata McGraw-Hill New Delhi.
2. Design for Manufacturability & Concurrent Engineering" by Michael F. Mense.

Reference Books:

1. "Value Engineering: Analysis and Methodology" by Larry D. Miles and Christopher H. S. Kim.
2. "Concurrent Engineering: Contemporary Issues and Modern Design Tools" edited by Andrew T. Campbell and Stephen B. Tully.
3. "Patent Strategy for Researchers and Research Managers" by H. Jackson Knight.

Course Code	Course Title						Core/Elective
6PC760ME	FINITE ELEMENT ANALYSIS LAB						Core
Pre requisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Strength of Material, Heat Transfer & Any CAD software	-	-	-	2	40	60	1

Course Objectives:

It is intended to make the students to :

- Understand fundamentals of the analysis software, its features and applications.
- Learn the basic element types in Finite Element analysis.
- Know the concept of discretization of continuum loading conditions.
- Analyze the structure using pre-processor and post-processor conditions.

Course Outcomes:

After completing the course, student will be able to:

CO1. Determine Stress, Strains and deflections under static, thermal and combined loading.

CO2. Analyse Plane stress, plane strain conditions & axi-symmetric loading on plane members to predict the failure behavior.

CO3. Analyse component with tetrahedron and brick elements.

CO4. Predict the natural frequencies and modes shapes using Modal and Harmonic analysis.

CO5. Simulate steady state heat transfer analysis of chimney, Transient heat transfer of casting.

Experiments:

1. Analysis of Plane Truss & Spatial Truss with various cross sections and materials to determine member forces, member strains & stresses, joint deflections under static, thermal and combined loading.
2. 2D & 3D beam analysis with different sections, different materials for different loads (forces and moments with different end supports).
3. 1D, 2D and 3D meshing with different element sizes for different CAD geometry (Proposed Experiment).
4. Static analysis of plates with a hole to determine the deformations, the Stresses to study the failure behavior and Stress Concentration Factor.
5. Plane stress, plane strain and axi-symmetric loading on the plane members with in plane loading to study the stresses and strains.
6. Static analysis of connecting rod with tetrahedron and brick elements
7. Static Analysis of flat and curved shell due to internal pressure and moments to estimate the strains, stresses and reaction forces and moments with different boundary conditions.
8. Buckling analysis of plates, shells and beams to estimate Bending Factor and modes.
9. Modal analysis of beams, plates and shells for natural frequencies and mode shapes.
10. Harmonic analysis of a Shaft subjected to periodic force and transient analysis of plate subjected to stepped and damped loading with varying time.
11. Steady state heat transfer Analysis of chimney and transient heat transfer analysis of solidification of castings.
12. Non-linear analysis of cantilever beam with non-linear materials at tip moment and post buckling analysis of shells for critical loads
13. Coupled field analysis static and thermal loads.
14. Flow analysis of pipe with different fluids/gasses/air for velocity and pressure gradients.
15. Implicit and Explicit Analysis of car with 300m/s (Proposed Experiment)

Note: Any 12 experiments to be conducted

Course Code	Course Title						Core/Elective
6PC751ME	**AUTOMATION AND ROBOTICS LAB**						Core
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
	-	**-**	**-**	**2**	**40**	**60**	**1**

Course Objectives:

It is intended to make the students to :

- Understand the principles of robotic sensing and actuation:
- Learn programming techniques for robot control
- Explore simulation software for robotic design and testing
- Design and build robotic systems for specific applications
- Gain skills in using simulation software to solve real-world engineering challenges

Course Outcomes:

After completing the course, student will be able to:

CO1 :Understand the fundamentals of robotic systems:

CO2:Develop practical skills in robot design and programming:

CO3: Apply theoretical in developing various path planning techniques.

CO4: Illustrate the working of innovative robotic devices

CO5: Gain proficiency in using simulation software.

List of experiments:

1. Build a robot that can follow a line on a flat surface.
2. Develop a robot that can autonomously avoid obstacles using ultrasonic sensors.
3. Program a robotic arm to pick up objects from one location and place them in another
4. Program a robot to navigate a complex course using sensors and algorithms.
5. Develop a simple interactive application where a robot can respond to human gestures or commands
6. Create a robot that can detect the colour of objects and sort them into designated areas
7. Control a robot wireless using Bluetooth or Wi-Fi.
8. Operate a robot using voice commands.
9. Demonstration of Robot with 2 DOF, 3 DOF, 4 DOF etc.
10. Hydraulic equipment simulation using H –Simulator
11. Pneumatic equipment simulation using P-Simulator
12. Simulation of PLC

Course Code	Course Title						Core / Elective
6PW752ME	**INTERNSHIP-II**						Core
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
-	-	-	-	4	40	60	2

Course Objectives:

1. Produce an accurate record of work performed during the Internship
2. Apply engineering knowledge to a problem in industry
3. Produce a technical report
4. Discuss work in a team environment, if relevant to the project
5. Conduct herself/himself responsibly, safely, and ethically in a professional environment

COURSE OUTCOMES: After the completion of course the students will be able to:

1. Able to design a small and simple product in hardware or software.
2. Able to complete the task or realize a pre specified 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 pre specified criteria.
4. Able to implement the selected solution and document the same.
5. Able to develop a small and simple product in hardware or software.

Summer Internship is introduced as part of the curriculum of encouraging students to work on problems of interest to industries. A batch of two to three students will be attached to a person from the Government or Private Organizations/Computer Industry/Software Companies/R&D Organization for a period of 4 weeks. This will be during the summer vacation following the completion of the VI Semester Course work.

One faculty coordinator will also be attached to each group (of 2 or 3 students) to monitor the progress and to interact with the industry co-ordinator (person from industry). The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship

After the completion of the project, each student will be required to:

1. Submit a brief technical report on the internship/training.
2. Present the work through a seminar talk (to be organized by the Department)

Award of Sessional marks are to be based on the performance of the students at the workplace and awarded by industry guide and internal guide (40 Marks) followed by presentation before the committee constituted by the department (60 Marks).

One faculty member will co-ordinate the overall activity.

Note: Students have to undergo Internship-II of 4 weeks at the end of semester VI and credits will be awarded after evaluation in VII semester.

Course Code	Course Title						Core/Elective
6OE703ME	**INTRODUCTION TO ROBOTICS**						Open Elective-III
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
--	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:
It is intended to make the students to :

- Familiarize with basic terminologies of the robotic science and essential knowledge required to get started in the field of Robotics.
- Learn different types of grippers and sensors used in robotics.
- Understand sensor selection criteria.
- Learn programming languages for robot programming.
- Understand the socio economic aspects and interdisciplinary applications of robotics.

Course Outcomes:
After completing the course, student will be able to:

CO1: Understand the principles and functions of robotic components.
CO2: Analyze the role of sensors, actuators, and controllers in robotic systems.
CO3: Apply kinematic principles to model and control robot movement.
CO4: Develop basic programming skills for robot control and simulation.
CO5: Understand socio economic aspects of robotics.

Unit-I
Introduction to Robotics:
Brief History, Basic Concepts of Robotics such as Definition, Three laws, Types of robots, Elements of Robotic Systems , DOF, Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc .Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.

Unit-II
Grippers and Sensors for Robotics:
Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system.
Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Selections of sensors. Need for sensors and vision system in the working and control of a robot.

Unit-III
Drives and Control for Robotics: Drive - Types of Drives, Types of transmission systems & Actuators.
Control Systems: Types of Controllers, Introduction to closed loop control.

Unit IV
Programming and Languages for Robotics: Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages, Generations of Robotic Languages, Introduction to VAL,RAIL, AML, Python, ROS etc., Development of languages since WAVE till ROS.

Unit V

Socio-Economic aspect of Robotisation: Socio-Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.

Text books:

1. "Robotics: Modelling, Planning and Control" by Bruno Siciliano, Springer.
2. "Introduction to Robotics: Mechanics and Control" by John J. Craig, Pearson.

Reference books:

1. "Robotics: Control, Sensing, Vision, and Intelligence" by C.S.G. Lee and K. S. Fu.
2. "Robot Modeling and Control" by Mark W. Spong.
3. "Robotics: Control, Sensing, Vision, and Intelligence" by C.S.G. Lee and K. S. Fu, McGraw-Hill Education.
4. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, Pearson.

Course Code	Course Title				Core/Elective		
4OE703EE	PROGRAMMABLE LOGIC CONTROLLERS				Open Elective-III		
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
--	3	-	-	-	40	60	3

Course Objectives:
It is intended to make the students to :

- Understanding of PLC programming, ladder logic.
- Analysis and classification of the process control
- Understanding PLC hardware units and utilizing them

Course Outcomes:
After completing the course, student will be able to:

CO 1. Describe typical components of a Programmable Logic Controller.
CO 2. State basic PLC terminology and their meanings.
CO 3. Use latch, timer, counter, and other intermediate programming functions.
CO 4. Explain and apply the concept of electrical ladder logic, its history, and its relationship to programmed PLC instruction.
CO 5. Design and program a small, automated industrial production line.

UNIT–I:
Introduction to PLC
What is PLC, concept of PLC, Building blocks of PLC, Functions of various blocks, and limitations of relays. Advantages of PLCs over electromagnetic relays. Different programming languages, PLC manufacturer etc

UNIT– II:
Working of PLC
Basic operation and principles of PLC, Scan Cycle, Memory structures, I/O structure, Programming terminal, power supply

UNIT-III:
Instruction Set
Basic instructions like latch, master control self-holding relays, Timer instruction like retentive timers, resetting of timers, Counter instructions like up counter, down counter, resetting of counters, Arithmetic Instructions (ADD,SUB,DIV,MUL etc.), MOV instruction, RTC(Real Time Clock Function), Watch Dug Timer, Comparison instructions like equal, not equal, greater, greater than equal, less than, less than equal.

UNIT–IV:
Ladder Diagram Programming
Programming based on basic instructions, timer, counter, and comparison instructions using ladder program.

UNIT–V:
Applications of PLCs
Object counter,On-off control, Car parking, Sequential starting of motors, Traffic light control, Motor in forward and reverse direction, Star-Delta, DOL Starters, Filling of Bottles, Room Automation.

TEXTBOOKS:

1. Programmable Logic Controller by Job Dan Otter; P.H. International, Inc, USA
2. Introduction to PLCs by Gary Dunning. McGraw Hill
3. Module on PLCs and their Applications by Rajesh Kumar, NITTTR Chandigarh

REFERENCES/SUGGESTEDREADING:

1. Programmable Logic Controller and Microcontrollers by Gurpreet Kaur and SK Sahdev by Uneek Publications, Jalandhar.
2. Module on "Allen BradlagPlC (SLC 500), Institution set-1, by Rajesh Kumar, NITTTR, Chandigarh
3. Module on "PLC Applications based on SLC 5/03" By Rajesh Kumar, NITTTR Chandigarh
4. CHUNGPA, "User's Manual :Universal PLC Training System CPS-3580U", English ver1, 2020.
5. Handbook, P. L. C. "Practical Guide to Programmable Logic Controllers." AutomationDirect. com.

Course Code	Course Title						Core/Elective
1OE703AD	MACHINE LEARNING						Open Elective-III
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
--	3	-	-	-	40	60	3

Course Objectives:
It is intended to make the students to :

- To learn the concepts of machine learning and types of learning
- To study various supervised learning algorithms.
- To learn ensemble techniques and various unsupervised learning algorithms.
- To understand assessment methods and evaluation parameters of machine learning algorithms

Course Outcomes:
After completing the course, student will be able to:

CO1: Describe types of data and their pre processing methods
CO2. Describe supervised, unsupervised learning methods and their appropriate evaluation procedures and metrics
CO3. Apply different supervised and unsupervised machine learning algorithms to different datasets
CO4. Evaluate different machine learning approaches and infers the best learning model for a given scenario

UNIT I
Introduction: Types of Machine Learning Algorithms: Parametric and Non-parametric Machine Learning Algorithms, Supervised, Unsupervised, Semi-Supervised and Reinforced Learning.
Data Objects and Attribute Types: Nominal Attributes, Binary Attributes, Ordinal Attributes, Numeric Attributes, Discrete versus Continuous Attributes.
Basic Statistical Descriptions of Data: Measuring the Central Tendency: Mean, Median, and Mode. Measuring the Dispersion of Data: Range, Quartiles, Variance, Standard Deviation.

UNIT II
Representation and Learning: Feature Vectors, Feature Spaces
Supervised Algorithms: Regression: Linear Regression, Logistic Regression. Evaluation Measures: SSE, RMSE, R2

UNIT III
Classification: Decision Tree, Naïve Bayes, K-Nearest Neighbors, Support Vector Machines.
Evaluation of classification: cross validation, hold out The Confusion Matrix, Accuracy, precision, recall, F-Score, Receiver Operator Characteristic (ROC) Curve

UNIT IV
Unsupervised Learning: Cluster Analysis: Similarity Measures.
Categories of clustering algorithms, k-means, Hierarchical Clustering.

UNIT V
Ensemble Algorithms: Bagging, Random Forest, Boosting

TEXTBOOKS

1. Machine Learning, Tom Mitchell, McGraw-Hill Science/Engineering/Math; (1997).
2. Data Mining -Concepts and Techniques, Jiawei Han, MichelineKamber, Jian Pei, III Edition, Morgan Kauffmann Publisher, 2012.

REFERENCE BOOKS

1. Machine Learning: An Algorithmic Perspective, Stephen Marsland, II Edition, Chapman & Hall.
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer. (2006)
3. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson, 2014.

Course Code	Course Title						Core/Elective
OE703CE	**ESSENTIALS OF ROAD SAFETY ENGINEERING**						Open Elective-III
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
--	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:

It is intended to make the students to :

C1. Comprehend global and Indian road accident trends to grasp fundamental road safety principles.

C2. Apply statistical and engineering tools to analyze traffic safety data effectively.

C3. Design road infrastructure with safety features considering vehicle and human factors.

C4. Manage traffic effectively to enhance road safety outcomes.

Conduct thorough road safety audits and propose evidence-based improvement strategies.

Course Outcomes:

After completing the course, student will be able to:

CO 1. Understand fundamental principles of road safety.

CO 2. Analyze traffic safety data using statistical methods and engineering techniques.

CO 3. Apply geometric design principles and integrate safety features into road infrastructure.

CO 4. Master traffic management systems to enhance road safety.

CO 5. Conduct road safety audits and develop comprehensive safety management systems.

Unit-I:

Global and Indian Road Safety Landscape: Current state of road safety, leading causes of accidents, comparison with global trends.

Accident Characteristics: Analyzing real-world accident data, understanding the "who, what, when, where, and why" of crashes.

Unit-II:

Traffic Engineering Fundamentals: Traffic flow, capacity analysis, role of traffic control devices like signs and signals.

Statistical Methods for Action: Applying regression analysis and other statistical tools to identify correlations between factors and accidents, predicting high-risk areas.

Unit-III:

Accident Investigations and Risk Management: Conducting thorough accident investigations, understanding root causes, and preventing future incidents.

Human Factors and Vehicle Characteristics: The impact of human behavior, perception limitations, and vehicle design features on road safety.

Road Design for Safety: Geometric design elements influencing safety (lane width, curves, sight distance) and road equipment (guardrails, delineators).

Road Lifecycle Approach: Strategies for safe and efficient road maintenance, reconstruction, and rehabilitation.

Unit-IV:

Traffic Signals & Street Lighting: Principles of traffic signal design considering traffic flow and pedestrian needs. Importance of proper street lighting for nighttime safety.

Provisions for Vulnerable Users: Dedicated infrastructure and design considerations for the

safety of pedestrians, cyclists, and other vulnerable road users.

The Power of Signs and Markings: Different types of road signs and pavement markings, design standards, and their role in guiding drivers and improving safety.

Unit-V:

Traffic Management Systems (TMS) & Intelligent Transportation Systems (ITS): Implementing technology to improve traffic flow and mitigate accidents.

Road Safety Audits: Conducting comprehensive road safety audits to identify potential safety issues in existing or planned road infrastructure.

Safety from Start to Finish: Best practices for construction site safety, including worker protection measures and proper signage.

Text Books:

1. Sarkar, Pradip Kumar, Maitri, Vinay, Joshi, G.J., Transportation Planning: Principles, Practices And Policies, Third Edition, 2021.
2. L.R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, 9th Edition, 2019.

Reference Books:

1. Geetam Tiwari (Editor), Dinesh Mohan (Editor), Transport Planning and Traffic Safety, CRC Press, 1st edition, 2016.
2. HSS Committee, Manual on Road Safety Audit (IRC:SP-088), Indian Road Congress, First Revision, 2019.

Course Code	Course Title						Core/Elective
3OE703CS	**HUMAN COMPUTER INTERACTION**						Open Elective
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
--	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:

It is intended to make the students to :

- To gain an overview of Human-Computer Interaction (HCI),
- To understand user interface design and alternatives to traditional "keyboard and mouse" computing
- To become familiar with the vocabulary associated with sensory and cognitive systems as relevant to task performance by humans
- To apply models from cognitive psychology to predicting user performance in various human-computer interaction tasks
- To analyze the importance of a design and evaluation methodology that begins with and maintains a focus on the user

Course Outcomes:

After completing the course, student will be able to:

1. Explain the capabilities of both humans and computers from the viewpoint of human information processing.
2. Describe typical human–computer interaction (HCI) models, styles, and various historic HCI paradigms.
3. Apply an interactive design process and universal design principles to designing HCI systems.
4. Describe and use HCI design principles, standards and guidelines.
5. Analyze and identify user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems

UNIT I

Introduction: Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design.

The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.

UNIT II

Design process – Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions.

Screen Designing: Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.

UNIT III

Windows – New and Navigation schemes selection of window, selection of devices based and screen based controls. Components – text and messages, Icons and increases – Multimedia, colours, uses problems, choosing colours.

UNIT IV

HCI in the software process, The software life cycle Usability Engineering Iterative design and proto typing Design Focus: Prototyping in practice Design rationale Design rules Principles to support usability Standards Golden rules and heuristics HCI patterns Evaluation techniques, Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. Universal design, Universal design principles Multi-modal interaction

UNIT V

Cognitive models Goal and task hierarchies

Design Focus: GOMS saves money Linguistic models The challenge of display-based systems Physical and device models Cognitive architectures Ubiquitous computing and augmented realities Ubiquitous computing applications research

Design Focus: Ambient Wood – augmenting the physical Virtual and augmented reality Design Focus: Shared experience

Design Focus: Applications of augmented reality Information and data visualization

Design Focus: Getting the size right.

TEXT BOOKS

1. The essential guide to user interface design, Wilbert O Galitz, Wiley Dream Tech.
2. Human – Computer Interaction. Alan Dix, Janet Fincay, GreGoryd, Abowd, Russell Bealg,Pearson Education

REFERENCE BOOKS

1. Designing the user interface. 3rd Edition Ben Shneidermann, Pearson Education Asia.
2. Interaction Design Prece, Rogers, Sharps. Wiley Dreamtech.
3. User Interface Design, Soren Lauesen , Pearson Education.
4. Human –Computer Interaction, D. R. Olsen, Cengage Learning.
5. Human –Computer Interaction, Smith - Atakan, Cengage Learning.

Course Code	Course Title						Core/Elective
5OE703EC	MEDICAL ELECTRONICS						Open Elective-III
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives: This course aims to familiarize

1. To familiarize students with the fundamental principles of medical electronics and the nature of bioelectric signals.
2. To provide students with the knowledge and skills necessary for the acquisition, processing, and interpretation of biosignals such as ECG, EEG, EOG, and EMG.
3. To enable students to understand the common artifacts and sources of noise in biosignals and develop techniques for artifact removal.
4. To introduce students to the clinical applications of biosignal analysis in the diagnosis and monitoring of various medical conditions.
5. To foster an understanding of emerging trends and technologies in medical electronics and their potential impact on healthcare.

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

1. Demonstrate an understanding of the principles underlying bioelectric signals and their relevance in medical diagnostics.
2. Apply appropriate techniques for the acquisition and preprocessing of biosignals using specialized instrumentation.
3. Analyze and interpret biosignals such as ECG, EEG, EOG, and EMG to identify normal and abnormal patterns.
4. Implement signal processing algorithms to remove artifacts and enhance the quality of biosignals for accurate diagnosis.
5. Evaluate the clinical significance of biosignal analysis in the context of specific medical conditions and treatment strategies.

UNIT -I

Medical Electronics Overview: Definition, scope, and importance in healthcare. Bioelectric Signals Basics: Nature, characteristics, and acquisition techniques. Signal Processing Fundamentals: Basics and artifact removal techniques.

UNIT – II

Physiology of the Heart: Understanding the cardiac cycle and ECG signal generation. ECG Signal Acquisition: Electrodes, instruments, and techniques. ECG Interpretation: Normal/abnormal waveforms analysis. ECG Artifacts and Noise: Sources and minimization methods.

UNIT – III

Fundamentals of Brain Signals: EEG signal generation and EEG signal acquisition techniques. EEG Signal Analysis: Preprocessing, feature extraction, and classification. EEG Artifacts: Identification and mitigation strategies.

UNIT – IV

Muscle Physiology: EMG signal generation and EMG signal acquisition techniques. EMG Signal Interpretation: Normal/abnormal waveforms analysis, Noise Sources and minimization methods.

UNIT – V

Other Biosignals Introduction: EOG and EDA overview. Wearable Medical Electronics: Continuous monitoring and diagnosis applications. Medical Electronics Trends: Recent advancements and future directions. Case Studies and Practical Applications: Real-world examples.

TEXT BOOKS:

1. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Engineering”, 4th Edition, Academic Press, 2012.
2. C. Raja Rao and Sujoy K. Guha, “Principles of Medical Electronics and Biomedical Instrumentation”, 5th Edition, McGraw Hill Education, 2018.

REFERENCE BOOKS:

1. Malcolm S. Milner, Iain Hunter, and David G. Sixto Jr., “Biomedical Signal Analysis: A Practical Guide”, 3rd Edition, Artech House, 2012.
2. IEEE Transactions on Biomedical Engineering

Course Code	Course Title						Core/Elective
5OE704EC	**INDUSTRIAL ELECTRONICS**						Open Elective-IV
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
BEE	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives: This course aims at

1. Introducing electronic device characteristics suitable for industrial applications
2. Designing AC to DC, DC to AC Converters, Amplifiers , inverters and SMPS
3. Understanding various voltage control techniques in power converters.
4. Comprehending quadrant operation of various power converters
5. Introducing various electronic techniques for industrial heating to minimize EM interference.

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

1. Understand Industrial Semiconductor devices SCR , DIAC, TRAIC, and MOSFET respectively.
2. Comprehend DC amplifiers, Operational amplifier and Instrumentation amplifier.
3. Design and analysis of DC to DC converters and DC to AC converters and different types of Choppers.
4. Develop skills to build and troubleshoot power electronic circuits.
5. Synthesis of PWM Inverters, UPS and Switched mode regulators

UNIT - I

Characteristics of Semiconductor Power Devices: Thyristor, power MOSFET and IGBT (Qualitative Treatment only), Protections and thermal considerations. Brief introduction to power devices: DIAC and TRIAC, MOS controlled thyristor, Power Integrated Circuit (Smart Power), Concept of fast recovery and Schottky diodes as free-wheeling and feedback diodes.

UNIT – II

DC Amplifiers: Need for DC amplifiers, DC amplifiers: Drift, Causes, Darlington Emitter Follower, Cascode amplifier, Stabilization, Operational Amplifiers, and Instrumentation Amplifiers.

Choppers circuits: Principle, methods and Configurations operations of Type A, Type B, Type C, Type D and type E choppers, TRIACS: Triggering modes, Firing Circuits, Control techniques for choppers: TRC and CLC.

UNIT – III

Regulated Power Supplies: Block diagram, Principle of voltage regulation, Series and Shunt type Linear Voltage Regulators, Protection Techniques: Short Circuit, over voltage and Thermal Protection. Switched Mode and IC Regulators: Switched Mode voltage regulator, Comparison of Linear and Switched Mode Voltage Regulators, monolithic voltage regulators Fixed and Adjustable IC Voltage regulators.

UNIT – IV

Single-Phase Inverters: Principle of operation of full bridge square wave, quasi square wave, PWM inverters and comparison of their performance. Driver circuits for above inverters voltage and harmonic control at output of inverter, Filters at the output of inverters, Single phase current source inverter. Block diagram and configuration of UPS, salient features of UPS, selection of battery and charger ratings.

UNIT – V

Industrial Applications-I: Industrial timers, Classification, types, Electronic Timers – Classification, RC and Digital timers. Electronic DC Motor Control.

Industrial Applications-II: High Frequency heating, principle, merits, applications, High frequency Source for Induction heating. Dielectric Heating: principle, material properties, Electrodes and their Coupling to RF generator.

TEXT BOOKS:

1. Theodore. H. Bogart, "Electronic Devices and circuits", Pearson Education, 6th Edition, 2003.
2. P.C. Sen., "Modern Power Electronics", 2nd Edition, Chand & Co., 2004.
3. V.R. Moorthi, "Power Electronics", Oxford University Press, 2005.

REFERENCE BOOKS:

1. G. K. Mithal and Maneesha Gupta, "Industrial and Power Electronics", Khanna Publishers, 19th Edition, 2003.
2. Ned Mohan, Robbins, "Power electronics", 3rd Edition, John Wiley and sons, 2002.
3. Biswanth Paul," Industrial Electronics and Control", PHI Learning, 3rd edition 2014.
4. S.Chatterjee and Bhattacharya ," Industrial Electronics and Control", Technical education series,1st edition 2017.

B.E. (Mechanical Engineering) - VIII SEMESTER

S. No.	Code No.	Subject	Scheme of Instructions				Scheme of Examination		Credits
			L	T	P/D	Duration in Hrs.	CIE	SEE	
Theory Courses									
1	*PE*	Professional Elective V / MOOCs	3	-	-	3	40	60	3
2	*PE*	Professional Elective VI / MOOCs	3	-	-	3	40	60	3
3	6PW853ME	Project Work	-	-	16	16	50	100	8
Total			**6**	**-**	**16**	**22**	**130**	**220**	**14**

Professional Elective – 5			**Professional Elective – 6**		
S. No.	**PE Stream**	**Course Title**	**S. No.**	**PE Stream**	**Course Title**
1	6PE817ME	Gas Dynamics and Jet Propulsion	1	6PE821ME	Heating Ventilation and Air Conditioning
2	6PE818ME	Automation in Production Systems	2	6PE822ME	Operations and Supply Chain Management **(MOOC's-3C)**
3	6PE819ME	Business Analytics	3	6PE823ME	Electric Vehicle Technology
4	6PE820ME	Total Quality Management	4	6PE824ME	Non Destructive Techniques

#Open Elective – 4		
S. No.	**Course Code**	**Course Title**
1	6OE804ME	Industrial Engineering & Management

offered by Mechanical Engineering Department to other departments.

Course Code	Course Title						Core/Elective
6PE817ME	GAS DYNAMICS AND JET PROPULSION						PE-V
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Fluid Mechanics	3	-	-	-	40	60	3

Course Objectives:
It is intended to make the students to :

- Understand basic concepts and isentropic flows
- Learn the flow through the ducts
- Learn normal and oblique shocks
- Learn the jet propulsion and space propulsion

Course Outcomes:
After completing the course, student will be able to:

CO1. Apply the fundamentals of compressible flow concepts and the use of gas tables.
CO2. Analyze the compressible flow behaviour in constant area ducts.
CO3. Analyze the development of shock waves and its effects.
CO4. Explain the types of jet engines and their performance parameters.
CO5. Explain the types of rocket engines and their performance parameters

Unit I
Basic Concepts of Compressible Flow
Compressible fluid flow-energy and momentum equations, stagnation stages, various regions of flow, reference velocities, effect of Mach number on compressibility. Types of waves, Mach cone, Mach angle.

Unit II
Flow through Ducts
Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties.

Unit III
Normal and Oblique Shocks
Governing equations, variation of flow parameters across the normal and oblique shocks. Prandtl Meyer relations. Flow in variable area ducts with normal shocks. Use of Tables and Charts.

Unit IV
Jet Propulsion
Types of jet engines-turboprop, turbojet, ramjet, pulsejet. Aircraft propulsion theory, performance analysis of turbo jet, parameters affecting flight performance, thrust augmentation.

Unit V
Rocket Propulsion
Types of rocket engines, propellants, combustion instabilities, rocket propulsion theory, performance of rocket engine, multistage rockets, specific impulse orbital and escape velocities calculations.

Text Books:

1. Anderson, J.D., "Modern Compressible flow", .McGraw Hill.
2. Yahya, S.M. "Fundamentals of Compressible Flow", New Age International (P) Limited, NewDelhi.

Reference Books:

1. Hill. P. and C. Peterson, "Mechanics and Thermodynamics of Propulsion", Addison – Wesley Publishing company.
2. Zucrow. N.J., "Aircraft and Missile Propulsion", Vol.1 & II, John Wiley.

Course Code	Course Title						Core / Elective
6PE818ME	**AUTOMATION IN PRODUCTION SYSTEMS**						PE-V
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
-	3	-	-	-	40	60	3

Course Objectives:
It is intended to make the students to :

- Learn principles and strategies of automation in manufacturing systems.
- Understand flow lines and assembly systems.
- Understand principles of inspection & testing methods in manufacturing systems.

Course Outcomes:
After completing the course, student will be able to:

CO1. Understand the importance of automation in production systems.
CO2. Analyze the automated flow lines in production systems.
CO3. Understand various types of assembly systems.
CO4. Classify different types of automated inspection & testing methods.
CO5. Understand the principles of Programmable Logic Controllers.

Unit- I

Introduction: Definition of Automation, Types of Production systems, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automation.
Manufacturing Systems- Components & classifications, Automation in manufacturing systems, principles and strategies, costs of manufacturing systems, Single-station manufacturing cells.

Unit- II

Automation Production Lines: Automated Flow lines, Methods of workpart Transport, Transfer Mechanism, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations.
Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines without Storage, Partial Automation, Automated Flow Lines with Storage Buffers.

Unit - III

Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi station Assembly Machines, Analysis of a Single Station Assembly Machine.
Assembly system and line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

Unit - IV

Automated Inspection and Testing Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods.

Unit - V

Programmable Logic Controllers (PLCs):

Introduction, definition & history of PLC, Principles of PLC, various parts of PLC: CPU, Monitor, PLC input & Output Modules: Solid state memory, processor, power supplies, PLC advantages, disadvantages & applications.

Text Books:

1. M. P. Groover - Automation, Production Systems and Computer Integrated Manufacturing, PHI.
2. Frank Lamb - Industrial Automation, Mc Graw Hill.
3. W. Buekinsham – Automation.

Reference Books:

1. Nick Dawkins - Automation and Controls.
2. Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang - Computer Aided Manufacturing, Pearson.
3. Peter G. Martin and Gregory Hale - Automation Made Easy.

Course Code	Course Title						Core/Elective
6PE819ME	**BUSINESS ANALYTICS**						PE-V
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:
It is intended to make the students to :

- Understand the role of business analytics within an organization.
- Become familiar with processes needed to develop, report, and analyze business data.
- Use decision-making tools/Operations research techniques.
- Manage business process using analytical and management tools.

Course Outcomes:
After completing the course, student will be able to:

CO1. Understand core principles of business analytics, scope and advantages.
CO2. Apply statistical and analytical techniques to solve business problems.
CO3. Implement organizational structures, information policies, and analyse strategies for data quality.
CO4. Create predictive and prescriptive models, Monte Carlo simulations and advanced analytics techniques to address complex business scenarios.
CO5. Implement various domains of business analytics to formulate strategical decisions.

Unit-I

Business analytics: Overview of business analytics, scope of business analytics, business analytics process, relationship of business analytics process and organization, competitive advantages of business analytics. statistical tools: statistical notation, descriptive statistical methods, review of probability distribution and data modelling, sampling and estimation methods overview.

Unit-II

Trends and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology**.**

Unit-III

Organization Structures of Business analytics: Team management, Management Issues, Designing information policy, Outsourcing, ensuring Data Quality, Measuring contribution of business analytics, Managing changes. Descriptive analytics, predictive analytics, predicative modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, Nonlinear optimization**.**

Unit-IV

Forecasting Techniques: Qualitative and judgmental forecasting, statistical forecasting models, forecasting models for stationary time series, forecasting models for time series with a linear trend, forecasting time series with seasonality, regression forecasting with casual variables, selecting appropriate forecasting models. Monte Carlo simulation and risk analysis, Monte Carle simulation using analytic solver platform, new product development model, newsvendormodel, overbooking model, cash budget model.

Unit-V

Decision Analysis: **F**ormulating decision problems, decision strategies with and without outcome probabilities, decision trees, the value of information, utility and decision making. recent trends in embedded and collaborative business intelligence, visual data recovery, data storytelling and data journalism.

Text Books:

1. Business Analytics: Data Analysis & Decision Making" by Wayne L. Winston.
2. Business Analytics: Methods, Models, and Decisions" by James R. Evans.

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Course Code	Course Title						Core / Elective
6PE820ME	**TOTAL QUALITY MANAGEMENT**						PE-V
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
Statistics	3	-	-	-	40	60	3

Course Objectives:

It is intended to make the students to :

- Introduce the concept of Total Quality management.
- Learn and understand the principle of Total Quality management.
- Develop feedback and suggestion systems for quality management.
- Enhance the knowledge of tools and techniques in quality management.
- Acquaint with different aspects of quality system in manufacturing industries.

Course Outcomes:

After completing the course, student will be able to:

CO1. Apply TQM techniques in engineering applications.

CO2. Apply quality management philosophies and quality circle concepts in engineering industries.

CO3. Apply statistical techniques in TQM.

CO4. Application of tools and methods for quality management in TQM.

CO5. Implement TQM Systems.

UNIT - I

Introduction

Introduction to quality management: Definition and framework of TQM, benefits, awareness and obstacles. Quality statements – vision, mission and policy statements. Customer perception of quality, Translating needs into requirements, Customer retention and cost of quality.

UNIT - II

TQM Principles

Quality management philosophies: Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle.

UNIT - III

Statistical Process Control

Introduction to statistical quality control (SQC), capability and Reliability: Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributes. Process capability – meaning, significance. Reliability– definitions, reliability in series and parallel systems, product life characteristics curve.

UNIT - IV

TQM Tools and Techniques

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector. Bench marking . Quality functions development (QFD) –House of quality (HOQ), building a HOQ, QFD process. POKA YOKE, Management tools for quality improvement, Juran‘s improvement programme, Tools for process improvement.

UNIT -V

Quality Systems

Need for ISO 9000, ISO 9001-2008 Quality System: Elements, Documentation, Quality Auditing: QS 9000 - ISO 14000 - Concepts, Requirements and Benefits. TQM Implementation in manufacturing and service sectors.

Text Books:

1. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd.
2. Total Quality Management/P. N. Mukherjee/PHI.

Reference Books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning.
2. Quality Management/Kanishka Bedi/Oxford University Press.
3. Dale H.Besterfield et al, Total Quality Management, Third edition, Pearson Education.
4. Dale H. Besterfiled, et at., "Total quality Management", Third Edition, Pearson Education Asia, Indian Reprint.

Course Code	Course Title						Core/Elective
6PE821ME	HEATING VENTILATION & AIR-CONDITIONING						PE-VI
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Applied Thermodynamics & Heat Transfer	3	-	-	-	40	60	3

Course Objectives:
It is intended to make the students to :

- Understand effects of solar radiation and internal heat sources on heating/cooling loads.
- Understand air quality, effects of relative humidity, control of microbial growth in building ventilation.
- Familiarize with design air conditioning systems using cooling load calculations.
- Learn the fundamental principles of air conditioning systems and different methods for load calculation during summer and winter.

Course Outcomes:
After completing the course, student will be able to:

CO1. Analyse the effects of relative humidity in building ventilation.
CO2. Understand the necessity of indoor air quality and need for building ventilation.
CO3. Develop air conditioning system for summer and winter load calculation.
CO4. Identifying the selection of outside and inside design conditions of air conditioning systems.
CO5. Design an HVAC system for a residential or commercial building.

Unit I

Introduction to heating system: Heat gain through glass-calculation of solar heat gain through ordinary glass tables-shading devices-effect of shading devices. Thermal resistance of various building materials.

Heating load calculations: Winter heating load calculation-heat losses through structure-heat losses due to infiltration. Effects of solar radiation and internal heat sources on heating loads. Methods for estimating energy requirements for heating.

Unit II

Introduction to ventilation system- Fundamentals of good indoor air quality Need for building ventilation, Effects of R.H. in building ventilation, Control of microbial growth.

Supply systems: Air Inlet system, Filters, heating & cooling equipment, Supply Fans, Ducts, Grills, Diffusers, For distribution of air in the work place.

Exhaust systems: General exhaust systems. Local exhaust system, Removal of pollutants and contaminated air. Air cleaning devices, Exhaust Fans.

Unit III

Psychrometry: Properties of moist air. Important Psychrometry properties, Dry bulb temperature, Wet bulb temperature, Relative humidity, Humidity ratio, degree of saturation, Dew point temperature and Enthalpy, Psychometric chart, Psychrometric process in air conditioning equipment, Bypass factor and sensible heat factor.

Applied psychrometry: Use of Effective and Grand sensible heat factor, Selection of air conditioning equipment for cooling and dehumidification.

Unit IV

Air conditioning processes: Mixing process. Summer, winter and year round air Conditioning system, Hot and dry outdoor conditions. Hot and humid outdoor conditions. Winter air conditioning system. Year round air conditioning system.

Comfort air conditioning: Thermodynamics of human body. Body regulation process against heat and cold. comfort chart, effective temperature, factors governing optimum effective temperature, Design consideration. Selection of outside and inside design conditions,

Air conditioning control system: Basic elements of the control system, temperature, humidity & pressure controls, refrigeration, room thermostat.

Unit V

Air conditioning systems: All water, All air, Air water system. Unitary System, Window air conditioner, Split and Central air conditioning system.

Cooling load calculations: Occupancy load, lighting load, appliance load, product load, difference between summer & winter load calculations.

Air distribution: Room air distribution, types of supply air outlets, mechanism of flow through outlets, selection and location of outlets, Distribution patterns of outlets.

Ducts: Definition and types, materials for ducts and its specification, friction loss in ducts, grills, diffusers, registers, rectangular equivalent of circular duct.

Air duct designs: Equal friction method, static regain method, velocity reduction method, duct construction.

Text Books:

1. Refrigeration & Air-Conditioning by C.P. Arora.
2. Refrigeration & Air-Conditioning by Domkundwar.

Reference Books:

1. Refrigeration & Air-Conditioning by V.K. Jain.
2. ASHRAE Hand Book.
3. Hand Book of Air Conditioning System design by Carrier.

Course Code	Course Title						Core/Elective
6PE822ME	OPERATIONS AND SUPPLY CHAIN MANAGEMENT						PE-VI
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:
It is intended to make the students to :

- Learn the concepts and principles of operations and supply chain management.
- Acquire skills in operational processes in manufacturing and service environments.
- Understand the role of inventory management and logistics in optimizing supply chain performance.
- Explore strategies for coordinating and managing the flow of materials and information across the supply chain.
- Learn quantitative and qualitative tools and techniques to solve operations and supply chain management problems.

Course Outcomes:
After completing the course, student will be able to:

CO1. Analyze operational processes to identify areas for improvement.
CO2. Implement strategies to optimize inventory levels and reduce supply chain costs.
CO3. Apply quantitative techniques to solve operations and supply chain management problems.
CO4. Understand the importance of coordination and collaboration among supply chain partners.
CO5. Understand supply chain management issues and solutions.

Unit I

Introduction to Operations and Supply Chain Management: Definitions and Scope of Operations and Supply Chain Management, Historical Perspective and Evolution of Operations Management, Role of Operations and Supply Chain Management in Business Strategy, Globalization and Outsourcing in Supply Chain Management, Trends and Challenges in Operations and Supply Chain Management.

Unit II

Operations Strategy and Process Design: Operations Strategy Formulation and Implementation. Product and process design, Process analysis and improvement Techniques. Lean Manufacturing principles and practices, Six Sigma and Total Quality Management (TQM).

Unit III

Inventory Management and Logistics: Inventory Types and Costs, Inventory Control Models (EOQ, ROP), Supply Chain Network Design, Transportation and Distribution Management, Warehousing and Materials Handling.

Unit IV

Supply Chain Coordination and Collaboration: Demand Forecasting and Planning, Supplier Relationship Management (SRM), Vendor Managed Inventory (VMI) and Collaborative Planning, Forecasting, and Replenishment (CPFR), Information Sharing and Technology in Supply Chain Management, Risk Management in Supply Chains.

Unit V

Current Trends and Future Directions in Operations and Supply Chain Management: Sustainable Operations and Green Supply Chain Management, Omni-channel Retailing and E-commerce Logistics, Supply Chain Resilience and Agility, Digital Transformation and Industry 4.0, Ethical and Social Responsibility in Supply Chains.

Text Books:

1. "Operations and Supply Chain Management" by F. Robert Jacobs and Richard Chase
2. "Supply Chain Management: Strategy, Planning, and Operation" by Sunil Chopra and Peter Meindl

Reference Books:

1. "Essentials of Supply Chain Management" by Michael H. Hugos.
2. "Manufacturing Planning and Control for Supply Chain Management" by F. Robert Jacobs, William Berry, D. Clay Whybark, and Thomas Vollmann.
3. "Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies" by David Simchi-Levi, Philip Kaminsky, and Edith Simchi-Levi.

Course Code	Course Title						Core / Elective
6PE823ME	**ELECTRIC VEHICLE TECHNOLOGY**						PE-VI
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
Elements of Electrical Engineering & Automobile Engineering	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:

It is intended to make the students to learn:

- The basics of electric vehicles and their working
- The basics of batteries and their role for electric vehicle applications
- The knowledge of various types of electric vehicles
- The real time challenges in the implementation of this technology

Course Outcomes:

After completing the course, student will be able to:

CO1.**Understand** the concepts and design of electric vehicle.

CO2.**Understand** charging methods of batteries and sizing of ultra-capacitors.

CO3. **Apply** a suitable drive scheme for developing an electric vehicle for specific application.

CO4. **Design** and develop basic schemes of electric vehicles.

CO5. **Analyse** battery charging and discharging characteristics and estimate electric vehicle battery capacity.

Unit I:

Introduction to Electric Vehicles: Sustainable Transportation - EV System - EV Advantages – Vehicle Mechanics - Performance of EVs - Electric Vehicle drive train - EV Transmission Configurations and Components-Tractive Effort in Normal Driving - Energy Consumption - EV Market - Types of Electric Vehicle in Use Today - Electric Vehicles for the Future.

Unit-II

Electric Vehicle Modelling - Consideration of Rolling Resistance - Transmission Efficiency – Consideration of Vehicle Mass - Tractive Effort - Modelling Vehicle Acceleration -

Unit-III

Introduction to electric vehicle batteries - electric vehicle battery efficiency - electric vehicle battery capacity- electric vehicle battery charging - electric vehicle battery fast charging - electric vehicle battery discharging- electric vehicle battery performance – testing.

Unit-IV

Modelling Electric Vehicle Range -Aerodynamic Considerations - Ideal Gearbox Steady State Model - EV Motor Sizing - General Issues in Design.

Unit-V

Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles - The Impact of Plug-in Hybrid Electric Vehicles on Distribution Networks – Sizing Ultra capacitors for Hybrid Electric Vehicles.

Text Books:

1. Electric Vehicle Battery Systems – Sandeep Dhameja – Newnes - New Delhi.
2. Electric Vehicle Technology Explained - James Larminie, John Lowry - John Wiley & Sons Ltd.

Reference Books:-

1. Hybrid electric Vehicles Principles and applications with practical perspectives -Chris Mi, Dearborn- M. Abul Masrur, David Wenzhong Gao - A John Wiley & Sons, Ltd.
2. Electric & Hybrid Vehicles – Design Fundamentals -Iqbal Hussain, Second Edition, CRC Press.

Course Code	Course Title						Core / Elective
6PE824ME	**NON DESTRUCTIVE TECHNIQUES**						PE-VI
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:
It is intended to make the students to :

- Know various types of non-destructive testing methods.
- Learn the principle and process of various non destructive techniques like LPT, MPI, ECT, UT and Radiography.
- Understand advantages, limitations and applications of LPT, MPI, ECT, UT and Radiography.

Course Outcomes:
After completing the course, student will be able to:

CO1. Understand the basics of non-destructive testing (NDT) in finding surface and sub surface defects.
CO2. Select and Identify suitable non destructive technique to detect defects in materials with physical contact.
CO3. Select and Identify suitable non destructive technique to detect defects in materials without physical contact.
CO4. Apply X-rays and Gamma rays to find sub surface defects.
CO5.Apply Ultrasonic techniques to identify the location of flaws.

Unit -I
Introduction: Introduction and fundamentals of destructive and non-destructive testing. Merits and demerits of NDT, NDT versus destructive testing, Overview of Non Destructive testing methods for the detection of manufacturing defects.
Visual Inspection: Fundamentals of Visual Testing – vision, lighting, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibro scopes – light sources and special lighting.

Unit -II
Liquid Penetrate Testing Principle, procedure, characteristics of penetrant, types of penetrants, Preparation of test materials – Application of penetrants to parts, removal of excess penetrants, post cleaning – Control and measurement of penetrant process variables – selection of penetrant methods – solvent removable, water washable, post emulsifiable , Interpretation and evaluation of test results - dye penetrant process , applicable codes and standards.

Unit -III

Eddy Current Testing:

Generation of eddy currents – effect of change of impedance on instrumentation – properties of eddy currents – eddy current sensing elements, probes, type of coil arrangement – absolute, differential, lift off, operation, advantages, limitations and application. Factors affecting sensing elements and coil impedance - test part and test system –Signal to noise ratio – equipment's, reference samples, calibration, inspection of tubes, cylinders, steel bars, welded tubing, plates and pipes.

Unit -IV

Ultrasonic Testing:

Principle of sound propagation, types of sound waves, principles of UT, methods of UT, advantages and limitations. Various types of transducers, probe – calibration methods, contact testing and immersion testing methods, ultra sonic testing techniques , through transmission techniques, pulse echo testing techniques , reference of standard block techniques for normal beam inspection flaw , characterization technique, defects in welded products tested by UT.

Unit -V

Radiography

Principle & uses of radiography, limitation principle, radiation sources, production of X-rays, X-ray spectra, attenuation of radiation, shadow formation enlargement and distortion, radiographic film and paper, inspection of simple and complex shapes, radiation hazard, protection against radiation. **Acoustic Emission:**

Physical principles, sources of emission, instrumentation and applications. Other NDT Techniques: Neuron radiography, laser induced ultrasonics, surface analysis, and thermography.

Text Books:

1. J. Prasad and C.G.K. Nair, Non-Destructive Test and evaluation of materials, Tata McGraw-Hill Education, 2nd edition .
2. B. Raj, T. Jayakumar and M. Thavasimuth, Practical Non-Destructive Testing, Alpha Science International Limited, 3rd edition .

Reference Books:

1. Barry Hull & Vernon John, _Non-Destructive Testing.
2. Non-Destructive examination and quality control, ASM International.
3. T. Rangachari, J. Prasad and B.N.S. Murthy, Treatise on Non-Destructive Testing and Evaluation, Navbharath enterprises.
4. ASM Metals Handbook,"Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

Course Code	Course Title						Core / Elective
6PW803ME	**PROJECT WORK**						Core
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
Statistics	-	-	-	16	50	100	8

Course Objectives:
It is intended to make the students to:

- Enhance practical and professional skills.
- Familiarize with tools and techniques of systematic literature survey and documentation.
- Learn industry practices and team work.
- Work with innovative and entrepreneurial ideas.

Course Outcomes:
After completing the course, student will be able to:

CO1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the Academic program to the real-world problems.
CO2. Evaluate different solutions based on economic and technical feasibility.
CO3. Effectively plan a project and confidently perform all aspects of project management.
CO4. Demonstrate effective written and oral communication skills.
CO5. Present effective outcome/result of the research work carried out for the project

The aim of Project work is to make student implement and evaluate the proposal of their interest in field of engineering. Students can also be encouraged to do full time internship as part of Project work based on the common guidelines for the department. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Grouping of students in a batch of three student
2. Allotment of Project guide to students group
3. Project monitoring at regular intervals.

Re-grouping/re-allotment has to be completed by the 1st week of VIII semester so that students get sufficient time for completion of the project.

Both project and internship will be monitored at least twice in a semester through student presentation for the award of sessional marks.

Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for 25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the department. The students are required to submit draft copies of their project report within one week after completion of instruction and before conduct of final viva-voce.

Note: Three periods of contact load will be assigned to each project guide.

Course Code	Course Title						Core/Elective
4OE804EE	SENSORS AND TANSDUCERS						Open Elective-IV
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
--	3	-	-	-	40	60	3

Course Objectives: The objective of this course is to make the student

1. To understand the principle of operation of Transducers and Sensors
2. To understand the application of Transducers and Sensors

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

1. Explain the basic principle of operation of Transducers and Sensors. Distinguish different sensors and transducers.
2. Identify suitable transducer by comparing different industrial standards and procedures for measurement of physical parameters
3. Estimate the performance of different transducers.
4. Design real life electronics and instrumentation measurement systems.
5. Apply smart sensors, bio-sensors, PLC and Internet of Things to different applications.

UNIT – I:

Introduction: Definition, significance of measurement and instruments. Principle of sensing & transduction, transducer classification, Transducer characteristics, emerging fields of sensor technologies**.**

Resistive transducers: Potentiometers: types, loading error, metal and semiconductor strain gauges, types, resistance measuring methods, strain gauge applications: Load and torque measurement.

UNIT – II:

Inductive transducers: Transformer type, synchros, eddy current transducers, LVDT: Construction, material, input-output characteristics. Optical Sensors: LDR, Photo Diode, Stroboscope, IR Sensor.

Capacitive transducers: Variable distance-parallel plate type, variable area- parallel plate type, cylindrical type, differential type, variable dielectric constant type, calculation of sensitivity. Capacitive microphone, fluid level measurement.

UNIT-III:

Piezoelectric transducers: piezoelectric effects, Materials, natural and synthetic types – their comparison, Charge and voltage coefficient, Force and stress sensing, displacement measurement.

Magnetic Transducer: Hall effect sensors

Magneto strictive transducers: principle, positive and negative magneto striction

UNIT –IV:

Thermal sensors: Resistance temperature detector (RTD): principle, materials and types; **Thermistor**: principle, materials and types; Thermocouple, Thermoelectric effects, laws of thermocouple, thermocouple types, construction. IC temperature sensor, PTAT type sensor. **Radiation sensors:** types, characteristics and comparison. Pyroelectric type.

UNIT – V:

Micro-sensors and smart sensors: Construction, characteristics and applications. Standards for smart sensor interface.

Recent Trends in Sensor Technologies: Introduction; Film sensors (Thick film sensors, thin film sensor)

TEXT BOOKS:

1. Transducers and Instrumentation , D.V.S. Murthy, Prentice Hall, 2008
2. Sensors and Transducers, D. Patranabis, Prentice Hall India, 2003
3. Measurement Systems - Application and Design, E.O. Doebelin, McGraw-Hill, 2008

REFERENCES /SUGGESTED READING:

1. Instrument Transducers - An Introduction to their Performance and Design", H.K.P. Neubert , Oxford University Press, 1999.
2. Measurement Systems and Sensors, WaldemarNawrocki Artech House, 2016.
3. Semiconductor sensors", S.M. Sze, Wiley - Interscience, 1994
4. Instrumentation Measurement and Analysis", B. C. Nakara&Chaudhry TATA McGraw-Hill, 2009
5. Smart Sensors and Sensing Technology, Daniel E. Suarez, Nova Science Publishers, 2011

Course Code	Course Title						Core/Elective
1OE804AD	**BIG DATA ANALYTICS**						Open Elective-IV
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
--	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:
It is intended to make the students to :

- Understand the Big Data Platform and overview of Apache Hadoop
- Provide HDFS Concepts and Interfacing with HDFS
- Understand Map Reduce Jobs
- Provide handson Hadoop Eco System Pig, Hive
- Understand various Hadoop Eco Systems like H base, Zookeeper

Course Outcomes:
After completing the course, student will be able to:

CO1: Explain the foundations, definitions, and challenges of Big Data.
CO2. Use Hadoop file system interfaces.
CO3. Program using HADOOP and Map reduce.
CO4. Understand various Hadoop Eco Systems like Pig, Hive.
CO5. Outline Hadoop Eco System using H Base, Zookeeper.

UNIT I
Introduction to Big Data and HadoopTypes of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analyzing Data with UNIX tools, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Echo System.

UNIT II
HDFS (Hadoop Distributed File System)The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file systeminterfaces, Data flow, Hadoop I/O: Compression, Serialization, Avro and File-BasedData structures.

UNIT III
Map ReduceAnatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

UNIT IV
Hadoop Eco System-IPig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig withDatabases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

UNIT V
Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, Hive QL, Tables, Querying Data and User Defined Functions.

TEXTBOOKS
1. Hadoop: The Definitive Guide, Tom White, III Edition, O'reily Media, 2012.

REFERENCE BOOKS
1. Big Data Analytics, Seema Acharya, Subhasini Chellappan, Wiley 2015.
2. Intelligent Data Analysis, Michael Berthold, David J. Hand, Springer, 2007.

Course Code	Course Title						Core/Elective
OE804CE	**REMOTE SENSING AND GIS**						Open Elective-IV
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
--	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:

It is intended to make the students to :

C1. Basics of remote sensing and Sensor Characteristics
C2. Energy interactions with atmosphere and Earth surface features
C3. Map projections and Data models in GIS
C4. Spatial Data creation
C5. Spatial data and Terrain modelling analysis

Course Outcomes:

After completing the course, student will be able to:

CO 1. Explain the basics of Remote Sensing, different types of satellite and sensors
CO 2. Define the principles of satellite remote sensing, able to comprehend the energy interactions with earth surface features, spectral properties of water bodies
CO 3. Demonstrate the basic concept of GIS and its applications, know different types of data representation in GIS
CO 4. Create the spatial data using various techniques
CO 5. Develop models using spatial & Terrain Analysis

Unit-I:

Basics of Remote Sensing: Definition, History, Advantages, Aerial Photography and Satellite Remote Sensing, Components of Remote Sensing System: Energy Source, Energy-Atmosphere Interaction, Energy Interaction with Atmosphere and Surface Materials, Spectral Signatures

Unit-II:

Remote Sensing Platforms: Aircrafts and Satellites, Orbital Characteristics of Sun-synchronous and Geostationary satellites - Special Purpose Satellites; Remote Sensing Sensors: Types of Sensors, Active and Passive; Framing Systems (Cameras) - Scanning System; Sensor Characteristics: Spatial Resolution, Spectral Resolution, Radiometric Resolution, Temporal Resolution.

Unit-III:

Introduction to GIS: History of development of GIS- Geo Spatial Data - GIS operations- Standard GIS packages, Applications of GIS;

Datum and Map Projections: Concept of Datum, Coordinate Systems and Map Projections , Transformations

Unit-IV:

Data Models: Spatial and Non-Spatial Data models; Spatial Digital formats
Spatial Data Creation: Scanners, digitizers; Digital Elevation Models; Sources of Errors & Corrections- Rotation and Resampling methods, Morphometric analysis-Triangular Irregular Network (TIN).

Unit-V:

Spatial Data Analysis: Raster data analysis; Vector data analysis - Buffering, Overlay, Union, Intersect, Merging, splitting operations

Terrain Modelling & Analysis: Contouring, Vertical profiling, Hill shading, 3D perspectives; Slope & Aspect analysis, Viewshed & watershed analysis.

Software: Introduction to QGIS or ARCGIS software and its interface to perform spatial analysis

Text Books:

T1. M.Anji Reddy – "Textbook of Remote Sensing and Geographic Information Systems", 3rd Edition, BS Publications, 2008.

T2. K.T.Chang –"Introduction to Geographic Information Systems", 4th Edition, McGraw Hill International Edition, 2016

Reference Books:

R1. Lillesand, T., Kiefer, R. W., & Chipman, J. – "Remote Sensing and Image Interpretation", 7th Edition, John Wiley& Sons, 2015

R2. Punmia, B.C. & Jain A.K.—"Higher Surveying", 15th Edition, Laxmi Publications,2005.

Course Code	Course Title						Core/Elective
3OE804CS	DATA SCIENCE						Open Elective-IV
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
--	3	-	-	-	40	60	3

Course Objectives:

It is intended to make the students to :

- Learn fundamental knowledge on basics of data science
- Understand various statistical concepts like linear and logistic regression
- Learn fundamentals of how to obtain, store, explore, and model data efficiently.
- Understand the concepts of classification and clustering

Course Outcomes:

After completing the course, student will be able to:

CO 1. Recognize the different levels of Data Science concepts for visualization of data.

CO 2. Demonstrate the data visualization and statistical techniques, for describing data structure property.

CO 3. Analyze the basics of probability and statistics models for data exploration

CO 4. Make use of Hypothesis testing for statistical analytics for destroying target based on the mission requirements.

CO 5. Demonstrate numerous open source data science tools to solve real-world problems through industrial case studies

UNIT I

Introduction: What is Data Science, Where Do We See Data Science, and How Does Data Science Relate to Other Fields, The Relationship between Data Science and Information Science, Computational Thinking, Skills for Data Science, Tools for Data Science, Issues of Ethics, Bias, and Privacy in Data Science.

UNIT II

Data Collection and Data Pre-Processing: Data Types-Structured Data, Unstructured Data, Challenges with Unstructured Data, Data Collections- Open Data, Social Media Data, Multimedia Data, Data Storage and Presentation, Data Pre-processing -Data Cleaning, Data Transformation, Data Reduction, Data Discretization

UNIT III

Exploratory Data Analysis: data summarization, data distribution, Frequency Distribution, Measures of Centrality, Dispersion of a Distribution, Diagnostic Analytics-Co-relations Predictive Analytics, Perspective Analytics, Exploratory Analysis, hypothesis testing using confidence intervals, using p-values.

UNIT IV

Predictive Modeling: Linear Regression, Simple Linear Regression model building, Multiple Linear Regression, Logistic regression, Robust Regression. Evaluation Measures: SSE, RMSE.

UNIT V

Classification: Decision Tree Induction, Support Vector Machine, K-Nearest neighbours (KNN), performance measures: The Confusion Matrix, precision, recall, F-Score, Receiver Operator Characteristic (ROC) Curve. **Clustering:** K-means Clustering.

TEXT BOOKS

1. A Hands on Introduction to Data Science, Chirag Shah, Cambridge University Press 2020
2. Practical Statistics for Data Scientists, Peter Bruce and Andrew Bruce,O"Reilly, 2017.
3. R for Data Science,Hadley Wickham and Garrett Grolemund, O"Reilly, 2017

REFERENCE BOOKS

1. R Programming for Data science, Roger D Peng, Lean Publishing, 2016.
2. Introduction to Data Science, Rafael A Irizarry, Lean Publishing,2016.
3. R Data Analysis cookbook, VishwaVishwanathan and Shanthi Vishwanathan,2015

Course Code	Course						Core/Elective
6OE804ME	**INDUSTRIAL ENGINEERING AND MANAGEMENT**						Open Elective-IV
Prerequisite	**Contact Hours Per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives

It is intended to make the students to :

- Learn the concept of Management.
- Understand role of PERT and CPM techniques in project management.
- Learn various material procurement policies.
- Understand the costing and cost control in engineering industries.
- Learn job evaluation methods.

Course Outcomes

After completing the course, student will be able to:

CO1. Understand the concept of scientific management.
CO2. Apply different types of inventory models in material management.
CO3. Apply the concepts of PERT and CPM techniques in project management**.**
CO4. Analyse the elements of costing and determine the selling price.
CO5. Apply job evaluation and merit rating techniques to evaluate the performance of employees.

Unit I

Management: Introduction to Management, Scientific Management, Systems approach to Management, MBO, and Decision Making Process. Personnel Management, Functions of personnel management, types of training, Collective bargaining and labour participation in management.

Unit II

Cost Accounting and Control: Introduction, Elements of cost, types of cost- prime cost, overhead cost, factory cost, total cost. Selling price, nature of cost, control and accounting of materials, labor, and over head cost, depreciation, break even analysis, break even chart.

Unit III

Job Evaluation and Merit Rating: Job evaluation: Introduction, definition and concept, objectives, procedure and methods-ranking method, classification or grading method, factor comparison method and point method, Merit rating: Introduction, definition, objectives, and methods- rating scale, check list and employee comparison method.

Unit-IV

Material Management: Importance of inventory control, types of inventory models Inventory costs, deterministic inventory models, Basics of EOQ models, production model without shortages, Purchase model with instantaneous replenishment, production model with shortages, Inventory model with price breaks, Inventory model with probabilistic demand.

Unit-V

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

Text books:

1. OP Khanna, Industrial engineering and management, Dhanpat Rai Publications.
2. SK Sharma &Savita Sharma," A course in Industrial Engineering & Operations Management",
   S K Kataria& Sons.

Reference Books:

1. M.Mahajan, *"Industrial Engineering and Production Management"*, Dhanpatrai& sons, New Delhi.
2. S Kalavathi, "*Operations Research"*, Vikas Publishing House Pvt. Ltd.
3. V. K. Kapoor , "*Operations Research"*, S. Chand, New Delhi.