DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction
and
Syllabus of

B.E. (Mechanical Engineering)
VII& VIII SEMESTER

With effected from the Academic Year **2025-2026**

UNIVERSITY COLLEGE OF ENGINEERING
(AUTONOMOUS)
OSMANIA UNIVERSITY
HYDERABAD–500007, TELANGANA.

UNIVERSITY COLLEGE OF ENGINEERING (AUTONOMOUS)

Vision

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

Mission

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

DEPARTMENT OF MECHANICAL ENGINEERING

Vision

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

Mission

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

Programme Educational Objectives (PEOs) for B.E. (Mechanical Engineering) Programme

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

Programme Outcomes (POs) of B.E. (Mechanical Engineering) Programme

Engineering Graduates will be able to:

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and a mechanical engineering to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems related to mechanical engineering and allied fields reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the mechanical engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able tocomprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the mechanical engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs) of B.E. (Mechanical Engineering) Programme

Engineering Graduates will be able to:

PSO1	Apply the principles of collaborative and multi-disciplinary approach for solving problems.
PSO2	Able to interact with industry and R&D institutions leading to start-ups/ budding entrepreneurs.

SCHEME OF INSTRUCTION EXAMINATION

B.E VII Semester (Mechanical Engineering)

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hrs/wk	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	PC701ME	Thermal Turbo Machinery	3	0	0	3	40	60	3
2	PC702ME	Automation in Manufacturing	3	0	0	3	40	60	3
3	PC703ME	Operations Research	3	0	0	3	40	60	3
4	PC704ME	Robotic Engineering	3	0	0	3	40	60	3
5	Professional Elective-IV		3	0	0	3	40	60	3
6	Open Elective-II		3	0	0	3	40	60	3
PRACTICALS									
7	PC751ME	Thermal Engineering Lab-II	-	-	2	2	25	50	1
8	PC752ME	CAM and Automation Lab	-	-	2	2	25	50	1
9	PW751ME	Summer Internship	-	-	2	2	50	-	2
10	PW752ME	Project Work–I	-	-	6	6	50	-	3
Total			**18**	**-**	**12**	**30**	**390**	**460**	**25**

Note: Students are required to complete a 6-week mandatory summer internship at the end of VI-semester in a relevant industry/research institution, evaluation in VII-semester for credits.

Course Corse	Professional Elective – IV
PE741ME	Product Design and Development
PE742ME	Mechanical Vibrations
PE743ME	Waste Heat recovery and Co-generation
PE744ME	Heating Ventilation and Air Conditioning
PE745ME	Sustainable Manufacturing
PE746ME	Energy Conservation and Management
PE747ME	Supply Chain Management
PE748ME	Bio Mechanics
PE749ME	Entrepreneurship
PE750ME	Industry 4.0: Principles and Technologies
PE751ME	MEMS:Design and Manufacture

Course Corse	Open Elective-II
OE701BM	Basic Medical Equipment
OE702BM	Artificial Intelligence in Health Care
OE701CE	Green Building Technology
OE702CE	Plumbing Technology
OE701CS	Cloud Computing
OE702CS	Database Management System
OE701EC	Embedded Systems Design
OE702EC	Basics of IoT
OE701EE	Optimization Techniques
OE702EE	Non-Conventional Energy Sources
OE701ME	Nano Technology
OE702ME	Start up Entrepreneurship

Course Code	Course Title						Course Type
PC701ME	**THERMALTURBO MACHINERY**						**Core**
Prerequisite	Contact hours per week				**Duration of SEE**	**Scheme of Evaluation**	**Credits**
	L	**T**	**D**	**P**	**(Hours)**	**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives:

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

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

1. The Students are expected to formulate governing equations of compressible flows and derive relations among fluid flow properties.
2. The Students are expected to be able to predict the compressible flow properties behavior with friction, heat transfer and shock waves.
3. The Students are expected to be able to classify turbo machines and explain working principle of Rotodynamic compressors and calculate performance parameters.
4. The Students are expected to explain classification and working principles of steam turbines, and draw velocity diagrams and calculate performance parameters.
5. The Students are expected to be able to explain working principles of gas turbine cycles and understand methods to improve their efficiency. They should be able to understand working principles and performance parameters of Jet and Rocket Propulsion Systems

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

UNIT-II

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

UNIT-III

Definition and classification of turbo machines, Euler's equation for energy transfer. Rotodynamic compressors: General classification, comparison with positive displacement compressors. Concept of shape number-selection of impeller. Axial flow compressors: Stage velocity triangles, enthalpy-entropy diagram, Euler's work input, flow coefficient, blade loading coefficient, relations for static pressure rise in rotor,stator and stage. Stage and polytropic efficiency. Factors affecting stage pressure ratio. Degree ofreaction. Surging, stalling and choking. Centrifugal compressors: Elements of a centrifugal stage, stage velocity triangles, performance of different types of impellers- forward, radial and backward swept blades. Enthalpy-entropy diagram, degree of reaction. Slip factor, actual work and stage and polytropic efficiency.

UNIT-IV

Steam Turbines: Classification, flow over blades, impulse and reaction turbines, Pressure and velocity compounding of steam turbines. Impulse steam turbines: Velocity triangles-single and multistage De Laval turbine, effect of bladefriction, axial thrust, effect of blade speed ratio on stage and blade efficiency. Partial Admission, height of turbine blades. Parson's reaction turbine: Reaction stage analysis, degree of reaction, maximum blade efficiency, representation on enthalpy-entropy diagram. Height of turbine blades.

UNIT-V

Gas turbines: Classification and comparison of open and closed cycles. Thermodynamic Analysis of Brayton/Joule cycle. Methods to improve thermal efficiency of gas turbine cycles: inter cooling, reheat and regeneration. Jet Propulsion: Aircraft propulsion turbo engines: Turbo jet, turboprop, turbofan, ramjet and pulse jet engines. Propulsion performance parameters: Thrust force, thrust power and thrust Specific fuel consumption. Thrust, propulsion, transmission and overall efficiencies. Rocket Propulsion: Working principle, propulsion efficiency. Types of Rocket engines: Solid propellant and liquid propellant engines.

Suggested Reading:

1. Yahya S M, Fundamentals of compressible flow, New age international publishers, 2018.
2. Balachnadran P, Fundamentals of Compressible fluid dynamics, Prentice Hall of India, New Delhi, 2006.
3. Rathakrishnan E, Gas Dynamics, Prentice Hall of India, New Delhi, 2003.
4. R K Rajput, Thermal Engineering, Laxmi Publications, 2020.
5. Gopalakrishnan G, Prithvi Raj D, A treatise on Turbomachines, Scitech Publications, Chennai, 2002.

Course Code	Course Title						Course Type
PC702ME	**AUTOMATION IN MANUFACTURING**						**Core**
Prerequisite	Contact hours per week				**Duration of SEE**	**Scheme of Evaluation**	Credits
	L	**T**	**D**	**P**	**(Hours)**	**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives:

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

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

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies, Basic structure of PLC and Micro-controllers.
IntroductiontoModellingandSimulation:Productdesign,processroutemodelling,Introductionto Product Life Cycle Management, PLM Software's, Components of PLM Software

SuggestedReadings:

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

Course Code	Course Title						Course Type
PC703ME	**OPERATIONS RESEARCH**						**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

Course Outcomes:

1. To understand the basics of OR, including mathematical modeling, feasible solutions and optimization using LPP and formulate Dual LPP
2. To formulate and solve transportation, Network and assignment problems
3. To apply Inventory models , sequencing models and queuing models in industry
4. To model and solve decision models, replacement models and Dynamic programming problems.
5. To familiarize with constrained and unconstrained non linear programming problems.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT- I

Introduction: Operations Research models: Characteristics, applications, and limitations.
Linear Programming Problem: Introduction, Basic Assumptions, Formulation, graphical method, simplex method, Big M and Two-Phase method. Duality principle, Primal and Dual Problems, Sensitivity Analysis and Economic Interpretation.
Integer programming: Introduction, Types of Integer programming, Branch and bound methods

UNIT-II

Transportation Assignment Models – Traveling Salesman problem, North west corner method, Vogel's approximation method.**Networks models:** Shortest route – Minimal spanning tree – Maximum flow models – CPM and PERT networks – Critical path scheduling – float calculation and its importance–Cost reduction by crashing the activity.

UNIT-III

Sequencing models: Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines, processing 2 jobs through m machines.
Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – discount models – Inventory control models in practice.
Queueing models– Single server and multi-server models – Poisson input – Exponential service – Constant rate service – Infinite population

Unit-IV

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

Replacement models – Models based on service life – Economic life – Single / Multi variable search technique

Dynamic Programming: Introduction- Terminology, Bellman's principle of optimality- Applications of Dynamic programming- shortest path problem- linear programming problem.

UNIT-V

Nonlinear programming:

Unconstrained Nonlinear programming: One-dimensional search, derivatives, Taylor series, and conditions for local optima, convex/concave functions, and global optimality, Gradient search method

Constrained Nonlinear programming: Constrained nonlinear programming models, convex, separable, quadratic and polynomial geometric programming, Lagrange multiplier methods, Kuhn-Tucker optimality conditions.

Suggested Reading:

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

course Code	Course Title							Course Type
PE704ME	**ROBOTIC ENGINEERING**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To provide student with the requisite knowledge of the various sub-disciplines in serial robots such as various robot configurations, kinematics, dynamics, control & manipulation, and computer-based acquisition etc.
- To provide adequate background in both analysis and design of serial robots
- To help students develop robots for needs of industry and society

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

1. Identify and classify various robot configurations with their workspaces and their usage in industry.
2. Perform forward and inverse kinematics operations & determine singularity conditions for various robot configurations.
3. Compare and contrast various techniques available to find forward and inverse dynamic solutions for various general robot configurations.
4. Implement various path planning techniques & control algorithms for computing end effector motions for generalized robotic tasks.
5. Interface various hardware and software components to develop robotic systems for industry &evaluate their performance.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

Brief History, Types of robots, Overview of robot subsystems, Robot specifications, joints and its types, types of links, Degrees of freedom of robots, accuracy, precision, resolution and repeatability, Robot classification: kinematic configurations, actuators, control mechanisms, concept of workspace, End effectors and Grippers, Mechanical, Electrical, vacuum and other methods of gripping. Applications of robots, specifications of different industrial robots.

UNIT-II

Rotation matrices, Representation of orientation and translation, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT-III

Angular velocity and acceleration of joints & links, skew symmetric matrices, Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots.

UNIT-IV

Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks, Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, Computed torque control, force control, hybrid control, neural network based control of manipulator, fuzzy control of manipulator, CNN based control of manipulator.

UNIT-V

Sensors: types of sensors, tactile & non tactile sensors, sensors to measure Position, velocity & acceleration measurement, Optical encoders. Range and Proximity sensing, acoustic, pneumatic, Hall Effect sensor, Eddy current sensors, Force and Torque sensors. Different types of End effectors for industrial Robots.

Vision: Image acquisition, types & components of vision system, Image representation, digitization, binary, gray scale, RGB representation, Image processing, Image segmentation, image smoothening, object descriptors, object recognition. Robots used in general applications like material handling, process applications, assembly operations, inspection applications.

Suggested Reading:

1. Spong and Vidyasagar, Robot Dynamics & Control, John Wiley and Sons, Ed.,1990
2. Mittal and Nagrath, Industrial Robotics, Tata McGraw Hill Publications, 2004.
3. Saha&Subirkumarsaha, Robotics, TMH, India.
4. Asada and Sllotine, Robot analysis and intelligence, BS Publications, India.
5. Fu. K.S., GonZalez R.C., Lee C.S.G. Robotics, Control-sensing vision and Intelligence, McGraw Hill, Int. Ed., 1987.
6. Groover M P, Industrial Robotics, McGraw Hill Publications, 1999.

e-Resources/Software

1. Robotic Operating System (ROS), Open source software, ros.org.com.
2. Robotics toolbox in MATLAB.

Course Code	Course Title							Course Type
PE741ME	**PRODUCT DESIGN AND DEVELOPMENT**							**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives: The student should be able to

- Analyze essential design factors
- Develop product plans by evaluating opportunities, resources, and timelines
- Design modular architectures considering supply chain and platform strategies.
- Validate designs through iterative prototyping and quality testing.
- Implement modern development processes

CourseOutcomes: Upon successful completion of thiscourse,the student will be able to:

1. Define product design and its role in innovation.
2. Plan products by analyzing opportunities, allocating resources, and translating customer needs into design priorities
3. Design product architectures and apply industrial design principles to optimize functionality, manufacturability, and user experience.
4. Apply Design for Manufacturing (DFM) principles to optimize product cost and quality, and implement effective prototyping strategies to validate designs
5. Apply contemporary product development methodologies

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

Introduction to product design, Design by evolution and innovation, Essential factors of product design, Production consumption cycle, Flow and value addition in production consumption cycle, Morphology of design, Characteristics of Successful Product Development, Challenges of Product Development.

UNIT-II

Product planning: Product planning process, identify opportunities, evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process Identifying customer needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

UNIT-III

Product architecture: implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, and related system level design issues. Industrial design: Assessing the need for industrial design impact, process, managing and accessing the quality of industrial design.

UNIT-IV

Design for X (DFX): Design for manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors, design for assembly, service and quality.

Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes.

UNIT-V

Product Development: A modern product development process, reverse engineering and redesign product development process, product life cycle, product development teams, Product development planning, Manufacturing and economic aspects of product development, trade-off.

Suggested Reading:

1. Karl T. Ulrich, Steven D. Eppinger, Product Design and Development, 6th Edition, McGraw-Hill Education, 2016.
2. Kevin Otto, K.Wood, Product Design and Development, Pearson Education, 2013.
3. Kenneth B.Kahn, Product Planning Essentials, Yes dee Publishing, 2011.
4. Clive L.Dym, Patrick Little, Engineering Design: A Project-based Introduction, 3rdEdition, John Wiley & Sons, 2009.
5. Kevin Otto, Kristin Wood, Product Design, Indian Reprint, PearsonEducation, 2004.
6. Boothroyd G, Dewhurst P and Knight W, Product Design for Manufacture and Assembly, 2nd Edition, Marcel Dekker, New York, 2002.

Course Code	Course Title							Course Type
PE742ME	**MECHANICAL VIBRATIONS**							**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

Course Outcomes:

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

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

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

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

Course code	Course Title							Course Type
PE743ME	**WASTE HEAT RECOVERY AND CO-GENERATION**							**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

Course Outcomes: Student will be

1. Understand waste heat sources, recovery methods, and how to use it in industries.
2. Design and analyze heat exchangers, including performance calculations and pressure drop evaluation for tube-based systems.
3. Design recuperators using thermodynamic principles, compare types, and select materials based on heat transfer parameters.
4. Understand cogeneration concepts, thermodynamic advantages, efficiency, benefits, costs, and industrial applications.
5. Understand how to capture waste heat and use it in power plants while meeting regulations

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT I

Definition, Sources, Quantity and quality of waste heat. Technologies for waste heat recovery and utilization. Need of storage systems for waste heat. Utilization of Waste Heat - Continuous and Intermittent. Energy requirements of industry. Various forms of waste heat available.

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Suggested Reading:

1. Donald Q. Kern, "Process Heat Transfer", McGraw Hill International Editions, Chemical Engineering Series, 1965.
2. Wylen V. and Sonntag, "Fundamentals of Classical Thermodynamics" - SI Version, Wiley Eastern Ltd., 1993.
3. David Hu S., "Handbook of Industrial Energy Conservation", Van Nostrand Reinhold Co., 1983.
4. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford, 1987.
5. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.

Course Code	Course Title							Course Type
PE744ME	**HEATING VENTILATION AND AIR CONDITIONING**							**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

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

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

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

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

Commercial and Industrial Applications: Air conditioning of Houses, Offices, Hotels, Restaurants, Departmental stores, Theatres, Auditorium, and Hospitals.
Transport air conditioning: Automobile, railways, Marine and air craft.
Special applications: Computers, storage of medicine and vaccine, cold storages, printing, textiles, leather industries and various products and process industries.

Suggested Reading:

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

e- Resources:

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

Course Code	Course Title							Course Type
PE745ME	**SUSTAINABLE MANUFACTURING**							**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

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

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

1. Clarke, Abigail & John K.Gershenson, Design for the Life Cycle. Life-cycle Engineering Laboratory, Michigan Technological University, 2006.
2. Finster, MarkP., Sustainable Perspectives to Design and Innovation, 2013.
3. Ramaswamy, Rohit,Design and Management of Service Processes: Keeping Customers for Life, Prentice Hall, 1996.
4. Schmitt, Brent, Customer Experience Management, Wiley and Sons, 2003.
5. J. Paulo Davim, Sustainable Manufacturing, Wiley-ISTE, 2010.

Course code	Course Title						Course Type
PE746ME	**ENERGY CONSERVATION AND MANAGEMENT**						**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

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

1. Learn energy conservation principles, efficiency concepts, and how to identify energy waste in real-world systems.
2. Learn to work with heat energy systems (steam, oil, gases), calculate energy values, understand power transmission, and identify energy losses.
3. Understand how fuels produce energy, how machines convert it, and how to calculate power losses
4. Learn to analyze energy waste and apply conservation planning to save costs
5. Gain skills in modeling energy efficiency for industrial systems, from data analysis to forecasting demand.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

1. Gottschalk C.M., "Industrial Energy Conservation", John Wiley & Sons, 1996.
2. Chaturvedi P., and Joshi S., "Strategy for Energy Conservation in India", Concept PublishingCo., New Delhi, 1997.
3. A.S. Hovan George Dr. A. Shaji George, Dr. A. Shahul Hameed, Energy Conservation & Management, 1st Book Rivers, 2024.
4. Thipse, Energy Conservation and Management, Narosa Publication, 2014.
5. BenardMakaa, Energy Conservation and Management for Professionals, River Publishers, 2025.

Course Code	Course Title						Course Type
PE747ME	**SUPPLY CHAIN MANAGEMENT**						**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives:

- To understand the basics of supply chain management and its decision-making process.
- To learn about the key drivers that affect supply chain performance and how to measure them.
- To explore how to design supply chain networks and choose locations for facilities.
- To understand forecasting methods and how to plan supply and demand effectively.
- To learn how to manage uncertainty, maintain safety inventory, and coordinate activities in a supply chain.

Course Outcomes: After completion of this course, the students shall be able to:

1. Relate competitive and supply chain strategies
2. Identify drivers of supply chain performance
3. Analyze factors influencing network design.
4. Analyze the influence of forecasting in a supply chain
5. Evaluate the role of aggregate planning, inventory, IT and coordination in a supply

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT- I

Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope.

UNIT-II

Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit.

UNIT III

Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation.

UNIT IV

Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting.

Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC.

UNIT V

Managing uncertainty in a SC: Safety Inventory.

Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect

Suggested Reading:

1. F. Robert Jacobs, Richard B. Chase, Ravi Shankar, Operations and Supply Chain Management, 17th Edition, McGraw Hill, 2023.
2. Sunil Chopra, Peter Meindl, Supply Chain Management: Strategy, Planning, and Operation, 7th Edition, Pearson, 2018.
3. Janat Shah, Supply Chain Management: Text and Cases,Second Edition,Pearson Education India, 2016.
4. Lora M. Cecere, Supply Chain Metrics that Matter, 1st Edition, John Wiley & Sons Inc, 2015.
5. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Wendy Bishop, Designing and Managing the Supply Chain, 3nd Edition, McGraw Hill, 2008.

Course Code	Course Title						Course Type
PE748ME	**BIO MECHANICS**						**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

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

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

1. Margareta Nordin, Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System, 5th Eition, Lippincott Williams & Wilkins, 2023.
2. N.A. Abu Osman, Prosthetic Biomechanics in Engineering, CRC Press, 2021.
3. NihatÖzkaya, Dawn Leger, David Goldsheyder, Margareta Nordin, Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, 4th Edition, Springer, 2017.
4. Joseph Hamill, Kathleen M. Knutzen, Timothy R. Derrick, Biomechanical Basis of Human Movement, 4th Edition, Wolters Kluwer, 2015.
5. Robert L.Huston, Principles of Biomechanics, CRC Press, 2013.

References

1. Bruce M. Koeppen and Bruce A. Stanton, Berne & Levy Physiology, 6th Updated Edition, Mosby Elsevier, 2010.
2. David A. Winter, Biomechanics and Motor Control of Human Movement, 4th Edition, Wiley, 2009.
3. Susan J. Hall, Basic Biomechanics, 6th Edition, McGraw Hill, 2007.

Course Code	Course Title						Course Type
PE749ME	**ENTREPRENEURSHIP**						**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives: To inspire and motivate students to develop an entrepreneurial mindset and explore opportunities for starting their own ventures.

- To equip students with the essential knowledge and skills required for establishing and managing small and medium-scale enterprises.
- To enable students to understand the process of project identification, formulation, analysis, financing, and implementation.
- To develop an understanding of project management tools such as CPM and PERT, and their application in effective project planning and control.
- To familiarize students with the behavioral, ethical, and time management aspects essential for successful entrepreneurship.

Course Outcomes (COs):
Upon successful completion of this course, student will be able to:

1. **Explain** the structure and dynamics of the Indian Industrial Environment and its Role in Promoting Entrepreneurship.
2. **Identify** The Characteristics and Competencies of Entrepreneurs and **Evaluate** Innovative Business Ideas for Potential Ventures.
3. **Develop** Project Proposals Through Effective Formulation, Financial and Risk Analysis, and Feasibility Assessment.
4. **Apply** Project Management Techniques Such as **CPM and PERT** for efficient project Planning, Scheduling, and Control.
5. **Demonstrate** understanding of Entrepreneurial Behavior, Leadership, Motivation, and Effective Time Management Practices.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha, Entrepreneurship, 11th Edition,McGraw Hill, 2020.
2. Prasanna Chandra, Project – Planning, Analysis, Selection, Implementation and Review, 8th Edition, McGraw-HillEduction., 2017.
3. Helmut Kohlert, DawudFadai, Hans-Ulrich Sachs, Entrepreneurship for Engineers, De GruyterOldenbourg, 2013
4. Vasant Desai, Dynamics of Entrepreneurial Development and Management, 6th Edition, Himalaya Publishing House, 2011.
5. Stephen R. Covey, A. Roger Merrill and Rebecca R. Merrill, First Things First, Pocket Books, 2003.

Course Code	Course Title						Course Type
PE750ME	**INDUSTRY 4.0: PRINCIPLES AND TECHNOLOGIES**						**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- Understand the foundational concepts of Industry 4.0, its historical evolution, and its impact on modern manufacturing systems.
- Explore cutting-edge technologies (IoT, AI, big data) and frameworks shaping Industry 4.0-driven business transformations.
- Design a phased roadmap for adopting smart manufacturing, logistics, and predictive analytics in Industry 4.0.
- Examine the role of IIoT, robotics, and sensor technologies in industrial automation and maintenance.
- Develop strategies to overcome challenges and leverage opportunities in the future workforce and Industry 4.0 ecosystems.

Course Outcomes: Upon completion on this course, students will be able to:

1. Explain the evolution of industrial revolutions and compare Industry 4.0 systems with traditional factories.
2. Analyze the key components (IoT, AI, big data) and frameworks driving Industry 4.0 transformations.
3. Develop a strategic roadmap for implementing smart manufacturing and logistics in Industry 4.0.
4. Evaluate applications of IIoT and advanced robotics in industrial automation.
5. Propose strategies to address workforce and technological challenges in the Industry 4.0 era.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

Unit-I

Introduction, Idea of Industry 4.0, Various Industrial Revolutions, Origin concept of Industry4.0,Industry 4.0 Production system, How is India preparing for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory.

Unit-II

Trends in Industry 4.0:

Introduction, Main Concepts and Components of Industry 4.0, State of Art Technologies, Proposed Framework for Industry 4.0, Trends of Industrial Big Data and Smart Business Transformation.

Unit-III

Roadmap for Industry 4.0:

Introduction, Proposed Framework for Technology Roadmap: Strategy Phase, Development Phase, Smart Manufacturing, Types of Smart Devices, Smart Logistics, Smart Cities, Predictive Analytics.

Unit-IV

Advances in the Era of Industry 4.0:

Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Things, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly, Idiot- Industrial Iota.

Unit-V

The Role of Industry 4.0 and Future Aspects:

Introduction, Challenges & Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

Suggested Reading:

1. YilmazUygun, Industry 4.0: Principles, Effects and Challenges, Nova Science Publishers In, 2020.
2. Dominik T. Matt, VladimírModrák, Helmut Zsifkovits, Industry 4.0 for SMEs: Challenges, Opportunities and Requirements, 1st Edition, Palgrave Macmillan, 2020.
3. Alp Ustundag, EmreCevikcan, Industry 4.0: Managing The Digital Transformation, Springer, 2018.
4. Christoph Jan Bartodziej, The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Gabler, 2017.
5. Alasdair Gilchrist, Industry 4.0 The Industrial Internet of Things, Apress Publisher, 2016.

Online PDF books:

1. Architecting for the Cloud: AWS Best Practices, Amazon Web Services, 2024.
2. Stuart Russell, Peter Norvig, Artificial Intelligence a modern approach, 4th Edition, Pearson Education, 2020.

Course Code	Course Title							Course Type
PE751ME	**MEMS:DESIGN AND MANUFACTURE**							**Professional Elective -IV**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- This course provides a detailed overview to smart materials, piezoelectric materials structures and its characteristics.
- To study of Smart structures and modeling helps in Vibration control using smart materials in various applications.
- To familiarize with various microelectronic mechanical systems which find extensive usage in industrial applications.
- to understand the principles and concepts of using MEMS, ER & MR Fluids for various applications

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

1. Describe the overview of different kinds of smart materials and their applications
2. Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, Biomimetics and MEMS with principles of working.
3. Describe the various fabrication processes of smart materials and MEMS
4. Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication
5. Summarize the methods and uses of Micro fabrications, Biomimetics, types of polymersused in MEMS, Fibre optics, piezoelectric sensing and actuation

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT I

Introduction to smart materials and MEMS: an overview- scaling issues in MEMS -Micro sensors, some examples –Micro actuators, some examples– Micro systems – Examples of smart systems.

UNIT II

Smart composites - piezoelectric materials, shape memory alloys, magnetic materials -Electro and magneto-statics, Electro active polymers and electrostrictive materials - measurement techniques for MEMS.

UNIT III

Fabrication processes - Structure of silicon and other materials Silicon wafer processing; Thin-film deposition, Lithography, Etching, LIGA, Micromachining, Thick-film processing, Smart material processing.

UNIT IV

Mechanics of materials- Stresses and deformation: bars and beams - Micro device suspensions: lumped modelling -Residual stress and stress gradients - Thermal loading; bimorph effect - Vibrations of bars and beams - Gyroscopic effect

UNIT V

Electronics and packing - Semiconductor devices - Signal conditioning for micro systems devices-Vibration control of a beam - Integration of micro systems and microelectronics - Packaging of microsystems.

Suggested Reading:

1. Tai Ran Hsu, MEMS And Microsystems: Design and Manufacture,McGraw Hill Education, 2017.
2. Donald J. Leo, Engineering analysis of smart material systems, 1st Edition, John Wiley Sons, 2007.
3. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, Wiley, 2006.
4. Stephen D. Senturia, Microsystem Design,cbspd, 2006.
5. Mohamed Gad-el-Hak, MEMS: Design and Fabrication, Second Edition, CRC Press, 2006.

Course Code	Course Title						Course Type
OE701BM	**BASIC MEDICAL EQUIPMENT**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives:

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

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

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT – I

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

UNIT – II

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

UNIT – III

Medical Imaging Equipment:

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

UNIT – IV

Critical care Equipment:

Ventilators: Mechanics of respiration, artificial ventilators, Positive pressure ventilator, Types and classification of ventilators. Drug delivery system: Infusion pumps, basic components, implantable infusion system, closed loop control in infusion pump.

Cardiac Defibrillators: Need for defibrillators, DC defibrillator, Implantable defibrillators, Defibrillator analyzer.]

UNIT – V

Therapeutic Equipment:

Cardiac pacemakers: Need for cardiac pacemakers, External and implantable pacemakers, types. Dialysis Machine: Function of kidney, artificial kidney, Dialyzers, Membranes, Hemodialysis machine. Lithotripters: The stone diseases problem, Modern Lithotripter systems, extra corporeal shockwave therapy.

Suggested Reading:

1. R.S.Khandpur, Hand Book ofBiomedical Instrumentation, Tata McGrawHill, Third Edition, 2014.
2. John G.Webster, Medical Instrumentation Application and design, Wiley India Edition,2009.
3. AneeshBasheer, Sreelakshmi M, KaleshSidasavan, Dr. AbhijitBhowmik, A First Handbook of Medical Instruments, Wolters Kluwer India, 2024.
4. Pallavi Dixit,Medical Imaging (X-RAY) Technology,Emmess Medical Publishers,2022.
5. Dr.S.SuganyaK.Padmapriya, Therapeutic Equipment, Lakshmi Publications, 2021.

Course Code	Course Title						Course Type
OE702BM	**ARTIFICIAL INTELLIGENCE IN HEALTH CARE**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives: The course is taught with the objectives of enabling the student to:

- To introduce students to the fundamentals of Artificial Intelligence (AI) with a focus on healthcare applications.
- To explore AI techniques in clinical diagnostics and decision-making.
- To understand the role of AI in medical imaging, disease prediction, patient monitoring, and personalized medicine.
- To examine ethical, legal, and regulatory considerations in the deployment of AI in healthcare.
- To enable students to design and evaluate AI-based healthcare solutions for improving patient outcomes and operational efficiency

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

1. Understand and explain the fundamental AI concepts and techniques relevant to healthcare.
2. Apply machine learning and deep learning methods to analyze medical data and assist in clinical decision-making.
3. Analyze AI-based diagnostic tools used in medical imaging and disease prediction.
4. Evaluate the implementation challenges and ethical implications of AI in healthcare systems.
5. Design AI-driven healthcare applications and propose data-driven solutions to real-world health problems.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT–I

Introduction to Artificial Intelligence: Definition. AI Applications, AI representation. Properties of internal Representation, General problem solving, production system, control strategies: forward and backward chaining. Uninformed and informed search techniques. A* and AO* Algorithm

UNIT–II

Machine Learning and Deep Learning for Healthcare: Supervised, unsupervised, and reinforcement learning. Classification and regression techniques in clinical datasets. Neural networks, CNNs, RNNs and their applications. Case studies: Diabetes prediction, cancer classification, readmission prediction. Model evaluation: accuracy, precision, recall, ROC curves.

UNIT–III

AI in Medical Imaging and Diagnostics: Image processing fundamentals and feature extraction. AI in radiology: X-rays, CT, MRI, Ultrasound. Computer-aided diagnosis systems. Deep learning for medical image segmentation and classification. Real-world tools: Google DeepMind, IBM Watson Health.

UNIT-IV

Natural Language Processing in Healthcare: Basics of NLP and its significance in healthcare. Clinical text mining and named entity recognition (NER).Chatbots and virtual health assistants. AI in Electronic Health Record (EHR) processing. Case study: Predictive analysis from clinical notes.

UNIT – V

Ethical, Legal, and Future Perspectives. Ethical concerns: bias, transparency, and ability. Data privacy and security in AI systems. Regulatory aspects: FDA, HIPAA, CDSCO. Human-AI collaboration in clinical settings. Future directions: AI in genomics, telemedicine, and wearable technologies.

Suggested Reading:

1 Eugene, Charniak, Drew Mcdermott: Introduction to artificial intelligence.
2 Elaine Rich and Kerin Knight, Nair B., “Artificial Intelligence (SIE)”, McGraw Hill- 2008.
3 Mathias Goyen, Artificial Intelligence in Healthcare: Past, Present and Future, Elsevier, 2021.
4 Eric Topol, Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Basic Books, 2019.
5 Parashar Shah, AI in Healthcare: A Practical Guide, BPB Publications, 2021.

Course Code	Course Title						Course Type
OE701CE	**GREEN BUILDING TECHNOLOGY**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives:

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

Course Outcomes: Student will be

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT- I

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

UNIT- II

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

UNIT- III

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

UNIT- IV

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

UNIT- V

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

Suggested Reading:

1. Michael Bauer, Peter Mösle and MichaelSchwarz,Green Building – Guidebook for Sustainable Architecture, Springer, Heidelberg, Germany, 2010.
2. Norbert Lechner, Heating, Cooling, Lighting - Sustainable Design Methods for Architects,Wiley, New York, 2015.
3. Mike Montoya, Green Building Fundamentals, Pearson, USA, 2010.
4. Charles J. Kibert, Sustainable Construction - Green Building Design and Delivery,John Wiley & Sons, New York, 2008.
5. Regina Leffers, Sustainable Construction and Design, Pearson / Prentice Hall, USA,2009.
6. James Kachadorian, The Passive Solar House: Using Solar Design to Heat and Cool Your Home, Chelsea Green Publishing Co., USA, 1997.

Course Code	Course Title						Course Type
OE702CE	**PLUMBING TECHNOLOGY**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives: The course is taught with the objectives of enabling the student to:

- Understand plumbing components for various systems such as water supply, waste water, high rise buildings
- Study various plumbing fixtures materials, tools and equipment
- Study the codes and standards in the building industry for plumbing

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

1. Understand and identify the various plumbing related systems, component and types,
2. Ability to understand various plumbing terminology for water supply
3. Ability to understand various plumbing fixtures materials, tools and equipment.
4. Understand about different pumping systems available.
5. Comprehend the importance of codes, the key responsibilities of a plumbing sector and plumber

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT – I

Building Plumbing: - Introduction to Plumbing Systems, components of plumbing systems, and basic physics as related to plumbing. Various types of home plumbing systems for water supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.

UNIT – II

Plumbing Terminology: Definitions, use/purpose of Plumbing Fixtures - accessible, readily accessible, aerated fittings, AHJ, bathroom group, carrier, flood level rim, floor sink, flushometer valve, flush tanks, lavatories, macerating toilet, plumbing appliances, plumber.

Traps: indirect waste, vent, blow off, developed length, dirty arm, FOG, indirect waste, receptors, slip joints, trap, and vent.

Water supply: angle valve, anti-scald valve, backflow, bypass, check valve, cross connection, ferrule, gate valve, gray water, joints

UNIT– III

Plumbing Fixtures and Fittings: Definitions of plumbing fixtures, fittings, appliances and appurtenances; maximum flow rates, water closets, bidets, urinals, flushing devices, washbasins, bath/shower, toilets for differently abled, kitchen sinks, water coolers, drinking fountain, clothes washer, dish washer, mopsink, overflows, strainers, prohibited fixtures, floor drains, floor slopes,

location of valves, hot water temperature controls, installation standard dimensions in plan and elevation.

UNIT – IV

Pumping Systems: Terminology, pump heads, types of Pumps, applications, pump selection, pump characteristics, pumps and motors, pump efficiency, motor efficiency, Hydro Pneumatic Systems(HPS), Zoning, Storm Water and Drainage Pumps, introduction to starters and control panels.

UNIT – V

Codes and Standards: Scope, purpose; codes and standards in the building industry, UIPC-I, NBC and other codes, Local Municipal Laws, approvals, general regulations, standards, water supply, protection of pipes and structures, waterproofing.

Introduction to the Sector and the Job Role:

Overview of the Plumbing Sector- Importance and scope of plumbing in construction and maintenance, career opportunities in plumbing.

Understanding the Job Role of a Plumber – Duties and responsibilities of a plumber, Skills and attributes required for a plumber.

Safety Measures and Regulations –Importance of safety in plumbing, Basic safety regulations and practices.

Tools and Equipment – Introduction to basic plumbing tools and equipment, Proper use and handling of plumbing tools.

Suggested Reading:

1. Uniform Illustrated Plumbing Code-India (UIPC- I) published by IPA and IAPMO (India)
2. National Building Code (NBC) of India
3. IS17650 Part1 and Part2 for Water Efficient Plumbing Products
4. Water Efficient Products-India (WEP-I) published by IPA and IAPMO (India)
5. Water Efficiency and Sanitation Standard (WE. Stand) published by IPA and IAPMO (India)
6. Water Pollution, Berry, CBS Publishers.
7. A Guide to Good Plumbing Practices, a book published by IPA.
8. O.P.Gupta, Elements of Water Pollution Control Engineering, Khanna Book Publishing, New Delhi
9. S.M.Patil, Plumbing Engineering Theory,DesignandPractice,1999
10. G. Birdie, Water supply and sewerage system

e-Resources:

1. www.nptel.co.in
2. https://ndrfandcd.gov.in/Cms/NATIONA0LBUILDINGCODE.aspx

Course Code	Course Title						Course Type
OE701CS	**CLOUD COMPUTING**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To introduce basic concepts cloud computing and enabling technologies
- To learn about Auto-Scaling, capacity planning and load balancing in cloud
- To introduce security, privacy and compliance issues in clouds
- To introduce cloud management standards and programming models

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

1. Understand the basic approaches and Core ideas of Cloud Computing.
2. Understand the Challenges and approaches in the management of the Cloudenvironments.
3. Familiarize with advanced paradigms and solutions necessary for building and managing Modern Cloud environments.
4. Envision use of Cloud environment in Enterprise.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT– I

Introduction, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource Pooling sharing and provisioning.

UNIT – II

Scaling in the Cloud, Capacity Planning, Load Balancing, File System and Storage,

UNIT – III

Multi-tenant Software, Data in Cloud, Database Technology, Content Delivery Network, Security Reference Model, Security Issues, Privacy and Compliance Issues

UNIT – IV

Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services

UNIT –V

Enterprise architecture and SOA, Enterprise Software , Enterprise Custom Applications, Workflow and Business Processes, Enterprise Analytics and Search, Enterprise Cloud Computing Ecosystem.

Suggested Reading:

1. Cloud Computing - Sandeep Bhowmik, Cambridge University Press, 2017.
2. Enterprise Cloud Computing - Technology, Architecture, Applications by Gautam Shroff, Cambridge University Press, 2016.
3. Kai Hwang, Geoffrey C.Fox, Jack J.Dongarra, Distributed and Cloud Computing From Parallel Processing to the Internet of Things, Elsevier, 2012.
4. https://aws.amazon.com/about-aws/
5. https://cloud.google.com/why-google-cloud?hl=e
6. https://azure.microsoft.com/en-gb/

Course Code	Course Title						Course Type
OE702CS	**DATA BASE MANAGEMENT SYSTEMS**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives:

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

Course Outcomes: Student will be

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT – I

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

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

UNIT – II

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

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

UNIT – III

Advanced SQL: SQL Data Types and Schemas, Integrity Constraints, Authorization, Embedded SQL, Dynamic SQL, Functions and Procedural Constructs, Recursive Queries, Advanced SQL Features. Relational Database Design: Features of Good Relational Design, Atomic Domains and First Normal Form, Functional-Dependency Theory, Decomposition using Functional Dependencies.

UNIT – IV

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

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

UNIT – V

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

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

Suggested Reading:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, Database System Concepts, McGraw-Hill International Edition, 6th Edition, 2010.
2. Johannes Gehrke, Raghu Ramakrishnan, Database Management Systems, 3rd Edition, McGraw Hill Higher Education, 2002.
3. Elmasri, Navathe, Somayajulu, Fundamentals of Database Systems, Pearson Education, 4th Edition, 2004.
4. Thomas Connolly, Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition, Pearson Education, 2019.
5. Mark L. Gillenson, Fundamentals of Database Management Systems, 3rd Edition, Wiley, 2024.

Course Code	Course Title						Course Type
OE701EC	**EMBEDDED SYSTEMS DESIGN**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives:

- To understand the processor selection criteria for Embedded System Design.
- To provide a clear understanding of role of firmware, operating systems in correlation with hardware systems.
- To gain the knowledge of tool chain for embedded systems.
- To understand the importance of RTOS in building real time systems
- To gain knowledge on internal working procedure of RTOS

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

1. Understand the working of a simple embedded system and embedded system applications
2. Design an Embedded System firmware
3. Use Embedded Software Development Tools for Designing Embedded System Applications
4. Understand RTOS and its use in Embedded environment
5. Understand RTOS concepts like Task Communication and Task Synchronization.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

Introduction to Embedded Systems:

Embedded systems Vs General computing systems, History of Embedded systems, classification, Characteristics and quality attributes of Embedded Systems Challenges in Embedded System Design, Application and Domain specific Embedded Systems.

UNIT-II

Embedded firmware and Design and Development:

Embedded Firmware Design Approaches and Development languages and Programming in Embedded C

UNIT-III

Embedded Software Development Tools:

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

UNIT-IV

Introduction to Real Time Operating Systems:

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

UNIT-V

Task Communication:

Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

Suggested Reading:

1. Shibu, K.V., Introduction to Embedded Systems, 1st Ed., TMH, 2009.
2. Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd Edition, TMH, 2008.
3. An Embedded Software Primer - David E. Simon, Pearson Education.
4. Jean.J.Labrosse, MicroC/OS-II, Taylor & Francis, 2002.

Course Code	Course Title						Course Type
OE702EC	**BASICS OF IoT**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives: The course is taught with the objectives of enabling the student to:

- To understand the concepts of the Internet of Things and be able to build IoT applications
- To learn the programming and use of Arduino and Raspberry Pi boards Designand detail the deep beams.
- To study about various IoT case studies and industrial applications.

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

1. Known basic protocols in sensor networks.
2. To Know the Architecture and Protocols of IoT.
3. Python programming and interfacing for Raspberry Pi.
4. Interfacing sensors and actuators with different IoT architectures.
5. Compare IoT Applications in Industrial & real world

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT- I

Introduction to the Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols.

UNIT- II

IoT Architecture: Physical and Logical design of IoT, IoT frameworks, IoT Protocols – MQTT, COAP, 6LOWPAN.

UNIT- III

Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi.

UNIT -IV

IoT applications in home, Infrastructures, Buildings, Security, Industries, Home appliances, other IoT electronic equipments.

UNIT- V

Prototyping and Programming for IoT: Sensors, Actuators, Micro Controllers, SoC, Choosing a platform, prototyping hardware platforms- Arduino, Raspberry Pi, Prototype in Physical design- Laser Cutting, 3D-Printing, CNC milling, techniques for writing Embedded code.

Suggested Reading:

1. Raj Kamal, Internet of Things – Architecture and Design Principles, McGraw Hill Education Pvt. Ltd., 2017
2. Terokarvinen,kemo,karvinenandvilleyvaltokari,Makesensors, 1st Edition, maker media, 2014.
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
4. ArshdeepBahga, Vijay Madisetti,Internet of Things – A hands-on approach, Universities Press, 2015.
5. Rao, M., Internet of Things with Raspbery Pi 3: Leverage the power of Raspberry Pi 3 and JavaScript to build exciting IoT projects, Packt Publishing Ltd, 2018.
6. HwaiyuGeng, P.E, Internet of Things and Data Analytics, Wiley Publications, 2017.

Course Code	Course Title						Course Type
OE701EE	**OPTIMIZATION TECHNIQUES**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

Course Outcomes: Student will be

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT – I

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

UNIT– II

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

Suggested Reading:

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

Course Code	Course Title						Course Type
OE702EE	**NON-CONVENTIONAL ENERGY SOURCES**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

Course Outcomes: Student will be able to

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT- I

Review of Conventional and Non-Conventional energy sources, Need for non-conventional energy sources Types of Non-conventional energy sources, Fuel Cells, Principle of operation with special reference to H2O2 Cell, Classification and Block diagram of fuel cell systems, Ion exchange membrane cell, Molten carbonate cells, Solid oxide electrolyte cells, Regenerative system, Regenerative Fuel Cell, Advantages and disadvantages of Fuel Cells, Polarization, Conversion efficiency and Applications of Fuel Cells.

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

Energy from Biomass, Biomass conversion technologies / processes, Photosynthesis, Photosynthetic efficiency, Biogas generation, Selection of site for Biogas plant, Classification of Biogas plants, Details of commonly used Biogas plants in India, Advantages and disadvantages of Biogas generation, Thermal gasification of biomass, Biomass gasifies.

Suggested Reading:

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

Course Code	Course Title					Course Type		
OE701ME	**NANO TECHNOLOGY**							**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

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

1. Learn nanotechnology basics: nanoscale properties, synthesis methods, applications, and challenges.
2. Understand nano-materials and characterization methods.
3. Explore nanoparticles, nanowires, and nanotubes - their creation, special qualities, and real-world uses.
4. Study fabrication processes and nano-scale techniques for device manufacturing.
5. Develop skills in nanofabrication techniques while exploring nanocomposite synthesis and biomaterial applications for medical/industrial uses.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

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

UNIT-II

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

UNIT-III

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

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

UNIT-IV

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

UNIT-V

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

Suggested Reading:

1. A.K.Bandyopadyay, Nano Materials, New Age Publications, 2007.
2. T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnolgy, Tata McGraw-Hill, 2008.
3. Carl. C. Koch, Nano Materials Synthesis, Properties and Applications, Jaico Publishing House, 2008.
4. WilliaIllsey Atkinson, NanoTechnology, Jaico Publishing House, 2009.
5. Jeremy J. Ramsden, Nanotechnology: An Introduction, Second Edition, Elsevier Inc, 2016.

Course Code	Course Title					Course Type	
OE702ME	**START UP ENTREPRENEURSHIP**						**Open Elective-II**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

Course Outcomes: Student will be able to:

1. Learn creative thinking methods, idea evaluation strategies, and innovation management to balance discovery with practical implementation.
2. Transform ideas into startups by validating concepts, mapping business value, and turning risks into opportunities through strategic planning.
3. Learn to turn vision into action by managing failure, resistance, and team dynamics in startups.
4. Create and validate an action-driven business framework through prioritized planning, iterative testing, and adaptive execution mapping.
5. Create startup financial plans with cash flow models, capital analysis, bootstrapping strategies, risk evaluation, and time-phased business budgets.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Action driven business plan: Creating a completed non-business plan (a series of actions each of which moves your idea toward implementation), including a list of the activities to be undertaken, with degrees of importance (scale of 1 to 3, where 1 is ‗most important'). A revision of the original product or service idea, in light of information gathered in the process, beginning

to design the business or organization that will successfully implement your creative idea. Preparing an activity map.

UNIT V

Startup financing cycle: Preparing an initial cash flow statement, showing money flowing out (operations; capital) and flowing in. Estimate your capital needs realistically. Prepare a bootstrapping option (self-financing). Prepare a risk map. Prepare a business plan comprising five sections: The Need; The Product; Unique Features; The Market; Future Developments. Include a Gantt chart (project plan –
Detailed activities and starting and ending dates); and a project budget.

Suggested Reading:

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

Course Code	Course Title						Course Type
PC751ME	**THERMAL ENGINEERING LAB-II**						**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
	-	**-**	**-**	**2**	**3**	**25** / **50**	**1**

Course Objectives:

- To understand working principles of heat transfer equipment
- To understand the flow phenomena on cascade blades.
- Understand the fundamental applications of measuring instruments in equipment

Course Outcomes:

1. Able to find the performance of compressors, blowers
2. Understand the working of wind tunnel and flow over turbine or compressor blades
3. Able to estimate the heat transfer in various types of heat exchangers
4. Able to find out conductivity of solids and liquids and convection in liquids
5. Able to calculate COP of air-conditioning apparatus

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

List of Experiments

1. To determine Thermal conductivity of metal rod.
2. To determine Thermal conductivity of insulating powder
3. To conduct performance test on Centrifugal blower with forward swept blades.
4. To conduct performance test on Centrifugal blower with backward swept blades.
5. To conduct performance test on Centrifugal blower with radial swept blades.
6. To determine Heat transfer coefficients in Forced Convection.
7. To determine Heat transfer coefficients in Natural Convection.
8. To determine Heat transfer coefficients in Unsteady State of Heat Transfer.
9. To compare heat transfer phenomena using stainless steel pipe and copper pipe on heat pipe demonstrator
10. To determine COP of Air-conditioning Test Rig
11. To find lift and drag coefficients on Cambered NACA Airofoil Blades in a Wind Tunnel

To find lift and drag coefficients on Uncambered NACA Airofoil Blades in a Wind Tunnel

List of Experiments

Course Code	Course Title							Course Type
PC752ME	**CAM AND AUTOMATION LAB**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	-	**-**	**-**	**2**	**3**	**25**	**50**	**1**

Course Objectives:

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

Course Outcomes: The students will be able to

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

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

List of Experiments

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

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

Course Code	Course Title						Course Type
PW751ME	**SUMMER INTERNSHIP**						**Practical**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	-	**-**	**-**	**2**	**3**	**50**	**-**	**2**

Course Objectives:

Thecourseistaught withtheobjectivesofenablingthestudentto:

1 Provide students with exposure to real-time engineering environments.
2 Develop problem identification and professional engineering skills.
3 Enable students to apply tools, techniques, and engineering knowledge in industry tasks.
4 Enhance teamwork, communication, ethics, and workplace professionalism.
5 Strengthen technical reporting, presentation, and result interpretation skills.

Course Outcomes:

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

1. Design/develop as mall and simple product in hardware or software.
2. Complete the task or realize a pre-specified target,with limited scope,rather than Taking up a complex task and leave it.
3. Learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to pre-specified criteria.
4. Implement the selected solution and document the same.
5. Prepare technical reports and presentations integrating ethical, societal, and sustainability considerations.

CO-PO Articulation Matrix

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

Summer Internship is introduced as part of the curricula for encouraging students to work on problems ofinterest to industries.A batchof two orthree students will be attached to adperson from an Electronics Industry / R& D Organization / National Laboratory/Any other program approved by the department for a period of 6-8 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the industry guide.

After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminal talk to be organized by the department. Award of Sectional marks are to be based on the performance of the student at the work place forejudged by industry guide and internal guide(25Marks)followed by presentation in front of the committee constituted by the department (25 Marks). One faculty member to co-ordinate the overall activity of Summer Internship.

Evaluation Rubrics

Criteria	Weight	Excellent (4)	Good (3)	Satisfactory (2)	Poor (1)
Understanding of Assigned Work	10	Fully understands tasks, quick learning, applies concepts independently	Understands tasks with minor guidance	Basic understanding, requires frequent support	Unable to understand tasks even with support
Technical Skills & Execution	15	Demonstrates strong technical skills, implements tasks accurately	Good execution with minor errors	Basic execution, limited technical application	Poor technical ability, incomplete work
Problem-Solving & Use of Tools	10	Identifies alternatives, evaluates options, uses appropriate tools	Identifies some alternatives, limited evaluation	Uses basic tools only	No problem-solving or tool usage
Professionalism, Teamwork & Discipline	10	Highly professional, proactive, excellent teamwork and punctuality	Good teamwork and discipline	Occasional lapses	Poor teamwork, irregular
Internship Report & Presentation	5	Well-structured, clear, with insights	Good quality, minor errors	Acceptable but basic	Poorly written or unclear

Evaluation Criteria

Criteria	Selection of Internship and Problem Formulation	Innovation/ Practical	Team work/ dependability/ professionalism/ learning ability	Methodology/Approach/ conducting experiments/ technical skills	Analysis of the	Report writing	Presentation	Response to queries	Impact/ Outcome of the work/ Publication/ Prototype /	Total
Marks	5	5	5	5	10	5	5	5	5	50

***Students have to undergo summer internship of 6 Weeks duration at the end**

Course Code	Course Title							Course Type
PW 761 EC	**PROJECT WORK-I**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	-	**-**	**-**	**6**	**6**	**50**	**-**	**3**

Course Objectives: The course is taught with the objectives of enabling the student:

- To develop skills in identifying and formulating engineering problems, including social and technological challenges.
- To conduct systematic literature reviews and critically analyze existing solutions addressing societal needs and efficiency.
- To plan and propose feasible solutions incorporating current technologies, focusing on practicality and initial innovation.
- To foster teamwork, communication, and project management skills for collaborative problem-solving.
- To encourage ethical considerations and preliminary sustainability assessment in project proposals, emphasizing social impact.

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

a. Clearly define engineering problems considering social issues and technological constraints.
b. Critically review literature to understand challenges and existing solutions.
c. Develop feasible project plans with measurable objectives.
d. Demonstrate teamwork and effective communication through presentations and reports.
e. Formulate project proposals integrating ethics, sustainability, and social responsibility**.**

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

Allotting students to faculty supervisors:

The process of assigning project supervisors to students is generally carried out in the VI semester when guides are allotted for Mini Projects. Often, the same supervisors continue to oversee students during their main project phases in VII and VIII semesters, ensuring continuity and effective mentoring.Various departments within the University College of Engineering currently implement several models for this allocation process, including:

- **Based on CGPA** Students are ranked according to their cumulative grade point average (CGPA). Supervisors are allotted starting with higher-ranked students selecting projects or guides first, balancing the supervisor workload.

- **Based on Hall Ticket Number** Allocations are made sequentially according to students' hall ticket numbers, ensuring an unbiased distribution. This method is straightforward and minimizes allocation disputes.
- **Based on Student Choice** Students submit preferences for supervisors or project topics, and allotment is made based on availability and aligning interests.

Project Process & Evaluation Criteria

A project coordinator is appointed to oversee the process, including:

- Collection of project topics and descriptions from faculty members and industry.
- Grouping students into teams of 3 to 5 members based on interests and project availability.
- Allotting project guides to each group.

Orientation sessions such as special lectures and workshops may be conducted to familiarize students with:

- Problem identification,
- Literature survey techniques,
- Research tools,
- Ethical, social, and sustainability considerations relevant to their projects.

After these orientations, each group formalizes their project proposal, either based on their own ideas or suggestions from supervisors.

Project seminar schedules are prepared by the coordinator, usually spanning from the 5th week to the last week of the semester, and strict adherence is expected.

Each group is required to:

- Submit a one-page project synopsis at least one week prior to the seminar for display on the notice board.
- Deliver a 30-minute seminar presentation followed by a 10-minute discussion.
- Submit a technical write-up on their project and seminar.

The seminar presentation should encompass:

- Problem definition and specifications,
- Literature survey with a broad knowledge of available techniques to solve the problem,
- Detailed planning of the work, including preparation of bar (activity) charts,
- Oral and written presentation of the project.

At least two evaluators (faculty members) assess each seminar to award sessional marks to students based on the evaluation criteria mentioned in the rubrics.

Internship Provision and Exit Option

Students availing themselves of internship opportunities for durations of six months to one year may opt to exit from the regular project allotment process.

- Such students must submit a completion certificate from the internship organization as proof.
- They are required to submit a comprehensive internship report equivalent to the project documentation standards.
- These students may be reassigned to a new supervisor or guided by an industry mentor.

Aim of the Project Work

The project work aims to develop engineering solutions to realistic problems by applying knowledge and skills gained in various courses, alongside current technologies and industry practices. Students are encouraged to understand current problems in their domain and explore methodologies to address them.

Evaluation Rubrics

Evaluation Criteria	**Marks**	**Excellent (85-100%)**	**Good (70-84%)**	**Fair (50-69%)**	**Poor (<50%)**
Problem Definition & Objectives	10	Clearly defined, innovative, socially relevant objectives	Clear and relevant objectives with minor scope issues	Objectives somewhat unclear or limited social relevance	Poorly defined or irrelevant objectives
Literature Survey	15	Comprehensive, critical analysis, and diverse sources	Good review, some missing recent or relevant works	Basic review, lacks depth or breadth	Inadequate or superficial literature survey
Project Planning & Methodology	10	Detailed, realistic plan with innovative methodology	Adequate plan, methodology minor gaps	General plan, methodology is vague or incomplete	Poor planning, methodology not feasible
Presentation & Communication	10	Clear, confident, engaging presentation with strong visuals	Generally clear and organized presentation	Adequate presentation, lacks engagement or clarity	Unclear, disorganized, ineffective presentation
Ethical & Social Consideration	5	Explicit inclusion of ethics and sustainability aspects	Some acknowledgment of ethical/social considerations	Minimal ethics or sustainability discussion	No consideration of ethics or sustainability

Evaluation Criteria

Criteria	Relevance of the Topic	Literature Review	Framing Objectives	Methodology/problem solution	Report writing	Total
Marks	10	10	10	10	10	50

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

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hrs/wk	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	**MC801CE**	**Environmental Science** (Mandatory Course – I)	3	-	-	3	40	60	--
2	**Mandatory Course – II**		3	-	-	3	40	60	--
3	**Mandatory Course – III**		3	-	-	3	40	60	--
PRACTICALS									
4	**PW851ME**	**Project Work - II**	**-**	**-**	**12**	**12**	**50**	**100**	**6**
Total			**9**	**0**	**12**	**21**	**170**	**280**	**6**

Table 1. Mandatory Courses II & III

S.No.	Course Code	Course Title
1	**MC802HS**	Intellectual Property Rights
2	**MC803HS**	English for Technical Paper Writing
3	**MC804HS**	Constitution of India
4	**MC805HS**	Essence of Indian Traditional Knowledge
5	**MC806HS**	Stress Management by Yoga
6	**MC807HS**	Sports

Mandatory Course Registration Note:

- **Requirement:** A student must register **any two** mandatory courses from **Table 1**.
- **Credits:** These courses carry **NO credits**.
- **Importance:** Despite having no credits, passing these courses is **compulsory** (required for progression/completion).

Course Code	Course Title						Course Type
MC801CE	**ENVIRONMENTAL SCIENCE**						**Mandatory Course -I**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
Water Resource Engineering	**L**	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**-**

Course Objectives: The course is taught with the objectives of enabling the student to:

- Comprehend the need of environmental science, ethics and issues
- Realize the availability and utilization of various natural resources
- Illustrate the characteristics and functions of Ecosystem
- Study various environmental pollution effects, prevention and control acts
- Understand the concepts of Biodiversity and its conservation needs

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

1. Application and awareness of various environmental issues for sustainable society
2. Acquaintance with utilization of various natural resources
3. Capacity to understand and practice for sustainability of ecosystem.
4. Knowledge of social and environment related issues and their preventive measures
5. Ability in conserving and protecting the biodiversity

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

Multidisciplinary nature of Environmental studies:

Definition, scope and importance, Need for public awareness, Environmental ethics: issues and possible solutions, Global Warming and Climate change, Acid rain, Ozone layer depletion. Environment and human health, Population growth, Sustainable development and SDGs

UNIT-II

Natural Resources:

Types of Natural Resources, Role of individual in conservation of natural resources, equitable use of resources for sustainable life styles, Natural resources and associated problems.

Land Resources: Land as a resource, land degradation, soil erosion and desertification.

Forest resources: Use and Overexploitation, Deforestation, Timber Extraction, Mining, Dams, and their Effects on Forests and Tribal People

Water resources: Water Resources: Use and Overutilization of Surface and Ground Water, Floods, Drought, Conflicts over Water, Dams – Benefits and problems

Mineral Resources: Use and Exploitation, Environmental Effects of Extracting and using Mineral Resources

Food Resources: World Food Problems, Changes Caused by Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer-Pesticide Problems, Water Logging, Salinity, Energy Resources.

UNIT-III

Ecosystems:

Concept of an Ecosystem, Types, Structure and function of an ecosystem, Producers, consumers, decomposers. Energy flow in the ecosystems, Ecological succession, Food chains, food webs and ecological pyramids.

Introduction, types, characteristic features, structure and functions - Forest ecosystem, Grass land ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT-IV

Environmental Pollution:

Definition, Causes, effects and control measures - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards,

Environmental Protection: Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife conservation and protection act, Forest conservation and protection act, Role of an individual's, communities and NGOs in prevention of pollution

Solid waste Management: Causes, effects and control measures of urban and industrial wastes

UNIT-V

Biodiversity and its Conservation:

Definition: genetics, species and ecosystem diversity, Spatial Patterns of Species Richness, Shannon's, Simpson's Diversity Index. Bio-geographically classification of India. Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local level. India as a mega diversity nation. Hot-spots of biodiversity,

Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts. Endangered and endemic spaces of India.

Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity, Biological Diversity Act, 2002.

Suggested Reading:

1. ErachBharucha., Textbook of Environmental Studies, UGC, New Delhi and BharathiVidyapeeth Institute of Environment Education and Research, Pune.
2. MahuaBasu and Xavier SavarimuthuSJ., Fundamentals of Environmental Studies,Cambridge University Press, New Delhi, 2017.
3. Mishra D D., Fundamental Concepts in Environmental Studies, S Chand & Co Ltd., New Delhi, 2010.
4. Botkin and Keller., Environmental Science, Wiley India Pvt., Ltd., New Delhi, 2012.
5. Gilbert, M. Masters., Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt., Ltd., New Delhi, 1995.
6. Sasi Kumar, K. and SanoopGopi Krishna., Solid waste Management, Prentice-Hall of India Pvt., Ltd., New Delhi, 2009.
7. Daniel D. Chiras, Environmental Science, Jones & Bartlett Learning Publishers Inc, Burlington, MA, 2014.

Course Code	Course Title						Course Type
MC802HS	**INTELLECTUAL PROPERTY RIGHTS**						**Mandatory Course-II/III**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
Evaluation	**L**	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**-**

Course Objectives: The course is taught with the objectives of enabling the student to:

- Acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
- Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
- Provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.

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

1 Understand the concept of intellectual property rights.
2 Develop proficiency in trademarks and acquisition of trade mark rights.
3 Understand the skill of acquiring the copy rights, ownership rights and transfer.
4 Able to protect trade secrets, liability for misappropriations of trade secrets.
5 Apply the patents and demonstration of case studies.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT – I

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT – III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

UNIT – IV

Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

UNIT –V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Suggested Reading:

1 Halbert, Resisting Intellectual Property, Taylor & Francis Ltd, 2007.
2 Mayall, Industrial Design, McGraw Hill,1992
3 Niebel, Product Design, McGraw Hill, 1974.
4 Asimov, Introduction to Design, Prentice Hall, 1962.
5 Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age,2016.
6 T. Ramappa, Intellectual Property Rights Under WTO, S. Chand, 2008.

Course Code	Course Title						Course Type
MC803HS	**ENGLISH FOR TECHNICAL PAPER WRITING**						**Mandatory Course-II/III**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
Evaluation	**L**	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**-**

Course Objectives:

- Understand that how to improve your writing skills and level of readability.
- Learn about what to write in each section.
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.

Course Outcomes:

1 Able to plan and prepare paragraphs, avoiding ambiguity and grammatical errors
2 Writing of abstracts, paraphrasing and plagiarism
3 Providing critical and thorough review of literature, discussions and conclusions
4 Able to exhibit key skills for writing titles, introduction, abstract.
5 Able to show key and necessary skills for paper writing, phrases, results.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT-I

Root Words, Synonyms and Antonyms, One word substitutes, importance of Punctuation, Sentence Structure, Subject Verb Agreement, Noun Pronoun Agreement, Redundancy, Cliche

UNIT-II

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness,

UNIT-III

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT-IV

Describing, Defining, Classifying, Providing examples or evidence, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check,

UNIT-V

Key skills are needed when writing a Title, Abstract, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions -Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Reading:

1. Norman Lewis, Word Power Made Easy, Anchor Books, New York, Reprint Edition, 2014.
2. C.R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition, New Age International Publishers, New Delhi, 2019.
3. P.C. Wren and H. Martin, A Comprehensive Grammar of the English Language, Revised and Updated by N.D.V. Prasada Rao, S. Chand Publishing, New Delhi, Latest Edition.
4. Goldbort R, Writing for Science, Yale University Press (available on Google Books), 2006.
5. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.
6. Highman N Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book. 1998
7. Adrian Wallwork English for Writing Research Papers, Springer New York Dordrecht Heidelberg, London. 2011.

Course Code	Course Title						Course Type
MC804HS	**CONSTITUTION OF INDIA**						**Mandatory Course-II/III**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
Evaluation	**L**	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**-**

Course Objectives:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role
- Entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

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

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru
4. The eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
5. Discuss the passage of the Hindu Code Bill of 1956.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT – I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT – II

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT – III

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT – IV

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation.

Panchayat raj: Introduction, PRI: ZillaPanchayat, Elected officials and their roles, CEO ZillaPanchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT – V

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Reading:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Code	Course Title						Course Type
MC805HS	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**						**Mandatory Course-II/III**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
Evaluation	**L**	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**-**

Course Objectives: The course aims at enabling the students to

- Comprehend the Basic fundamental aspects of Society, Culture and Heritage.
- Understand the significant aspects of Traditional Hindu Social Organization and vedic literature both at individual level and societal level.
- Inculcate a philosophical insight through shad darshanas and a spiritual outlook through Yoga Sutras.
- Realize the significance and the utilitarian aspect of the traditional knowledge system through case studies.
- Appreciate the significance and necessity for the preservation of traditional knowledge system.

Course Outcomes: Student will be able to

1. Know the fundamental concepts of Society with regard to values, norms, cultural and nature of Indian culture.
2. Understand the connect between the Vedic literature and the traditional structural organization guiding at the various phases of life of an individual.
3. Recognize the importance of Darshanas and significance of Yoga sutra in building up a holistic life perspective.
4. To inculcate a pursuit of looking deeper into IKS for addressing the multi-faceted contemporary issues both at local and global platform.
5. Analyze the significance and the measures for the preservation of Traditional Knowledge System.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT - I

Fundamental Concepts : Society, Definition and its Characteristics; Values- Norms, Role-Status, Order and Stability, Habits, Custom; Understanding difference between Belief and Ritual, Tradition and Heritage; Culture : Definition and its Characteristics; Characteristics of Indian Culture; Concept of Unity in Diversity.

UNIT - II

Indian Traditional System: Traditional Hindu Organization: Purusharthas, Varna Dharma and Ashrama Dharma. Indian Traditional Scripturesand their Classification; General Understanding of Vedas : Rig veda, Samaveda, Yajur Veda, and Atharvaveda, Upanishads; Smritis : Itihasa, Puranas, Agamas, Upvedas, and Vedangas.

UNIT - III

Traditional Philosophies / School of thoughts: Darshanas: philosophies of 6 Schools: Nyaya, Vaisheshika, Samkhya, Yoga, Mimamsa and Vedanta; Nastika School of Philosophy: Charvaka, Jainism and Bhuddhism; Yoga and Spirituality.

UNIT - IV

Traditional Knowledge System : Definition of Traditional knowledge, Indigenous Knowledge System; Case studies of Ancient traditional Knowledge System Astronomy, Vastu-Shatras, Wootz Steel lost technology of IKS, Water Management, and Agriculture.

UNIT - V

Protection of Traditional Knowledge - Significance and Need of Protection of Traditional Knowledge ; and measure for protection of TK, Role of the Government to harness TK. Documentation and Preservation of IKS , Approaches for conservation and Management of nature and bio-resources, Approaches and strategies to protection and conservation of IKS.

Suggested Reading:

1. V. Sivaramnkrishna (Ed.). Cultural Heritage of India-Course Material, BharatiyaVidyaBhavan, Mumbai. 5th Edition, 2014
2. Swami Jirntman and Modern Physics and Vedant, BharatiyaVidyaBhavan
3. Fritzof Capra. Tao of Physics.
4. Fritzof Capra, The wave of Life.
5. V N Jba (Eng. Trans.). Tarkasangraha ofAnnam Bhana, InternationalChinmay Foundation, Velliamad. Amaku.am
6. Yoga Sutra of Patanjali, Ramakrishna Mission,Kolkatta
7. GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with VyasaBhashya. VidyanidhiPrakasham, Delhi, 2016.
8. RN Jha. Science of Consciousness Psychotherapy and Yoga Practices. VidyanidhiPrakasham, Delhi, 2016.
9. P R Shamin (English translation),ShodashangHridayam

ourse Code	Course Title							Course Type
MC806HS	**STRESS MANAGEMENT BY YOGA**							**Mandatory Course-II/III**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
Evaluation	**L**	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**-**

Course Objectives: The course is taught with the objectives of enabling the student to:

- Creating awareness about different types of stress and the role of yoga in the management of stress.
- Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
- Prevention of stress related health problems by yoga practice.

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

1. To understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through Asanas
5. Improve work performance and efficiency.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

UNIT – I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT – II

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT – III

Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayamaand Meditation in the management of stress.

UNIT – IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas – Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT – V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati- Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1. Yogic Asanas for Group Training - Part-I: Janardhan Swami YogabhyasiMandal, Nagpur
2. Swami Vivekananda, Rajayoga or Conquering the Internal Nature, Advaita
3. Ashrama (Publication Department), Kolkata
4. NagendraH.RnadNagaratna R, Yoga Perspective in Stress Management, Bangalore, Swami Vivekananda Yoga Prakashan

Web resource:

1. https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2. https://freevideolectures.com/course/3539/indian-philosophy/11

Course Code	Course Title						Course Type
MC807HS	**SPORTS**						**Mandatory Course-II/III**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
Evaluation	**L**	**T**	**D**	**P**		**CIE**	**SEE**
	3	**-**	**-**	**-**	**3**	**40**	**60**	**-**

Course Objectives:

- To develop an understanding of the importance of sport in the pursuit of a healthy and active lifestyle at the College and beyond.
- To develop an appreciation of the concepts of fair play, honest competition and good sportsmanship.
- To develop leadership skills and foster qualities of co-operation, tolerance, consideration, trust and responsibility when faced with group and team problem-solving tasks.
- To develop the capacity to maintain interest in a sport or sports and to persevere in order to achieve success.
- To prepare each student to be able to participate fully in the competitive, recreational and leisure opportunities offered outside the school environment.

Course Outcomes:

1. Students' sports activities are an essential aspect of university education, one of the most efficient means to develop one's character and personal qualities, promote the fair game principles, and form an active life position.
2. Over the past year, sports have become much more popular among our students. Let us remember the most memorable events related to sports and physical training.
3. Special attention was paid to team sports. Our male and female games and sports have achieved remarkable progress at a number of competitions.
4. Our teams in the main sports took part in regional and national competitions. Special thanks to our team in track and field athletics, which has been revitalized this year at ICT and which has won Javelin competition.
5. Staff of our faculties and students of Sports, Physical Development, & Healthy Lifestyle of Faculty congratulates everyone on the upcoming New Year and wishes you robust health and new victories in whatever you conceive.

CO-PO Articulation Matrix

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

Correlation rating: Low/Medium/High: 1/2/3 respectively

I. **Requirements:**

1. Track Paint (students should bring)
2. Shoes
3. Volley Ball, Foot Ball and Badminton (Shuttle)
4. Ground, Court, indoor stadium and swimming pool

II. **Evaluation Process:** Total Marks

a. 40 marks for internal exam (continuous evaluation)
   i. 16 marks for viva
   ii. 24 marks for sports & fitness

b. 60 marks for end exam
c. 20 marks for viva
d. 40 marks for sports & fitness

Course Code	Course Title							Course Type
PW851ME	**PROJECT WORK - II**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
Able to define Problem with specifications	**-**	**-**	**-**	**12**	**12**	**50**	**100**	**6**

Course Objectives: The course is taught with the objectives of enabling the student to:

- To implement the project proposal developed in Project Work–I.
- To expose students to experimentation, modeling, design, or simulation.
- To train students in data analysis, validation, and interpretation.
- To build teamwork, technical communication, and project management foundations.
- To encourage innovation that helps in developing prototype models with social impacts and societal impact awareness in project conception.

Course Outcomes:

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

1. Implement engineering solutions addressing real-world social and technological impacts.
2. Prepare structured literature reviews supporting project relevance.
3. Develop and validate innovative project solutions with measurable outcomes.
4. Demonstrate teamwork and professional communication through presentations and documentation.
5. Produce final project reports integrating ethics, sustainability, and societal benefit.

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

Correlationrating: Low/ Medium/ High:1 / 2 /3respectively.

The primary aim of Project Work Phase II is to implement and critically evaluate the proposal developed during Project Work Phase I. Students are also encouraged to undertake full-time internships as part of Project Work Phase II, in accordance with the common guidelines applicable across all departments of UCE, contingent upon their selection.

Students engaged in internships are required to draft a new project proposal in consultation with both the industry coordinator and their project guide within two weeks of commencing the internship period. The Department will appoint a project coordinator responsible for overseeing the following activities:

Re-grouping students, including removal of those who have opted for internships from groups formed during Project Work Phase I.

Re-allotment of the internship students to appropriate project guides.

Continuous project monitoring at regular intervals.

All regrouping and re-allotments must be completed by the second week of the eighth semester, allowing sufficient time for project completion.

Both internship and departmental projects will undergo at least two monitoring reviews per semester, conducted through student presentations to award sessional marks. The evaluation committee, comprising faculty members and the project supervisor, will conduct these reviews.

The first project review, worth 25 marks, shall be conducted after the completion of five weeks of instruction.

The second project review, also worth 25 marks, will take place after twelve weeks of instruction.

Common norms for the final project report documentation will be established by the respective departments. Students are required to submit draft copies of their project reports within one week after the completion of instruction.

The final evaluation at the end of the semester will consist of a viva-voce examination structured as follows:

Student groups must submit a detailed project report approved by their Project Work Phase II guide(s) prior to the scheduled date of the external viva-voce examination.

The Chairperson of the Board of Studies (BOS) will nominate internal and external examiners and forward the panel to the examination cell of UCE, O.U.

The internal examiner will coordinate the examination schedule in consultation with the external examiner, in alignment with batch-wise presentations.

The Project Work Phase II guide should be present during the presentation sessions of their allocated batch.

Marks awarded jointly by the external and internal examiners will be submitted in a sealed cover to the examination cell after completion of the viva-voce examinations.

The external examiner, in consultation with the Head of Department, will allocate a total of 100 marks based on the project report, presentation, and viva-voce performance. The assessment will consider:

A group presentation, generally limited to 30 minutes per batch, including the viva-voce session.

Evaluation of the depth of understanding demonstrated in the report, oral presentation, and responses during the viva.

Note: Each project guide will have a contact load of three periods per week assigned for project supervision.

Evaluation Rubrics

CIE Rubrics – 50 Marks

Criteria	Weight	Excellent (4)	Good (3)	Satisfactory (2)	Poor (1)
Problem Understanding & Objectives	10	Problem well-defined, measurable objectives, strong justification	Clear definition, minor refinements needed	Ambiguous objectives, insufficient justification	Unclear problem or copied statement
Methodology / Design	15	Correct, innovative, appropriate tools used	Mostly correct, moderate innovation	Basic design, limited tools	Incorrect or no methodology
Implementation & Results	15	Fully implemented, validated results, meets objectives	Partially implemented, reasonable results	Limited implementation, weak results	Minimal or no implementation
Draft Report Quality	5	Very well organized, proper references	Well written, few errors	Average structure	Poorly written, no references
Progress Reviews	5	Regular, proactive, meets milestones	Regular, meets most milestones	Irregular, partial progress	No progress or irregular attendance

SEE Rubrics – 100 Marks

Criteria	Weigh t	Excellent (4)	Good (3)	Satisfactory (2)	Poor (1)
Problem Definition & Objectives Achieved	20	Clear problem, complete achievemen t of objectives	Mostly achieved, minor gaps	Partial achievement	Very little achieve ment
Methodology / System	25	Robust design,	Correct design,	Basic design	Incorrect or

Architecture		strong technical depth, innovation	moderate depth		shallow design
Implementation, Validation & Results	30	High-quality implementation, strong testing, validated results	Good implementation with limited validation	Partial implementation	No working result
Final Project Report	15	Professional quality, complete, well-structured	Good quality, minor issues	Acceptable	Poorly written / incomplete
Presentation & Viva	10	Excellent clarity, strong technical answers	Good presentation, moderate answers	Basic answers, weak clarity	Unable to answer

Evaluation Criteria
CIE
After 5 weeks

Criteria	Problem Formulation/ topic	Literature Review	Methodology/ Knowledge on the topic	Report / documentation	Presentation	Total
Marks	5	5	5	5	5	25

After 12 weeks

Criteria	Problem Formulation/ Literature review	Quality of work/ Originality/ Innovation	Methodology/ Approach and Results	Report / documentation	Presentation and Response to queries	Total
Marks	5	5	5	5	5	25

SEE

Criteria	Problem Formulation	Innovation/ Practical Application/ Quality of work	Literature Review	Methodology	Analysis of result	Report writing	Presentation	Response to queries	Impact/ Outcome of the work/ Publication/ Prototype / model designing	Total
Marks	10	5	10	5	30	20	10	5	5	100