Scheme of Instruction & Syllabi

(In line with AICTE Model Curriculum with effect from AY 2026-27)

MASTER OF ENGINEERING

I to IV SEMESTERS

TWO YEAR POST GRADUATE DEGREE PROGRAMME

IN

MECHANICAL ENGINEERING

Specialization in CAD/CAM

(R–26 Regulation)

MUFFAKHAM JAH COLLEGE OF ENGINEERING & TECHNOLOGY
An Autonomous Institution
Affiliated to Osmania University, Approved by AICTE
Accredited by NBA & NAAC (A+)

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MECHANICAL ENGINEERING DEPARTMENT
M.E. - CAD/CAM
SCHEME OF INSTRUCTION & EXAMINATION

(In line with AICTE Model Curriculum with effect from AY 2026-27)

S E M E S T E R - I			Scheme of Instruction				Scheme of Examination			Credits
S. No.	Course Code	Name of the Course	Lecture	Tutorial	Practical	Contact Hrs/Wk.	C.I.E.	S.E.E.	Duration in Hrs	
1	26PC5111CD	Advanced CAD	3	-	-	3	40	60	3	3
2	26PC5112CD	Computer Integrated Manufacturing	3	-	-	3	40	60	3	3
3	26PE511XCD	Professional Elective – I	3	-	-	3	40	60	3	3
4	26PE511XCD	Professional Elective – II	3	-	-	3	40	60	3	3
5	26OE910XXX	Open Elective	3	-	-	3	40	60	3	3
6	26AD900XXX	Audit Course – I	2	-	-	2	50	-	-	0
7	26PC5151CD	Advanced CAD Lab	-	-	3	3	40	60	3	1.5
8	26PC5152CD	CAM and Automation Lab	-	-	3	3	40	60	3	1.5
9	26PW5153CD	Seminar	-	-	3	3	50	-	-	1.5
		Total	**17**	**00**	**09**	**26**	**380**	**420**	**21**	**19.5**

S E M E S T E R - II			Scheme of Instruction				Scheme of Examination			Credits
S. No.	Course Code	Name of the course	Lecture	Tutorial	Practical	Contact Hrs/Wk.	C.I.E.	S.E.E.	Duration in Hrs	
1	26PC5121CD	Additive Manufacturing Technologies & Applications	3	-	-	3	40	60	3	3
2	26PC5122CD	Advanced Finite Element Techniques	3	-	-	3	40	60	3	3
3	26PE512XCD	Professional Elective – III	3	-	-	3	40	60	3	3
4	26PE512XCD	Professional Elective – IV	3	-	-	3	40	60	3	3
5	26SD5125ME	Research Methodology & IPR	3	-	-	3	40	60	3	3
6	26AD901XHS	Audit Course – II	2	-	-	3	50	-	-	0
7	26PC5156CD	Advanced Computational Lab	-	-	3	3	40	60	3	1.5
8	26PW5128CD	Mini Project	-	-	6	6	40	60	3	3
		Total	**17**	**00**	**9**	**27**	**330**	**420**	**21**	**19.5**

S E M E S T E R - III			Scheme of Instruction				Scheme of Examination			Credits
S. No.	**Course Type/Code**	**Name of the Course**	**Lecture**	**Tutorial**	**Practical**	**Contact Hrs/Wk.**	**C.I.E.**	**S.E.E.**	**Duration in Hrs**	
1	26PE521XCD	NPTEL Course / MOOCs Course Certification*	As Per NPTEL							3
2	26PW5212CD	Major Project Dissertation-I	-	-	20	20	40	60	3	10
		Total	**-**	**-**	**20**	**20**	**40**	**60**	3	**13**

S E M E S T E R - IV			Scheme of Instruction				Scheme of Examination			Credits
S. No.	**Course Type/Code**	**Name of the course**	**Lecture**	**Tutorial**	**Practical**	**Contact Hrs/Wk.**	**C.I.E.**	**S.E.E.**	**Duration in Hrs**	
1	26PW5221CD	Major Project Dissertation-II	-	-	32	32	50	150	3	16
		Total	**-**	**-**	**32**	**32**	**50**	**150**	3	**16**

PC: Program Core **PE:** Professional Elective **OE**: Open Elective
AD: Audit Course **MC**: Mandatory Course **HS**: Humanities and social science
SD: Skill Development Course
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination

Note:
The students are required to register for an NPTEL/MOOCs course (8 or 12 Weeks) during the M.E. (ME) III Semester. Upon successful completion of the course, they must submit the NPTEL/MOOCs certificate to receive the allotted credit score.

List of Subjects of Open Elective

S. No.	Course Code	Course Title
1	26OE9101CE	Cost Management of Engineering projects (Not for CED Students)
2	26OE9102CS	Business Analytics (Not for CSE Students)
3	26OE9103EC	Embedded System Design (Not for ECE Students)
4	26OE9104EE	Waste to Energy (Not for EEE Students)
5	26OE9105ME	Industrial Safety (Not for MED Students)

List of Subjects of Professional Electives I to IV

S. No.	Course Code	Course Title
1	26PE5111CD	Digital Manufacturing
2	26PE5112CD	**Green Composites**
3	26PE5113CD	Data Analysis using Machine learning
4	26PE5114CD	Smart Materials
5	26PE5115CD	**Quality Engineering in Manufacturing**
6	26PE5116CD	Artificial Intelligence in Manufacturing.
7	26PE5121CD	**Industrial Robotics**
8	26PE5122CD	Laser based Micro Manufacturing
9	26PE5123CD	**Surface Engineering.**
10	26PE5124CD	Digital twin and Industry 5.0
11	26PE5125CD	Machine Learning for Intelligent Systems
12	26PE5126CD	MEMS: Design and Manufacturing

List of Subjects of Audit Course-I

S. No.	Course Code	Course Title
1	26AD9001HS	English for Research Paper Writing
2	26AD9002CE	Disaster Management
3	26AD9003HS	Sanskrit for Technical Knowledge
4	26AD9004HS	Value Education

List of Subjects of Audit Course-II

S. No.	Course Code	Course Title
1	26AD9011HS	Constitution of India and Fundamental Rights
2	26AD9012HS	Pedagogy Studies
3	26AD9013HS	Stress Management by Yoga
4	26AD9014HS	Personality Development through life Enlightenment Skills

Semester Wise Distribution of Credits:

Semester	Credits as Per AICTE	Credits Allocated
I	18	19.5
II	18	19.5
III	16	13
IV	16	16
Total Credits	**68**	**68**

NPTEL COURSES

	Name of the Course (July - December)
12 Weeks	Energy Conservation and Waste Heat Recovery.
12 Weeks	Basics of Materials Engineering.
12 Weeks	Material Selection for Mechanical Design.
12 Weeks	Automation in Manufacturing.
12 Weeks	Rapid Manufacturing.
12 Weeks	Mechanical Behavior of Polymers & Composites.
12 Weeks	Sustainable Energy Technology.
12 Weeks	Metal Additive Manufacturing.
8 Weeks	Principles of Metal Forming Technology.
8 Weeks	Laser Based Manufacturing.
8 Weeks	Toyota Production System.
8 Weeks	Innovation Business Models and Entrepreneurship.
8 Weeks	Foundation of Digital Business.
8 Weeks	Advanced Machining Processes

Course Code	Course Title						Core/Elective
26PC5111CD	ADVANCED CAD						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To provide knowledge on geometric modeling and its concepts.
2. To introduce wire frame modeling techniques.
3. To understand surface modeling techniques.
4. To realize the solid modeling techniques using CAD tools.
5. To recognize the CAD standards and transformations.

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

CO1. Understand the CAD process and geometric modelling concepts
CO2. Analyze the utility and application of wire frame modelling
CO3. Comprehend the concepts of surface modelling
CO4. Apprehend and apply the concepts of solid modelling techniques.
CO5. Recognize graphics by using transformations and analyze the utility of data exchange formats with dimensioning and tolerances.

UNIT- I: CAD Tools and 3D Modeling

CAD Tools: Definition of CAD Tools, Graphics Standards, Graphics Software, Requirements of Graphics Software, Functional Areas of CAD, Efficient use of CAD Software. Basics of Geometric Modelling: Requirement of Geometric 3D Modeling, Geometric Models.

UNIT- II: Wireframe Modeling Techniques

Classification of Wireframe Entities, Curve Representation Methods. Parametric Representation of Analytic Curves: Line, Circle, Arc, Conics. Parametric Representation of Synthetic Curves: Hermite Cubic Curve, Bezier Curve, B-Spline Curve wire, NURBS.

UNIT- III: Surface Modeling Methods

Classification of Surface Entities, Surface Representation Methods. Parametric Representation of Analytic Surfaces: Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Parametric Representation of Synthetic Curves: Hermite Cubic Surface, Bezier Surface, B-Spline Surface, Blending Surface, Surface Manipulations.

UNIT- IV: Solid Modeling Concepts

Geometry and Topology, Boundary Representation, Euler Poincare Formula, Euler Operators, Constructive Solid Geometry, CSG Primitives, Boolean Operators, Sweeping, Solid Manipulations, Feature Modeling.

UNIT- V: CAD Transformations and Standards

Transformations: 2-D and 3-D Transformations, Translation, Scaling, Rotation, Reflection, Evaluation Data Exchange Formats, GKS, IGES, Step. Dimensioning and Tolerances: Linear, Angular, Angular Dimensions, Maximum Material Condition (MMC), Least Material Condition (LMC), Regardless of Feature Size (RFS).

Suggested Reading:

1. Mastering CAD/CAM, Ibrahim Zeid, McGraw Hill Education, 1st Edition, 2007.
2. CAD/CAM: Computer-Aided Design and Manufacturing, Mikell P. Groover, Pearson Education, 1st Edition, 2003.
3. CAD / CAM / CIM P. Radhakrishnan and S. Subramanian, New Age International Publishers, 3rd Edition, 2008.
4. Principles of Computer Aided Design and Manufacturing, Farid Amirouche, Pearson Education, 1st Edition, 2004.
5. Computer Numerical Control Concepts and programming, Warren S. Seames, Thomson Delmar Learning, 1st Edition, 2002.
6. CAD/CAM Principles and Applications, P.N. Rao, TMH, 3rd Edition, 2010.
7. CAD/CAM, Ishrat Meera Mirzana, Radiant Publishing House, 4th Edition, 2014

Course Code	Course Title						Core/Elective
26PC5112CD	COMPUTER INTEGRATED MANUFACTURING						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand why CIM is needed, how it has developed over time, its basic principles, and the idea of Concurrent Engineering.
2. To learn about the role of database management in CIM and get to know different CIM technologies.
3. To explore the smart automation technologies
4. To understand basic networking ideas that help connect all important parts of a company, and learn about different CIM models used in industries.
5. To recognize the future trends in manufacturing.

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

CO1. Learn the basics and history of Computer Integrated Manufacturing (CIM).
CO2. Use database ideas to handle and organize manufacturing data.
CO3. Study and plan automated production lines and systems.
CO4. Understand how networking helps connect different parts of a company in CIM.
CO5. Look into future manufacturing methods like AI, Lean, Agile, and online manufacturing.

UNIT – I: Introduction to CIM

The meaning of Manufacturing, Types of Manufacturing; Basic Concepts of CIM: CIM Definition, Elements of CIM, Evolution of CIM, Benefits of CIM, Needs of CIM, Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Model-Based Systems Engineering (MBSE),Framework for integration of Life-cycle phases in CE, Concurrent Engineering Techniques, Integrated Product Development(IPD), Product Life-Cycle Management (PLM), Interaction between computation and physical processes and Smart Factories in CIM.

UNIT – II: Manufacturing Data Management & PDM

Introduction to Manufacturing Data: types, sources, and importance, Database fundamentals: DBMS concepts, architecture, relational vs. non-relational databases, SQL basics: DDL (Create, Alter, Drop, Truncate, View), DML (Insert, Retrieve, Update, Delete). Creating and manipulating a manufacturing database (illustrative examples). Role of databases in CIM: integration with ERP, MES, and PLM systems. Product Data Management (PDM): concepts, advantages, link to PLM. Emerging trends: cloud databases, IoT-driven data management.

UNIT – III

Smart Automation Systems and Adaptive Production Lines: Introduction to Assembly Lines, how automated flow lines work; Methods of moving parts between stations (conveyor belts, rotary index tables, and simple robotic arms). New Trends in Material Handling: Moving from fixed conveyor belts to Autonomous Mobile Robots (AMRs) and smart cart systems that change paths automatically. Buffer Storage & Line Safety.

UNIT –IV: Enterprise-Wide Integration in CIM and CIM Models

Introduction to Networking, Principles of Networking, Network Terminology, Types of Networks: LAN, MAN, WAN; Selection of Network Technology: Communication medium, Network Topology, Medium access control Methods, Signalling methods; Network Interconnection and Devices, Network Performance. Need for enterprise integration, Enterprise systems: ERP, intranet, extranet, cloud integration.

UNIT – V: Future Trends in Manufacturing Systems

The Future Automated Factory: Trends in Manufacturing, The Future Automated Factory, Human Workers in the Future Automated Factory, The social impact. Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems. 5G Communication for Industrial Automation, Introduction to Sustainable Manufacturing and Green Technologies.

Suggested Reading:

1. Vajpayee, S. K. (1999). *Principles of Computer Integrated Manufacturing*. Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Singh, Nanua. (1996). *Systems Approach to Computer Integrated Design and Manufacturing*. John Wiley & Sons, New Delhi.
3. Radhakrishnan, P., Subramanyan, S., & Raju, V. (2017). *CAD/CAM/CIM* (4th Edition). New Age International (P) Ltd., New Delhi.
4. Alavudeen, A., & Venkateshwaran, N. (2008). *Computer Integrated Manufacturing*. Prentice-Hall of India Pvt. Ltd., New Delhi.
5. Groover, M. P. (2020). *Automation, Production Systems, and Computer-Integrated Manufacturing* (5th Edition). Pearson Education.

Course Code	Course Title						Core/Elective
26PC5121CD	ADDITIVE MANUFACTURING TECHNOLOGIES & APPLICATIONS						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand the fundamentals, classification, applications, and role of AM in Industry 4.0.
2. To study various liquid, jetting, binder, and extrusion-based AM processes.
3. To learn powder-based, DED, sheet lamination processes and rapid tooling techniques.
4. To understand reverse engineering, topology optimization, AM data formats, and software tools.
5. To explore advanced applications and future trends in Additive Manufacturing.

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

CO1: Explain AM fundamentals, processes, applications, and Industry 4.0 integration.
CO2: Describe working principles and applications of liquid and extrusion-based AM processes.
CO3: Analyze powder-based, DED, sheet lamination AM processes and rapid tooling techniques.
CO4: Apply reverse engineering, topology optimization, and AM software tools.
CO5: Identify advanced AM applications and future trends in manufacturing.

UNIT-I

Introduction to Additive Manufacturing and Industry 4.0 Integration:

Introduction to AM: Fundamentals of Prototyping, Need for time compression in product development, Need for AM in modern manufacturing, Historical overview, Commonly used Terms, AM process chain, Classification of AM processes, applications, advantages and limitations, AM wheel, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies. Role of AM in Industry 4.0.

UNIT-II

Additive Manufacturing Processes – Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies.

Vat Photo-polymerization AM Systems: Photopolymers, photo polymerization Stereo lithography Apparatus (SLA), Direct Light Processing (DLP) and Continuous Direct Light Processing (CDLP).

Material Jetting AM Systems: Material Jetting, Nano particle jetting, PolyJet Printing (PJ) and Drop-On-Demand (DOD) material jetting.

Binder Jetting AM Systems: Three dimensional Printing (3DP).

Material Extrusion AM Systems: Fused Deposition Modeling (FDM).

UNIT-III

Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies.

Powder Bed Fusion AM Systems: Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).

Direct Energy Deposition (DED) AM Systems: Laser Engineered Net Shaping (LENS) and Electron Beam Additive Manufacturing (EBAM), Wire Arc Additive Manufacturing (WAAM). **Sheet Lamination AM Systems:** Laminated Object Manufacturing (LOM) and Ultrasonic Additive Manufacturing (UAM).

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT, Rapid Tooling Classification, Direct vs. Indirect Tooling methods,

RT Techniques: Arc Spray Metal Deposition, Investment casting, Sand Casting, 3D Keltool, Direct AIM, LOM Tools, DTM Rapid Tool, Direct Tool, Metal Tooling using 3DP.

UNIT-IV

Reengineering in AM: Reengineering Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.

Topology Optimization: Role of AM in Topology optimization.

AM Data Formats: STL Format, STL File Problems, STL file Repairs, other Formats, Consequence of Building Valid and Invalid Tessellated Models.

AM Softwares: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab, etc.

UNIT V

Advanced Applications

AM Applications: in Design, Engineering, Analysis and Planning,

AM across sectors: Aerospace, Automotive, Jewelry, Art, Architecture, GIS applications,

Biomedical Applications: Planning and simulation of complex surgery, Custom Implants, Dental surgeries, Prosthetic design, and Production of Medical Devices,

Scientific applications: Forensic Science, Anthropology, including anatomical modeling.

Future Trends in AM: The important future trends in Additive AM such as: Large-scale AM, Integration with IoT Platforms, AI and machine learning integration, Implementation of digital twins, smart factories, 4D printing, Multi-material printing, Sustainable manufacturing, Industry 4.0 integration, Faster and smarter AM systems.

Suggested Reading:

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific Publications, 4th Edition, 2019.
2. Ian Gibson, David W. Rosen, Brent Stucker, Mahyar K. Mohammadi "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" Springer, 3rd Edition, 2021.
3. Andreas Gebhardt, Jan-Steffen Hotter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing" Hanser Publishers, 2nd Edition, 2016.
4. Amit Bandy opadhyay, Susmita Bose "Additive Manufacturing" CRC Press, 2015.
5. Wholers Report — Terry Wohlers, Wohlers Associates.
6. Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer, 2001.
7. Rapid Prototyping & Engineering Applications — Frank W. Liou, CRC Press, Taylor & Francis Group, 2011.

Course Code	COURSE TITLE						Core/Elective
26PC5122CD	**ADVANCED FINITE ELEMENT TECHNIQUES**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:

1. To understand how the Finite Element Method (FEM) works and how it is used to analyse structures.
2. To learn about analysis of trusses and frames.
3. To study how to create and use different types of elements in 1D and 2D
4. To know about thermal and dynamic analysis
5. To apprehend about finite element formulation for 3D problems

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

CO1. Determine the shape functions and stiffness matrices and finite element equations.

CO2. Analyze the behavior of the trusses and frames.

CO3. Investigate complex structural problems.

CO4. Evaluate the thermal behavior of different systems.

CO5. Determine the behavior of the 3D systems.

UNIT-I

Introduction: Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Problem: Finite element modelling. Local, natural and global coordinates and shape functions. Potential Energy approach: Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions.

UNIT-II

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

UNIT-III

Finite element modelling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modelling of Axisymmetric solids subjected of axisymmetric loading with triangular elements. Convergence requirements and geometric isotropy.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod.

Dynamic analysis: Formulation of finite element modelling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors. Analysis of a uniform shaft subjected to torsion using Finite Element Analysis.

UNIT-V

Finite element formulation of three dimensional problems in stress analysis. Finite Element formulation of an incompressible fluid. Potential flow problems Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Suggested Reading:

1. Tirupathi R Chandraputla and Ashok. D. Belegundu, *Introduction of Finite Element in Engineering,* Prentice Hall of India, 1997.
2. Rao S.S., *The Finite Element Methods in Engineering,* Pergamon Press, 1989.
3. Segerland. L.J., *Applied Finite Element Analysis,* Wiley Publication, 1984.
4. Reddy J.N., *An Introduction to Finite Element Methods,* Mc Graw Hill Company, 1984.
5. G. Ramamurty, Applied Finite Element Analysis, I.K. International Publishing House Pvt. Ltd.

Course Code	Course Title						Core/Elective
26PE5111CD	DIGITAL MANUFACTURING						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To provide the importance of digital Manufacturing in the current scenario.
2. To make students understand about Cyber-physical systems and functionality.
3. To provide the Comparison and applications of Subtractive and Additive Manufacturing Processes.
4. To learn the concepts of Product life cycle, Product data management system and Management information systems.
5. To familiarize the Reverse Engineering Concepts Digital thread and Digital twin.

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

CO1. Understand the concept of digital manufacturing, technology and its potential in modern manufacturing process.

CO2. Recognize the role of cyber physical systems in digital manufacturing.

CO3. Compare and select the subtractive and additive manufacturing processes for a given application.

CO4. Analyze the role of product life cycle and database management systems in manufacturing systems.

CO5. Understand the concepts of reverse engineering, digital thread and digital twins.

UNIT – I

Introduction to digital manufacturing: Introduction to industrial revolutions, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, digital manufacturing and its Global scenario. Impact on manufacturing careers, Operation Mode of Digital Manufacturing System, Merits and demerits of digital Manufacturing systems.

UNIT – II

Cyber Physical Systems: Introduction. Sensing and Actuation. Next Generation Sensors, Augmented Reality and Virtual Reality, Role of artificial Intelligence and Big Data analytics in manufacturing. Need of cyber security in Industry 4.0, Basics of Industrial IoT and its scope.

UNIT – III

Subtractive and Additive Manufacturing: Introduction, Comparison on the basis of application. Hardware: input devices, types of motors, encoders, drive mechanisms and controllers. Additive Manufacturing Processes: Steriolithograhy, fused deposition modelling, selective laser melting, direct metal deposition, sheet lamination.

UNIT –IV

Product database management systems: Types, Management information system, Manufacturing data preparation, Shop-floor control, Automatic identification systems (sensors, trackers) Product life cycle management: Introduction, Types of Product Data, Product life cycle management (PLM) systems, integrated information systems in product lifecycle, Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

UNIT – V

Reverse engineering: Introduction, need of Reverse engineering process and basics steps involved. Application domain. Reverse engineering hardware and software.3D object scanning, Solid reconstruction from point cloud and tessellated data, downstream applications. Digital design: Definition, Introduction, data storage and sharing in digital threads, Type of digital twins, tools and components of digital twins.

Suggested Reading:

1. James G. Bralla, ―Hand book of product design for manufacturing‖ McGraw Hill Co., 1986
2. K.G. Swift ―Knowledge based design for Manufacture‖, Kogan page Limited, 1987.
3. Chitale, A.K, and Gupta, R.C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
4. Product Design for Manufacture and Assembly by Geoffrey Boothroyd, CNC Press, 2010
5. Design for Manufacturability Handbook, McGraw-Hill Handbooks,1998.

Course Code	Course Title						Core/Elective
26PE5112CD	GREEN COMPOSITES						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand the fundamentals of green composites and sustainable materials.
2. To learn about natural fibres, biopolymers, and eco-friendly reinforcement materials.
3. To gain knowledge of processing methods and characterization techniques.
4. To understand the environmental benefits, biodegradability
5. To understand applications of green composites.

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

CO1: Recognize concept and importance of green composites.
CO2: Understand the role of fibre treatment in improving properties.
CO3: Interpret mechanical and thermal characterization results.
CO4: Evaluate the environmental performance of green composites
CO5: Identify industrial applications of green composites.

Unit-I

Introduction to Green Composites: Introduction to composite materials, Classification of composites, Green composites: definition, need and scope, Sustainability and circular economy concepts, Constituents of green composites: natural fibres and biodegradable matrices, Advantages, limitations and engineering applications.

Unit-II

Natural Fibres and Biopolymer Matrices: Natural fibres: jute, flax, hemp, sisal, coir, bamboo, banana and kenaf, Physical, mechanical and chemical properties of natural fibres, Biopolymer matrices: PLA, starch, PHA, cellulose, bio-epoxy, Fibre treatment methods (alkali, silane and acetylation), Fibre–matrix interface and adhesion.

Unit-III

Processing and Characterization of Green Composites: Fabrication methods: Hand lay-up, Compression moulding, Injection moulding, Extrusion. Mechanical testing: Tensile, Flexural, Impact, Hardness. Introduction to characterization techniques: SEM, FTIR, DSC, TGA.

Unit-IV

Performance and Environmental Aspects: Mechanical behaviour of green composites, Moisture absorption and durability, Thermal stability, Biodegradation and compostability, Recycling and disposal methods, Introduction to Life Cycle Assessment (LCA), Environmental regulations and eco-labels.

Unit-V

Applications and Recent Developments: Green composites in: Automotive components, Building and construction, Packaging, Furniture, Consumer products, Biomedical applications, Hybrid green composites, Nanocellulose-based composites, Future trends and challenges, Case studies from Indian industries.

Suggested Reading:

1. Thomas, S., & Balakrishnan, P. (Eds.). (2021). *Green Composites*. Springer Nature, Singapore.
2. Mallick, P. K. (2007). *Fiber-Reinforced Composites: Materials, Manufacturing, and Design* (3rd Edition). CRC Press, Taylor & Francis Group, Boca Raton, FL, USA.
3. Chawla, K. K. (2012). *Composite Materials: Science and Engineering* (3rd Edition). Springer, New York, USA.
4. Chung, D. D. L. (2010). *Composite Materials: Science and Applications* (2nd Edition). Springer, London, UK.
5. Agarwal, B. D., Broutman, L. J., & Chandrashekhara, K. (2018). *Analysis and Performance of Fiber Composites* (4th Edition). John Wiley & Sons, Hoboken, NJ, USA.

Course Code	Course Title						Core/Elective
26PE5113CD	DATA ANALYSIS USING MACHINE LEARNING						Elective
	Contact Hours per Week						
Prerequisite	L	T	D	P	CIE	SEE	Credits
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand data analysis, ML concepts, and mechanical engineering applications.
2. To apply data preprocessing, feature engineering, and visualization techniques.
3. To develop supervised ML models for regression, classification, and validation.
4. To explore clustering, dimensionality reduction, and neural network concepts.
5. To implement ML solutions for predictive maintenance, fault diagnosis, and smart manufacturing.

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

CO1: Understand data analytics concepts and machine learning techniques.
CO2: Preprocess and visualize mechanical engineering data.
CO3: Apply appropriate machine learning algorithms to mechanical engineering problems.
CO4: Evaluate and interpret model performance using engineering datasets.
CO5: Use ML tools like Python, Scikit-learn, TensorFlow for implementation.

Unit I

Introduction to Data Analysis and ML in Mechanical Engineering: Basics of data science and machine learning, Importance in mechanical systems (condition monitoring, predictive maintenance, thermal analysis), Types of data: numerical, categorical, time-series, image data, Overview of tools: Python, Pandas, NumPy, Jupyter Notebook

Unit II

Data Preprocessing and Visualization: Data cleaning, normalization, outlier detection, Feature engineering: scaling, encoding. Data visualization using Matplotlib, Seaborn

Unit III

Supervised Learning Techniques: Regression (Linear, Polynomial, Ridge, Lasso), Classification (Decision Trees, k-NN, SVM, Logistic Regression), Model validation: cross-validation, confusion matrix, accuracy, precision

Unit IV

Unsupervised and Advanced ML Techniques: Clustering: K-means, Hierarchical clustering, Dimensionality reduction: PCA, LDA, Introduction to Neural Networks and Deep Learning (overview only)

Unit V

Applications in Mechanical Engineering: Predictive Maintenance using time-series analysis, Quality Control and Process Optimization, Fault Diagnosis in Mechanical Systems, Smart Manufacturing and Industry 4.0 concepts

Case Study: i) Vibration data preprocessing for fault diagnosis, ii) Predicting machine failure or material fatigue iii) ML model development on a real mechanical dataset iv) Grouping thermal patterns in heat transfer analysis

Suggested Reading:

1. Mitchell, T. M. (1997). *Machine Learning*. McGraw-Hill Education, New York, USA.
2. Gopal, M. (2019). *Applied Machine Learning* (2nd Edition). McGraw-Hill Education (India) Pvt. Ltd., New Delhi.
3. Bishop, C. M. (2006). *Pattern Recognition and Machine Learning*. Springer, New York, USA.
4. Burkov, A. (2019). *The Hundred-Page Machine Learning Book*. Andriy Burkov, Quebec, Canada.
5. Hastie, T., Tibshirani, R., & Friedman, J. (2021). *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* (2nd Edition, Corrected Printing). Springer, New York, USA.
6. VanderPlas, J. (2016). *Python Data Science Handbook: Essential Tools for Working with Data* (1st Edition). O'Reilly Media, Sebastopol, CA, USA.

Software/Tools Used:

- Python (NumPy, Pandas, Scikit-learn, Matplotlib, Seaborn)
- Jupyter Notebook
- TensorFlow/Keras (for basic neural network examples)

Course Code	Course Title						Core/Elective
26PE5114CD	SMART MATERIALS						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To provide the basics of smart materials.
2. To make students analyze Constitutive Relationships.
3. To understand the Mathematical modeling for response of piezo beam.
4. To understand High-Band Width, Low Strain Smart Sensors.
5. To apply the smart materials to engineering problems.

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

CO1: Understand basics of smart materials.
CO2: Analyze direct and reverse effect of piezo.
CO3: Understand and Evaluate Principles of piezo, Magnetostrictive materials, SMA.
CO4: Analyze design of piezoelectric materials
CO5: Understand High-Band Width, Low Strain Smart Sensors and Intelligent Devices

Unit-I.

Overview of Smart Materials: Piezoelectric Materials: Introduction to Smart Material, Applications of Smart Material, Smart systems using Smart Material Materials, Smart Actuators, Direct and Reverse Effects, Piezoelectric Materials, History of Piezoelectricity, Piezoelectric Materials, Piezoelectric Materials, Piezoceramic Actuator, Constitutive Relationship, Piezoceramic Polymers &Composites Composites Bimorphs & Piezostacks.

Unit II

Magnetostrictive Smart Materials & Active Smart Polymer: A Brief History of Magnetostrictive Material Materials, effects of Magnetostriction, Actuators Developed using Terfenol D, Sensors Developed using Terfenol-D., Magnetostrictive Composites. What is Active Smart Polymer Classifications of Electro active Polymers, Actuators Developed using EAP, Sensors Developed using EAP, Future of IPMC Ionic Polymer Metal Composite (IPMC), Actuators Developed using IPMC Actuators Developed using IPMC, Sensors Developed using IPMC, Future of IPMC, Shape Metallic alloys that show Shape Memory Effect, Actuators Developed using SMA, Sensors Developed using SMA, Future of SMA.

Unit III

Modelling of Piezoelectric Material: Piezoelectric Property, Crystal structure Crystal Structure, Constitutive Relationship, Active Strain Evaluation, Piezoelectric Coefficients, A Comparison of Properties, Comparison of Properties, Actuators Developed using Piezoelectric Material induced Strain Actuation (ISA), Uniform Strain Model, Static Equilibrium Configuration against, Uniform Strain Configuration against Bending Strain, ISA – Euler-Bernoulli Model , ISA Model for Magnetostrictive

Unit IV

High-Band Width, Low Strain Smart Sensors: Piezoelectric Actuators – Piezoceramic Unimorph and Bimorphsp, Amplified Piezoactuators Piezoelectric Composites– Piezoelectric Composites Piezo-transducres, Electrostrictive (PMN) Actuators, Magnetostrictive Actuators, Magnetostrictive Actuators, Delamination Sensing and Vibration Control using Magnetostrictive Control using Magnetostrictive Materials, Piezoelectric Inchworm Devices Piezoelectric Fuel Injectors , Ultrasonic Motors.

Unit V

Intelligent Devices based on Smart Materials: Piezoelectric Inchworm Devices, Inchworm devices for Actuation, Sizes and Specifications, Inchworm Devices for Locomotion, Unimorph Thunder, Rainbow Actuators, Rainbow and Thunder Actuation, Active Elasto-dynamic Motion, A Case history of Sensor Application, Introduction to MEMS Devices, MEMS based Accelerometers.

Suggested Reading:

1. Culshaw, B. (2000). *Smart Structures and Materials*. Artech House Publishers, Boston, MA, USA.
2. Gauenzi, P. (Ed.). (2009). *Smart Structures: Physical Behaviour, Mathematical Modelling and Applications*. John Wiley & Sons Ltd., Chichester, UK.
3. Cady, W. G. *Piezoelectricity: An Introduction to the Theory and Applications of Electromechanical Phenomena in Crystals* (Dover Edition). Dover Publications Inc., New York, USA.
4. NPTEL. *Smart Materials and Intelligent System Design*. National Programme on Technology Enhanced Learning (NPTEL), IIT Kanpur. Available at: https://nptel.ac.in/courses/112104173 (Accessed: July 2026).

Course Code	Course Title						Core/Elective
26PE5115CD	QUALITY ENGINEERING IN MANUFACTURING						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand the principles of quality engineering and robust design.
2. To apply Taguchi methods for quality improvement through parameter and tolerance design.
3. To analyze experimental data using Analysis of Variance (ANOVA).
4. To design experiments using orthogonal arrays and interpret the results.
5. To understand modern quality management systems and continuous quality improvement tools.

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

CO1: Understand the concept of quality engineering in design and production.

CO2: Analyze tolerances of different components in various designs.

CO3: Perform analysis of variance in different levels.

CO4: Perform calculations through orthogonal arrays.

CO5: Understand and implement concepts of brain storming, bench marking and fishbone diagram.

Unit-I

Quality Value and Engineering: An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances. (N-type, S- type and L-type).

Unit-II

Tolerance Design and Tolerancing: Functional limits, tolerance design for N- type. L-type and S-type characteristics, tolerance allocation for multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

Unit-III

Analysis of Variance (ANOVA): NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

Unit –IV

Orthogonal Arrays: Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

Unit – V:

ISO-9000 Quality System, BDRE, 6-sigma, Bench marking, Quality circles Brain Storming - Fishbone diagram - problem analysis**.**

Suggested Reading:

1. Taguchi Techniques for Quality Engineering, Philip J Ross, McGraw Hill, Intl. 13th Edition, 2005.
2. Quality Engineering in Production systems I G. Taguchi, A. Elsayed et al / McGraw Hill Intl. Edition, 1989.
3. Taguchi Methods explained: Practical steps to Robust Design / Papan P. BagchiI Prentice Hall. Pvt. Ltd.,New Delhi.

Course Code	Course Title						Core/Elective
26PE5116CD	ARTIFICIAL INTELLIGENCE IN MANUFACTURING						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To explain applications and goals of Artificial Intelligence.
2. To teach techniques and structure of Expert Systems.
3. To explain the role of computers and electronics in Artificial Intelligence.
4. To analyze case studies how Artificial Intelligence can be used in industry
5. To expose to various technologies which are integral part of Artificial Intelligence.

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

CO1: Explain the fundamentals and problem-solving techniques of Artificial Intelligence.
CO2: Describe the concepts, structure, and applications of Knowledge-Based (Expert) Systems.
CO3: Apply knowledge representation, inference methods, and expert system development tools.
CO4: Analyze the applications of expert systems in manufacturing and industrial automation.
CO5: Apply expert system concepts to solve real-world manufacturing problems through case studies.

Unit I

Artificial Intelligence - Definition Components - Scope - Application Areas; Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques.

Unit II

Knowledge Based Systems (Expert Systems) - Definition - Justification - Structure – Characterization.

Unit III

Knowledge Sources – Expert - Knowledge Acquisition- Knowledge Representation – Knowledge Base - Inference Strategies - Forward and Backward Chaining; Expert System Languages – ES Building Tools or Shells; Typical examples of shells.

Unit IV

Expert Systems Software for Manufacturing applications in CAD, CAPP, MRP, Adaptive Control, Robotics, Process Control, Fault Diagnosis, Failure Analysis; Process Selection, GT etc. Linking Expert Systems to other software such as DBMS, MIS, MDB; Process Control and Office Automation.

Unit V

Case studies of typical applications in Tool selection, Process selection, Part classification, Inventory control, Process Planning etc.

Suggested Reading:

1. Russell, Artificial Intelligence: A Modern Approach, 2/E, Pearson Education Inc., 2009.
2. Intelligent manufacturing systems – Andrew Kusiak, Prentice Hall, 1990.
3. M. Tim Jones, Artificial Intelligence: A Systems Approach, Jones and Bartlett Publishers, Canada, 2009.
4. Robotics Technology and Flexible Automation by Deb, S.R. TMH, 1994.

Course Code	Course Title						Core/Elective
26PE5121CD	INDUSTRIAL ROBOTICS						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand the fundamentals and applications of industrial robots.
2. To develop student's skills in performing spatial transformations associated with rigid body motions using transformation matrices and forward kinematics.
3. To analyze inverse kinematics, Jacobian, singularities, and trajectory planning of robotic manipulators.
4. To evaluate the statics, dynamics, and control of robotic manipulators.
5. To understand the role of sensors and machine vision in robotic and automation

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

CO1: Understand basic concepts of industrial robotics and applicatios with different manipulator configurations.

CO2:Apply transformation matrices and DH parameters to determine the forward kinematics of robotic manipulators.

CO3: Analyze inverse kinematics, Jacobian, singularities, and trajectory planning for robotic systems.

CO4: Evaluate the statics, dynamics, and control of planar robotic manipulators using PD and PID controllers.

CO5: Apply robotic sensors and machine vision techniques for object detection and intelligent robotic applications.

UNIT-I

Fundamentals of Robotics:

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT-II

Motion Analysis and Control: Rotation matrices, Euler angle and RPY representation, Homogeneous Transformation, Denavit Hartenberg Transformation Matrix, representation of absolute position and orientation in terms of joint parameters, Forward Kinematics of standard industrial manipulators.

UNIT-III

Inverse Kinematics of 2-DOF, 3-DOF manipulators., inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks.

UNIT-IV

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, Independent joint control, PD and PID feedback, actuator models,

UNIT-V

Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic

applications, image acquisition and pre-processing. Segmentation and region characterization object recognition by image matching and based on features.

Suggested Reading:

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
4. Introduction to Robotics Mechanics and Control, John J. Craig, Pearson Education, 3 Edition, 2005.
5. Robot Analysis and Control, H. Asada and J. E. Slotine, Wiley, 2nd Edition, 2021.
6. Fundamentals of Robotics: Analysis and Control, Robert J. Schilling, Pearson Education, 2nd Edition, 2022.

Course Code	Course Title						Core/Elective
26PE5122CD	LASER BASED MICRO MANUFACTURING						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course objectives:

1. To understand the basics of laser technology and laser operation.
2. To explain laser–material interaction and material removal mechanisms.
3. To understand laser-based manufacturing and machining processes.
4. To analyze the principles and process parameters of laser drilling and laser cutting.
5. To explore laser-assisted machining, micromachining, and industrial applications.

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

CO1: Define various terms and properties related to laser radiations

CO2: Apply concept of laser material interaction for finding response parameters of materials having feasibility for ablation

CO3: Explain laser based machining processes for casting, forming, joining, and allied processes

CO4: Determine micromachining output responses considering given influencing parameters such as ablation properties, process, and techniques

CO5: Analyze quality of cut in laser drilling considering focus, assisting gases, and design of nozzle.

UNIT-I

Basics of Laser Electromagnetic radiation – Laser operation mechanism - Stimulated Emission – Amplification - Properties of Laser Radiation – Types of Laser

UNIT-II

Laser Material Interaction Absorption of Laser Radiation- Thermal Effects, Heating, melting and Vaporization – Thermal analysis – Moving source of heat - Vapor Expansion and Recoil Pressures - Plasma Formation – Material removal process Ablation

UNIT-III

Laser machining Overview of Conventional machining processes and non-conventional processes – Laser in manufacturing – Laser casting – laser forming- Laser joining – Laser machining. -materials for Laser machining. – Economic aspect for conventional and Laser machining process.

UNIT-IV

Laser Drilling Laser Drilling Approaches-Melt Expulsion-Analysis of Laser Drilling Process- Quality of holes- Laser Parameters – Focusing – Assist gases and their pressure- Nozzle design Laser cutting Evaporative Laser Cutting - Laser Fusion Cutting- Mass momentum Balance of molten material - Energy Balance for losses - Oxygen-Assistance- Controlled Fracture Technique – quality aspect –Striations effect- Dross- Heat-Affected Zone.

UNIT-V

Laser Assisted Machining Laser-Assisted Machining LAM Process Surface Finish and Integrity Machining Using Single Laser Beam- Intersecting Laser Beams- Application of 3D Laser machining 03 Hours Laser Micromachining Laser Micromachining mechanisms- Laser Ablation- Factors Influencing Ablation Rate- Ablation Damage- Laser-Assisted Chemical Etching- Micromachining Techniques- Direct Writing- Mask Projection- Interference- Combined Techniques- Laser Micromachining Applications -Laser Marking and Engraving

Suggested Reading:

1. J. Dowden. The Theory of Laser Materials processing, Springer, 2009.
2. N. B. Dahotre, S. P. Harimkar. Laser fabrication and machining of materials, Springer, 2008.
3. E. Fogarassy, D. Geohegan. Laser Ablation, Imprint North Holland Elsevier Publications, 1996.
4. J. Lawrence, D. G. Waugh. Laser surface engineering Processes and application, Wood Head Publishing Series, 2015.
5. K. Sugioka, M. Meunier, A. Piqué, Laser Precision microfabrication, Springer, 2010.

Course Code	Course Title						Core/Elective
26PE5123CD	**SURFACE ENGINEERING**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:

1. To understand the fundamentals of surface engineering, surface preparation methods, and coating technologies.
2. To explain different wear mechanisms and the selection of wear-resistant materials.
3. To understand corrosion mechanisms and methods for corrosion prevention.
4. To analyze surface modification and coating techniques for improving material performance.
5. To apply surface engineering principles to control wear, corrosion, fatigue, and material degradation.

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

CO1: Describe the principles of surface engineering, surface preparation methods, and coating classifications.

CO2: Analyze various wear mechanisms and select suitable wear-resistant materials for engineering applications.

CO3: Explain corrosion mechanisms and recommend appropriate corrosion control techniques.

CO4: Evaluate surface modification and coating processes for enhancing surface properties.

CO5: Apply appropriate surface engineering techniques to minimize material degradation and improve component performance.

UNIT-I

Introduction Surface engineering: Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coating

UNIT-II

Wear: Adhesive wear, Abrasive and erosive wear, Wear induced by mechanical fatigue of the worn surface, melting wear, fretting wear and diffusive wear, Analytical models of wear, Wear resistant materials, Fatigue, fracture and creep.

UNIT-III

Corrosion: Corrosion of metals in aqueous media: Electrochemistry and aqueous corrosion, Electrochemical corrosion of machinery and structures, Corrosion inhibitors, Materials factors in aqueous corrosion. Oxidative reactions of metals with oxygen, sulphur and other halogens.

UNIT-IV

Integral Coatings and Modified Surface Layers: Introduction, Thermally or mechanically modified surface layers: Induction hardening, Laser and electron beam surface hardening, Shot-peening, Thermochemical methods of coating: Galvanization and hot-dipping, Carburizing, carbonitriding, nitriding, nitrocarburizing & boronizing, Advanced surface modification technologies: Plasma nitriding and plasma carburization, Surface alloying by laser and electron beam, Ion implantation.

UNIT-V

Control of Materials Degradation: Introduction, Methodology of analysing materials degradation, Selection of optimal surface engineering technology, Control of wear by surface engineering, Principles of coating selection for wear resistance, Selection of specific surface engineering techniques for specific wear mechanisms, Control of corrosion by surface engineering, Control of fatigue and fracture by surface engineering.

Suggested Reading:

1. T. Burakowski, T. Wierzchon. Surface engineering of metals, CRC Press, 2020.
2. A. W. Batchelor, L. N. Lam, M. Chandrasekaran. Materials degradation and its control by surface engineering, 3rd Edition, Imperial college press, 2011.
3. L. I. Tushinsky, I. Kovensky, A. Plokhov, V. Sindeyev, P. Reshedko. Coated Metal: Structure and Properties of Metal-Coating Compositions, Springer, Germany, 2002.
4. M. Ohring. Materials Science of Thin Films, 2nd Edition, Academic Press, 2002.
5. L. I. Tushinsky, I. Kovensky, A. Plokhov, V. Sindeyev, P. Reshedko. Materials Degradation and Its Control by Surface Engineering, 3Ed Hardcover – Illustrated, February 2011.

Course Code	Course Title						Core/Elective
26PE5124CD	DIGITAL TWIN AND INDUSTRY 5.0						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand the fundamentals, applications, and enabling technologies of Digital Twin.
2. To explain the role of Digital Twin in discrete industries and product lifecycle improvement.
3. To analyze the applications of Digital Twin in process industries and process optimization.
4. To understand Industry 5.0 concepts, smart manufacturing, and related digital technologies.
5. To evaluate the benefits and industrial applications of Digital Twin for improving productivity and efficiency.

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

CO1: Describe Digital Twin concepts, architecture, and supporting technologies.
CO2: Apply Digital Twin concepts for discrete manufacturing and digital enterprise applications.
CO3: Analyze Digital Twin applications for process monitoring, safety, and optimization.
CO4: Explain Industry 5.0 principles and smart manufacturing technologies.
CO5: Assess the impact of Digital Twin on quality improvement, process efficiency, and production flexibility.

UNIT-I

Introduction to Digital Twin and Enabling Technologies: Definition of Digital Twin, types of industry and key requirements, importance and applications in process, product, and service industries, history of Digital Twin, role of Digital Twin Technology (DTT) in industrial innovation, technologies and tools enabling Digital Twin, virtual CAD models, control parameters, real-time systems, handshaking through internet, cyber-physical systems.

UNIT-II

Digital Twin in Discrete industries: Basics and trends in discrete industry, control system requirements in discrete industry, digital twin of a product, digital thread in discrete industry, data collection and analysis for product and production improvements, automation simulation, digital enterprise.

UNIT-III

Digital Twin in Process Industries: Basics and trends in process industry, control system requirements in process industry, digital twin of a plant, digital thread in process industry, data collection and analysis for process improvements, process safety, automation simulation, digital enterprise.

UNIT-IV

Industry 5.0 and Smart Manufacturing: Industrial revolutions overview, definition and principles of Industry 5.0, applications of Industry 5.0 in process and discrete industries, benefits and challenges of Industry 5.0, smart manufacturing, Internet of Things 5.0, industrial gateways, basics of communication requirements, cognitive systems in Industry 5.0.

UNIT-V

Benefits and Applications of Digital Twin: Improvement in product quality, enhancement of production processes and process safety, identifying bottlenecks and improving efficiency, achieving production flexibility, continuous prediction and tuning of processes through simulation, reducing time to market.

Suggested Reading:

1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing the Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2018
2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019
3. Uthayan Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press,2022.
4. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress., United States ,2015

E-Resources:

1. https://nptel.ac.in/courses/110/106/110106169 – NPTEL: Digital Transformation Strategy (IIT Roorkee) – includes modules on Digital Twin and smart industry practices.
2. https://www.coursera.org/learn/digital-twin – Coursera: Digital Twins: Implementation (by University of Colorado) – practical insights into Digital Twin applications.
3. https://www.edx.org/course/industry-4-0-how-to-revolutionize-your-business – edX: Industry 4.0 – covers evolution to Industry 5.0, smart factories, and Digital Twin technology.

Course Code	Course Title						Core/Elective
26PE5125CD	MACHINE LEARNING FOR INTELLIGENT SYSTEMS						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand the fundamentals of machine learning, regression techniques, and AI applications in robotics.
2. To learn classification algorithms and ensemble learning techniques for intelligent decision-making.
3. To understand clustering methods and dimensionality reduction techniques for data analysis.
4. To study neural networks, deep learning models, and their applications in robotic systems.
5. To understand reinforcement learning concepts and their applications in AI-enabled robotics.

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

CO1: Explain machine learning concepts, types, regression methods, and performance evaluation metrics.

CO2: Apply classification and ensemble learning algorithms for solving intelligent system problems.

CO3: Analyze clustering and PCA techniques for feature extraction and data reduction.

CO4: Develop understanding of neural networks and deep learning approaches for robotic applications.

CO5: Apply reinforcement learning concepts for decision-making and autonomous robotic systems.

UNIT-I

Fundamentals of Machine Learning and Regression: Introduction to Machine Learning and learning concepts, Types of Machine Learning: supervised, unsupervised, and reinforcement learning, Classification and regression problems, Evaluation metrics and loss functions for classification and regression, Linear regression and its applications, Applications of Artificial Intelligence in robotics

UNIT-II

Classification Algorithms and Ensemble Learning: Support Vector Machine (SVM) algorithm and applications, learning with decision trees, Construction of decision trees, Classification problems and examples, Ensemble learning concepts, Bagging, boosting, and random forest algorithms, Applications of ensemble methods in intelligent systems

UNIT-III

Clustering and Dimensionality Reduction: Introduction to clustering techniques, Types of clustering: Agglomerative (hierarchical) clustering, K-means clustering, K-means clustering algorithm and applications, Introduction to dimensionality Reduction-Principal Component Analysis (PCA), Feature selection using PCA, Case study: PCA-based robot guidance

UNIT-IV

Neural Networks and Deep Learning: Introduction to artificial neural networks. Perceptron model, Multi-Layer Perceptron (MLP) architecture, Backpropagation algorithm and error minimization, Practical implementation of MLP, Applications of neural networks in robotics, Introduction to deep learning, Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN)

UNIT-V

Reinforcement Learning and Robotic Applications: Introduction to reinforcement learning (RL), Reinforcement learning concepts and examples, Markov Decision Process (MDP), Components of reinforcement learning: Agent, Environment, State, Action, Reward. Learning strategies and applications: Case study: Reinforcement learning in robotics, Future trends in AI-enabled robotic systems

Suggested Reading:

1. K.S. Fu, R.C. Gonzalez, and C.S.G. Lee "Robotics: Control, Sensing, Vision, and Intelligence". McGraw-Hill, 1st Edition, 1987.
2. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar "Robot Modeling and Control". Wiley, 1st Edition, 2005.
3. John J. Craig "Introduction to Robotics: Mechanics and Control". Pearson, 4th Edition, 2017.
4. Stuart Russell and Peter Norvig "Artificial Intelligence: A Modern Approach", Pearson, 4th Edition, 2020.
5. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, and Nicholas G. Odrey, "Industrial Robotics: Technology, Programming, and Applications". Mc Graw Hill, 2nd Edition, 2012

Course Code	Course Title						Core/Elective
26PE5126CD	MEMS: DESIGN AND MANUFACTURING						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To introduce the fundamentals, design principles, and applications of MEMS devices.
2. To study microfabrication and micromachining processes used in MEMS manufacturing.
3. To understand the operation of micro sensors, micro actuators, and microstructures.
4. To explore materials, modeling, and simulation techniques for MEMS design.
5. To examine packaging, testing, and reliability aspects of MEMS products.

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

CO1: Explain the structure, working principles, and applications of MEMS devices.
CO2: Select suitable materials and fabrication techniques for MEMS manufacturing.
CO3: Analyze the design and performance of micro sensors and micro actuators.
CO4: Use modeling and simulation tools for MEMS product development.
CO5: Evaluate packaging, reliability, and industrial applications of MEMS.

UNIT-I

MEMS and Microsystems: MEMS and Microsystems, Evolution of Micro Fabrication, Microsystems and Microelectronics, Microsystems and Miniaturization, Applications of Mems in Industries, Micro Sensors, Micro Actuation, MEMS with Micro Actuators Micro Accelerometers, Micro Fluidics.

UNIT - II

Engineering Science for Microsystems: Design Atomic Structure of Matter, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics.

UNIT – III

Engineering Mechanics for Microsystems: Design Static Bending of Thin plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics and Overview of Finite Element Stress Analysis.

UNIT - IV

Thermo Fluid Engineering and Microsystems: Design Overview of Basics of Fluid Mechanics in Macro and Micro scales, Basic equations in Continuum Fluid Dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid flow in Sub micrometer and Nano scale, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin films and solids in Sub Micrometer Scale, Design Considerations, Process Design Mechanical Design, Mechanical design using FEM, Design of a Silicon Die for a Micro pressure sensor.

UNIT - V

Materials for MEMS and Microsystems: Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, Chemical and Physical vapor deposition, etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process.

Suggested Reading:

1. MEMS and Microsystems: Design and Manufacturing, Tia-Ran Hsu, Tata McGraw-Hill, 1st Edition, 2002.
2. Foundations of MEMS, Chang Liu, Pearson Education, 2nd Edition, 2012.
3. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Artech House, 1st Edition, 2000.
4. Micro Robots and Micromechanical Systems, W.S.N. Trimmer, Sensors and Actuators, Volume 19, 1989.
5. Applied Partial Differential Equations, D.W. Trim, PWS-Kent Publishing, Boston, 1st Edition, 1990.
6. MEMS: Introduction and Fundamentals, Mohamed Gad-el-Hak, CRC Press, 3rd Edition, 2022.
7. Microelectromechanical Systems: Design and Analysis, Tai-Ran Hsu, John Wiley and Sons, 2nd Edition, 2023.
8. Design and Development Methodologies for MEMS and Microfluidic Devices, Paul Kirby and Philip LeDuc, Elsevier, 1st Edition, 2022.

Course Code	Course Title						Core/Elective
26SD5125ME	RESEARCH METHODOLOGY AND IPR						Mandatory Course
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand research concepts, objectives, motivation, and significance.
2. To develop skills in literature review, research reporting, and proposal writing.
3. To apply research design, experimental methods, and sampling techniques.
4. To analyze data using collection methods and statistical tools.
5. To understand IPR, patents, licensing, and technology transfer processes.

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

CO1: Define research problem, review and asses the quality of literature from various sources

CO2: Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various research designs

CO3: Collect the data by various methods: observation, interview, questionnaires

CO4: Analyse problem by statistical techniques: ANOVA, F-test, Chi-square

CO5: Understand and apply for patent and copyrights.

UNIT - I

Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods Verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem

UNIT - II

Literature Survey and Report writing: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Need of Review, Guidelines for Review, Record of Research Review. Report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanism of writing a report. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

UNIT - III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, developing a Research Plan, Steps in sample design, types of sample designs.

UNIT - IV

Data Collection and Analysis: Methods of data collection, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Importance of Parametric, non-parametric test, testing of variance of two normal populations, use of Chi-square, ANOVA, F-test, z-test.

UNIT - V

Intellectual Property Rights: Meaning, Nature, Classification and protection of Intellectual Property, the main forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, granting of patent, Rights of a patent, Licensing, Transfer of technology.

Suggested Readings:

1. C.R Kothari, Research Methodology, Methods & Technique‖; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers‖, MJP Publishers, 2011
3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation‖, Sterling Publications Pvt. Ltd., New Delhi, 2004
4. G.B. Reddy, Intellectual Property Rights and the Law 5th Ed. 2005 Gogia Law Agency
5. Ajit Parulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd, 2006.

Course Code	Course Title						Core/Elective
26PC5151CD	ADVANCED CAD LAB						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	3	40	60	1.5

Course Objectives:

1. To understand surface, sheet metal, and solid modelling concepts and commands.
2. To create 2D/3D part models using surface, sheet metal, and solid modelling tools.
3. To apply constraints, modifications, and assembly features for component development.
4. To develop assemblies and manage assembly features using CAD tools.
5. To generate engineering drawings with dimensioning, sectional views, and annotations.

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

CO1: Apply surface modeling commands to create engineering components using CAD software.
CO2: Develop sheet metal components using appropriate modeling tools and manufacturing features.
CO3: Create solid models of mechanical parts using standard solid modeling techniques.
CO4: Assemble multiple part models using assembly constraints and perform basic assembly modifications.
CO5: Generate detailed engineering drawings with dimensions, sectional views, and annotations following drafting standards.

List of Exercises:

1. Understand the various commands related to surface modelling
2. Create 2/3 components of using the surface modelling commands
3. Understand the various commands related to sheet metal modelling
4. Create components using sheet metal modelling and understand the significance of sheet metal components
5. Introduction to solid modelling various commands
6. Creation of various parts of 2 or 3 components
7. Creation of part models using constraints, part modifications.
8. Creation of Assemblies and their commands
9. Adding another assembly features – display
10. Creation of engineering drawing details such as dimensioning, sectional views, adding aesthetics

Course Code	Course Title						Core/Elective
26PC5152CD	CAM AND AUTOMATION LAB						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	3	40	60	1.5

Course Objectives:

1. To understand CNC machines, programming concepts, and manufacturing processes.
2. To develop CNC part programs for turning, milling, and contouring operations.
3. To apply CAM tools for NC code generation and CNC simulation.
4. To implement PLC programming, automation systems, and machine integration.
5. To manufacture components using CNC and additive manufacturing techniques.

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

CO1: Perform CNC turning and milling operations by developing and executing part programs.

CO2: Generate and simulate NC programs using CAM software for machining applications.

CO3: Develop PLC programs to implement basic logic operations, latching, and timer-based control systems.

CO4: Integrate CNC machines, robots, and material handling systems for automated manufacturing applications.

CO5: Fabricate engineering components using 3D printing technology and evaluate additive manufacturing processes.

List of Exercises:

Understanding of CNC Machines and CNC Programming and Creation of

1. Facing, turning on CNC lathe machine.
2. Step turning, taper turning on CNC lathe machine.
3. Contouring on CNC lathe machine.
4. Pocketing and contouring on CNC milling machine.
5. Simulation and development of NC code using any CAM software.
6. Programming for integration of various CNC machines, robots and material handling systems.
7. Implementation of Logic gates (AND, OR, XOR, NAND) using PLC
8. PLC program to Latch and Unlatch output with time delay
9. Component 1 manufacturing using 3D printing
10. Component 2 manufacturing using 3D printing.

Course Code	Course Title						Core/Elective
26PC5156CD	ADVANCED COMPUTATIONAL LAB						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	3	40	60	1.5

Course Objectives:

1. To understand finite element analysis concepts and ANSYS software applications.
2. To perform structural analysis of mechanical components using FEA techniques.
3. To analyze thermal, modal, harmonic, and buckling behavior of engineering structures.
4. To apply coupled field and CFD analysis methods for engineering problems.
5. To evaluate stresses, deformations, and performance of mechanical systems using simulation tools.

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

CO1: Gain knowledge of different types of analyses available in ANSYS.
CO2: Perform simulations of static analysis on mechanical components using ANSYS
CO3: Analyze the dynamic behavior and properties of engineering components.
CO4: Analyze the thermal behavior and properties of mechanical components.
CO5: Perform CFD analysis on various profiles using ANSYS

List of Exercises:

1. Introduction of Finite Element Analysis Software (Ansys)
2. To determine the nodal deflection, elements stresses and strain for the basic Linked (bar & Truss) element.
3. To determine the deflection, shear force and bending moment of the cantilever and simply supported beams.
4. To perform static analysis of a corner bracket.
5. To perform stress analysis of rectangular plate with one & multiple holes using plane stress conditions
6. To perform analysis of a circular plate using axisymmetric shell element
7. To determine steady state thermal analysis on circular rod / Composite wall / fins
8. To determine un-steady state thermal analysis on circular rod / Composite wall / fins
9. To perform modal analysis / harmonic analysis on cantilever beam
10. To perform buckling analysis on hallow shaft or cylinder
11. To perform structural and thermal analysis on a structure (Couple filed analysis)
12. To perform CFD analysis on airfoil profile structure.

Note: At least 10 Experiments are to be conducted using ANSYS or any simulation software.

Course Code	Course Title						Core/Elective
26PW5153CD	SEMINAR						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	3	50	-	1.5

Course Objectives:

1. To explore recent developments through literature survey and technical reading.
2. To analyze research papers and consolidate relevant technical information.
3. To develop structured seminar presentations and technical reports.
4. To communicate technical concepts effectively through presentations and discussions.
5. To evaluate research outcomes, conclusions, and future scope in the selected domain.

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

CO1: Develop the habit of referring the journals for literature review.
CO2: Understand the gist of the research paper.
CO3: Identify the potential for further scope.
CO4: Present the work in an efficient manner.
CO5: Write the documentation in standard format.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.
The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

Course Code	Course Title						Core/Elective
26PW5128CD	**MINI PROJECT**						**Core**
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
-	**-**	**-**	**-**	**6**	**40**	**60**	**3**

Course Objectives:

1. To develop research skills through literature review, problem identification, and project planning.
2. To apply research techniques in mathematical, experimental, or numerical investigations.
3. To execute interdisciplinary and industry-relevant mini projects under faculty guidance.
4. To analyze results and document findings with proper technical justification.
5. To present project outcomes through reports, discussions, and technical presentations.

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

CO1: Formulate a specific problem and give solution
CO2: Develop model/models either theoretical/practical/numerical form
CO3: Solve, interpret/correlate the results and discussions
CO4: Conclude the results obtained
CO5: Write the documentation in standard format

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter-disciplinary/ industry relevance.
- The students can select a mathematical modelling based/Experimental investigations or Numerical modelling
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference

Departmental committee: Supervisor and a minimum of two faculty members

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

Course Code	Course Title						Core/Elective
26PW5212CD	MAJOR PROJECT PHASE DISSERTATION – I						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	20	40	60	10

Course Objectives:

1. To develop research-oriented project skills through problem identification and analysis.
2. To conduct literature reviews and formulate research problems with objectives.
3. To apply scientific, design, and data analysis techniques for solving problems.
4. To document research outcomes through reports and preliminary findings.
5. To present dissertation work effectively through technical presentations and discussions.

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

CO1: Exposed to self-learning various topics.

CO2: Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.

CO3: Learn to write technical reports.

CO4: Develop oral and written communication skills to present.

CO5: Defend their work in front of technically qualified audience

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, Osmania University and Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

Course Code	Course Title						Core/Elective
26PW5221CD	MAJOR PROJECT PHASE DISSERTATION – II						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	32	50	150	16

Course Objectives:

1. To execute research projects through systematic methodology and analysis.
2. To develop comprehensive project reports with literature review, methodology, and results.
3. To apply experimental or numerical techniques for solving engineering problems.
4. To analyze outcomes, draw conclusions, and identify future scope of work.
5. To present project findings through technical reports and seminars.

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

CO1: Use different experimental techniques and will be able to use different software/ computational /analytical tools.

CO2: Design and develop an experimental set up/ equipment/test rig.

CO3: Conduct tests on existing set ups / equipment's and draw logical conclusions from the results after analyzing them.

CO4: Either work in a research environment or in an industrial environment.

CO5: Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester - III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head, Osmania University and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS & Head, Osmania University (All together)	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce0

Course Code	Course Title						Core/Elective
26OE9101CE	COST MANAGEMENT OF ENGINEERING PROJECTS						Open Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand cost concepts, costing systems, and their role in decision-making and operational control.
2. To learn project planning, execution, cost control, and commissioning processes.
3. To apply cost analysis techniques, profit planning methods, and strategic costing approaches.
4. To understand activity-based cost management, budgeting techniques, and performance measurement systems.
5. To apply quantitative techniques for effective cost management and decision-making.

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

CO1: Explain cost concepts, inventory valuation methods, and costing systems for managerial decisions.

CO2: Analyze project execution stages, cost control methods, and project management practices.

CO3: Apply marginal costing, CVP analysis, variance analysis, and strategic cost management techniques.

CO4: Evaluate cost management tools, budgeting methods, and organizational performance measurement techniques.

CO5: Apply quantitative methods such as LPP, PERT/CPM, transportation, assignment, simulation, and learning curve techniques for cost optimization.

UNIT-I

Introduction and Overview of the Strategic Cost Management Process: Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision- Making.

UNIT-II

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. **Importance Project site**: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT-III

Cost Behaviour and Profit Planning Marginal Costing: Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

UNIT-IV

Activity-Based Cost Management: Bench Marking; Balanced Score Card and Value-Chain Analysis.

Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT-V

Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Readings:

1. Cost Accounting – A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.

Course Code	Course Title						Core/Elective
26OE9102CS	BUSINESS ANALYTICS						Open Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To understand the fundamentals, scope, process, and statistical tools used in business analytics.
2. To learn data visualization, regression analysis, and business analytics technologies for decision-making.
3. To understand analytics management, data mining, and predictive and prescriptive analytics techniques.
4. To study forecasting methods, simulation techniques, and risk analysis models for business applications.
5. To apply decision analysis techniques and understand emerging trends in business intelligence and analytics.

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

CO1: Explain business analytics processes, applications, and basic statistical methods.

CO2: Apply regression techniques, data exploration, and visualization methods for business problems.

CO3: Analyze predictive, prescriptive, and data mining approaches for effective business decisions.

CO4: Apply forecasting models and simulation techniques for prediction and risk assessment.

CO5: Apply decision analysis methods and evaluate recent trends in business intelligence and data analytics.

UNIT-I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT-II

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

UNIT-III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT-IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform,

New- Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT-V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without 8 Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Recent Trends in Embedded and collaborative business intelligence, Visual data 4 recovery, Data Storytelling and Data journalism.

Suggested Readings:

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

Course Code	Course Title						Core/Elective
26O9103EC	EMBEDDED SYSTEM DESIGN						Open Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To detailed overview of important concepts of Embedded system
2. To analyse PIC microcontroller, its features and programming
3. To describe ARM Microcontroller architectural details and instruction set
4. To understand ARM Memory management
5. To learn the techniques to develop an embedded system and case studies

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

CO1: Understand the fundamentals of the embedded system design
CO2: Enumerate the instruction set of ARM Processor by studying the architecture of ARM core
CO3: Acquire knowledge on the serial, parallel and network communication protocols.
CO4: Learn the embedded system design life cycle and co-design issues.
CO5: List the various embedded software development tools used in the design of embedded system for various applications.

UNIT I

Introduction to Embedded Systems: Overview of Embedded System Architecture, Challenges & Trends of Embedded Systems, Hardware Architecture, Software Architecture. Application areas of Embedded Systems and Categories of Embedded Systems. Embedded System Design and Co-Design issues and Design Cycle Process

UNIT II

PIC 18: Family Overview, Architecture, Instruction Set, Addressing modes. Timers, interrupts of PIC 18, Capture/Compare and PWM modules of PIC 18

UNIT III

ARM Architecture: ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families. Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions.

UNIT IV

ARM Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instruction Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions. Exception and interrupt handling.

ARM Memory Management: Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation Access Permissions, Context Switch.

UNIT V

Embedded Software Development Tools, Host and Target Machines, Linkers/Locators for Embedded Software, Getting Embedded Software into the Target System. Debugging Techniques.

Case Studies: Design of Embedded Systems using Microcontrollers – for applications in the area of communications and automotives. (GSM/GPRS, CAN, Zigbee)

Suggested Readings:

1. Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd Edition, TMH, 2008.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM Systems Developer's Guides – Designing

& Optimizing System Software, Elsevier, 2008.
3. Mazidi, MCKinlay and Danny Causey, PIC Microcontrollers and Embedded Systems, Pearson Education, 2007
4. David.E. Simon, An Embedded Software Primer, 1st Edition, Pearson Education, 1999
5. Jonathan W. Valvano, Embedded Microcomputer Systems, Real Time Interfacing, Thomas Learning, 1999.

Course Code	Course Title						Core/Elective
26OE9104EE	Waste to Energy						Open Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. Understand biomass resources and waste-to-energy technologies.
2. Learn biomass gasification systems and their applications.
3. Understand biomass combustion systems and improved stoves.
4. Study biogas technology and biomass conversion processes.
5. Explore biofuels, waste-to-energy, and biomass energy programs.

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

CO1: Classify biomass resources and waste-to-energy processes.

CO2: Explain biomass gasification systems and applications.

CO3: Describe biomass combustion systems and their operation.

CO4: Explain biogas systems and biomass conversion methods.

CO5: Describe biofuel production and biomass energy applications.

UNIT-I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors. Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-II

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-III

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-IV

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction

UNIT-V

Biochemical conversion: Anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Readings:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book, Khandelwal, K. C. and Mahdi, S. S., Vol. I &

II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Code	Course Title						Core/Elective
26OE9105ME	INDUSTRIAL SAFETY						Open Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

1. To apply knowledge of causes of industrial accidents and implement effective preventive measures.
2. To use fundamental principles of Maintenance Engineering to improve industrial reliability.
3. To identify and apply methods to prevent wear and corrosion in industrial equipment.
4. To demonstrate fault tracing techniques to diagnose problems in machinery.
5. To implement periodic and preventive maintenance procedures for various industrial machines and equipment.

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

CO1: Apply concepts of engineering systems safety in industrial environments.
CO2: Identify causes of industrial accidents and implement appropriate preventive actions.
CO3: Use basic tools and techniques required for different maintenance processes.
CO4: Apply methods to reduce and prevent wear and corrosion in industrial settings.
CO5: Identify faults in equipment such as machine tools, IC engines, and boilers. Implement periodic and preventive maintenance strategies for industrial machinery including motors, pumps, compressors, and machine tools.

Unit-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety colour codes. Fire prevention and firefighting, equipment and methods.

Unit-II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Suggested Readings:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company
3. Pump-hydraulic Compressors, Audels, McGraw Hill Publication
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London

Course Code	Course Title						Core/Elective
26AD9001HS	ENGLISH FOR RESEARCH PAPER WRITING						Audit I
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	2	-	-	-	50	-	0

Course Objectives:

1. To understand the fundamentals, purpose, scope, and significance of academic research writing.
2. To learn the structure, formatting, citation, and indexing requirements of a research paper.
3. To understand research methodologies, literature review, and ethical practices in research writing.
4. To develop skills to write, organize, revise, and finalize a quality research paper.
5. To understand the research publication process and develop effective research presentation skills.

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

CO1: Explain the concepts, objectives, and importance of academic research writing.
CO2: Prepare research papers following standard formatting, citation, and referencing guidelines.
CO3: Apply appropriate research methods, conduct literature reviews, and maintain academic integrity.
CO4: Develop and refine a research paper through drafting, editing, and proofreading.
CO5: Identify suitable journals for publication and deliver effective research presentations using appropriate communication techniques.

UNIT - I

Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.

UNIT - II

Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

UNIT - III

Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

UNIT - IV

Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft –Revising/Editing - The final draft and proof reading.

UNIT - V

Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – Advantages/Benefits

Presentation Skills: Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

Suggested Readings:

1. C. R Kothari, Gaurav, Garg, ―Research Methodology Methods and Techniques‖, 4/e, New Age International Publishers.
2. Day R, ―How to Write and Publish a Scientific Paper**",** Cambridge University Press, 2006

3. MLA Hand book for writers of Research Papers‖, 7/e, East West Press Pvt. Ltd, New Delhi
4. Lauri Rozakis, Schaum's, Quick Guide to Writing Great Research Papers‖, Tata McGraw Hills Pvt. Ltd, New Delhi.

Course Code	Course Title						Core/Elective
26AD9002CE	DISASTER MANAGEMENT						Audit I
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	2	-	-	-	50	-	0

Course Objectives:

1. To understand the concepts, types, and characteristics of disasters and hazards.
2. To explain the causes, impacts, and consequences of natural and man-made disasters.
3. To identify disaster-prone regions in India and understand their associated hazards.
4. To learn disaster preparedness, monitoring, risk evaluation, and community response strategies.
5. To understand disaster risk reduction, mitigation strategies, and disaster management programs in India.

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

CO1: Explain the fundamentals of disasters, hazards, and their classifications.
CO2: Analyze the impacts of natural and man-made disasters on society and the environment.
CO3: Assess disaster vulnerability in different regions of India and identify major hazard zones.
CO4: Apply disaster preparedness and risk assessment techniques using modern tools and community participation.
CO5: Evaluate disaster risk reduction and mitigation strategies for effective disaster management.

UNIT-I

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT-III

Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT-IV

Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation,

Programs of Disaster Mitigation in India.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal Book Company.
2. Sahni, Pardeep (Eds.), "Disaster Mitigation Experiences and Reflections", PHI, New Delhi.
3. Goel S. L., "Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Course Code	Course Title						Core/Elective
26AD9003HS	SANSKRIT FOR TECHNICAL KNOWLEDGE						Audit I
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	2	-	-	-	50	-	0

Course Objectives:

1. To understand the fundamentals of the Sanskrit language, grammar, and sentence construction.
2. To explore the contributions of Sanskrit literature to basic sciences and mathematics.
3. To understand the role of Sanskrit in the development of civil, mechanical, electrical, and electronics engineering concepts.
4. To examine the relationship between Sanskrit and computer science, including programming and computational logic.
5. To understand the contributions of Sanskrit to biotechnology and chemical engineering concepts.

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

CO1: Demonstrate basic knowledge of Sanskrit grammar, vocabulary, and simple sentence formation.
CO2: Explain the contributions of Sanskrit texts to mathematics and basic sciences.
CO3: Describe the applications of Sanskrit knowledge in engineering disciplines.
CO4: Analyze the relevance of Sanskrit concepts in computer science and information technology.
CO5: Explain the role of Sanskrit in biotechnology and chemical engineering and its relevance to modern scientific developments.

UNIT-I

Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa- parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)

UNIT-II

Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series).
The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).

UNIT-III

Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):

Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower-Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)

UNIT-IV

Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vedic command words- analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.

UNIT-V

Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthi yanthram.

Suggested Readings:

1. M Krishnamachariar, History of Classical Sanskrit Literature, TTD Press, 1937.
2. M.R. Kale, A Higher Sanskrit Grammar: For the Use of School and College Students, Motilal Banarsidass Publishers, 2015.
3. Kapail Kapoor, Language, Linguistics and Literature: The Indian Perspective, ISBN- 10: 8171880649, 1994.
4. Pride of India, Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5. Shri Rama Verma, Vedas the source of ultimate science, Nag publishers, 2005.

Course Code	Course Title						Core/Elective
26AD9004HS	VALUE EDUCATION						Audit I
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	2	-	-	-	50	-	0

Course Objectives:

1. To understand the concepts of human values, ethics, morals, and their significance in personal and social life.
2. To develop self-management skills and cultivate ethical values for personal growth.
3. To understand the importance of spiritual outlook and social values in personality development.
4. To explore value-based teachings from holy books and their relevance to ethical living.
5. To understand the concepts of Dharma, Karma, Guna, and their role in character building.

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

CO1: Explain the principles of human values, ethics, and moral behaviour.
CO2: Demonstrate self-management skills and ethical values in personal and professional life.
CO3: Apply social and spiritual values to promote positive behaviour and harmonious relationships.
CO4: Analyze value-based teachings from holy books and their application in everyday life.
CO5: Interpret the concepts of Dharma, Karma, and Guna for ethical decision-making and responsible conduct.

UNIT-I

Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.

UNIT-II

Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT-III

Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.

UNIT-IV

Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

UNIT-V

Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

Suggested Readings:

1. Chakroborty, S.K., Values & Ethics for organizations Theory and practice‖, Oxford University Press,
   New Delhi, 1998.

2. Jaya Dayal Goyandaka, Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur, 2017.

Course Code	Course Title						Core/Elective
26AD9011HS	**CONSTITUTION OF INDIA AND FUNDAMENTAL RIGHTS**						**Audit II**
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
-	**2**	**-**	**-**	**-**	**50**	**-**	**0**

Course Objectives

1. To provide knowledge about the historical background and making of the Indian Constitution.
2. To develop an understanding of the fundamental rights, duties, and directive principles of state policy.
3. To familiarize students with the structure, powers, and functions of the main organs of governance.
4. To introduce the framework of local administration and the importance of grassroots democracy.
5. To create awareness about the role of the Election Commission and welfare institutions for marginalized groups.

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

CO1: Explain the historical development, philosophy, and salient features of the Indian Constitution.

CO2: Demonstrate understanding of fundamental rights, duties, and directive principles.

CO3: Describe the composition, powers, and functions of Parliament, Executive, and Judiciary.

CO4: Analyze the roles and responsibilities of officials in local governance and the significance of grassroots democracy.

CO5: Evaluate the role of the Election Commission and welfare bodies in promoting equality and social justice.

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: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: 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 Readings:

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						Core/Elective
26AD9012HS	PEDAGOGY STUDIES						Audit II
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	2	-	-	-	50	-	0

Course Objectives:

1. To present the basic concepts of design and policies of pedagogy studies.
2. To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. To familiarize various theories of learning and their connection to teaching practice.
4. To create awareness about the practices followed by DFID, other agencies and other researchers.
5. To provide understanding of critical evidence gaps that guides the professional development

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

CO1: Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.

CO2: Examine the effectiveness of pedagogical practices.

CO3: Understand the concept, characteristics and types of educational research and perspectives of research.

CO4: Describe the role of classroom practices, curriculum and barriers to learning.

CO5: Understand Research gaps and learn the future directions.

UNIT-I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT-II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT-III

Evidence on the Effectiveness of Pedagogical Practices: Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT-IV

Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT-V

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

Suggested Readings:

1. Ackers J, Hardman F, Classroom Interaction in Kenyan Primary Schools, Compare‖, 31 (2): 245 – 261, 2001.
2. Agarwal M, Curricular Reform in Schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3. Akyeampong K, Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER), Country Report 1. London: DFID, 2003.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J, Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count? International Journal Educational Development, 33 (3): 272- 282, 2013.
5. Alexander R J, Culture and Pedagogy: International Comparisons in Primary Education, Oxford and Boston: Blackwell, 2001.
6. Chavan M, Read India: A mass scale, rapid, learning to read campaign, 2003.

Course Code	Course Title						Core/Elective
26AD9013HS	**STRESS MANAGEMENT BY YOGA**						**Audit II**
Prerequisite	**Contact Hours per Week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
-	**2**	**-**	**-**	**-**	**50**	**-**	**0**

Course Objectives:

1. To understand the fundamentals, history, and principles of Yoga.
2. To understand the concepts of stress, its types, and stress management techniques.
3. To learn the yogic approach to stress assessment and management through yoga practices.
4. To practice basic yoga asanas for physical fitness and mental well-being.
5. To develop skills in pranayama and meditation techniques for relaxation and stress reduction.

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

CO1: Explain the concepts, history, and principles of Yoga.
CO2: Identify different types of stress and apply basic stress management principles.
CO3: Apply yoga-based techniques such as asanas, pranayama, and meditation for stress management.
CO4: Demonstrate the practice of fundamental yoga asanas with correct posture and technique.
CO5: Perform basic pranayama and meditation practices to enhance physical and mental well-being.

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, Pranayama and 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 Readings:

1. "Yogic Asanas for Group Training - Part-I", Janardhan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, "Rajayoga or Conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.
3. Nagendra H.R and Nagaratna R, "Yoga Perspective in Stress Management", Swami Vivekananda Yoga Prakashan, Bangalore.

Course Code	Course Title						Core/Elective
26AD9014HS	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS						Audit II
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	2	-	-	-	50	-	0

Course Objectives:

1. To understand the ethical values and virtues presented in *Neetisatakam*.
2. To develop a disciplined and responsible approach towards personal and professional life.
3. To interpret the teachings of the *Bhagavad Gita* for holistic personality development.
4. To apply the principles of self-management, emotional balance, and ethical decision-making.
5. To appreciate the relevance of the *Bhagavad Gita* in addressing contemporary personal and societal challenges.

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

CO1: Explain the moral values, wisdom, virtues, and ethical principles discussed in Neetisatakam.

CO2: Demonstrate responsible behavior and positive attitudes in day-to-day life based on ethical teachings.

CO3: Interpret key concepts of the Bhagavad Gita related to self-discipline, duty, and personality development.

CO4: Apply the teachings of the Bhagavad Gita to improve emotional stability, leadership, and decision-making.

CO5: Analyze the relevance of the Bhagavad Gita in promoting ethical living and holistic development in the present-day context.

UNIT - I

Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT - II

Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT - III

Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT - IV

Statements of Basic Knowledge - Shrimad Bhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT - V

Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Readings:

1. Srimad Bhagavad Gita, Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Online Resources: NTPEL: http://nptel.ac.in/downloads/109104115/