Scheme of Instruction & Syllabi

(In line with AICTE Model Curriculum with effect from AY 2025-26)

MASTERS OF ENGINEERING

I to IV SEMESTERS

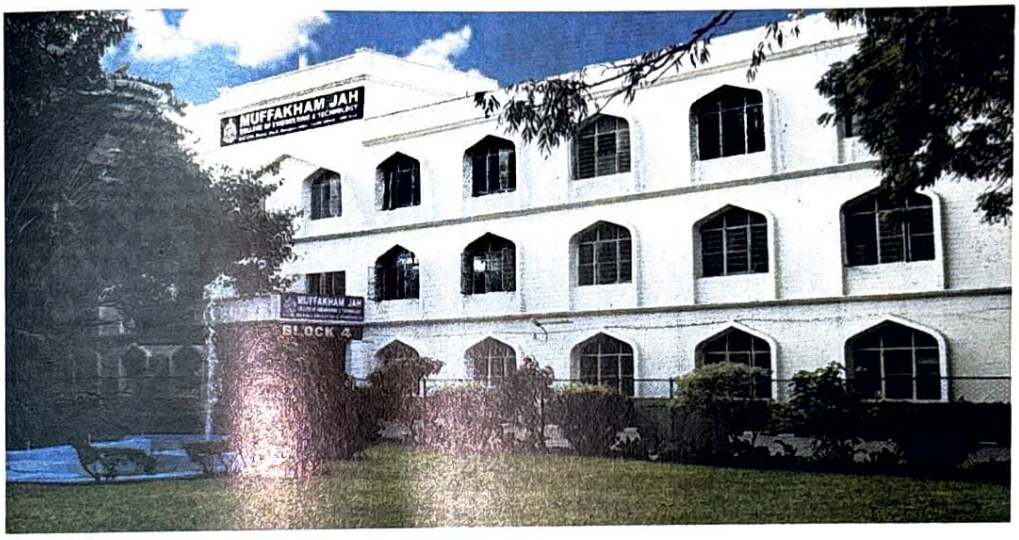
TWO YEAR POST GRADUATE DEGREE PROGRAMME

IN

MECHANICAL ENGINEERING

Specialization in CAD/CAM

(R–25 Regulation)



MUFFAKHAM JAH COLLEGE OF ENGINEERING & TECHNOLOGY

An Autonomous Institution

Affiliated to Osmania University, Approved by AICTE,

Accredited by NBA & NAAC (A+)

Mount Pleasant, 8-2-249 to 267, Road No.3, Banjara Hills,

Hyderabad– 500 034, Telangana, India

Website: www.mjcollege.ac.in, E-Mail: principal@mjcollege.ac.in,

Phone Nos.: 040-22280301 / 305

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Board of Studies in Mechanical Engineering
Muffakham Jah College of Engg. & Tech. (Autonomous)
Road No. 3, Banjara Hills, Hyderabad-34, (T.G.)

MECHANICAL ENGINEERING DEPARTMENT
M.E. - CAD/CAM

SCHEME OF INSTRUCTION & EXAMINATION
(In line with AICTE Model Curriculum with effect from AY 2025-26)

SEMESTER - 1			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	25PC5101CD	Computer Aided Modelling and Design	3	-	-	3	40	60	3	3
2	25PC5102CD	Computer Integrated Manufacturing	3	-	-	3	40	60	3	3
3	25PE51XXCD	Professional Elective – I	3	-	-	3	40	60	3	3
4	25PE51XXCD	Professional Elective – II	3	-	-	3	40	60	3	3
5	25MC5161ME	Research Methodology & Intellectual Property Rights	3	-	-	3	40	60	3	3
6	25AD900XXX	Audit Course – I	2	1	-	3	50	-	-	0
7	25PC5151CD	Advanced CAD Lab	-	-	3	3	50	-	3	1.5
8	25PC5154CD	Seminar	-	-	3	3	50	-	3	1.5
		Total	**17**	**01**	**06**	**24**	**350**	**300**		**18**

SEMESTER - 2			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	25PC5103CD	Computer Aided Mechanical Design and Analysis	3	-	-	3	40	60	3	3
2	25PC5104CD	Finite Element Techniques	3	-	-	3	40	60	3	3
3	25PE51XXCD	Professional Elective – III	3	-	-	3	40	60	3	3
4	25OE910XXX	Open Elective	3	-	-	3	40	60	3	3
5	25AD901XHS	Audit Course – II	2	1	-	3	50	-	-	0
6	25PC5152CD	CAM and Automation Lab	-	-	3	3	50	-	3	1.5
7	25PC5153CD	Computational Lab	-	-	3	3	50	-	3	1.5
8	25PC5155CD	Mini Project with Seminar	-	-	6	6	50	-	3	3
		Total	**14**	**01**	**12**	**27**	**360**	**240**		**18**

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SEMESTER - 3			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	25PE51XXCD	Professional Elective – IV	3	-	-	3	40	60	3	3
2	25PE51XXCD	Professional Elective – V	3	-	-	3	40	60	3	3
3	25PC5156CD	Major Project Phase-I	-	-	20	20	100	-	3	10
		Total	**06**	**-**	**20**	**26**	**180**	**120**		**16**

SEMESTER - 4			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	25PC5157CD	Major Project Phase-II (Dissertation)	-	-	32	32	-	200	3	16
		Total	**-**	**-**	**32**	**32**	**-**	**200**		**16**

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

Note:

1. Each contact hour is a Clock Hour.
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a Particular laboratory.
3. The students who are willing to register for MOOCs in the M.E. (ME) III – semester Instead of Professional Electives – IV & V, should register for those of the courses, approved by the CBoS, OU and respective college MOOCs Coordinator. Those students are strictly not permitted to appear for either CIE or SEE of Professional Electives – IV & V if they abstain from attending the semester classwork. Further, for students willing to appear for both MOOCS and Professional Electives, they should fulfil the minimum attendance criteria.

List of Subjects of Open Elective

S. No.	Course Code	Course Title
1	25OE9101CE	Cost Management of Engineering Projects
2	25OE9102CS	Business Analytics
3	25OE9103EC	Embedded System Design
4	25OE9104EE	Waste to Energy
5	25OE9105ME**	Industrial Safety

Note: ** Open Elective Subject is not offered to the students of Mechanical Engineering Department.

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List of Subjects of Professional Electives I to V

S. No.	Course Code	Course Title
1	25PE5116CD	Product Design and Process Planning
2	25PE5117CD	Design for Manufacture
3	25PE5118CD	Mechanics of Composite Materials
4	25PE5119CD	Optimization Techniques
5	25PE5120CD	Design of Press Tools
6	25PE5121CD	Additive Manufacturing Technologies & Applications
7	25PE5122CD	Fracture Mechanics
8	25PE5123CD	Experimental Techniques and Data Analysis
9	25PE5124CD	Mechanical Vibrations
10	25PE5125CD	Computational Fluid Dynamics
11	25PE5126CD	Robotic Engineering
12	25PE5127CD	Advanced Metrology
13	25PE5128CD	Control of Dynamic Systems
14	25PE5129CD	Advanced Materials Technology
15	25PE5130CD	Failure Analysis and Design

List of Subjects of Audit Course-I

S. No.	Course Code	Course Title
1	25AD9001HS	English for Research Paper Writing
2	25AD9002CE	Disaster Management
3	25AD9003HS	Sanskrit for Technical Knowledge
4	25AD9004HS	Value Education

List of Subjects of Audit Course-II

S. No.	Course Code	Course Title
1	25AD9011HS	Constitution of India and Fundamental Rights
2	25AD9012HS	Pedagogy Studies
3	25AD9013HS	Stress Management by Yoga
4	25AD9014HS	Personality Development through life Enlightenment Skills

Semester Wise Distribution of Credits:

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

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Course Code	Course Title				Core/Elective		
25 PC 5101 CD	**Computer Aided Modeling and Design**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To introduce the fundamentals of CAD systems and to understand geometric modelling concepts including 2D/3D entities, primitives, and transformations.
- To develop knowledge of wireframe, surface, and solid modelling techniques used in product design.
- To explore advanced modelling concepts such as feature-based, assembly, behavioural, and top-down design.
- To familiarize students with international data exchange standards such as IGES, PDES, STL, and STEP.
- To understand the principles of dimensioning, geometric tolerances, and surface finish in CAD models.

Course Outcomes

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

CO1: Apply geometric modelling concepts and perform 2D/3D transformations for engineering entities.

CO2: Construct wireframe models using analytic and synthetic curve/surface representations.

CO3: Construct surface models using analytic and synthetic curve/surface representations.

CO4: Develop solid models using techniques such as Boolean operations, B-Rep, and CSG and Integrate advanced modelling approaches in product development

CO5: Utilize standard data exchange formats for model sharing and interoperability and Demonstrate appropriate geometric tolerances and surface finish in CAD models.

UNIT-I

Introduction to CAD: Criteria for selection of CAD workstations, Shigley Design Process, Design criteria, Geometric modeling, entities, 2D & 3D Primitives. 2D & 3D Geometric Transformations: Translation, Scaling, Rotation, Reflection and Shearing, concatenation.

UNIT-II

Wire frame modeling: Curves: Curve representation. Analytic curves – lines, Circles, Ellipse, Conics. Synthetic curves – Cubic, Bezier, B-Spline, NURBS.

UNIT-III

Surface Modeling: Surface entities, Surface Representation. Analytic Surface – Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Synthetic Surface-Cubic, Bezier, B-spline, Coons.

UNIT-IV

Solid Modeling Techniques: Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration, Boundary Representation (B-rep) & Constructive Solid Geometry (CSG).

Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioral Modeling, Conceptual Design & Top Down Design.

UNIT-V

Data exchange formats: IGES, PDES, STL, STEP.

Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Geometric tolerances and Surface finish.

Suggested Reading:

1. Ibrahim Zeid, CAD/CAM, Theory and Practice, Mc Graw Hill, 1998.
2. Foley, Van Dam, Feiner and Hughes, Computer Graphics Principles and Practice, 2nd Ed., Addison – Wesley, 2000.
3. Martenson, E. Micheal, Geometric Modelling, John Wiley & Sons, 1995.
4. Hill Jr, F.S., Computer Graphics using open GL, Pearson Education, 2003.
5. P.N. Reddy, Taj Reddy and C. Srinivas Rao, Production Drawing Practice, The HI-TECH Publishers, 2002.

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Course Code	Course Title						Core/Elective
25 PC 5102 CD	**Computer Integrated Manufacturing**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To Understand why CIM is needed, how it has developed over time, its basic principles, and the idea of Concurrent Engineering.
- To Learn about the role of database management in CIM and get to know different CIM technologies and systems like DFMA, CAPP, MRP, Cellular Manufacturing, and Flexible Manufacturing Systems.
- To Understand basic networking ideas that help connect all important parts of a company, and learn about different CIM models used in industries.

Course Outcomes

At the end of this course, 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, Techniques for CE (cross-functional teams, design for manufacturability), 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, big data analytics, IoT-driven data management.

UNIT – III:

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

UNIT –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, Signaling methods; Network Interconnection and Devices, Network Performance. Need for enterprise integration, Enterprise systems: ERP, intranet, extranet, cloud integration, Case study: Digital Equipment Corporation (DEC) and DECnet protocol.

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. S.Kant Vajpayee: Principles of Computer Integrated Manufacturing, Printice-Hall India.
2. Nanua Singh: Systems Approach to Computer Integrated Design and Manufacturing- John Wiley.
3. P.Radhakrishnan, S.Subramanyam: CAD/CAM/CIM, New Age International
4. Alavudeen, Venkateshwaran: Computer Integrated Manufacturing, Printice-Hall India
5. Mikell P.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia.

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Course Code	Course Title						Core/Elective
25 PC 5103 CD	**Computer Aided Mechanical Design and Analysis**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To Apply the principles of plate bending to analyze structural components subjected to different stress conditions.
- To Apply the principles of plate bending to analyze structural components subjected to different stress conditions.
- To Demonstrate the design of pressure vessels subjected to internal and external pressure loads
- To use fundamental concepts to evaluate the effect of thermal stresses on pressure vessels.
- To Implement methods to analyze and prevent buckling in pressure vessels.
- To Apply numerical techniques to solve dynamic problems involving multiple degrees of freedom.
- To use numerical methods to solve eigenvalue problems related to structural dynamics and vibrations.

Course Outcomes

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

CO1: Apply stress analysis techniques to determine stresses in plates under various loading conditions.

CO2: Demonstrate the ability to design pressure vessels for practical engineering applications.

CO3: Implement design strategies to avoid buckling failure in cylindrical structures.

CO4: Solve vibration problems in stepped beams and bars using appropriate methodologies.

CO5: Analyze system stability using numerical methods for multi-degree-of-freedom systems.

Unit-I

Stresses in flat plates: Introduction, Bending of plate in one direction, Bending of plate in two perpendicular directions, Thermal stresses in plates, Bending of circular plates of constant thickness, Bending of uniformly loaded plates of constant thickness.

Unit-II:

Design of pressure Vessels: Introduction and constructional features of pressure vessels, stresses in pressure vessels, shrink fit stresses in built up cylinders, autofrettage of thick cylinders, thermal stresses and their significance. Stress concentration at a variable thickness, thickness transition in a cylindrical vessel, about a circular hole, elliptical openings, reinforcement design

Unit-III

Buckling in vessels: Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

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Unit-IV

Eigen Value Problems: Properties of Eigen values and Eigen Vectors, Torsional, Longitudinal vibration, lateral vibration, Sturm sequence. Subspace iteration and Lanczo's method. Component mode synthesis. Eigen value problems applied to stepped beams and bars.

Unit-V

Dynamic Analysis: Direct integration method, Central difference method, Wilson-θ method, Newmark method, Mode superposition, Single degree of freedom system response, Multi degree of freedom system response, Rayleigh damping, Condition for stability. Suggested Reading:

Suggested Reading:

1. John F. Harvey, P.E., Theory and Design of Pressure Vessel, CBS Publisher & Distributors PVT. Ltd., 2001.
2. V. Rammurti, Computer Aided Mechanical Design and Analysis, Tata Mc Graw Hill-1992.
3. John, V. Harvey, Pressure Vessel Design: Nuclear and Chemical Applications, Affiliated East West Press Pvt. Ltd., 1969.
4. Abdel-Rehman Ragab & Salah Edin Bayoumi, Engineering Solid Mechanics, CRC Press, 1998
5. Annaratone, Donatello, Pressure Vessel Design, Springer verlag, 2007
6. Henry Bednar, Pressure vessel Design handbook, Krieger Pub Co; 2nd Edition.
7. Chandrasekhra, Theory of Plates, University Press, 2001

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Course Code	Course Title						Core/Elective
25 PC 5104 CD	**Finite Element Techniques**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives

- Understand how the Finite Element Method (FEM) works and how it is used to analyze structures.
- Learn the basics of approximation methods used in structural analysis.
- Study how to create and use different types of elements in 1D, 2D, and 3D.
- Learn how to model and analyze structures using planar, solid, and plate elements.

Course Outcomes

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

CO1: Determine the shape functions and stiffness matrices and finite element equations
CO2: Analyse the behavior of the trusses and frames
CO3: Analyse complex structural problems
CO4: Analyse the thermal behavior of different systems
CO5: Determine the dynamic behavior of the 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

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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.

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Course Code	Course Title						Core/Elective
25 PE 5116 CD	**Product Design and Process Planning**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To apply creative thinking and essential product development principles to create successful and market-ready products.
- To use the concepts of product reliability, copyright, value engineering, and cost estimation to support efficient product design.
- To implement appropriate machining processes, tolerance improvement methods, and material selection techniques in product development.
- To apply modern design approaches, ergonomic principles, and integrate design with manufacturing and production control processes.

Course Outcomes

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

CO1: Apply product and process design principles to real-world engineering problems.

CO2: Use reliability analysis tools to estimate and improve product performance.

CO3: Select and Implement suitable manufacturing processes based on functional requirements and applications.

CO4: Apply industrial ergonomic standards and principles in product design for user comfort and safety.

CO5: Use computer-based tools for managing and controlling manufacturing operations effectively.

Unit-I

Product design and process design functions, selection of a right product, essential factors of product design, Morphology of design, sources of new ideas for products, evaluation of new product ideas. Product innovation Procedure-Flow chart. Qualifications of product design Engineer. Criteria for success/failure of a product. Value of appearance, colours and Laws of appearance.

Unit-II

Product reliability, Mortality Curve, Reliability systems, Manufacturing reliability and quality control. Patents: Definitions, classes of patents, applying for patents. Trademarks and copyrights. Cost and quality sensitivity of products, Elements of cost of a product, costing methods, cost reduction and cost control activities. Economic analysis, Break even analysis Charts. Value engineering in product design, creativity aspects and techniques. Procedures of value analysis – cost reduction, material and process selection.

Unit-III

Various manufacturing processes, degree of accuracy and finish obtainable, process capability studies. Methods of improving tolerances. Basic product design rules for Casting, Forging, Machining, Sheet metal and Welding. Physical properties of engineering materials and their importance on products. Selection of plastics, rubber and ceramics for product design.

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Unit-IV

Industrial ergonomics: Man- machine considerations, ease of maintenance. Ergonomic considerations in product Design-Anthropometry Design of controls, man-machine information exchange. Process sheet detail and their importance, advanced techniques for higher productivity. Just -in -time and Kanban System. Modern approaches to product design; quality function development. Rapid prototyping

Unit-V

Role of computer in product design and management of manufacturing, creation of manufacturing data base, Computer Integrated Manufacturing, communication network, production flow analysis. Group Technology, Computer Aided product design and process planning. Integrating product design, manufacture and production control.

Suggested Reading:

1. Niebel, B.W., and Draper, A.B., Product design and process Engineering, Mc Graw Hill Kogalkusha Ltd., Tokyo, 1974.
2. Chitale, A.K, and Gupta, R.C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Mahajan, M. Industrial Engineering and Production Management, Dhanpath Rai & Co., 2000

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Course Code	Course Title						Core/Elective
25 PE 5117 CD	**Design for Manufacture**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To Apply general design principles to enhance manufacturability of components.
- To Demonstrate the design process for manufacturing metallic components.
- To apply techniques to develop various shapes in metallic component design.
- To Implement appropriate design strategies for non-metallic components.
- To use suitable methods and tools for efficient component assembly in product development.

Course Outcomes

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

CO1: Apply design strategies for the economical utilization of raw materials in manufacturing.
CO2: Use knowledge of secondary manufacturing processes to enhance product functionality.
CO3: Demonstrate the application of shape-forming principles in metallic component design.
CO4: Apply standard practices to design non-metallic components based on performance needs.
CO5: Use computer-aided tools to evaluate and improve economical assembly processes.

Unit-I

Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization. Economic Use of Raw Materials: Ferrous and, non-ferrous materials plastics and composites.

Unit-II

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

Unit-III

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

Unit-IV

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

Unit-V

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

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Suggested Reading:

1. James G. Bralla. —Hand book of product design for manufacturingl McGraw Hill Co., 1986
2. K.G. Swift —Knowledge based design for Manufacturel. 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.
6. Design for manufacturability by David M. Anderson. Productivity Press. 2014.

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Course Code	Course Title						Core/Elective
25 PE 5118 CD	**Mechanics of Composite Materials**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To Apply knowledge of various types of composite materials and their classifications in engineering applications.
- To use the mechanical and physical properties of composites to assess their suitability for different conditions.
- To demonstrate the analysis of laminar structures and calculate stresses in composite layers.
- To apply strength theories and failure criteria to predict performance of composite structures.
- To use analytical techniques to evaluate stress distribution in plates and cylindrical composite shells.

Course Outcomes:

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

CO1: Apply the role of fibers and matrix materials in fabricating various types of composites.

CO2: Implement micromechanics principles to determine the behavior of composite materials.

CO3: Analyze and apply concepts to evaluate the behavior of composite beams under different loading conditions.

CO4: Apply theoretical models to assess unidirectional and orthotropic lamina composite behavior.

CO5: Solve analytical methods to evaluate stresses in composite plates and cylindrical shells.

Unit-I

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

Unit-II

Micromechanics of Composites: Mechanical Properties-Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties-Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

Unit-III

Macromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.

Unit-IV

Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites Fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and

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de-lamination failure, fatigue of laminate composites. Effect of variability of fiber strength. Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.

Unit-V

Analysis of plates and shells: Plate equilibrium equations, bending of composite plates. Levy and Navier solution for plates of composite materials. Analysis of composite cylindrical shells under axially symmetric loads.

Suggested Reading:

1. Jones, R.M., Mechanics of Composite Materials, Mc Graw Hill Co., 1967
2. Calcote, L.R., The Analysis of Laminated Composite Structures, Van Nostrand, 1969
3. Whitney, I.M. Daniel, R.B. Pipes, Experimental Mechanics of Fibre Reinforced Composite Materials, Prentice Hall, 1984.
4. Hyer, M.W., Stress Analysis of Fibre Reinforced Composite Materials, Mc Graw Hill Co., 1998
5. Carl. T. Herakovich, Mechanics of Fibrous Composites, John Wiley Sons Inc., 1998.

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Course Code	Course Title						Core/Elective
25 PE 5119 CD	**Optimization Techniques**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- Understand the fundamentals of simulation and the application of Monte Carlo methods.
- Learn decision-making processes under conditions of certainty, risk, and uncertainty.
- Study integer programming techniques for solving optimization problems.
- Apply dynamic programming principles to address various optimization challenges.
- Gain knowledge of classical optimization methods using Lagrange multipliers and Kuhn-Tucker conditions.

Course Outcomes

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

CO1: Perform simulations for a variety of practical applications using appropriate techniques.

CO2: Apply decision theory methods, including decision trees, to make informed decisions under certainty, risk, and uncertainty.

CO3: Formulate and solve optimization problems using different integer programming methods.

CO4: Utilize dynamic programming strategies to solve complex optimization problems.

CO5: Solve constrained optimization problems using Lagrangian multipliers and Kuhn-Tucker conditions effectively.

UNIT-I

Simulation: Introduction, Advantages, Limitations and Applications of Simulation, Types of Simulation, Simulation Models, Monte Carlo Simulation, Random Number, Pseudo Random Number, Simulation of Queuing system, Investment & Budgeting Problems, Quality Control Problems, Sequencing Problems, and Maintenance Problem in Inventory Control.

UNIT-II

Decision Theory: Introduction, Decision, Decision Making & Decision Theory, Types of Decisions, decision making process, Types of Decision making Environment: **Decision making under certainty** – Expected Monetary Value (EMV), Expected Opportunity Loss (EOL) Criterion & Expected Value of Perfect Information (EVPI) Criterion **Decision making under risk**- Criterion of Pessimism or Manimax, Criterion of Optimism or Maximin, Minimax Regret Criterion, Criterion of Realism & Criterion of Rationality **Decision making under uncertainty** and **Decision tree analysis**: Introduction, Procedure of Constructing Decision Trees & Solution through Decision Tree Analysis.

UNIT-III

Integer Programming: Introduction, Types of Integer Programming Problems, Gomory"s Cutting Plane method. Branch and Bound method for all Integer Programming Problems & Mixed Integer Programming Problems

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UNIT-IV

Dynamic Programming: Introduction- Bellman"s principle of Optimality-Application of dynamic Programming-Linear Programming Problem-Capital budgeting problem

UNIT-V

Classical Optimization: Introduction; Unconstrained problems of maxima and minima. constrained problems of maxima and minima; Constraints in the form of equations – Lagrangian method; Constraints in the form of inequalities -Kuhn-tucker conditions.

Suggested Reading:

1. S.S. Rao, Optimization Theory and Applications, NAI Publishers, Hyderabad, 1995.
2. S.D. Sharma, Operations Research, Kedarnath and Co. Publishers, Meerut, 2004.
3. V. K. Kapoor, Operations Research, S. Chand, New Delhi, 2004.
4. Hamdy A. Taha, Operations Research, Pearson Education, New York, 2001.
5. Bronson-Schaum Series, Operations Research, McGraw Hill, Singapore, 1983.
6. David Goldberg, Genetic Algorithms, S Chand Publications, 2006.

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Course Code	Course Title						Core/Elective
25 PE 5120 CD	**Design of Press Tools**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To study the classification of presses
- To study the different components of the press tools
- To study about the various types of operations of press tools
- To study about bending in dies
- To study about drawing and forming operations

Course Outcomes

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

CO1: Understand the various press tool operations and analyse the forces involved in it
CO2: Analyse the design of die plates, punches etc.
CO3: Analyse the various aspects in the design of dies
CO4: Determine the construction and working principles of dies based on application
CO5: Design and analyse the drawing and forming operations for practical application problems

UNIT-I

Classification of presses – Specification of Presses – Safety Devices in Presses – Principles of loading and unloading equipment – Various press tool operations – Selection of types of presses – Theory of shearing – Clearance concept – Location of clearance for regular and irregular shapes – Analysis of forces – Force, power & energy – Stock strip terms – Layouts – Economic utilization – Dimensioning of punches and die openings with tolerance.

UNIT-II

Classification of dies viz. shearing, bending, drawing & forming – Terminology of press tool elements – Design considerations of various elements viz. die plates, stock guides, strippers & types – Shedders – Stops

- function and types – Pilots - function and types – Punches types – Punches mounted in punch holder – Calculation of spring, rubber, ejector – Shear and its application – Types of shear (cutting with inclined edges) – Alignment system design of press tools.

UNIT-III

Design of dies – Simple piercing/blanking – Inverted die – Compound die – Progressive dies – Rules for developing stock – Strip layouts for progressive dies – Types of progressive dies viz. blank through, slug cur-off and shear cut off – Load centre – Necessity – Analytical and graphical method to determine load centre (i.e. centre of pressure) – Miscellaneous dies – Shaving, Horn, Cam actuated and precision lamination dies – Fine blanking dies – Principles - design considerations.

UNIT-IV

Bending dies – Theory of bending – Blank development – Spring back effect – Spring back factor –

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Methods of correction to overcome spring back – both practical and theoretical – Types of bending dies viz. V, U and L – Pressure pad dies – Forces in bending – Construction and working principles – Press brake Tooling – Curling – Flanging – Principles of stretch forming – Stretch forming dies.

UNIT-V

Drawing and forming: Definition of drawing, redrawing, reverse redraw – Theory of drawing for metal flow in cylindrical shells – Blank development – Algebraic - centre of gravity, segment area and layout method – Severity of draw – Reduction – Strain factor – Draw force calculation – Draw die edge radius consideration – Blank holder – Stages in draw dies – Calculations – Drawing of rectangular components – Blank development – Draw beeds – Ironing – Defects in draw – Modern metal forming techniques viz. rubber pad forming, explosive forming, magnetic pulse forming, roll forming – Awareness of various software for sheet metal operations, both for analysis and design.

Suggested Reading:

1. Fundamentals of Tool Design – ASTME, Prentice Hall, New Delhi, 1987
2. Die Design Handbook – AISME, Mc Graw Hills, Newyork, 1965
3. Eary & Reed, Shear Working of Metals, Prentice Hall, New Delhi, 1969
4. Basic Die Making & Advance Die Making – D. Eugene Ostergaard, Mc Graw Hill
5. Tool Design by Cyril Donaldson – Tata Mc Graw Hill, New Delhi.

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Course Code	Course Title						Core/Elective
25 PE 5121 CD	**Additive Manufacturing Technologies and Applications**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To know the fundamentals of Additive Manufacturing (AM) and compare it with conventional CNC technology.
- To understand the working principle, advantages, limitations and applications of various AM Technologies and also various types of data formats and errors.
- To know the role of AM in Topology optimization and understand the applications of AM in various fields like Biomedical, Aerospace, Automobile and other domains.

Course Outcomes

After completion of the course student will be able to:

CO1: Interpret the features of Additive Manufacturing and compare it with conventional CNC Technology.

CO2: Illustrate the working principle, advantages, limitations and applications of various Additive Manufacturing Technologies.

CO3: Analyze the concepts AM systems and Rapid Tooling systems and Identify the role of Topology optimization in AM.

CO4: Interpret various types of data formats and STL file errors used in AM and analyze the features of different types of software's used in 3D Printing.

CO5: Apply the knowledge of various AM technologies for developing new and innovative applications.

UNIT-I

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies. Role of AM in Industry 4.0.

UNIT-II

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 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.

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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).
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, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.
Topology Optimization: Role of AM in Topology optimization.

UNIT-IV
Reengineering in AM: Reengineering Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.
AM Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Slicing Algorithms: Rock Algorithm, Crawford's algorithm, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques,
AM Software's: 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.

UNIT-V
AM Applications: Application – Material Relationship, Application in Design, Engineering, Analysis and Planning, Aerospace, Automotive, Jewelry, Coin, GIS, Arts, Architecture. Medical and Bioengineering Applications, Forensic Science and Anthropology, Visualization of Biomolecules.
Cost Estimation in AM: Cost Model, Build Time Model, Laser Scanning Vat Photo-polymerization Example, Life-Cycle Costing.

Suggested Reading:

1. Ian Gibson, David W Rosen, Brent Stucker,"Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Second Edition, Springer, 2010.
2. Chee Kai, Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific, 2017.
3. Frank W. Liou "Rapid Prototyping & Engineering Applications", Second Edition, CRC Press, Taylor & Francis Group, 2019.
4. Rafiq Noorani, "Rapid Prototyping: Principles and Applications in Manufacturing", First Edition, John Wiley & Sons, 2006.
5. Dr. Mohammed Viquar Mohiuddin, "Smart Manufacturing – The future of Automated Production", Scicraft Hub Publication, 2025.
6. NPTEL Course on Rapid Manufacturing.

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Course Code	Course Title				Core/Elective		
25 PE 5122 CD	**Fracture Mechanics**				**Elective**		
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives

- To understand the different types and modes of material failure.
- To learn the fundamental concepts of elastic fracture mechanics and crack behavior.
- To study the principles governing crack growth rate and its influence on failure.
- To explore the concepts of elastic–plastic fracture mechanics.
- To understand and apply various crack growth laws in engineering materials.

Course Outcomes

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

CO1: Comprehend the fundamental concepts and mechanisms of fracture in materials.

CO2: Analyze the influence of crack size and crack growth on the failure of components.

CO3: Evaluate the mechanics of energy release rate during crack propagation.

CO4: Apply the principles of elastic–plastic fracture mechanics to practical problems.

CO5: Select appropriate materials and design approaches to minimize or prevent fracture failure.

UNIT-I

Introduction: Crack in a Structure – Griffth Criterion – Cleavage fracture – Ductile fracture – Fatigue Cracking. Service failure analysis.

UNIT-II

Elastic Crack: Elastic Crack tip stress field – Solution to crack problems. Effect of finite size stress intensity factor – Special cases – Irwin plastic zone correction. Actual shape of plastic zone – Plane stress – Plane strain.

UNIT-III

Energy Principle: Energy release rate – Criterion for crack growth – Crack resistance curve – Principles of crack arrest – Crack arrest in practice. Fatigue Crack Growth: Fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor – Variable amplitude service loading, retardation model.

UNIT-IV

Elastic Plastic Fracture Mechanics: Elastic plastic fracture concept – Crack tip opening displacement – J- integral technique; Determination of J-using FEM.

UNIT-V

Application of Fracture Mechanics: Fracture design – Selection of materials – fatigue crack growth rate curve – Stress intensity factor range – Use of crack growth law.

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Suggested Reading:

1. Broek, D., Elementary Engineering Fracture Mechanics, Springer Science & Business Media, 2012.
2. John M. Barson and Stanely T. Rolfe, Fracture and Fatigue Control in Structures, Prentice Hall, 1987.
3. Jean Cemative and Jean Louis Chboche, Mechanics of Solid Materials, Cambridge University Press, 1987.

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Course Code	Course Title						Core/Elective
25 PE 5123 CD	**Experimental Techniques and Data Analysis**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To understand the working principles of instruments used for measuring cutting forces and temperature.
- To gain knowledge of various precision measuring instruments used in metallurgical investigations.
- To understand the fundamental concepts of experimental design and data collection.
- To learn data analysis techniques and methods for optimizing experimental procedures to obtain reliable results.

Course Outcomes

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

CO1: Measure and analyze cutting forces, displacements, and stresses during experiments.

CO2: Apply various techniques and instruments for accurate temperature measurement.

CO3: Examine and interpret microstructures using advanced metallurgical techniques.

CO4: Design experiments effectively and perform data analysis for meaningful conclusions.

CO5: Optimize experimental procedures and data interpretation for improved accuracy and performance.

UNIT-I

Measurement of Cutting Forces: Strain gauge and piezoelectric transducers and their characteristics. Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and strain measurements by photoelasticity. Holography, interferometer, Moir techniques, strain gauge rosettes.

UNIT-II

Temperature Measurement: Circuits and instrumentation for different transducers viz, bimetallic, expanding fluid, electrical resistance, thermister, thermocouples, pyrometers. Flow Measurement: Transducers for flow measurements of Non-compressible and compressible fluids. Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Dopler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schlieren photography, Interferometer.

UNIT-III

Metallurgical Studies: Optical and electron microscopy, X-Ray diffraction, Bragg's Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, electron microprobe. Surface Measurements: Micro hardness, roughness, accuracy of dimensions and forms. 3 -D co-ordinate measuring machines.

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UNIT-IV

Experiment design & data analysis: Statistical methods, Randomized block design, Latin and orthogonal squares, factorial design. Replication and randomization. Data Analysis: Deterministic and random data, uncertainty analysis, tests for significance: Chi -square, student's t-test. Regression modelling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modelling.

UNIT-V

Taguchi Methods: Experiment design and planning with Orthogonal arrays and linear graphs. Additive cause effect model. Optimization of response level. Identification of Design and noise factors.

Performance evaluation and Optimization by signal to noise ratios. Concept of loss function and its application.

Suggested Reading:

1. Holman, J.P.: Experimental Methods for Engineers, McGraw Hill Int., New York.
2. Venkatesh, V.C., and Chandrasekharan, Experimental Methods in Metal Cutting, Prentice Hall of India, Delhi.
3. Davis, O.V.; The Design and Analysis of Industrial Experiments, Longman, London.
4. Box and Jenkins; Time Series analysis, Forecasting and control, Holden Day, San Francisco.
5. Dove and Adams, Experimental stress analysis and motion measurement, Prentice Hall of India, Delhi.
6. Tapan P. Bagchi, Taguchi Methods Explained, Prentice Hall of India, Delhi.

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Course Code	Course Title						Core/Elective
25 PE 5124 CD	**Mechanical Vibrations**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives

- Understand how single degree of freedom systems vibrate freely, with and without damping.
- Analyze the response of single degree of freedom systems under forced vibration with and without damping.
- Learn to model and analyze two degree of freedom vibration systems for both free and forced vibration cases.
- Apply matrix methods and Lagrange's equations to derive and solve equations of motion for multi-degree of freedom systems.
- Determine natural frequencies and mode shapes of mechanical systems using analytical and approximate methods.

Course Outcomes

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

CO1: Understand the causes of vibration and types of vibration
CO2: Analyze the behavior of systems undergoing free and forced vibrations
CO3: Analyse the dynamics of systems with two and multiple degrees of freedom
CO4: Determine the natural frequencies and mode shapes using different analytical methods
CO5: Explore various specialized techniques for measuring vibrations

UNIT-I

Free Vibration of Single Degree of Freedom Systems: Introduction, Free Vibration of an Undamped Translational System, Equation of Motion using Newton's second law of motion, Equation of motion using other methods, Equation of motion of a spring, mass system in vertical position, solution, Harmonic Motion Free Vibration of an Undamped Torsional System- Equation of motion. Free Vibration with Viscous Damping- Equation of motion.

UNIT-II

Forced Vibration of Single Degree of Freedom Systems: Introduction, Response of an Undamped system under harmonic force, Total response, Beating Phenomenon. Response of a Damped System under Harmonic Force- Total Response, Quality Factor and Bandwidth, Response of a Damped system under the Harmonic Motion of the base, Fore Transmitted, Relative Motion..

UNIT-III

Two Degree of Freedom Systems: Introduction, Equations of Motion for forced Vibration, Free Vibration Analysis of and undamped system, Torsional system, Coordinate Coupling and Principal Coordinates, forded Vibration Analysis, Semi definite Systems, Self- Excitation and stability Analysis.

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UNIT-IV

Multi-degree of Freedom Systems: Introduction Modeling of Continuous systems as Multi-degree of Freedom systems, Using Newton's second law to derive equations of motion. Influence Coefficients. Potential and kinetic energy expressions in matrix form, Generalized coordinates and generalized forces, Using Lagrange's equations to derive equations of motion, Equations of motion of undamped systems in matrix form, Eigen value problem, solution of the Eigen value problems – solution of the characteristic equation, orthogonality of normal modes, repeated Eigen values.

UNIT-V

Determination of Natural Frequencies and Mode Shapes: Introduction, Dunkerley's formula. Rayleigh's Method- Properties of Rayleigh's Quotient, Computation of the Fundamental Natural Frequency, Fundamental Frequency of Beams and Shafts. Holzer's Method-Torsional systems, Spring Mass Systems. Jacobi method, Standard Eigen value Problems.

Suggested Reading:

1. Rao S. S Mechanical Vibrations, 5 Edition, Prentice Hall, 2011
2. V.P. Singh, Mechanical vibrations, Dhanpat Rai Publications, 2015
3. Collacott, R.A., *Mechanical Fault Diagnosis and Condition Monitoring,* Chapman & Hall, London, 1982.
4. John S. Mitchell, *Introduction to Machinery Analysis and Monitoring,* Penn Well Books, Penn Well Publishing Company, Tulsa, Oklahoma, 1993.
5. J S Rao, Vibration condition monitoring of machines, CRC Press, 2000
6. Nakra, B.C. Yadava, G.S. and Thuested, L., *Vibration Measurement and Analysis,* National Productivity Council, New Delhi, 1989.
7. G.K. Groover Mechanical Vibrations, Publisher: Nem Chand & Bros.

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Course Code	Course Title						Core/Elective
25 PE 5125 CD	**Computational Fluid Dynamics**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To formulate the conservation equations of fluid flow in differential form and convert them into algebraic equations using numerical methods.
- To understand and apply the finite difference method for solving fluid flow problems.
- To learn the finite volume method and its solution procedures for various fluid flow applications.

Course Outcomes

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

CO1: Comprehend the fundamental concepts of fluid dynamics and turbulence modeling.
CO2: Formulate and derive partial differential equations representing different flow conditions.
CO3: Design and generate computational grids suitable for various fluid flow applications.
CO4: Apply the finite difference method to obtain numerical solutions of flow equations.
CO5: Analyze and interpret fluid flow systems using the finite volume method.

UNIT-I

Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Differential equations for steady and unsteady state heat conduction. Differential equations for diffusion. Introduction to turbulence, Turbulence models- mixing length model, K- turbulence Model.

UNIT-II

Classification of PDEs – Elliptic, parabolic and hyperbolic equations. Initial and boundary value problems. Concepts of Finite difference methods – forward, backward and central difference. Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.

UNIT-III

Grid Generation- Types of grid O,H,C. Coordinate transformation, algebraic methods. Unstructured grid generation.

UNIT-IV

Finite difference Solutions-Parabolic PDEs – Euler, Crank Nicholson, Implicit methods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressible flow using Stream function – Vorticity method & MAC method.

UNIT-V

Introduction to Finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.

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Suggested Reading:

1. Pradip Niyogi, Chakrabartty SK, Laha M.K., „Introduction to Computational Fluid Dynamics",
   Pearson Education, 2005.
2. Muralidhar K, Sundararajan T, „Computational Fluid flow and Heat transfer", Narosa Publishing
   House, 2003.
3. Chung, T J, „Computational Fluid Dynamics", Cambridge University Press, 2002.
4. John D Anderson, „Computational Fluid Dynamics", Mc Graw Hill, Inc., 1995.
5. Patankar, S.V, „Numerical Heat transfer and Fluid flow", Hemisphere Publishing Company, New
   York, 1980.

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Course Code	Course Title						Core/Elective
25 PE 5126 CD	**Robotic Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To develop students' understanding of various robotic structures and their workspaces.
- To build proficiency in performing spatial transformations related to rigid body motion.
- To enhance skills in conducting kinematic analysis of robotic systems.
- To provide knowledge of singularities and their effects on robot operation.
- To introduce the principles and techniques of trajectory planning in robotic motion.
- To impart knowledge and analytical skills related to robot control systems.

Course Outcomes

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

CO1: Identify and describe the subsystems of robots, including actuators, grippers, and sensors.
CO2: Analyze the forward and inverse kinematics of robotic systems.
CO3: Apply kinematic principles to determine motion parameters and workspace configurations.
CO4: Evaluate the forces, torques, and control strategies involved in robotic motion.
CO5: Select and integrate appropriate sensors and controllers for effective robot operation

UNIT-I

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, 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

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

UNIT-III

Inverse Kinematics, 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, nonlinearity of manipulator models, Computed torque control, force control, hybrid control.

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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. Harry Asada & Slottine "Robot Analysis& Control", Wiley Publications, 2014
5. S K Saha, "introduction to Robotics ", 2nd edition, TMH, 2013

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Course Code	Course Title						Core/Elective
25 PE 5127 CD	Advanced Meterology						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To understand the fundamental concepts and principles related to measurements and metrology.
- To study the types, applications, and working principles of gauges and comparators.
- To learn about various measuring machines, methods for thread measurement, and the forms and sources of errors encountered during surface measurement.

Course Outcomes

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

CO1: Understand the standards, principles, and techniques of measurement and calibration.

CO2: Analyze the applications and effectiveness of different gauges and comparators.

CO3: Explain the working and applications of various measuring machines.

CO4: Identify and evaluate different forms of measurement errors.

CO5: Perform and interpret measurements of screw thread parameters with accuracy.

UNIT-I

End & line standards for length, Airy & Bessel points, desirable features of end standards, slip gauge manufacture, calibration of end standards by interferometry. NPL gauge interferometer, calibration of line standards by micrometer microscope – superposition, coincidence and symmetric straddling, photoelectric microscope and Moir fringe techniques, measurement of large displacements using lasers, calibration of Tomlinson gauges by interferometry. Photoelectric Autocollimator, calibration of polygons & circular scales. Types of interchangeability, dimensional chains.

UNIT-II

Fixed & Indicating Gauges: Taylor"s principles of gauge design, limitations of ring & plug gauges, position and receiver gauges, types of indicating gauges. Comparators: Multirange Sigma comparator, Back pressure and free flow type pneumatic comparators, Differential back pressure gauge, usage of different types of jets, contact & non-contact tooling. Amplification selection. Air to electric transducer, Differential transducer, Variation transducer, Preprocess, In-process & Post process gauging, computation & match gauging. Usage of LVDT & Capacitive type gauge heads. Automatic inspection.

UNIT-III

Measuring Machines: Floating carriage diameter measuring m/c. Universal measuring m/c. Matrix internal diameter measuring machine. Optical dividing head. Coordinate measuring machine, Optical projector-light beam systems, Work tables, measurement techniques, fixturing & accessories. Sources of error in measurement. Design principles of measuring machines Abbe's rule, Kelvin coupling, flexible steel strip, advantages & limitations of hydrostatic & aerostatic

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bearings.

UNIT-IV

Form Errors: Evaluation of straightness & flatness, usage of beam comparator, evaluation of roundness – intrinsic & extrinsic datums. Talyrond. PGC, RGC, MZC & LSC, methods, roundness evaluation for even & odd number of lobes. Surface Finish: stylus instrument (TALYSURF), M & E Systems, numerical assessment, vertical & horizontal descriptors, profile as a random process, usage of interferograms. Plastic replica technique.

UNIT-V

Screw Threads: Measurement of thread elements for internal & external threads, progressive periodic, drunkenness and irregular pitch errors. NPL pitch measuring machine, virtual effective diameter, thread gauging. Gears: measurement of tooth thickness, involute profile, pitch, concentricity and alignment, rolling gear test.

Suggested Reading:

1. R.K. Jain, Engineering Metrology, Khanna Publishers
2. ASTME, Hand Book of Industrial Metrology, Prentice Hall of India Pvt Ltd.
3. I.C. Gupta, A Text Book of Engineering Metrology, Dhanpat Rai & Sons.

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Course Code	Course Title						Core/Elective
25 PE 5128 CD	**Control of Dynamic Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives

- To introduce the fundamental concepts of control systems and develop the ability to formulate mathematical models and design feedback control systems.
- To equip students with analytical tools for evaluating the performance and stability of linear feedback control systems.
- To enable students to analyze, design, simulate, and experimentally validate both linear and nonlinear control systems considering practical limitations.
- To provide a thorough understanding of negative and positive feedback systems and their applications in circuit analysis and control system design.
- To impart knowledge of frequency compensation techniques and their applications in the design of linear and nonlinear control systems.

Course Outcomes

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

CO1: Develop and apply mathematical models to represent various physical systems.

CO2: Analyze system dynamics using pole–zero configurations.

CO3: Apply state-space representation and methods for control system analysis and design.

CO4: Evaluate the behavior and response of nonlinear control systems.

CO5: Assess the stability and performance of different control systems using appropriate analytical techniques.

UNIT-I

Mathematical Modelling of physical systems, 1st, 2nd order and higher order systems, transient, steady state analysis, steady state errors, Performance Indices.

UNIT-II

Poles, zeros, zero and pole placements, Routh's criteria, Root locus Technique, Bode plots, Nyquist criterion, Compensation circuits

UNIT-III

State space method, state transition matrix, canonical forms, Diagonalisation, solutions of homogeneous and non-homogenous equations, zero and pole placement using state space techniques, controllability and observability, state controllability matrix, state observability matrix.

UNIT-IV

Non-Linear Systems Phase plane analysis: Phase portraits, Singular points characterization. Analysis of non- linear systems using phase plane techniques, Existence of limit cycles.

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UNIT-V

Stability Analysis Concept of stability. Stability in the sense of Lyapunov and absolute stability, autonomous systems, the invariance principle, linear systems and linearization, non-autonomous systems, linear time varying systems and linearization.

Suggested Reading:

1. K. Ogata, "Modern Control Engineering", Pearson India, 3rd Edition.
2. Norman Nise, "Control System Engineering", Prentice Hall India, Fourth Edition
3. Anand Kumar, "Control System Theory", Prentice Hall India.
4. M.Vidyasagar, "Nonlinear systems analysis", Second Edition, Prentice Hall, 1993
5. H.Khalil, "Nonlinear Systems", Macmillan Publishing Company, NY, 1992.
6. A.Isidori, "Nonlinear Control Systems" 3rd edition, Springer Verlag, London, 1995.
7. B. Brogliato, R. Lozano, B. Maschke, O. Egeland, "Dissipative Systems Analysis and Control", Springer Verlag, London, 2nd edition, 2007.

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Course Code	Course Title						Core/Elective
25 PE 5129 CD	**Advanced Materials Technology**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To provide fundamental knowledge and practical understanding of different engineering materials and their mechanical behavior.
- To offer hands-on experience in studying the elastic, plastic, and failure behavior of materials under various loading conditions.
- To develop knowledge of material selection criteria and introduce the fundamentals of composite materials.

Course Outcomes

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

CO1: Explain the elastic and plastic behavior of materials and their relevance to engineering applications.

CO2: Understand and analyze the fracture behavior of different materials.

CO3: Select suitable materials based on mechanical properties and application requirements.

CO4: Identify and relate the applications of various industrial materials to real-world engineering problems.

CO5: Evaluate the metallurgical factors influencing the mechanical behavior of materials.

UNIT-I

Elastic and Plastic Behavior: Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solution hardening, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviours
- Super plasticity - Deformation of non-crystalline material.

UNIT-II

Fracture Behavior: Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter
- Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of non-metallic materials – Failure Analysis, sources of failure, procedure of failure analysis.

UNIT-III

Selection of Materials: Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing - Case

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studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

UNIT-IV

Modern Metallic Materials: Dual phase steels, Micro alloyed, High strength low alloy (HSLA), steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nanocrystalline materials, bio materials.

UNIT-V

Non-Metallic Materials

Composite materials: Types, production techniques of each type, Production of fibers, properties mechanics of composites, manufacturing of metal matrix, Ceramic matrix composite, Carbon-Carbon composite- properties and testing of composite material, areas of application.

Plastics, rubber, foams, adhesives and coatings - Structure, properties and applications of engineering polymers.

Advanced structural ceramics: WC, TiC, TaC, Al_2O_3, SiC, Si_3N_4, CBN and diamond - properties, processing and applications.

Suggested Reading:

1. Thomas H. Courtney, " Mechanical Behavior of Materials ", McGraw-Hill, 2000.
2. Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials", 3rd Edition, Butterworth-Heinemann, 1977.
3. Flinn, R.A. and Trojan, P.K.., "Engineering Materials and their Applications ", (4th Edition), Jaico Publishing, 1999.
4. George E. Dieter, "Mechanical Metallurgy ", McGraw Hill, 1988.
5. Metals Hand Book, Vol.10, "Failure Analysis and Prevention ", (10th Edition), 1994.
6. Willam D. Callister, Jr., "Material Science and Engineering: An introduction", John Wiley & Sons, Inc, 2003.
7. Willam F. Smith, "Principles of Materials Science and Engineering", 3rd edition, McGraw Hill, 2002.

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Course Code	Course Title						Core/Elective
25 PE 5130 CD	**Failure Analysis and Design**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To highlight the significance of good design and the various factors that influence it.
- To explain the importance of ergonomics and aesthetics in achieving effective design.
- To understand the role of scientific methods in addressing problems throughout the product development cycle—from initiation to delivery.
- To comprehend the phenomenon and significance of fracture, methods for its evaluation, and the impact of fatigue on crack propagation.

Course Outcomes

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

CO1: Understand the fundamental principles of design.

CO2: Analyze the utility and application of various design methodologies.

CO3: Comprehend the core concepts of fracture mechanics.

CO4: Perform service failure analysis effectively.

CO5: Understand the principles of fatigue and its role in crack propagation.

UNIT-I

DESIGN FUNDAMENTALS Importance of design- The design process-Considerations of Good Design – Morphology of Design –Organization for design– Computer Aided Engineering – Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.

UNIT-II

DESIGN FUNDAMENTALS Importance of design- The design process-Considerations of Good Design – Morphology of Design –Organization for design– Computer Aided Engineering – Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.

UNIT-III

FRACTURE MECHANICS: Introduction, Modes of fracture failure Griffith Analysis, Energy release rate, Energy release rate of DCB specimen; Stress Intensity Factor: SIF's for edge and centre line crack, Fracture toughness, Elastic plastic analysis through J-integral method: Relevance and scope, Definition of J-integral, Path independence, stress strain relation, Strain Energy Release Rate Vs J-integral. Failure analysis and determination of stress patterns from plastic Flow observations – Dynamic loading– Fracture types in tension.

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UNIT-IV

APPLICATIONS OF FRACTURE MECHANICS Introduction –Through cracks emanating from holes – Corner cracks at holes – Cracks approaching holes-Combined loading-Fatigue crack growth binder- Mixed mode loading-Fracture toughness of weld metals-Service failure analysis

UNIT-V

FATIGUE CRACK PROPOGATION— Mechanism of fatigue crack initiation, propagation and growth, Fatigue data representation, Factors influencing Fatigue strength, Fatigue life prediction, prevention of fatigue failures, corrosion fatigue. Cumulative fatigue damage

Suggested Reading:

1. Ibrahim Dieter, George E., Engineering Design - A Materials and Processing Approach, McGraw Hill, International Editions, Singapore, 2000.
2. Pahl, G, and Beitz, W., Engineering Design, Springer Verlag, NY. 1984.
3. David Broek, Elementary Engineering Fracture Mechanics, Fifthoff and Noerdhoff International Publisher, 1978.
4. Prashant Kumar, Elements of Fracture Mechanics. Wheeler Publishing, 1999
5. S T. Rolfe and J M Barsom, Fracture and Fatgue control in structure, Prentice Hall
6. KRY Simha, Fracture Mechanics for Modern Engineering Design, University Press

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Course Code	Course Title						Core/Elective
25 MC 5161 ME	**Research Methodology and IPR**						**Mandatory Course**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	**40**	**60**	**3**

Course Objectives

To make students to

- To introduce the fundamental concepts of research, its objectives, motivation, and significance in academic and industrial contexts.
- To develop skills in conducting literature surveys, reviewing research papers, and preparing effective research reports and proposals.
- To provide an understanding of research design, experimental design, and various sampling techniques.
- To familiarize students with data collection methods, data organization, and application of statistical tools for analysis and interpretation.
- To impart knowledge on Intellectual Property Rights (IPR), patents, licensing, and technology transfer for protecting and commercializing research outcomes.

Course Outcomes

At the end of this course, 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 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

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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 & Techniquel; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineersl, MJP Publishers, 2011
3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computationl, 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

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Course Code	Course Title						Core/Elective
25 OE 9101 CE	**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

- To apply modern software packages to conduct analysis of real world data.
- To understand the technical underpinning of engineering economic analysis.
- The ability to apply the appropriate analytical techniques to a wide variety of real world problems and data sets.
- To summarize and present the analysis results in a clear and coherent manner.

Course Outcomes

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

CO1: Students should be able to learn the cost concepts in decision making

CO2: Student should be able to do cost planning and Marginal Costing

CO3: Students should be able to create a database for operational control and decision making.

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 Behavior 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.

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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

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Course Code	Course Title						Core/Elective
25 OE 9102 CS	**Business Analytics**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- Understand the role of business analytics within an organization
- Analyse data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making
- To become familiar with processes needed to develop, report, and analyse business data
- Use decision-making tools/Operations research techniques
- Mange business process using analytical and management tools
- Analyse and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.
- Student will able to understand the basic rules of research formulation and procedure for obtaining patent rights

Course Outcomes

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

CO1: Students will demonstrate knowledge of data analytics

CO2: Students will demonstrate the ability of think critically in making decisions based on data and deep analytics

CO3: Students will demonstrate the ability to use technical skills in predicative and prescriptive modelling to support business decision-making

CO4: Students will demonstrate the ability to translate data into clear, actionable insights

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

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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.

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Course Code	Course Title						Core/Elective
25 OE 9103 EC	**Embedded System Design**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives

- Detailed overview of important concepts of Embedded system
- Analyse PIC microcontroller, its features and programming
- Describe ARM Microcontroller architectural details and instruction set
- Understand ARM Memory management
- Learn the techniques to develop an embedded system and case studies

Course Outcomes

After completing this course, the student 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

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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.

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Course Code	Course Title						Core/Elective
25 OE 9104 EE	**Waste to Energy**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

- To enable students to aware about the generation of energy from the waste.

Course Outcomes

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

CO1: Students should able to learn the Classification of waste as a fuel.

CO2: Students should able to learn the Manufacture of charcoal.

CO3: Students should able to carry out the designing of gasifiers and biomass stoves.

CO4: Student should able to learn the Biogas plant technology.

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.

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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.

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Course Code	Course Title						Core/Elective
25 OE 9105 ME	**Industrial Safety**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives

By the end of this course, students will be able to:

- Apply knowledge of the causes of industrial accidents and implement effective preventive measures.
- Use fundamental principles of maintenance engineering to enhance industrial reliability.
- Identify and apply methods to prevent wear and corrosion in industrial equipment.
- Demonstrate fault-tracing techniques to diagnose machinery problems.
- Implement periodic and preventive maintenance procedures for various industrial machines and equipment.

Course Outcomes

After completing this course, students will be able to:

CO1: Apply engineering safety concepts in industrial environments.

CO2: Identify causes of industrial accidents and implement preventive actions effectively.

CO3: Use basic tools and techniques required for different maintenance processes.

CO4: Apply methods to minimize wear and prevent corrosion in industrial equipment.

CO5: Diagnose faults in equipment such as machine tools, IC engines, and boilers, and implement periodic and preventive maintenance strategies for 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.

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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

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Course Code	Course Title						Core/Elective
25 AD 9001 HS	**English for Research Paper Writing**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**1**	-	-	**50**	-	**0**

Course Objectives

- Understand that how to improve your writing skills and level of readability
- Understand the nuances of language and vocabulary in writing a Research Paper.
- Develop the content, structure and format of writing a research paper.
- Produce original research papers without plagiarism

Course Outcomes

After completing this course, the student will be able to:

CO1: Interpret the nuances of research paper writing.

CO2: Differentiate the research paper format and citation of sources.

CO3: To review the research papers and articles in a scientific manner.

CO4: Avoid plagiarism and be able to develop their writing skills in presenting the research work.

CO5: Create a research paper and acquire the knowledge of how and where to publish their original research papers.

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.

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Suggested Readings:

1. C. R Kothari, Gaurav, Garg, —Research Methodology Methods and Techniquesl, 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 Papersl, 7/e, East West Press Pvt. Ltd, New Delhi
4. Lauri Rozakis, Schaum's, Quick Guide to Writing Great Research Papersl, Tata McGraw Hills
   Pvt. Ltd, New Delhi.

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Course Code	Course Title						Core/Elective
25 AD 9002 CE	**Disaster Management**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**1**	**-**	**-**	**50**	**-**	**0**

Course Objectives

- To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
- To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
- To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.

Course Outcomes

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

CO1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction

CO2: and humanitarian response.

CO3: Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.

CO4: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

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-IV

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

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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.

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Course Code	Course Title						Core/Elective
25 AD 9003 HS	**Sanskrit for Technical Knowledge**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	2	1	-	-	50	-	0

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
- To explore the huge knowledge from ancient Indian literature

Course Outcomes

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

CO1: Develop passion towards Sanskrit language
CO2: Decipher the latent engineering principles from Sanskrit literature
CO3: Correlates the technological concepts with the ancient Sanskrit history.
CO4: Develop knowledge for the technological progress
CO5: Explore the avenue for research in engineering with aid of Sanskrit

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

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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.

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Course Code	Course Title						Core/Elective
25 AD 9004 HS	**Value Education**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**1**	-	-	**50**	-	**0**

Course Objectives

- Understand the need and importance of Values for self-development and for National development.
- Imbibe good human values and Morals
- Cultivate individual and National character.

Course Outcomes

After completion of the course, students will be able to:

CO1: Gain necessary Knowledge for self-development

CO2: Learn the importance of Human values and their application in day to day professional life.

CO3: Appreciate the need and importance of interpersonal skills for successful career and social life

CO4: Emphasize the role of personal and social responsibility of an individual for all-roundgrowth.

CO5: Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.

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,

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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 practicel, Oxford University Press,
   New Delhi, 1998.
2. Jaya Dayal Goyandaka, Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose
   Meaningl, Gita Press, Gorakhpur, 2017.

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Course Code	Course Title						Core/Elective
25 AD 9011 HS	**Constitution of India and Fundamental Rights**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	2	1	-	-	50	-	0

Course Objectives

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

Course Outcomes

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

CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2: Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

CO3: Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

CO4: Discuss the passage of the Hindu Code Bill of 1956.

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

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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.

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Course Code	Course Title						Core/Elective
25 AD 9012 HS	**Pedagogy Studies**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**1**	-	-	**50**	-	**0**

Course Objectives

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

Course Outcomes

At the end of this course, 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.

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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, Comparel, 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.

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Course Code	Course Title						Core/Elective
25 AD 9013 HS	**Stress Management by Yoga**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**1**	**-**	**-**	**50**	**-**	**0**

Course Objectives

The Course will introduce the students to

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

Course Outcomes

After successful completion of the course, the students will be able to:

CO1: Understand yoga and its benefits.
CO2: Enhance Physical strength and flexibility.
CO3: Learn to relax and focus.
CO4: Relieve physical and mental tension through asanas.
CO5: Improve work performance and efficiency.

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.

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Course Code	Course Title						Core/Elective
25 AD 9014 HS	**Personality Development Through Life Enlightenment Skills**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**1**	**-**	**-**	**50**	**-**	**0**

Course Objectives

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes

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

CO1: Develop their personality and achieve their highest goal of life.
CO2: Lead the nation and mankind to peace and prosperity.
CO3: Practice emotional self-regulation.
CO4: Develop a positive approach to work and duties.
CO5: Develop a versatile personality.

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/

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Course Code	Course Title						Core/Elective
25 PC 5151 CD	**Advanced CAD Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**3**	**50**	**0**	**1.5**

Course Objectives

- Introduce students to various commands and techniques in surface, sheet metal, and solid modelling.
- Enable students to create individual components and assemble multiple parts effectively.
- Teach students to generate accurate and detailed engineering drawings with proper dimensioning, sectional views, and aesthetic features.

Course Outcomes

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

CO1: Understand and apply commands related to surface modelling.

CO2: Create 2–3 components using surface modelling techniques.

CO3: Understand and utilize commands for sheet metal modelling.

CO4: Design and create sheet metal components and understand their significance in practical applications.

CO5: Gain knowledge of solid modelling commands and their applications.

CO6: Create multiple parts (2–3 components) using solid modelling techniques.

CO7: Assemble part models using constraints, modify parts, and add assembly features effectively.

CO8: Generate detailed engineering drawings, including dimensioning, sectional views,

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. Assembling of part models using constraints, part modifications, adding another assembly features – display
8. Creation of engineering drawing details such as dimensioning, sectional views, adding aesthetics

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Course Code	Course Title						Core/Elective
25 PC 5152 CD	**CAM and Automation Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**3**	**50**	**0**	**1.5**

Course Objectives

- Teach students basic CNC machining operations and their uses.
- Help students create and simulate NC/CNC programs using CAM software.
- Introduce PLC programming for automation and control.
- Show students how to make components using 3D printing.

Course Outcomes

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

CO1: Carry out CNC programming on Lathe operations

CO2: Carry out CNC programming on Milling operations

CO3: Execute the PLC programming for various applications

List of Exercises:

Understanding of CNC Machines and CNC Programming and Creation of

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

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Course Code	Course Title						Core/Elective
25 PC 5153 CD	**Computational Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**3**	**50**	-	**1.5**

Course Objectives

- Introduce students to Finite Element Analysis (FEA) software such as ANSYS.
- Teach students to analyze structural components, including beams, plates, and brackets.
- Enable students to perform thermal, modal, harmonic, and buckling analysis.
- Familiarize students with coupled-field and CFD analysis for engineering applications.

Course Outcomes

At the end of this course, 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.

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Course Code	Course Title						Core/Elective
25 PC 5154 CD	**Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**3**	**50**	-	**1.5**

Course Objectives

The main objectives of the seminar course are to:

- Help students gain knowledge in a chosen area by studying recent trends and developments.
- Improve the ability to read, analyze, and summarize research papers and technical articles.
- Build confidence in communication by preparing and delivering a structured PowerPoint presentation.
- Encourage critical thinking and active discussion during the question-and-answer session.
- Promote independent learning and research skills through self-study and exploration of related topics.
- Develop technical writing skills by preparing a clear and well-formatted seminar report.

Course Outcomes

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

CO1: Develop the habit of referring to journals and research papers for literature review.
CO2: Understand and summarize the main ideas of research studies.
CO3: Identify the scope for further research and improvement.
CO4: Present their work clearly and effectively using appropriate presentation methods.
CO5: Prepare well-organized documentation in the prescribed 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

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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.

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Course Code	Course Title						Core/Elective
25 PC 5155 CD	**Mini Project with Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	6	50	-	3

Course Objectives

The main objectives of the mini project are to:

- Help students use classroom knowledge to solve real-life or research problems.
- Develop the ability to identify, plan, and solve technical or scientific issues.
- Encourage creativity and independent thinking through experiments or modeling.
- Give experience in planning, doing, and documenting a short research project.
- Improve teamwork, report writing, and presentation skills with faculty guidance.
- Expose students to interdisciplinary and industry-related projects.

Course Outcomes

After completing the mini project, students will be able to:

CO1: Choose a suitable research topic and set clear project goals.
CO2: Study and understand previous work related to the topic.
CO3: Use proper experimental or modeling methods to carry out the project.
CO4: Examine and explain the results clearly.
CO5: Write a neat and organized report with all necessary details.
CO6: Present the project work confidently using visuals and speech.
CO7: Work independently and manage time effectively under faculty guidance.

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

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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

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Course Code	Course Title						Core/Elective
25 PC 5156 CD	**Major Project Phase – I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**20**	**100**	-	**10**

Course Objectives

The main objectives of the project work are to:

- Apply theoretical knowledge to real-time or research-based problems.
- Develop skills in planning, experimentation, and data analysis.
- Encourage creativity and independent problem-solving.
- Improve literature review, report writing, and presentation skills.
- Maintain regular interaction with the supervisor for guidance and progress.

Course Outcomes

After completing the project work, students will be able to:

CO1: Identify and define a suitable research or design problem.
CO2: Review related literature and plan the project effectively.
CO3: Conduct experiments or simulations and analyze the results.
CO4: Present findings clearly through reports and presentations.
CO5: Work independently and manage the project efficiently under guidance.

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	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers

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coordinator from the respective department of the institution)	10	Report Preparation

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

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Course Code	Course Title						Core/Elective
25 PC 5157 CD	**Major Project Phase – II (Dissertation)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**32**	-	**200**	**16**

Course Objectives

The main objectives of the course are to:

- Continue the research work started in Major Project Phase I.
- Apply knowledge to plan, execute, and complete a detailed project.
- Develop skills in literature review, methodology, experimentation, or simulations.
- Improve technical writing and presentation skills through report and seminar.
- Encourage regular interaction with the supervisor for guidance and progress.

Course Outcomes

After completing the course, students will be able to:

CO1: Define the problem clearly and set project objectives.

CO2: Conduct a detailed literature review and organize methodology.

CO3: Perform experiments, simulations, or analysis and interpret results.

CO4: Prepare a well-structured report including conclusions and future scope.

CO5: Present the project work confidently to a panel of examiners.

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

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	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-Voce

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