M.Tech – CAD/CAM
Course Structure (MT25)
Applicable From 2025-26 Admitted Batch

S. No	Category	Breakup of credits (Total 68 credits)
1.	Programme-Core	20
2.	Programme- Elective	15
3.	Open Elective	3
4.	Mandatory Credit Course	2
5.	Project Work	28
6.	Audit Course	-
	TOTAL	**68**

I YEAR I SEMESTER

S. No.	Course Code	Course Title	Course Area	Hours Per Week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal (CIE)	External (SEE)	Total
1	2514001	Advanced CAD	PC	3	0	0	3	40	60	100
2	2514002	Additive Manufacturing	PC	3	0	0	3	40	60	100
3		Professional Elective - I	PE	3	0	0	3	40	60	100
4		Professional Elective - II	PE	3	0	0	3	40	60	100
5	2510001	Research Methodology and IPR	MC	2	0	0	2	40	60	100
6	2514040	Advanced Computer Aided Design Lab	PC	0	0	4	2	40	60	100
7	2514041	Additive Manufacturing Lab	PC	0	0	4	2	40	60	100
8		Audit Course-I	AC	0	0	0	0	100	-	100
Total Credits				**14**	**0**	**8**	**18**	**380**	**420**	**800**

I YEAR II SEMESTER

S. No.	Course Code	Course Title	Course Area	Hours Per Week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal (CIE)	External (SEE)	Total
1	2524003	Computer Integrated Manufacturing	PC	3	0	0	3	40	60	100
2	2524004	Manufacturing Systems: Simulation Modelling & Analysis	PC	3	0	0	3	40	60	100
3		Professional Elective - III	PE	3	0	0	3	40	60	100
4		Professional Elective - IV	PE	3	0	0	3	40	60	100
5	2524042	Simulation of Manufacturing Systems Lab	PC	0	0	4	2	40	60	100
6	2524043	Computer Aided Manufacturing Lab	PC	0	0	4	2	40	60	100
7	2524044	Mini Project With seminar	PS	0	0	4	2	100	-	100
8		Audit Course - II	AC	0	0	0	0	100	-	100
Total Credits				**12**	**0**	**12**	**18**	**380**	**420**	**800**

II YEAR I SEMESTER

S. No.	Course Code	Course Title	Course Area	Hours Per Week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal (CIE)	External (SEE)	Total
1		Professional Elective - V	PE	3	0	0	3	40	60	100
2		Open Elective	OE	3	0	0	3	40	60	100
3	2534045	Dissertation Work Review – I	PS	0	0	12	6	100	0	100
Total Credits				**6**	**0**	**12**	**12**	**180**	**120**	**300**

***Important: *Open Elective subject must be chosen from the list of open electives offered by OTHER departments.**

II YEAR II SEMESTER

S. No.	Course Code	Course Title	Course Area	Hours Per Week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal (CIE)	External (SEE)	Total
1.	2544046	Dissertation Work Review – II	PS	0	0	12	6	100	0	100
2.	2544047	Dissertation Viva - Voce	PS	0	0	28	14	0	100	100
TOTAL				**0**	**0**	**40**	**20**	**100**	**100**	**200**

Professional Elective - I

S.No	Course Code	Course Title
1	2514011	Advanced Finite Element and Boundary Element Methods
2	2514012	Experimental Stress Analysis
3	2514013	Sustainable Manufacturing

Professional Elective - II

S.No	Course Code	Course Title
1	2514014	Automation in Manufacturing
2	2514015	Computer Aided Process Planning
3	2514016	Industrial Robotics

Professional Elective - III

S.No	Course Code	Course Title
1	2524017	Intelligent Manufacturing Systems
2	2524018	Smart Manufacturing
3	2524019	Optimization Techniques and Applications

Professional Elective - IV

S.No	Course Code	Course Title
1	2524020	Mechatronics
2	2524021	MEMS: Design and Manufacturing
3	2524022	Fuzzy Logic and Neural Networks

Professional Elective - V

S.No	Course Code	Course Title
1	2534023	Design for Manufacturing & Assembly
2	2534024	Composite Materials
3	2534025	Artificial Intelligence Manufacturing

List of Open Elective

S.No	Course Code	Course Title
1	2534030	Business Analytics
2	2534031	Waste to Energy
3	2534032	Concurrent Engineering
4	2534032	Industrial Safety

Audit Course – I

S. No.	Course Code	Audit Course Title
1	2510002	English for Research Paper Writing
2	2510003	Disaster Management
3	2510004	Sanskrit for Technical Knowledge
4	2510005	Value Education

Audit Course – II

S. No.	Course Code	Audit Course Title
5	2520006	Constitution of India in Practice
6	2520007	Pedagogy Studies
7	2520008	Stress Management by Yoga
8	2520009	Personality Development Through Life Enlightenment Skills

I–I

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Course code: 2514001:Advanced CAD
(Professional Core – I)

IYEAR I SEM

L	T	P	C
3	0	0	3

CourseOverview:

This course introduces CAD tools, software standards, and the fundamentals of 3D geometricmodeling.It covers wireframe, surface, and solid modeling techniques along with curve and surface representations.Students learn CAD transformations, projections, visualization methods, and data exchange standards.The course also emphasizes evaluation of CAD systems, dimensioning, and tolerance principles for design application

Prerequisite: Engineering Graphics, Basics of Solid Mechanics

CourseObjective:The students willtrytolearn

1. To provide knowledge on geometric modeling and parametric design concepts.
2. To introduce curve, surface, and solid modeling techniques using CAD tools.
3. To understand finite element modeling and its CAD integration.
4. To apply CAD for design automation and optimization.
5. To develop skills in advanced CAD software and design validation tools.

CourseOutcomes:Aftersuccessfulcompletionofthecourse,studentsshouldbeableto

1. Understand the CAD process and geometric modelling concepts.
2. Analyze the utility and application of wire frame modelling.
3. Understand the concepts of surface modelling.
4. Understand and apply the concepts of solid modelling techniques.
5. Understand graphics by using transformations and analyse the utility of data exchange formats with dimensioning and tolerances.

Module-I:CAD Tools and 3D Modeling **[10]**

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software.

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Module-II:Geometric Modeling Techniques [09]

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

Module-III:Surface Modeling Methods [10]

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

Module-IV:Solid Modeling Concepts [09]

Geometry and Topology, Boundary Representation, Euler Poincare Formula, Euler Operators, Constructive Solid Geometry, CSG Primitives, Boolean Operators, CSG Expressions, Interior and Exterior, Closure, Sweeping, Linear and Non-Linear, Solid Manipulations, Feature Modeling.

Module–V:CAD Transformations and Standards [09]

Output primitives: Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm.

Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations -Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

Text Books:

1. CAD/CAM Concepts and Applications, Chennakesava R. Alavala, Prentice-Hall of Indi (PHI), 1st Edition, 2007.
2. Mastering CAD/CAM, Ibrahim Zeid, McGraw Hill International Edition, 1st Edition, 2004 .

ReferenceBooks:

1. CAD/CAM: Computer-Aided Design and Manufacturing, Mikell P. Groover, Pearson Education, 1st Edition, 2003.

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2. CAD / CAM / CIM P. Radhakrishnan and S. Subramanian, New Age International Publishers, 3rd Edition, 2008.
3. Principles of Computer Aided Design and Manufacturing, FaridAmirouche, Pearson Education, 1st Edition, 2004.
4. Computer Numerical Control Concepts and programming, Warren S. Seames, Thomson Delmar Learning, 1st Edition, 2002.
5. CAD/CAM Principles and Applications, P.N. Rao, TMH, 3rd Edition, 2010.

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Course code: 2514002:Additive Manufacturing
(Professional Core – II)

IYEAR I SEM

L	T	P	C
3	0	0	3

Course Overview:
This course introduces the fundamentals of Additive Manufacturing (AM), its history, processes, and applications. It covers liquid, solid, and powder-based AM systems along with rapid tooling techniques. Data formats, software tools, and mesh processing for AM are also discussed. Finally, industrial and medical applications highlight the practical significance of AM in various fields

Prerequisite: Basics of Manufacturing, Basic knowledge in Calculus, Physics, Thermodynamics, and Chemistry

Course Objective: The students will try to learn

1. To introduce the fundamentals of additive manufacturing technologies and processes.
2. To explain the principles of various AM techniques like SLS, SLA, FDM, and 3DP.
3. To study materials used in additive manufacturing and their properties.
4. To explore applications of additive manufacturing in prototyping and production.
5. To provide insights into design guidelines, limitations, and future trends in AM.

Course Outcomes: Aftersuccessful completion of the course, students should be able to

1. Understand the basic principles and classifications of additive manufacturing processes.
2. Select appropriate AM processes and materials for different applications.
3. Analyze design considerations specific to additive manufacturing.
4. Evaluate the performance and limitations of various AM techniques.
5. Apply additive manufacturing knowledge in product development and industrial applications.

Module-I:Introduction to AM **[10]**

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

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Process, Fundamental Automated Processes: Distinction Between AM and CNC, Other Related Technologies.

Module-II:Liquid and Solid-Based AM Systems [09]

Liquid-Based AM Systems: Stereo Lithography Apparatus (SLA): Models and Specifications, Process, Working Principle, Photopolymers, Photo Polymerization, Layering Technology, Laser and Laser Scanning, Applications, Advantages and Disadvantages, Case Studies. Solid Ground Curing (SGC): Models and Specifications, Process, Working Principle, Applications, Advantages and Disadvantages, Case Studies.

Poly Jet: Process, Principle, Working Principle, Applications, Advantages and Disadvantages, Case Studies. Micro Fabrication. Solid-Based AM Systems: Laminated Object Manufacturing (LOM): Models and Specifications, Process, Working Principle, Applications, Advantages and Disadvantages, Case Studies. Fused Deposition Modeling (FDM): Models and Specifications, Process, Working Principle, Applications, Advantages and Disadvantages, Case Studies. Multi-Jet Modelling (MJM): Models and Specifications, Process, Working Principle, Applications, Advantages and Disadvantages, Case Studies.

Module-III:Powder-Based AM [10]

Powder Based AM Systems: Selective Laser Sintering (SLS): Models and Specifications, Process, Working Principle, Applications, Advantages and Disadvantages, Case Studies. Three-Dimensional Printing (3DP): Models and Specifications, Process, Working Principle, Applications, Advantages and Disadvantages, Case Studies. Laser Engineered Net Shaping (LENS): Models and Specifications, Process, Working Principle, Applications, Advantages and Disadvantages, Case Studies. Electron Beam Melting (EBM): Models and Specifications, Process, Working Principle, Applications, Advantages and Disadvantages.

Module-IV:AM Data Formats and Software [09]

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL File Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Subdivision Techniques. AM Software's: Need For AM Software, Features of Various AM Software's Like Magics, Mimics, Solid View, View Expert, 3D View, Velocity 2, Rhino, STL View 3 Data Expert And 3 D

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Doctor, Surgi Guide, 3-Matic, Simplant, Mesh Lab.

Module–V:Industrial and Medical AM Applications [09]

Applications of AM, Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS Application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and Simulation of Complex Surgery, Customized Implants and Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Web Based Rapid Prototyping Systems.

Text Books:

1. Rapid Prototyping: Principles and Applications, Chee Kai Chua, Kah Fai Leong and Chu Sing Lim, World Scientific Publishing Co, Third Edition, 2010.
2. Additive Manufacturing: Materials, Processes, Quantifications and Applications, Kun Zhou, CRC Press, 1st Edition, 2021.

ReferenceBooks:

1. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D. T. Pham and S. S. Dimov, Springer, 1 st Edition 2001.
2. Wohlers Report 2000: Rapid Prototyping and Tooling State of the Industry, Terry T. Wohlers, Wohlers Associates, Fort Collins, CO, Annual Report, 2000.
3. Rapid Prototyping and Engineering Applications, Frank W. Liou, CRC Press, 2 Edition, 2019.
4. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker, Springer, 2nd Edition, 2015.
5. Additive Manufacturing: Design, Methods, and Processes, Andreas Gebhardt, Hanser Publishers, 2nd Edition, 2016.
6. Fundamentals of Additive Manufacturing for the Practitioner, Sheku Kamara, Javarro Russell, Klaus-Dieter Thoben, Wiley, 1st Edition, 2021.

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Course Code: 2514011:Advanced Finite Element and Boundary Element Methods (Professional Elective-1)

IYEAR I SEM

L	T	P	C
3	0	0	3

Course Overview:

This course introduces the fundamentals of Finite Element Analysis (FEA) for 1D, 2D, and 3D structural members. It covers trusses, beams, heat transfer, and dynamic analysis using finite element formulations. Advanced topics include plate bending, nonlinear analysis of solids, and boundary element methods. The course equips students with analytical and computational skills for solving real-world engineering problems

Prerequisite: Strength of Materials, Mathematics, Heat Transfer and Vibrations.

Course Objective: The students will try to learn

1. To introduce the basic concepts of the finite element method, the boundary element method.
2. To formulate and solve problems in 1D, 2D, and 3D using FEM.
3. To introduce BEM and its application in linear problems.
4. To study the numerical integration and solution techniques used in FEM/BEM
5. To expose students to software tools implementing FEM/BEM techniques.

Course Outcomes: Aftersuccessful completion of the course, students should be able to

1. Formulate and solve engineering problems using FEM and BEM.
2. Apply FEM to structural, thermal, and fluid flow problems.
3. Use boundary element formulation for linear problems with infinite domains.
4. Implement numerical methods to solve FEM/BEM equations.
5. Utilize commercial software for simulation and result interpretation.

Module-I:Finite Element Analysis of 1D Structural Members [10]

One Dimensional Problems: Formulation of Stiffness Matrix for a Bar Element, Properties of Stiffness Matrix, Characteristics of Shape Functions, Quadratic Shape Functions. Analysis of Trusses: Derivation of Stiffness Matrix for a Truss Element oriented Arbitrarily in to 2D plane,

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Calculation of Reaction Forces, Displacements, Stresses and Strains. Analysis of Beams: Derivation of Stiffness Matrix for Two Noded, Two Degrees of Freedom Per Node Beam Element, Load Vector, Deflection, Stresses, Shear Force and Bending Moment, Problems on Uniform Beams for Different types of Loads.

Module-II:2D and 3D Structural Element Analysis in FEA [10]

Finite Element Formulation of 2D Problems: Derivation of Element Stiffness Matrix for Two-Dimensional CST Element, Derivation of Shape Functions for CST Element, Elasticity Equations, Constitutive Matrix Formulation, Formulation of Gradient Matrix, Two Dimensional Iso parametric Elements and Numerical Integration, Problems.

Module-III:Thermal and Dynamic Analysis in FEA [09]

Steady State Heat Transfer Analysis: One Dimensional Finite Element Analysis of Fin and Composite Slabs. Two-Dimensional Steady State Heat Transfer Problems: Derivation of Thermal Stiffness Matrix for 2D Heat Transfer Problems-CST, Derivation of Thermal Force Vector for 2D Heat Transfer Problems. Dynamic Analysis: Formulation of Mass Matrices for Uniform Bar and Beam Elements using Lumped and Consistent Mass Methods, Evaluation of Eigen Values and Eigen Vectors for a Stepped Bar and Beam Problems.

Module-IV:Plate Bending and Nonlinear FEA of Solids [09]

Plate Bending: Introduction, Plate Behavior, C1 (Kirchhoff) Plate Elements, C0 (Mindlin) Plate Elements, Mindlin Beam, More Devices for C0 Plate Elements, Boundary Conditions, Analytical Problems.

Nonlinear Finite Element of Solids: Material Nonlinearities, Objective Rates, Nonlinear Elasticity, Plasticity, Viscoplasticity, Viscoelasticity.

Module–V:Boundary Element Method for Potential and Electrostatic Problems [10]

Applications of AM, Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS Application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and Simulation of Complex Surgery, Customized Implants and Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Web Based Rapid Prototyping Systems.

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Text Books:

3. The finite element methods in Engineering, S.S. Rao, Elsevier, 4th Edition, 2005.
4. Finite and Boundary Element Methods in Engineering, O.P. Gupta, Oxford and IBH Publishing Co. Pvt. Ltd., 1st Edition, 1991.

ReferenceBooks:

6. Finite Element Methods: Basic Concepts and Applications, AlavalaChennakesava R. PHI, 3rd Edition, 2012.
7. Introduction to Finite Elements in Engineering, Tirupathi R. Chandrupatla and Ashok D. Belegundu, Pearson Education, 4th Edition, 2011.
8. An Introduction to Finite Element Methods, J. N. Reddy, McGraw Hill Education, 3rd Edition, 2005.
9. The Finite Element Method in Engineering Science, O.C. Zienkowitz, McGraw Hill, 1st Edition, 1971.
10. A First Course in Finite Elements, Jacob Fish and Ted Belytschko, Wiley, 1st Edition, 2007.
11. Fundamentals of Finite Element Analysis, David Hutton, McGraw Hill Education, 1st Edition, 2004.

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Course code: 2514012:Experimental Stress Analysis
(Professional Elective-I)

IYEAR I SEM

L	T	P	C
3	0	0	3

CourseOverview:

This course focuses on experimental stress analysis techniques for measuring strain and evaluating structural behavior. It covers strain gauges, model analysis, structural similitude, and optical methods such as photo elasticity. Advanced topics include 3D photo elasticity, stress separation, and modern optical approaches. Specialized and non-destructive testing methods provide practical tools for structural assessment in engineering applications

Prerequisite: Strength of Materials, Theory of Elasticity (desirable).

Course Objective: The students will try to learn

1. Introduce the basic principles and methods of experimental stress analysis.
2. Provide an in-depth understanding of strain measurement using electrical and mechanical strain gauges.
3. Familiarize students with photo elasticity techniques and fringe interpretation in two and three dimensions.
4. Explore advanced optical methods and model analysis using structural similitude and dimensional analysis.
5. Introduce specialized experimental techniques and non-destructive testing (NDT) methods such as ultrasonic, X-ray, and brittle coating techniques.

Course Outcomes: After successful completion of the course, students should be able to

1. Understand the working principles of strain gauges and perform model analysis using theorems like Buckingham Pi and Muller-Breslau's.
2. Explain the fundamentals and applications of photo elasticity in 2D and 3D stress analysis.
3. Utilize various optical and mechanical tools for experimental stress measurement and validation.
4. Apply non-destructive testing techniques like ultrasonic testing, X-ray, gamma-ray, rebound hammer, and Moiré fringe methods for material evaluation.
5. Design experimental setups using model analysis, strain measurement, and advanced optical

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techniques to evaluate stress distribution in mechanical structures.

Module-I:Strain Measurement Techniques [10]

Strain Gauges, Mechanical and Optical Strain Gauges, Description and Operation, Electrical Resistance, Inductance and Capacitance Gauges, Detailed Treatment on Resistance Gauges, Measurement of Static and Dynamic Strains, Strain Rosettes, Effect of Transverse Strains, Use of Strain Recorders and Load Cells.

Module-II:Model Analysis and Structural Similitude [10]

Model Analysis, Structural Similitude, Use of Models, Structural and Dimensional Analysis, Buckingham Pi Theorem, Muller-Breslau's Principle for Indirect Model Analysis, Use of Begg's and Eney's Deformer's, Moment Indicators, Design of Models for Direct and Indirect Analysis.

Module-III:Photo elasticity and Optical Methods [09]

Two-Dimensional Photo elasticity, Stress Optic Law, Introduction to Polariscope, Plane and Circular Polariscope, Compensators and Model Materials, Material and Model Fringe Value, Calibration of Photo elastic Materials, Isochromatic and Isoclinic Fringes, Time Edge Effects.

Module-IV:3D Photo elasticity and Advanced Optical Analysis [09]

Three-Dimensional Photo elasticity, Introduction, Stress Freezing Techniques, Stress Separation Techniques, Scattered Light Photo elasticity, Reflection Polariscope.

Module–V:Specialized and Non-Destructive Testing [10]

Miscellaneous Methods, Brittle Coating Method, Birefringence Techniques, Moiré Fringe Method, Non-Destructive Testing, Ultrasonic Pulse Velocity Technique, Rebound Hammer Method, X-Ray Method, Gamma-Ray Method.

Text Books:

1. Experimental Stress Analysis, J.W. Dally and W.F. Riley, McGraw-Hill, 2nd Edition, 1991.
2. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers / Dhanpat Rai Publications, Revised Edition, 2009.

ReferenceBooks:

1. Experimental Stress Analysis, Sadhu Singh, Dhanpat Rai Publications, Revised Edition,

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2009.
2. Handbook of Experimental Stress Analysis, Max Hetenyi, John Wiley and Sons, New York, 1st Edition, 1950.
3. Photoelasticity, M.M. Frocht, Vol. I and II, John Wiley and Sons, New York, 1st Edition, 1941 (Vol. I) and 1948 (Vol. II).
4. C. Rama Rao, Experimental Stress Analysis, University Press, 1st Edition, 2013.
5. N. Ramesh Babu, Experimental Stress Analysis: Principles and Practice, Anuradha Publications, 1st Edition, 2008.
6. R.K. Rajput, Strength of Materials (For NDT and Stress Analysis Reference), S. Chand and Company, Revised Edition, 2015.

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Course code: 2514013 SUSTAINABLE MANUFACTURING
(Professional Elective - I)

I YEAR I SEM

L	T	P	C
3	0	0	3

CourseOverview:

This course introduces the fundamentals of sustainability and sustainable development by addressing social, economic, and environmental dimensions, along with the role of technology in promoting sustainable manufacturing, its scope, need, and benefits. It covers tools and techniques such as Life Cycle Assessment, Design for Environment, R3/R6 cycles, and sustainable product development approaches, while also focusing on environmental assessment methods and international standards like EIA, ISO 14001, and PAS 2050. Further, the course explores sustainable product design through recycling methods, eco-friendly design practices, and multi-criteria decision-making approaches. It concludes with sustainability metrics, indicators, and corporate social responsibility, enabling learners to integrate sustainability into product design, manufacturing, and business strategies for long-term environmental, social, and economic benefits.

Prerequisite:Manufacturing Processes, Environmental Science

Course Objective: The students will try to learn

1. The course to provide an understanding of the principles and need for sustainability in manufacturing.
2. The methods for reducing energy consumption, material waste, and harmful emissions.
3. The course to explore sustainable product design, green supply chains, and life cycle analysis.
4. The course to introduce eco-friendly manufacturing technologies and sustainability metrics.
5. The course to promote decision-making frameworks for implementing sustainability in industry.

Course Outcomes: After successful completion of the course, students should be able to

1. Understand the core concepts of sustainable manufacturing.
2. Analyze manufacturing processes for environmental impacts

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3. Apply life cycle assessment tools in product and process design.
4. Integrate sustainability principles in supply chain and resource management
5. Recommend sustainable strategies for various manufacturing systems.

Module-I:Fundamentals of Sustainability [09]

Concepts of Sustainability and Sustainable Development, Need for Sustainable Development, Components of Sustainability, Social, Economic and Environmental Dimensions, Linkages Between Technology and Sustainability, Sustainable Manufacturing, Scope, Need and Benefits.

Module-II:Sustainable Manufacturing Tools [09]

Tools and Techniques of Sustainable Manufacturing, Environmental Conscious Quality Function Deployment, Life Cycle Assessment, Design for Environment, R3 and R6 Cycles, Design for Disassembly, Sustainable Product Development and Various Phases.

Module-III:Environmental Assessment and Standards [09]

EIA Methods, CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 Standards, Environmental Impact Parameters, Interactions between Energy and Technology and their Implications for Environment and Sustainable Development.

Module-IV:Sustainable Product Design [07]

Design for Recycling, Eco Friendly Product Design Methods and Methods to infuse sustainability in early Product Design Phases, Multi Criteria Decision Making in Sustainability.

Module–V:Sustainability Metrics and Corporate Responsibility [10]

Frameworks for Measuring Sustainability, Indicators of Sustainability, Environmental, Economic, Societal and Business Indicators, Concept Models and Various Approaches, Product Sustainability and Risk / Benefit Assessment, Corporate Social Responsibility.

TEXT BOOKS:

1. Industrial Development for the 21st Century: Sustainable Development Perspectives, D. Rodick, United Nations, Department of Economic and Social Affairs, 1st Edition, 2007.

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2. Sustainable Manufacturing and Design, Kaushik Kumar, J. Paulo Davim, Apple Academic Press, 1st Edition, 2021.

REFERENCE BOOKS:

1. Sustainability in Manufacturing, Günther Seliger, Springer, 1st Edition, 2007.
2. Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives, R. Stark, G. Seliger and J. Bonvoisin, Springer, 1st Edition, 2017.
3. Handbook of Sustainable Manufacturing, G. Atkinson, S. Dietz, E. Neumayer Edward Elgar Publishing Limited, 1st Edition, 2007.
4. Green Manufacturing: Fundamentals and Applications, David A. Dornfeld, Springer, 1st Edition, 2013.
5. Sustainable Manufacturing: Industrial Engineering Perspective, S. Vinodh, CRC Press, 1st Edition, 2021.
6. Sustainable Manufacturing Processes: Selected Challenges and Case Studies, R. Golinska-Dawson and A. Kolinski, Springer, 1st Edition, 2020.

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Course code: 2514014 AUTOMATION IN MANUFACTURING
(Professional Elective - II)

IYEAR I SEM

L	T	P	C
3	0	0	3

CourseOverview:

This course provides a comprehensive understanding of automation in manufacturing, beginning with the fundamentals of production systems, computerized support, automation principles, strategies, and levels of automation. It covers material handling systems, including equipment, design considerations, transport systems, storage strategies, automated storage, and automatic data capture technologies like barcodes and ADC. Students will learn about manual assembly lines, design for assembly, line balancing techniques, and considerations in single and mixed model assembly systems. The course further explores automated production lines, storage buffers, and the analysis of transfer lines with or without storage. It also focuses on automated assembly systems, including design principles, quantitative analysis, parts delivery mechanisms, and workstation arrangements. Overall, the course equips learners with the knowledge and analytical skills to design, evaluate, and implement automation solutions for modern manufacturing systems

Prerequisite:Production Technology, Machine Tools, Operations Research

Course Objective: The students will try to learn

1. The basics of automation and its classification in manufacturing systems.
2. The control systems, types of automation, and their hardware components.
3. The course to analyse automated material handling, storage, and inspection systems.
4. The course to provides knowledge on transfer mechanisms and principles of system integration.
5. The course in evaluating the economic aspects and strategies of implementing manufacturing automation.

Course Outcomes: After successful completion of the course, students should be able to

1. Classify different types of automation and describe their roles in modern manufacturing
2. Analyze discrete and continuous control systems used in automation.
3. Design material handling systems and storage solutions for automated facilities.
4. Understand inspection systems, transfer mechanisms, and integration methods.

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5. Apply cost analysis and automation strategies in real-world manufacturing contexts.

Module-I:Introduction to Automation [10]

Automation in Production Systems, Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies. Manufacturing Operations, Production Concepts and Mathematical Models. Costs of Manufacturing Operations, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automation.

Module-II:Material Handling [11]

Introduction, Overview of Material Handling Equipment, Considerations in Material Handling System Design, The 10 Principles of Material Handling. Material Transport Systems, Automated Guided Vehicle Systems, Monorails and Other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems. Storage Systems, Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated Storage Systems, Engineering Analysis of Storage Systems. Automatic Data Capture, Overview of Automatic Identification Methods, Bar Code Technology and Other ADC Technologies.

Module-III:Manual Assembly Lines [10]

Fundamentals of Manual Assembly Lines, Alternative Assembly Systems, Design for Assembly, Analysis of Single Model Assembly Lines, Line balancing problem, Largest Candidate Rule, Kilbridge and Wester Method, and Ranked Positional Weights Method, Mixed Model Assembly Lines, Considerations in Assembly Line Design.

Module-IV:Transfer lines [07]

Fundamentals of Automated Production Lines, Storage Buffers, Applications of Automated Production Lines. Analysis of Transfer Lines with No Internal Storage, Analysis of Transfer Lines with Storage Buffers.

Module–V:Automated Assembly Systems [09]

Fundamentals of Automated Assembly Systems, Design for Automated Assembly and Quantitative Analysis of Assembly Systems, Parts Delivery System at Workstations, Multi Station Assembly Machines and Single Station Assembly Machines, Partial Automation.

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TEXTBOOKS:

1.Automation, Production systems and computer integrated manufacturing, Mikel P. Groover, Pearson Education, 4th Edition, 2015.

2. CAD/CAM: Principles, Practice and Manufacturing Management, Chris Mc Mohan, Jimmie Browne, Pearson Edu. (LPE), 2nd Edition, 2000.

REFERENCE BOOKS:

1. Automation, Buckingham W, Haper and Row Publishers, New York, 3rd Edition, 1961.

2. Automation for Productivity, Hugh D. Luke, A Becker and Hayes publication, New York, 1st Edition, 1972.

3. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson Education, 5th Edition, 2023.

4. Computer Control of Manufacturing Systems, Yoram Koren, McGraw-Hill, 1st Edition, 1983.

5. Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design Yusuf
Altintas, Cambridge University Press, 2nd Edition, 2012.

6. Industrial Automation: Hands On, Frank Lamb, McGraw-Hill Education, 1st Edition, 2013.

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Course code: 2514015 COMPUTER AIDED PROCESS PLANNING
(Professional Elective - II)

I YEAR ISEM

L	T	P	C
3	0	0	3

CourseOverview:

This course provides an in-depth understanding of process planning and its role in modern manufacturing systems. It begins with the concepts of process planning, its relationship with production planning and concurrent engineering, and the use of computer-aided process planning (CAPP) and group technology. Students will learn about part design and representation, including drafting, dimensioning, tolerances, CAD tools, geometric modeling, and GT coding systems such as OPITZ and MICLASS. The course covers various process engineering and planning methods like experience-based planning, decision tables, process capability analysis, variant and generative planning approaches, and the use of AI in planning. It further explores the design and implementation of process planning systems, highlighting manufacturing system components and notable CAPP systems like CAM-I, MIPLAN, APPAS, AUTOPLAN, and PRO. Finally, the course focuses on integrated process planning systems, modular data structures, expert systems, and report generation, equipping learners with the knowledge to design and apply efficient, computer-integrated process planning strategies in manufacturing.

Prerequisite:Manufacturing Technology, Computer-Aided Design (CAD)

Course Objective: The students will try to learn

1. The course introducing the principles and methods of process planning in manufacturing systems.
2. The course to explain role of computers in automating and optimizing process planning.
3. The course to explore variant and generative process planning approaches.
4. The course integrating computer-aided process planning (CAPP) with CAD, CAM, and MRP systems.
5. The course and examine the benefits, challenges, and implementation of CAPP in industry.

Course Outcomes: After successful completion of the course, students should be able to

1. Explain the fundamentals of manual and computer-aided process planning.
2. Differentiate between variant and generative CAPP systems
3. Apply group technology and coding systems for process planning.

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4. Integrate CAPP with CAD/CAM and production control systems.
5. Design and evaluate CAPP solutions for efficient and automated manufacturing planning.

Module-I:Concepts of Process Planning [09]

The Place of Process Planning in the Manufacturing Cycle, Process planning and production Planning, Process planning and Concurrent Engineering, CAPP, Group Technology.

Module-II:Part Design and Representation [10]

Design, Drafting, Dimensioning, Conventional Tolerance, Geometric Tolerance, CAD, Input/Output Devices, Topology, Geometric Transformation, Perspective Transformation, Data Structure, Geometric Modelling for Process Planning, GT Coding, The OPITZ System, The MICLASS System, Problems.

Module-III:Process Engineering and Planning Methods [09]

Experience Based Planning, Decision Table and Decision Trees, Process Capability Analysis, Process Planning, Variant Process Planning, Generative Approach, Forward and Backward Planning, Input Format, AI, Problems.

Module-IV:Process Planning Systems [09]

Logical Design of Process Planning, Implementation Considerations, Manufacturing System Components, Production Volume, No. of Production Families, CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP, Problems.

Module–V:Integrated Process Planning Systems [09]

Totally Integrated Process Planning Systems: An Overview, Modulus Structure Data Structure, Operation, Report Generation, Expert Process Planning, Problems.

TEXT BOOKS:

1. Principle of process planning - A Logical Approach, Ideon Halevi and Roland D. Weill,

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Chapman and Hall, 1st Edition, 1995
2. An Introduction to automated process planning systems, Chang T. C. and Richard A. Wysk, Prentice Hall, 1st Edition, 1985.

REFERENCES:

1. An Expert Process Planning System: Fundamentals of Computer-Aided Process Planning, T.C. Chang, Prentice Hall, 1st Edition, 1985.
2. Systems Approach to Computer Integrated Design and Manufacturing, Nanua Singh, John Wiley and Sons, 1st Edition, 1996.
3. Computer Aided Manufacturing, P.N. Rao, Tata McGraw Hill Publishing Co., 2nd Edition, 2000.
4. Computer-Aided Manufacturing, Rao P.N., Tata McGraw Hill, 4th Edition, 2013.
5. Process Planning and Cost Estimation, R. Kesavan, C. Elanchezhian and B. Vijaya Ramnath, New Age International, 2nd Edition, 2010.
6. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson, 4th Edition, 2014

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Course code: 2514016 INDUSTRIAL ROBOTICS
(Professional Elective - II)

IYEAR I SEM

L	T	P	C
3	0	0	3

CourseOverview:

This course provides a comprehensive study of industrial robotics, their components, and applications in automation and manufacturing. It begins with robot basics, including anatomy, configurations, motions, drive systems, control systems, and the use of sensors such as position, velocity, tactile, proximity, and range sensors. The course covers manipulator kinematics, forward and inverse transformations, differential kinematics, Jacobian formulation, and trajectory planning using joint and Cartesian space schemes. Students will explore robot dynamics, including Lagrange-Euler and Newton-Euler formulations, as well as end effectors like grippers and tools, and machine vision systems for sensing, image processing, and object recognition. It also addresses robot programming techniques, motion interpolation, programming languages, and the structure and functions of textual robot languages. Finally, the course focuses on work cell design, control, interlocks, error detection, and practical industrial applications such as material transfer, machine loading/unloading, processing operations, assembly, inspection, and emerging future applications, equipping learners with the skills to design, analyze, and implement robotic systems in manufacturing.

Prerequisite:Kinematics of machinery

Course Objective: The students will try to learn

1. The course introduces the fundamentals of industrial robotics and robot configurations.
2. The course analyzes forward and inverse kinematics of robotic manipulators.
3. The course studies robot dynamics, end effectors, and machine vision systems.
4. The course focuses on robot programming, control techniques, and path planning.
5. The course explores industrial applications of robotics in manufacturing and automation.

Course Outcomes: After successful completion of the course, students should be able to

1. Understand robot structures, drive systems, sensors, and actuators.
2. Perform kinematic and dynamic analysis of robotic arms.
3. Evaluate and apply vision systems for robotic inspection and control.

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4. Develop robot programs using different programming methods.
5. Design robotic cells for manufacturing tasks and analyze their performance.

Module-I:Robot Basics and Sensors [10]

Introduction, Automation and Robotics, Robot Anatomy Configuration, Motions Joint Motion and Notation, Work Volume, Robot Drive System, Control System and Dynamic Performance, Precision of Movement. Control System and Components: Basic Concept and Modals Controllers Control System Analysis, Robot Actuators and Feedback Components (Sensors): Internal and External Sensors, Positions Sensors, Velocity Sensors, Desirable Features, Tactile, Proximity and Range Sensors, Uses Sensors in Robotics, Power Transmission Systems.

Module-II:Motion Analysis and Control [10]

Manipulator Kinematics, Position Representation Homogeneous Transformation, D-H Notation, D-H Transformation Matrix, Forward and Inverse Transformations, Problems on Planar and Spatial Manipulators, Differential Kinematics, Jacobian Formulation, Problems. Manipulator Path Control: Slew, Joint Interpolated and Straight-Line Motions. Trajectory Planning: Joint Space Scheme, Cartesian Space Scheme, Cubic Polynomial Fit Without and with Via Point, Blending, Problems.

Module-III:Dynamics, End Effectors and Vision [11]

Robot Dynamics: Lagrange – Euler and Newton - Euler formulations, problems on two link planar manipulators, configuration of robot controller, Problems. End Effectors: Grippers types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

Module-IV:Robot Programming and Languages [10]

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, Wait, Signal and Delay commands, Branching capabilities and Limitations. Robot Languages: Textual robot languages, Generation, Robot language structures, Elements and functions

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Module–V:Work Cell Design and Applications [10]

Robot Cell Design and Control: Robot cell layouts, Robot centered cell, In-line robot cell, Considerations in work cell design, Work cell control, Inter locks, Error detection, Work cell controller. Robot Applications: Material transfer, Machine loading, unloading. Processing operations, Assembly and Inspection, Future Applications.

TEXT BOOKS:

1. Introduction to Robotics Mechanics and Control, John J. Craig, Pearson Education, 3rd Edition, 2005.
2. Industrial Robotics: Technology, Programming, and Applications, Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, McGraw-Hill, 1 st REFERENCE BOOKS: 1. Edition, 1986.

REFERENCE BOOKS:

1. Robotics: Control, Sensing, Vision and Intelligence, K. S. Fu and R. C. Gonzalez and C. S. G. Lee, McGraw-Hill Education, 2nd Edition, 2023.
2. Robot Analysis: The Mechanics of Serial and Parallel Manipulators, Lung-Wen Tsai, John Wiley and Sons, 2nd Edition, 2022.
3. Robot Analysis and Control, H. Asada and J. E. Slotine, Wiley, 2nd Edition, 2021.

4. Fundamentals of Robotics: Analysis and Control, Robert J. Schilling, Pearson Education, 2nd Edition, 2022.
5. Robotics for Engineers, Yoram Koren, McGraw-Hill Education, 2nd Edition, 2023.

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Course Code: 2510001 RESEARCH METHODOLOGY AND IPR
(Mandatory Course)

I Year I Sem

L	T	P	C
2	0	0	2

Course Overview:

A Research Methodology and IPR course provides comprehensive training on the principles and practices of conducting research, including research design, data collection, analysis, and reporting, combined with a thorough understanding of Intellectual Property Rights (IPR) and their significance in protecting inventions and creative works, covering concepts like patents, trademarks, copyrights, and the legal processes for filing, managing, and exploiting intellectual property.

Prerequisite: Fundamentals of Statistics, Technical Writing Skills

Course Objectives:

1. To understand research fundamentals, methodologies, and the significance of research ethics.
2. To enable students to formulate research problems and conduct literature surveys effectively.
3. To introduce the principles of data collection, analysis, and interpretation in research.
4. To explain intellectual property rights, patents, copyrights, and trademarks.
5. To highlight the importance of IPR in protecting innovative ideas and research outcomes.

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

1. Understand the research process, methodologies, and ethics involved in scholarly work.
2. Formulate and define research problems with appropriate objectives.
3. Apply suitable data collection and analysis techniques for research projects.
4. Understand the various forms of intellectual property rights and legal aspects related to patents and copyrights.
5. Apply the knowledge of IPR to safeguard their innovations and research findings.

UNIT-I: Research Problem and Investigation Approaches [10]

Meaning of Research Problem, Sources of Research Problem and Criteria Characteristics of a Good Research Problem, Errors in Selecting a Research Problem, Scope and Objectives of

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Research Problem. Approaches of Investigation of Solutions for Research Problem, Data Collection, Analysis, Interpretation, Necessary Instrumentations.

UNIT-II: Literature Review and Ethics [09]

Effective Literature Studies Approaches, Analysis, Plagiarism, Research Ethics.

UNIT-III: Technical Writing and Proposals. [10]

Effective Technical Writing, How to Write Report, Paper Developing a Research Proposal, Format of Research Proposal, a Presentation and Assessment by A Review Committee.

UNIT-IV: Intellectual Property and Patenting [10]

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process Of Patenting and Development: Technological Research, Innovation, Patenting, Development. International Scenario: International Cooperation on Intellectual Property. Procedure for Grants of Patents, Patenting Under PCT.

UNIT-V: Patent Rights and Emerging IPR [10]

Patent Rights: Scope of Patent Rights, Licensing and Transfer of Technology, Patent Information and Databases, Geographical Indications. New Developments in IPR: Administration of Patent System. IPR of Biological Systems, Computer Software Etc., Traditional Knowledge Case Studies, IPR and IITs.

TEXTBOOKS:

1. Research methodology: an introduction for science and engineering students, Stuart Melville and Wayne Goddard, Juta and Co. Ltd, 1ST Edition, 1996.
2. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, SAGE, 2nd Edition, 2010.

REFERENCE BOOKS:

1. Resisting Intellectual Property, Debora J. Halbert, Routledge, Taylor and Francis, 1st Edition, 2005.
2. Industrial Design, W. H. (William Henry) Mayall, Iliffe Books (London), also McGraw-

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Hill editions, 1st Edition, 1974.

3. Intellectual Property in the New Technological Age, Robert P. Merges, Peter S. Menell and Mark A. Lemley, Aspen Casebook Series, Latest Edition, 2016.
4. Intellectual Property Rights under WTO, T. Ramappa, Wheeler Publishing, 1st Edition, 2000.
5. Research Methodology and IPR, P. N. Ganesan, Scitech Publications, 1st Edition, 2019.
6. Intellectual Property Rights: Unleashing the Knowledge Economy, Prabuddha Ganguli, Tata McGraw-Hill, 1st Edition, 2001.

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Course Code: 2514040: ADVANCED COMPUTER AIDED DESIGN LAB

I Year I Sem

L	T	P	C
0	0	4	2

Course over view:

An "Advanced Computer-Aided Design (CAD) Lab" course overview centers on using modern CAD/CAE software to create, analyze, and virtually manufacture 2D and 3D designs, emphasizing collaboration and the connection between design, analysis, and manufacturing processes in the digital age. These labs teach skills in 3D modeling, technical drawing, design analysis, and the generation of manufacturing codes using specialized software like AutoCAD and SolidWorks, preparing students for roles in digital design and engineering

Prerequisites: Computer Aided Design, Engineering Graphics

Course Objectives:

1. Provide hands-on training in 2D and 3D modeling using CAD software tools.
2. Familiarize students with dimensioning, geometric tolerancing and virtual product design.
3. Enable students to perform structural, dynamic, and advanced simulations using FEA software.
4. Develop skills in simulating real-world mechanical problems such as stress, vibration, buckling, and failure.
5. Integrate theoretical knowledge with practical applications through projects involving static and dynamic FEA analysis.

Course Outcomes:

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

1. Create accurate 2D and 3D models of mechanical components using CAD tools.
2. Apply dimensioning and tolerance techniques to enhance design clarity and manufacturability.
3. Assemble components virtually and simulate simple mechanisms with motion/animation features.
4. Perform structural analysis of trusses, beams, and frames using FEA tools.
5. Analyze advanced mechanical behavior including buckling, vibration, and fracture using FEA.

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List of Experiments:

1. Two-Dimensional Drawing using CAD Software
2. Three-Dimensional Drawing using CAD Software
3. Various Dimensioning and Tolerance Techniques on Typical Products using CAD Software
4. Assembly and Animation of Simple Assemblies like Screw Jack, Bolt-Nut Mechanism, etc.
5. Truss Analysis using FEA Software
6. Beam Analysis using FEA Software
7. Frame Analysis using FEA Software
8. Buckling Analysis of Columns using FEA Software
9. Harmonic Analysis using FEA Software
10. Fracture Analysis using FEA Software
11. Analysis of Laminated Composites using FEA Software
12. Couple-Field Analysis using FEA Software
13. Modal Analysis
14. Transient Dynamic Analysis
15. Spectrum Analysis

Note: Conduct any 12 out of the 15 exercises from the list of experiments.

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Course Code: 2514041 ADDITIVE MANUFACTURING LAB

I Year I Sem

L	T	P	C
0	0	4	2

Course over view:

An Additive Manufacturing (AM) Lab course provides hands-on experience with 3D printing technologies, teaching students to design for AM, operate AM machines, select materials, and perform post-processing on parts. Key topics include principles of AM, design tools, different material types, build preparation, and part inspection, with applications in various sectors like aerospace, medical, and automotive.

Prerequisites: Manufacturing Processes, Engineering Drawing, and CAD Modeling

Course Objectives:

1. To provide hands-on experience with additive manufacturing technologies.
2. To train students in CAD modeling and preparation of STL files for 3D printing.
3. To demonstrate operation and troubleshooting of 3D printers.
4. To develop skills in post-processing and inspection of printed components.
5. To expose students to material selection, process planning, and applications of additive manufacturing.

Course Outcomes:

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

1. Prepare 3D CAD models and convert them into printable formats.
2. Operate and calibrate different types of additive manufacturing machines.
3. Select appropriate materials and parameters for specific applications.
4. Inspect and evaluate the quality of printed parts through dimensional and visual checks.
5. Understand practical challenges and applications of additive manufacturing in real-world scenarios.

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List of Experiments:

1. Review of CAD Modeling Techniques and Introduction to Rapid Prototyping (RP)
2. Forming Groups and Assigning Creative Ideas
3. Generating STL Files from the CAD Models and Working on STL Files
4. Modeling Creative Designs in CAD Software
5. Assembling Creative Designs in CAD Software
6. Processing the CAD Data in Catalyst Software (Selection of Orientation, Supports Generation, Slicing, Tool Path Generation)
7. Simulation in Creality print
8. Printing 3D Model Plates
9. 3D Models – Simple 3D Objects
10. Printing of Cellular Structure

I–II

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Course Code: 2524003 COMPUTER INTEGRATED MANUFACTURING
(Professional Core – III)

I Year II Sem

L	T	P	C
3	0	0	3

CourseOverview:

Computer Integrated Manufacturing (CIM) involves the integration of computer systems into all aspects of manufacturing. The course introduces students to the application of computer technology in planning, designing, controlling, and operating manufacturing systems. It covers automation, robotics, CAD/CAM, CNC machines, flexible manufacturing systems, and the role of computer networks in modern industrial processes.

The course emphasizes the use of computers to improve productivity, accuracy, flexibility, and efficiency in manufacturing, preparing students for careers in advanced manufacturing and industrial automation.

Prerequisites:

Manufacturing Processes, Production Technology, and CAD/CAM

Course Objectives: To make the students:

1. Understand the role of computers in manufacturing.
2. Gain in-depth knowledge of manufacturing and database systems.
3. Understand the needs of the market and design products accordingly.
4. Design and develop material handling, storage, and retrieval systems for specific manufacturing applications.
5. Develop CIM systems for current manufacturing scenarios using computer and networking tools.

Course Outcomes:

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

1. Select the necessary computing tools for product development.
2. Use appropriate database systems for product manufacturing and storage for future use.
3. Apply the latest manufacturing technologies and software for product development.
4. Utilize modern manufacturing techniques and tools, including networking principles.
5. Apply the concepts of lean and agile manufacturing.

UNIT – I: Concepts of CIM **[10]**

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Meaning of Manufacturing, Types of Manufacturing; CIM Definition, Elements of CIM, CIM Wheel, Concept or Technology, Evolution and Benefits of CIM, Need for CIM, Hardware and Software, Fundamentals of Communication, Communication Matrix, Product Development Cycle.

Concurrent Engineering: Definition, Sequential vs. Concurrent Engineering, Benefits and Characteristics of Concurrent Engineering, Framework for Integration of Life Cycle Phases in CE, Concurrent Engineering Techniques, Integrated Product Development (IPD), Product Life Cycle Management (PLM), Collaborative Product Development.

UNIT – II: Database Systems and PDM [10]

Introduction to Manufacturing Data – Types and Sources, Database Terminology, Database Requirements, Database Models, Database Management Systems (DBMS), Architecture, Query Language.

SQL Concepts: Structure, Data Definition Language (Create, Alter, Drop, Truncate, View), Data Manipulation Language (Store, Retrieve, Update, Delete). Illustration of Creating and Manipulating a Manufacturing Database, SQL as a Knowledge Base Query Language, Features of Commercial DBMS – Oracle, MySQL, SQL Access, Sybase, DB2.

Product Data Management (PDM): Concept, Advantages, and Applications.

UNIT – III: Product and Manufacturing Systems [10]

Product Design: Market Needs, Design and Engineering, The Design Process. **Design for Manufacturability (DFM):** Component Design, Design for Assembly.

Computer-Aided Process Planning (CAPP): Basic Steps in Process Plan Development, Variant and Generative Process Planning, Feature Recognition in CAPP. **Material Requirements Planning (MRP) & Manufacturing Resource Planning (MRP–II).**

Cellular Manufacturing: Design of Cellular Systems, Cell Formation Approaches – Machine-Component Group Analysis, Similarity Coefficient-Based Approaches, Evaluation of Cell Design.

Shop-Floor Control: Data Logging and Acquisition, Automated Data Collection, Programmable Logic Controllers (PLC), Sensor Technology.

Flexible Manufacturing Systems (FMS): Physical Components, Types of Flexibility, Layout Considerations – Linear Single Machine, Circular Machine, Cluster, and Loop Layouts. Operational Problems and Benefits of FMS.

UNIT – IV: Networking and CIM Models [10]

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Networking Principles: Terminology, Types of Networks – LAN, MAN, WAN. Selection of Network Technology – Communication Medium, Network Topology, Medium Access Control Methods, Signaling Methods.

Network Architectures and Protocols: OSI Model, MAP and TOP, TCP/IP, Network Interconnection and Devices, Network Performance, Framework for Enterprise-Wide Integration.

CIM Models: ESPRIT-CIM OSA Model, NIST-AMRF Model, Siemens Model of CIM, Digital Equipment Corporation Model, IBM Concept of CIM.

UNIT – V: Lean Manufacturing [10]

Definition and Principles of Lean Manufacturing, Characteristics, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Performance Measures, Supply Chain, Benefits of Lean Manufacturing.

Introduction to Agile and Web-Based Manufacturing Systems.

TEXTBOOKS:

1. Principles of Computer Integrated Manufacturing – S. Kant Vajpayee, Prentice Hall India, 1st Edition, 1998.
2. Systems Approach to Computer Integrated Design and Manufacturing – Nanua Singh, John Wiley & Sons, 1st Edition, 1995.

REFERENCE BOOKS:

1. CAD, CAM, CIM – P. Radhakrishnan, S. Subramanyam, and V. Raju, New Age International Pvt. Ltd., 4th Edition, 2016.
2. Computer Integrated Manufacturing – A. Alavudeen and N. Venkateshwaran, Prentice Hall India Learning Pvt. Ltd., 1st Edition, 2010.
3. Manufacturing Planning and Control for Supply Chain Management – F. Robert Jacobs and William Lee Berry, McGraw-Hill Education, 7th Edition, 2023.
4. Automation, Production Systems, and Computer-Integrated Manufacturing – Mikell P. Groover, Pearson Education, 5th Edition, 2023.
5. Manufacturing Systems Engineering – Stanley B. Gershwin, Prentice Hall.

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Course code: 2524004Manufacturing Systems: Simulation Modelling and Analysis (Professional Core – IV)

IYEAR II SEM

L	T	P	C
3	0	0	3

CourseOverview:

This course introduces students to the principles and applications of simulation in manufacturing systems. It covers system modeling, statistical estimation, and hypothesis testing, followed by model validation, verification, and stochastic input modeling. Students will learn methods of random variate generation and explore simulation languages such as GPSS, SIMAN, and SIMSCRIPT. The course also emphasizes output data analysis, steady-state simulation, and evaluation methods. Practical applications include flow shop, job shop, queuing models, and inventory systems. By the end, students gain the ability to design, analyze, and validate simulation models for efficient manufacturing decision-making.

Prerequisite: Operations Research, Optimization Techniques, ProbabilityStatistics

Course Objective: The students will try to learn

1. Learn ways of analyzing the systems.
2. Classification of systems-based nature of dynamics and knowledge of elements.
3. To develop simulation model for dynamic discrete – event stochastic system.
4. To run the model and collect the data.
5. To analyze the output data of simulation for specified for performance measuresbased on type of simulation and method of output data analysis.

Course Outcomes: After successful completion of the course, students should be able to

1. Define the state of system W.R.T specified performance measures.
2. Develop simulation model for the said system
3. Generate random variations and learn various simulation languages.
4. Analyze through simulation the model and present the results to specified confidence level.
5. Apply simulation for flow shop systems and job shop systems.

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Module-I:System Modeling and Statistical Analysis [10]

System Analysis, Ways to Analyze the System, Model, Types of Models, Simulation,Definition, Types of Simulation Models, Steps Involved in Simulation, Advantages andDisadvantages. Parameter Estimation, Estimator, Properties Estimate, Point Estimate,Confidence Interval Estimates, Independent, Dependent, Hypothesis, Types of Hypotheses,Steps, Types 1 and 2 Errors, Framing, Strong Law of Large Numbers.

Module-II:Model Validation and Stochastic Inputs [10]

Building of Simulation Model, Validation, Verification, Credibility their Timing,Principles of Valid Simulation Modeling, Techniques for Verification, StatisticalProcedures for Developing Credible Model. Modeling of Stochastic Input Elements,Importance, Various Procedures, Theoretical Distribution, Continuous, Discrete theirSuitability in Modeling.

Module-III:Random Variate Generation and Simulation Languages [10]

Generation Of Random Variates, Factors for Selection, Methods, Inverse Transform,Composition, Convolution, Acceptance, Rejection, Generation of Random Variable,Exponential, Uniform Weibull, Normal Bernoullie, Binomial Uniform Poison.Simulation Languages, Comparison of Simulation Languages with General PurposeLanguages, Simulation Languages vs Simulators, Software Features, StatisticalCapabilities, GPSS, SIMAN, SIMSCRIPT, Simulation of M-M-1 Queue, Comparison ofSimulation Languages.

Module-IV:Output Data Analysis and Steady-State Simulation [09]

Output Data Analysis, Types of Simulation with Respect to Output Data Analysis,Warm Up Period, Welch Algorithm, Approaches for Steady State Analysis, Replication,Batch Means Methods, Comparisons.

Module–V:Simulation Applications in Manufacturing [09]

Applications of Simulation, Flow Shop System, Job Shop System M/M/1 Queues with Infinite and Finite Capacities, Simple Fixed Period Inventory System, New Boy Paper Problem.

Text Books:

1. Simulation Modelling and Analysis by Law, A.M. and Kelton, McGraw Hill, 2nd Edition, 1991.
2. Discrete-Event System Simulation, Jerry Banks and John S. Carson II, Prentice-Hall, 1st

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Edition, 1984.

ReferenceBooks:

1. Simulation of Manufacturing Systems, Allan Carrie, John Wiley and Sons, Chichester and New York, 1st Edition, 1988.
2. A Course in Simulation, Sheldon M. Ross, Macmillan Publishing Company, 1st Edition, 1990.
3. Simulation Modeling and SIMNET, H. A. Taha, Prentice Hall, 1st Edition, 1988.
4. Modeling and Simulation of Discrete Event Systems, Byoung Kyu Choi and DongHun Kang, Wiley, 2nd Edition, 2023.
5. Introduction to Simulation Using Simulink, Michael A. Dwyer, Springer, 1st Edition, 2023.
6. Simulation with AnyLogic, Andrei Borshchev, Springer, 2nd Edition, 2021.
7. Manufacturing Systems Modeling and Analysis, Guy L. Curry and Richard M. Feldman, Pearson Education, 2nd Edition, 2023.

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Course code: 2524017 Intelligent Manufacturing Systems
(Professional Elective – III)

IYEAR IISEM

L	T	P	C
3	0	0	3

CourseOverview:

This course focuses on the integration of advanced computing and intelligent techniques in modern manufacturing. It begins with computer-integrated manufacturing systems (CIM), covering CAD, CAM, CAPP, CAQC, and communication networks. Students learn about knowledge-based systems, representation schemes, and inference mechanisms for decision-making. The course introduces artificial intelligence, machine learning, and neural networks with applications in manufacturing. It further explores automated process planning, expert systems for equipment selection, and problem-solving approaches in knowledge-based systems. The final module covers group technology, clustering algorithms, and knowledge-based methods. By the end, students gain the ability to design intelligent systems for efficient manufacturing.

Prerequisite: Computer Integrated Manufacturing, Artificial Intelligence Basics

Course Objective: The students will try to learn

1. To understand the computer integrated manufacturing systems
2. To provide an in-depth understanding of components of knowledge-based systems
3. To provide an understanding of artificial intelligence
4. To design and develop automated process planning
5. To develop group technology for intelligent manufacturing systems

Course Outcomes:After successful completion of the course, students should be able to

1. Select the necessary tools for computer integrated manufacturing systems
2. Use appropriate knowledge of components of knowledge-based systems
3. Use machine learning techniques for intelligent manufacturing systems
4. Apply the concepts of automated process planning
5. Apply the group technology for intelligent manufacturing systems.

Module-I:Computer Integrated Manufacturing System [10]

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Computer Integrated Manufacturing Systems Structure and Functional Areas of CIM System,CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM, Manufacturing CommunicationSystems, MAP / TOP, OSI Model, Data Redundancy, Top- Down and Bottom-Up Approach,Volume of Information, Intelligent Manufacturing System Components, System Architectureand Data Flow, System Operation.

Module-II:Knowledge Based System Components and Representation [10]

Components of Knowledge Based Systems, Basic Components of Knowledge BasedSystems, Knowledge Representation, Comparison of Knowledge Representation Schemes,Interference Engine, Knowledge Acquisition.

Module-III:Artificial Intelligence and Neural Networks in Manufacturing [09]

Machine Learning, Concept of Artificial Intelligence, Conceptual Learning, Artificial NeuralNetworks, Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications inManufacturing.

Module-IV: Automated Process Planning and Equipment Selection [10]

Automated Process Planning, Variant Approach, Generative Approach, Expert Systemsfor Process Planning, Feature Recognition, Phases of Process Planning, Knowledge BasedSystem for Equipment Selection (KBSES), Manufacturing System Design, EquipmentSelection Problem, Modeling the Manufacturing Equipment Selection Problem, ProblemSolving Approach in KBSES, Structure of the KRSES.

Module–V:Group Technology and Knowledge Based Clustering [09]

Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, MatrixFormation, Similarity Coefficient Method, Sorting-Based Algorithms, Bond Energy Algorithm,Cost Based Method, Cluster Identification Method, Extended CI Method, Knowledge BasedGroup Technology, Group Technology in Automated Manufacturing System, Structure ofKnowledge Based System for Group Technology (KBSCIT) Data Base, Knowledge Base,Clustering Algorithm.

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Text Books:

1. Intelligent Manufacturing Systems, Andrew Kusiak, Prentice Hall, 1st Edition, 1990.
2. Artificial Neural Networks, Yagna Narayana, PHI, 1st Edition, 2006

ReferenceBooks:

1. Automation, Production Systems and CIM, Mikell P. Groover, PHI, 2nd Indian Reprint,2007.
2. Neural networks: A comprehensive foundation, Simon Haykin, PHI, 2nd Edition, 2005.
3. Artificial neural networks, B. Vegnanarayana, PHI Learning Pvt. Ltd., 1st Edition, 2006.
4. Neural networks in Computer intelligence, Li Min Fu, TMH, 1st Edition, 2003.
5. Neural Networks: A Comprehensive Foundation, James A. Freeman and David M.Skapura, Pearson education, 2nd Edition, 2004.
6. Introduction to Artificial Neural Systems, Jacek M. Zurada, JAICO Publishing House,Indian Edition, 2006.

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Course code: 2524018 Smart Manufacturing
(Professional Elective – III)

IYEAR IISEM

L	T	P	C
3	0	0	3

CourseOverview:

This course introduces the principles, technologies, and applications of Smart Manufacturing in the context of Industry 4.0. It begins with the evolution of industrial revolutions, sustainability aspects, and cybersecurity challenges. Students will explore the Industrial Internet of Things (IIoT), digital enterprise architecture, and enabling technologies such as cloud computing, augmented/virtual reality, big data, and analytics. The course covers intelligent sensing and actuation systems, including thermal, electrical, and electromechanical devices. It also emphasizes industrial communication systems, SCADA, PLC, and distributed control systems. Finally, real-world IIoT applications across automation, healthcare, transportation, agriculture, and process industries are discussed for holistic understanding.

Prerequisite: Computer Networks, Fundamentals of Mechatronics

Course Objective: The students will try to learn

1. To understand the basics of Industry 4.0
2. To understand the Business model and impact of IoT
3. To understand the concepts of virtual reality, lean manufacturing
4. To gain knowledge of various sensors and actuators.
5. To understand various data transmission technologies

Course Outcomes: **After** successful completion of the course, students should be able to

1. Explain Smart Business Perspective, Cyber security, Impacts of Industry 4.0.
2. Understand the basics of the Industrial Internet of Things.
3. Understand various key technologies.
4. Implement various sensors and actuators.
5. Understand different industrial transmission technologies and IOT applications in real life

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Module-I: Industry 4.0 Basics [10]

Industrial Revolution: Phases, Evolution of Industry 4.0, Environmental Impacts of Industrial Revolution, Applications, Design Requirements, Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Cyber Security, Impacts of Industry 4.0.

Module-II: Industrial Internet of Things and Digital Enterprise Architecture [10]

Industrial Internet of Things, Basics: IIoT and Industry 4.0, IIC, Industrial Internet Systems,Design of Industrial Internet Systems, Impact of Industrial Internet, Benefits of IndustrialInternet, Industrial Sensing, Industrial Processes, Features of IIoT for Industrial Processes,Industrial Plant, The Future Architecture, Digital Enterprise.Business Models and Reference Architecture of IIoT: Definition of a Business Model, Business Models of IIoT, Industrial Internet Reference Architecture.

Module-III: Enabling Technologies for Smart Manufacturing and IIoT [09]

Key Technologies: Off-site Technologies, Cloud Computing, Fog Computing. On-siteTechnologies, Augmented Reality, Virtual Reality, Smart Factories, Lean ManufacturingSystem, Big Data and Advanced Analytics.

Module-IV: Sensors and Actuators for Intelligent Systems [09]

Sensors: Various Sensor Types and Their Underlying Working Principles, Characteristics ofSensors, Resolution, Calibration, Accuracy and Others, Sensor Categories, Thermal,Mechanical, Electrical, Optical and Acoustic Sensors.Actuators: Thermal, Hydraulic, Pneumatic, Electromechanical Actuator.

Module–V: Industrial Communication Systems and IIoT Applications [10]

Industrial Data Transmission and Acquisition: Architecture of Various Data TransmissionTechnologies Like Foundation Fieldbus, Profibus, Highway Addressable Remote Transducer (HART), Interbus, Bitbus, Digital STROM, Controller Area Network, and Other Recent andUpcoming Technologies. Distributed Control System, SCADA and PLC System.IIoT Applications: IoT Applications on Industrial Automation, Factories and Assembly Line,Plant Security and Safety, Transportation, Agriculture, Healthcare, Home Automation, Oil,Chemical and Pharmaceutical Industry and Others.

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Text Books:

1. Introduction to Industrial Internet of Things and Industry 4.0, Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press, 1st Edition, 2021.
2. Internet of Things: A Hands-on Approach, Vijay Madisetti and Arshdeep Bahga,University Press, 1st Edition, 2015.
3. Introduction to Internet of Things: A Practical Approach, S.R.N. Reddy, Rachit Thukral,Manasi Mishra, ETI Labs, 1st Edition, 2016.

ReferenceBooks:

1. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress, 1st Edition,2016.
2. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, FlorianMichahelles, Springer, 1st Edition, 2011.
3. Smart Manufacturing: Concepts and Methods, Anthony Tarantino, CRC Press, 1st Edition, 2022.
4. Enabling the Internet of Things: From Integrated Circuits to Integrated Systems, Massimo Alioto, Springer, 1st Edition, 2017.
5. Industrial Internet of Things: Cybermanufacturing Systems, Sabina Jeschke, ChristianBrecher, Houbing Song, Danda B. Rawat, Springer, 1st Edition, 2017.
6. Cyber-Physical Systems: Foundations, Principles and Applications, HoubingSong,Danda B. Rawat, Sabina Jeschke, Christian Brecher, Morgan Kaufmann, 1st Edition,2016.

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Course code: 2524019 Optimization Techniques and Applications
(Professional Elective – III)

IYEAR IISEM

L	T	P	C
3	0	0	3

CourseOverview:

This course provides a comprehensive study of optimization methods and their applications in engineering and management. It begins with linear programming models, simplex methods, artificial variable techniques, and sensitivity analysis. Students will learn integer and stochastic programming approaches, including branch and bound and chance-constrained algorithms. The course covers single-variable and multivariable non-linear optimization using elimination, interpolation, direct search, and gradient-based methods. Advanced topics include geometric programming and modern optimization techniques such as genetic algorithms, simulated annealing, and particle swarm optimization. Emphasis is placed on problem formulation, solution strategies, and applying optimization tools to practical industrial and decision-making problems.

Prerequisite: Operations Research

Course Objective: The students will try to learn

1. To introduce the fundamentals of optimization and its role in engineering and decision making.
2. To develop the ability to formulate optimization problems for real-world applications.
3. To familiarize students with classical, numerical, and modern optimization techniques.
4. To enable analysis and comparison of various optimization algorithms for efficiency and accuracy.
5. To apply optimization methods to solve practical problems in manufacturing, design,and management.

Course Outcomes: **After** successful completion of the course, students should be able to

1. Apply suitable optimization techniques to solve single-variable and multivariableproblems.
2. Perform sensitivity analysis for parameter changes in Linear Programming Problems.
3. Solve integer and stochastic programming problems using appropriate algorithms.
4. Formulate and solve Goal Programming models for multi-objective optimization.
5. Apply metaheuristic methods such as Genetic Algorithm, Simulated Annealing, andParticle Swarm Optimization to real-world problems.

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Module-I:Linear Programming [10]

Formulation, Simplex Method and Artificial Variable Optimization Techniques: Big Mand Two-Phase Methods. Sensitivity Analysis: Changes in the Objective Coefficients,Constants and Coefficients of the Constraints. Addition of Variables, Constraints.Simulation,Introduction, Types, Steps, Applications. Inventory and Queuing,Advantages and Disadvantages.

Module-II:Integer and Stochastic Programming Techniques [10]

Integer Programming: Introduction, Formulation, Geometry Cutting Plane Algorithm, Zeroor One Algorithm, Branch and Bound Method.Stochastic Programming: Basic Concepts of Probability Theory, Random Variables,Distributions - Mean, Variance, Correlation, Co Variance, Joint Probability Distribution.Stochastic Linear Programming: Chance Constrained Algorithm

Module-III:Single Variable Non-Linear Unconstrained Optimization [09]

Elimination Methods: Uni-Model Function, Its Importance. Fibonacci Method and GoldenSection Method. Interpolation Methods: Quadratic and Cubic Interpolation Methods.

Module-IV:Multi variable non-linear unconstrained optimization [09]

Direct Search Methods, Univariant Method, Pattern Search Methods, Powell's, Hook Jeeves,Rosenbrock Search Methods. Gradient Methods: Gradient Of Function and its Importance,Steepest Descent Method, Conjugate Direction Methods: Fletcher- Reeves Method VariableMetric Method.

Module–V:Geometric Programming and Modern Optimization Methods [10]

Geometric Programming: Polynomials, Arithmetic, Geometric Inequality, UnconstrainedG.P, Constrained G.P (≤ Type Only).Non-Traditional Optimization Algorithms: Genetics Algorithm, Working Principles,Similarities and Differences Between Genetic Algorithm and Traditional Methods. SimulatedAnnealing, Working Principle, Simple Problems. Introduction to Particle Swarm Optimization. (PSO).

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Text Books:

1. Engineering Optimization: Theory and Practice, S. S. Rao, New Age International Pvt.Ltd Publishers, 3rd Edition, 2013.
2. Optimization for Engineering Design: Algorithms and Examples, KalyanmoyDeb,PHI, 2nd Edition, 2012

ReferenceBooks:

1. Operations Research: Theory and Applications, S. D. Sharma, Kedar Nath Ram NathPublisher, 4th Edition, 2022.
2. Operations Research: An Introduction, H. A. Taha, Pearson Publisher, 10th Edition,2019.
3. Optimization in operations research, R. L Rardin, Pearson Imprint, 3rd Edition, 2016.
4. Optimization Techniques, Chakraverty and P . R. Chandraputla, Pearson Asia, 1st Edition, 2011.
5. Optimization: Theory and Practice, Mohan C. Joshi and Kannan M. Moudgalya,Narosa Publishing House, 1st Edition, 2004.

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Course Code: 2524020MECHATRONICS
(Professional Elective – IV)

I YEAR IISEM

L	T	P	C
3	0	0	3

CourseOverview:

This subject introduces the fundamentals of Mechatronic Systems and Design, covering system elements, sensors, transducers, and signal conditioning. It explores actuators, hydraulic and pneumatic systems, microprocessors, microcontrollers, PLCs, and their applications in control. Students learn system modeling, simulation, data acquisition, and SCADA. Emphasis is placed on integrating mechanical, electronic, and control technologies for advanced mechatronic design and understanding future trends.

Prerequisite: Mechanical Engineering Fundamentals, Basic Electrical and Electronics Engineering

Course Objective: The students will try to learn

1. To understand the mechatronics systems.
2. To provide an in-depth understanding of components of knowledge-based systems.
3. To provide an understanding of artificial intelligence.
4. To design and develop automated process planning.
5. To develop group technology for intelligent manufacturing systems.

Course Outcomes: **After** successful completion of the course, students should be able to

1. Understand and describe different mechatronics systems.
2. Explain the principle of operation of various solid-state devices.
3. Describe the working of hydraulic and pneumatic actuating systems and use them appropriately.
4. Use program logic controls effectively.
5. Design mechatronic systems.

Module-I:Mechatronic Systems and Design Process **[10]**

Mechatronics Systems, Elements, Levels of Mechatronics System, Mechatronics Design Process, System, Measurement Systems, Control Systems, Microprocessor Based Controllers, Advantages and Disadvantages of Mechatronics Systems. Sensors and Transducers, Types, Displacement,

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Position, Proximity, Velocity, Motion, Force, Acceleration, Torque, Fluid Pressure, Liquid Flow, Liquid Level, Temperature and Light Sensors.

Module-II:Sensors, Transducers and Signal Conditioning [8]

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS and typical applications.

Module-III:Actuators and Drive Systems [8]

Design Consideration, Hydraulic and Pneumatic Actuating Systems, Fluid Systems, Hydraulic and Pneumatic Systems, Components, Control Valves, Electro Pneumatic, Hydro Pneumatic, Electro Hydraulic Servo Systems: Mechanical Actuating Systems and Electrical Actuating Systems.

Module-IV:Microprocessors, Microcontrollers and Interfacing [10]

Digital Electronics and Systems, Digital Logic Control, Micro Processors and Micro Controllers, Programming, Process Controllers, Programmable Logic Controllers, PLCs Versus Computers, Application of PLCs for Control.

Module-V: System Modeling and Simulation [9]

System and interfacing and data acquisition, DAQS, SCADA, A to D and D to a conversions; Dynamic models and analogies, System response. Design of mechatronics systems and future trends.

Text Books:

1. Mechatronics Integrated Mechanical Electronics Systems, K P Ramachandran and GK Vijaya Raghavan, Wiley India Edition, 2008.
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering, W Bolton, Pearson Education Press, 3rd Edition, 2005.

ReferenceBooks:

1. Mechatronics Source Book, Newton C. Braga, Thomson Publications, Chennai, 1st Edition, 2002.
2. Mechatronics System Design, Devdas Shetty, Richard A. Kolk, Thomson Learning, 2nd Edition, 2005.

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3. Mechatronics, M.D. Singh, J.G. Joshi, Prentice-Hall of India (PHI), 1st Edition, 2006.
4. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering, W. Bolton, Pearson Education, 4th Edition, 2012.
5. Mechatronics – Principles and Applications, Godfrey C. Onwubolu, Elsevier, Indian Print, 1st Edition, 2006.
6. Introduction to Mechatronics and Measurement Systems, David G. Alciatore and Michael B. Histand, McGraw-Hill Education, 6th Edition, 2023.

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Course Code: 2524021 MEMS: Design and Manufacturing
(Professional Elective – IV)

IYEAR IISEM

L	T	P	C
3	0	0	3

CourseOverview:

The course MEMS: Design and Manufacturing covers fundamentals of microsystems, including sensors, actuators, and fluidics, with applications in industries. It integrates engineering science, mechanics, thermofluid principles, and finite element analysis for reliable design. Emphasis is placed on materials like silicon, Gas, and polymers, along with fabrication techniques such as photolithography, deposition, etching, and micromachining for developing advanced MEMS devices.

Prerequisite:Electronic Circuits, Basic knowledge in material science

Course Objective: The students will try to learn

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

Course Outcomes: **After** successful completion of the course, students should be able to

1. Explain the structure, working principles, and applications of MEMS devices.
2. Select suitable materials and fabrication techniques for MEMS manufacturing.
3. Analyze the design and performance of micro sensors and micro actuators.
4. Use modeling and simulation tools for MEMS product development.
5. Evaluate packaging, reliability, and industrial applications of MEMS.

Module-I:MEMS and Microsystems **[9]**

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

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Module-II:Engineering Science for Microsystems Design [9]

Atomic Structure of Matter, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics.

Module-III:Engineering Mechanics for Microsystems Design [8]

Static Bending of Thin plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics and Overview of Finite Element Stress Analysis.

Module-IV:Thermo Fluid Engineering and Microsystems Design [10]

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

Module-V: Materials for MEMS and Microsystems [9]

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

Text Books:

1. MEMS and Microsystems: Design and Manufacturing, Tia-Ran Hsu, Tata McGraw-Hill, 1st Edition, 2002.
2. Foundations of MEMS, Chang Liu, Pearson Education, 2nd Edition, 2012.

ReferenceBooks:

7. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Artech

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House, 1st Edition, 2000.

8. Micro Robots and Micromechanical Systems, W.S.N. Trimmer, Sensors and Actuators, Volume 19, 1989.
9. Applied Partial Differential Equations, D.W. Trim, PWS-Kent Publishing, Boston, 1st Edition, 1990.
10. MEMS: Introduction and Fundamentals, Mohamed Gad-el-Hak, CRC Press, 3rd Edition, 2022.
11. Microelectromechanical Systems: Design and Analysis, Tai-Ran Hsu, John Wiley and Sons, 2nd Edition, 2023.
12. Design and Development Methodologies for MEMS and Microfluidic Devices, Paul Kirby and Philip LeDuc, Elsevier, 1st Edition, 2022.

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Course Code: 2524022 FUZZY LOGIC AND NEURAL NETWORKS
(Professional Elective – IV)

I YEAR IISEM

L	T	P	C
3	0	0	3

CourseOverview:
The subject Fuzzy Logic and Neural Networks focuses on intelligent control and decision-making techniques. It covers fuzzy set theory, logic control, fuzzification, defuzzification, and adaptive fuzzy systems with genetic and neuro-fuzzy approaches. Artificial Neural Networks, learning algorithms, mapping, and recurrent networks are explored. Case studies highlight applications in measurement, control, adaptive neural controllers, signal, and image processing, integrating theory with practical problem-solving.

Prerequisite: Probability and Statistics, Basics of Artificial Intelligence

Course Objective: The students will try to learn

1. To introduce the fundamentals of fuzzy logic and fuzzy set theory.
2. To study the design and application of fuzzy inference systems.
3. To understand the structure, learning algorithms, and applications of neural networks.
4. To explore hybrid systems integrating fuzzy logic and neural networks.
5. To apply fuzzy and neural computing techniques to real-world engineering problems.

Course Outcomes: **After** successful completion of the course, students should be able to

1. Explain fuzzy set theory, membership functions, and fuzzy rules.
2. Design fuzzy inference systems for decision-making and control applications.
3. Apply perceptron, backpropagation, and other learning algorithms in neural networks.
4. Develop hybrid neuro-fuzzy systems for complex problem solving.
5. Implement fuzzy logic and neural network models in engineering applications.

Module-I:Fuzzy Set Theory and Logic Control **[9]**

Basic Concepts of Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relation Equations, Fuzzy Logic Control, Fuzzification, Defuzzification, Knowledge Base, Decision Making Logic, Membership Functions, Rule Base.

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Module-II:Adaptive Fuzzy Systems **[9]**

Performance Index, Modification of Rule Base, Modification of Membership Functions, Simultaneous Modification of Rule Base and Membership Functions, Genetic Algorithms, Adaptive Fuzzy System, Neuro Fuzzy Systems.

Module-III:Artificial Neural Networks **[9]**

Introduction, History of Neural Networks, Multilayer Perceptions, Back Propagation Algorithm and its Variants, Different Types of Learning, Examples.

Module-IV:Mapping and Recurrent Networks **[9]**

Counter Propagation, Self Organization Map, Congnitron and Neocognitron, Hopfield Net, Kohonnen Nets, Grossberg Nets, Art-I, Art-II Reinforcement Learning.

Module-V: Case Studies **[9]**

Application of Fuzzy Logic and Neural Networks to Measurement, Control Adaptive Neural Controllers, Signal Processing and Image Processing.

Text Books:

1. C++, Neural Networks and Fuzzy Logic, Vallum B.R. and Hayagriva V.R., BPB Publications, New Delhi, 1st Edition, 1996.
2. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Wiley, 5th Edition, 2023.

ReferenceBooks:

1. Fuzzy Logic and Neural Networks, Chennakesava R. Alavala, New Age International, 1st Edition, 2008.
2. Neural Networks for Control, W. Thomas Millon, Richard S. Sutton, Paul J. Werbos, MIT Press, 1st Edition, 1992.
3. Fuzzy Sets, Fuzzy Logic: Theory and Applications, George J. Klir and Bo Yuan, Prentice-Hall of India Pvt. Ltd., New Delhi, 1st Edition, 1995.
4. Neural Networks and Fuzzy Systems, Bart Kosko, Prentice-Hall of India Pvt. Ltd., New Delhi, 1st Edition, 1994.

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5. Introduction to Fuzzy Control, Dimiter Driankov, Hans Hellendoorn, Michael Reinfrank, Narosa Publishing House, New Delhi, 1st Edition, 1996.
6. Introduction to Artificial Neural Systems, Jacek M. Zurada, Jaico Publishing House, New Delhi, Indian Edition, 1994.

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Course Code: 2524042 SIMULATION OF MANUFACTURING SYSTEMS LAB

IYear II Sem

L	T	P	C
0	0	4	2

PRE-REQUISITES: Manufacturing Systems, Simulation Modeling

COURSE OBJECTIVES

1. To provide hands-on experience in simulating manufacturing processes and systems.
2. To develop skills in using simulation software for production planning and control.
3. To analyze manufacturing system performance using simulation models.
4. To apply simulation for resource optimization and process improvement.
5. To prepare simulation-based reports for decision-making in manufacturing.

COURSE OUTCOMES

1. Develop simulation models for different manufacturing processes.
2. Use simulation tools to analyze production system performance.
3. Apply statistical analysis for interpreting simulation results.
4. Optimize manufacturing resources and workflows through simulation.
5. Document and present simulation studies effectively.

LIST OF EXPERIMENTS:

A. Manufacturing and Simulation

1. Study and Application of AutoMOD Software to Manufacturing Problems.
2. Study and Application of Flexsim Software to Manufacturing Problems.

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Write Subroutines in C-Language and Interlinking with Simulation Packages for the following Experiments.

1. AGV Planning Simulation.
2. ASRS Simulation and Performance Evaluation.
3. Integrated Simulation of Machines, AGVs, and AS/RS.
4. JIT System Simulation.
5. Kanban Flow Simulation.
6. Material Handling System Simulation.
7. MRP Problem Simulation. 8. Shop Floor Scheduling Simulation.

B. Precision Engineering (Using Suitable Software)

1. Simulation of Hydraulic and Pneumatic Circuits.
2. Simulation of Closed Loop Control Systems.
3. Study of Operation of Tool and Cutter Grinder, Twist Drill Grinder, Centerless Grinder.
4. Determination of Cutting Forces in Turning.
5. Experiments on AJM.
6. Inspection of Parts Using Tool Makers Microscope.
7. Surface Roughness Measurement and Form Testing.
8. Study of Microcontrollers and Programming for CNC Machine Tools and Controllers.
9. Studies on PLC Programming.
10. Study and Programming of Robots.

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Course Code: 2524043: COMPUTER AIDED MANUFACTURINGLAB

L	T	P	C
0	0	4	2

IYear II Sem

Course Over View:

A Computer-Aided Manufacturing (CAM) Lab course provides hands-on experience with software and machinery to automate the manufacturing process, covering topics like CNC machine operation, G-code programming, toolpath generation, and solid modeling to convert digital designs into physical parts with high precision and efficiency.

Prerequisites: Computer Aided Manufacturing, CNC Programming

Course Objectives:

1. To provide practical training in CNC programming and machine operation.
2. To develop skills in generating tool paths using CAM software.
3. To integrate CAD models into CAM systems for manufacturing.
4. To perform machining simulations for process verification.
5. To prepare detailed manufacturing documentation for CNC operations.

Course Outcomes:

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

1. Write and execute CNC programs for milling and turning operations.
2. Use CAM software to generate and optimize tool paths.
3. Simulate machining operations to verify accuracy and safety.
4. Integrate CAD geometry into CAM workflows.
5. Produce manufacturing documentation including setup sheets and process plans.

List of Experiments

A. CNC Turning:

1. **External Turning Operation:** Turning a mild steel cylindrical job to specified diameter and length.

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2. **Facing and Chamfering:** Facing both ends of a workpiece and adding chamfers as per drawing.
3. **Grooving and Parting-Off:** Machining a circumferential groove at a given position, followed by parting-off.
4. **Taper Turning:** Producing a specified taper using CNC programming commands.

B. CNC Milling:

1. **Face Milling:** Milling the top surface of an aluminium block to achieve a uniform finish.
2. **Slot Milling:** Producing a straight slot of given width and depth on a rectangular workpiece.
3. **Pocket Milling:** Machining a rectangular pocket with defined dimensions and depth.
4. **Profile Milling:** Machining an external contour as per the given profile drawing.

C. Robot Programming:

1. **Lead-Through Programming Using Teach Pendant:** Record and execute a pick-and-place operation involving three positions with defined approach and departure points.
2. **Forward and Inverse Kinematics with Trajectory Planning:** Program the robot to move its end-effector through a set of predefined Cartesian coordinates, compute joint angles (inverse kinematics), and verify path accuracy through smooth trajectory generation

II–I

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2534023: DESIGN FOR MANUFACTURING AND ASSEMBLY
(Professional Elective-V)

L	T	P	C
3	0	0	3

IIYear I Sem

Course Overview:

A Design for Manufacturing and Assembly (DFMA) course teaches engineers how to design products for efficient, cost-effective production and simpler assembly.

Course Objectives:

1. Introduce the principles and constraints of manufacturability that influence product design.
2. Familiarize students with Design for Manufacturability (DFM) methodology and its application across various manufacturing processes.
3. Enable students to identify infeasible or impractical designs early in the product development cycle.
4. Guide students to select appropriate materials and processes based on functionality and manufacturability.
5. Equip students with tools to improve assembly efficiency through manual and automated design considerations.

Course Outcomes:

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

1. Understand and evaluate quality and cost aspects of product design for manufacture and assembly.
2. Apply Boothroyd's systematic DFA/DFM methods to optimize design and improve manufacturability.
3. Integrate DFM principles in casting, machining, forming, welding, and plastic component design.
4. Analyze and identify key design variables to align product development with customer and process specifications.

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5. Apply automation and manual assembly techniques to enhance production efficiency and reliability.

UNIT-I: Design and Material Selection [9]

Introduction, Design Philosophy, Steps in Design Process, General Design Rules for Manufacturability, Basic Principles of Designing for Economical Production, Creativity in Design.

Selection of Materials for Design, Developments in Material Technology, Criteria for Material Selection, Material Selection Interrelationship with Process Selection, Process Selection Charts.

UNIT-II: Machining and Casting Design [10]

Machining Process: Overview of Various Machining Processes, General Design Rules for Machining, Dimensional Tolerance and Surface Roughness, Design for Machining Ease, Redesigning of Components for Machining Ease with Suitable Examples, General Design Recommendations for Machined Parts. Metal Casting: Appraisal of Various Casting Processes, Selection of Casting Process, General Design Considerations for Casting, Casting Tolerances, Use of Solidification Simulation in Casting Design, Product Design Rules for Sand Casting.

UNIT-III: Forming, Joining and Plastics [12]

Metal Joining: Appraisal of Various Welding Processes, Factors in Design of Weldments, GeneralDesignGuidelines,Pre-andPost-TreatmentofWelds,EffectsofThermalStressesin WeldJoints, Design of Brazed Joints.

Forging: Design Factors for Forging, Closed Die Forging Design, Parting Lines of Dies, Drop Forging Die Design, General Design Recommendations.

Extrusion and Sheet Metal Work: Design Guidelines for Extruded Sections, Design Principlesfor Punching, Blanking, Bending, Deep Drawing, Keeler-Goodman Forming Line Diagram, Component Design for Blanking.

Plastics: Viscoelastic and Creep Behavior in Plastics, Design Guidelines for Plastic Components, Design Considerations for Injection Moulding.

UNIT-IV:DesignofManualAssembly [10]

Design for Assembly: Fits in the Design Process, General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Classification System for Manual Handling, Classification System for Manual Insertion and Fastening, Effect of Part Symmetry on Handling Time, Effect of Part Thickness and Size on Handling Time, Effect of Weight on Handling Time, Parts Requiring Two Hands for Manipulation, Effects of Combinations of Factors, Effect of Symmetry, Effect of Chamfer Design on Insertion Operations, Estimation of Insertion Time.

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UNIT-V:DESIGN FOR ENVIRONMENT [09]

Introduction– Environmental objectives–Global issues–Regional and local issues–Basic DFE methods–Design guide lines–Example application–Life cycle assessment–Basic method–AT&T's environmentally responsible product assessment-Weighted sum assessment method–Life cycle assessment method–Techniques to reduce environmental impact–Design to minimize material usage–Design for disassembly–Design for recyclability–Design for manufacture–Design for energy efficiency –Design to regulations and standards.

TEXT BOOKS:

1. AssemblyAutomationandProductDesign,GeoffreyBoothroyd,MarcelDekker Inc.,New York, 1st Edition, 1992.
2. Engineering Design: A Materials and Processing Approach, George E. Dieter, McGraw- Hill International, 2nd Edition, 2000.
3. Handbook of Product Design, Geoffrey Boothroyd, Marcel DekkerInc., New York, 1st Edition, 1990.

REFERENCES:

1. Product Design for Manufacturing and Assembly, Geoffrey Boothroyd, Peter Dewhurst, Winston Anthony Knight, CRC Press, 3rd Edition, 2010.
2. DesignforManufacturabilityHandbook,JamesG.Bralla,McGraw-Hill,2ndEdition, 1999.
3. MaterialsandDesign:TheArtandScienceofMaterialSelectioninProductDesign, Michael F. Ashby and Kara Johnson, Butterworth-Heinemann, 3rd Edition, 2013.
4. ManufacturingProcesses for DesignProfessionals,RobThompson,ThamesandHudson, 1st Edition, 2007.
5. DesignandManufacturingofPlasticsProducts,NabilBashir,Wiley-Scrivener,1stEdition, 2020.

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Course Code: 2534024 COMPOSITE MATERIALS
(Professional Elective-V)

L	T	P	C
3	0	0	3

II Year I Sem

COURSE OVER VIEW:

A Composite Materials course provides foundational knowledge in the definition, history, and classification of composites, covering their advantages, disadvantages, and properties compared to traditional materials.

Prerequisite: Mechanics of Materials, Materials Science

Course Objectives:

1. To identify the properties of fiber and matrix materials used in commercial composites as well as some common manufacturing techniques.
2. To predict the elastic properties of both long and short fiber composites.
3. To understand the stress–strain relations in composite materials.
4. To study the macromechanical analysis of lamina and laminates.
5. To establish the failure criteria for laminated structures.

Course Outcomes:

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

1. Understand and differentiate various types of composites.
2. Identify different types of reinforcements and describe various manufacturing methods of composites.
3. Analyze problems related to the macro and micromechanical behavior of lamina.
4. Analyze problems related to the macromechanical behavior of laminates.
5. Apply the concepts developed in composite analysis to the design of aerospace structures.

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UNIT-I:CompositeMaterialsandApplications

Introduction, Classification Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites,Carbon–Carbon Composites, Fiber-Reinforced Composites and Nature Made Composites and Applications.

Reinforcements: Fibers, Glass, Silica, Kevlar, Carbon, Boron, Silicon Carbide and Born Carbide Fibers, Particulate Composites, Polymer Composites, Thermoplastics, Thermosets, Metal Matrix and Ceramic Composites.

UNIT-II:MechanicalBehaviorofComposites

Manufacturing of Polymer Matrix Composites (PMCs)-hand lay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-,bagmoulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state, vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs)–hot pressing reaction bonding process-infiltration technique, direct oxidation-interfaces

UNIT -III:Macro MechanicalAnalysisofLamina

Introduction, Definitions Stress, Strain, Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

UNIT-IV:LaminateMechanicsandHygro-thermalEffects

Introduction,Laminate Code, Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate, Hygro thermal Effects in a Laminate, Warpage of Laminates.

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UNIT -V:LaminatedCompositeDesignandFailure

Introduction, Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, Other Mechanical Design Issues, MMC and PMC.

TEXT BOOKS:

1. MechanicsofCompositeMaterials,R.M.Jones,McGraw-HillCompany,NewYork, 1st Edition, 1975.
2. EngineeringMechanicsofCompositeMaterials,IsaacM.Daniel,Oxford University Press, 1st Edition, 1994.

REFERENCEBOOKS:

1. AnalysisandPerformanceofFiberComposites,B.D.AgarwalandL.J.Broutman, Wiley-Interscience, New York, 1st Edition, 1980.
2. IntroductiontoCompositeMaterialsDesign,EverJ.Barbero,CRCPress,4th Edition, 2023.
3. EngineeringMechanicsofCompositeMaterials,IsaacM.DanielandOriIshai, Oxford University Press, 3rd Edition, 2023.
4. CompositeMaterials:Processing,Applications,andCharacterization,M. Balasubramanian, Springer, 2nd Edition, 2022.
5. Analysisand PerformanceofFiber Composites, BhagwanD.AgarwalandLawrence J.Broutman andK. Chandrashekhara,Wiley, 4thEdition, 2023.
6. StructuralAnalysisofCompositeMaterials,MarkE.Tuttle,CRC Press,3rdEdition, 2022.
7. MechanicsofCompositeMaterials,AutarK.Kaw,CRCPress,2ndEdition, 2006

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2534025: ARTIFICIAL INTELLIGENCE IN MANUFACTURING
(Professional Elective-V)

II Year I Sem

L	T	P	C
3	0	0	3

Course Over View:

An "Artificial Intelligence in Manufacturing" course overview typically covers how AI and Machine Learning (ML) are applied to optimize production, improve efficiency, and drive innovation in the manufacturing sector. Key topics include predictive maintenance, AI-driven process optimization, digital twins, intelligent robotics, and the integration of AI throughout the Industry 4.0 ecosystem, preparing professionals to implement AI solutions in smart factories

Prerequisite: ProductionSystems,FundamentalsofArtificialIntelligence

CourseObjectives:

1. Tointroducethefundamentalsofartificialintelligenceanditsrelevancein manufacturing.
2. TostudyAItechniquesapplicabletoproductionplanning,processcontrol,andquality management.
3. Toexploremachinelearningalgorithmsforpredictivemaintenanceandprocessoptimization.
4. ToapplyAIforreal-timemonitoring,robotics,andautomationinmanufacturing environments.
5. Tofamiliarizestudentswithcasestudiesandindustrialapplicationsof AIin manufacturing.

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

1. Understandthebasicconceptsof AIanditsapplicationsinmanufacturingsystems.
2. Applymachinelearningtechniquesformanufacturingprocessoptimization.
3. Analyzemanufacturingdataforpredictiveanalyticsanddecision-making.
4. ImplementAI-basedsolutionsinrobotics,automation,andprocesscontrol.
5. EvaluateAI-drivenmanufacturingsystemsforproductivityandqualityimprovement.

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UNIT – I: AI and Search Methods

Definition, History, Present State of Artificial Intelligence (AI), Phases of AI, Approaches to AI – Hard or Strong AI, Soft or Weak AI, Applied AI, Cognitive AI, and Application Domains Focused onManufacturing.Role of AI in Industrial Revolution 4.0 – Components, Advantages, and Challenges.

Problem Solving Methods:

1. **Uninformed Search:** Depth First Search (DFS), Breadth First Search (BFS), Uniform Cost Search (UCS), Depth Limited Search, Iterative Deepening Depth First Search (IDDFS), and Bidirectional Search.
2. **Informed Search (Heuristic Search):** Greedy Best First Search, A* Search, Memory Bounded Heuristic Search, Learning to Search Better, Simple Problems.

UNIT – II: Neural Networks

Introduction to Perceptron and Neural Networks, Activation and Loss Functions, Single Neuron of Human and Human Brain Modelling.

ANN Architecture: Input Layer, Hidden Layer, and Output Layer.
Types of Neural Networks:

- Single Layer Feed-Forward Network
- Multilayer Feed-Forward Network
- Multi-Layer Perceptron (MLP)
- Recurrent Networks or Feedback ANN, Characteristics of Neural Networks.
  Simple problems on Back Propagation Algorithms to minimize the error.

UNIT – III: Computer Vision and CNNs

Introduction to Convolutional Neural Networks (CNNs) – What is CNN, Common Uses for CNN, CNN Basic Architectures: LeNet, AlexNet, VGGNet, GoogLeNet, ResNet. Introduction to Images, Representation, Image Extraction, Segmentation, and Analysis. Simple demonstrations on image processing using ANN – Face Detection, Fingerprint Recognition, etc.

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UNIT – IV: Supervised and Unsupervised Learning

Unsupervised Learning: Definition, Basic Concepts, Applications, K-Means Clustering, Hierarchical Clustering, Dimension Reduction – PCA, Simple Examples. **Supervised Learning:** Definition, Basic Concepts, Applications, Linear Regression, Multiple Variable Linear Regression, Logistic Regression, Naive Bayes Classifiers, K-NN Classification, Support Vector Machine (SVM), Simple Examples.

UNIT – V: Reinforcement and Ensemble Learning

Reinforcement Learning: Reinforcement Learning (RL) Framework, Components of RL Framework, Types of RL Systems, Q-Learning, Simple Examples. **Ensemble Learning Techniques:** Introduction to Ensemble Methods, Decision Trees, Bagging, Random Forests, Boosting, Simple Examples.

TEXTBOOK:

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, Prentice-Hall, 3rd Edition (2009)
2. Nature-Inspired Optimization in Advanced Manufacturing Processes and Systems, Ganesh M.Kakandikar andDineshG.Thakur, CRC press,1stEdition, 2021.

REFERENCES:

1. ArtificialIntelligence,ElaKumar,Wiley-India,1stEdition,2020.
2. ArtificialIntelligence:ConceptsandApplications,LavikaGoel,Wiley-India,1st Edition, 2021.
3. Artificial Intelligence for Robotics and Industrial Applications, Abhishek Arora and Sanjeev Kumar, Wiley India, 1st Edition, 2023.
4. MachineLearningforManufacturing,DavidePolonioandPaoloRizzi,Springer,1st Edition, 2022.
5. Deep Learning for Vision Systems, Mohamed Elgendy, Manning Publications, 1stEdition, 2021.
6. Hands-OnArtificialIntelligenceforSmartManufacturing,FrancescoCarloMorabito, Springer,

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