SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)

(Approved by AICTE, New Delhi, Affiliated to JNTUK, Kakinada)

Accredited by NAAC with 'A+' Grade.

Recognised as Scientific and Industrial Research Organisation

SRKR MARG, CHINA AMIRAM, BHIMAVARAM – 534204 W.G.Dt., A.P., INDIA

Estd. 1980

Regulation: R25	**I - M.Tech. I - Semester**									
CAD/CAM										
COURSE STRUCTURE (With effect from 2025-26 admitted Batch onwards)										
Course Code	**Course Name**	**Category**	**L**	**T**	**P**	**Cr**	**C.I.E.**	**S.E.E.**	**Total Marks**	
D2510401	Advanced Finite Element Methods	PC	3	1	0	4	40	60	100	
D2510402	Advanced CAD	PC	3	1	0	4	40	60	100	
D2510403	AI & ML for Mechanical Engineering	PC	3	1	0	4	40	60	100	
#PE-I	Program Elective -I	PE	3	0	0	3	40	60	100	
#PE-II	Program Elective -II	PE	3	0	0	3	40	60	100	
D2510404	Material Processing and Characterization Lab	PC	0	1	2	2	40	60	100	
D2510405	Advanced CAE Lab	PC	0	1	2	2	40	60	100	
D2510406	Seminar-I	PR	0	0	2	1	100	--	100	
		TOTAL	**15**	**5**	**6**	**23**	**380**	**420**	**800**	

	Course Code	**Course Name**
#PE-I	D25104A0	Mechanical Behavior of Materials & Characterization
	D25104A1	Optimization and Reliability
	D25104A2	Mechatronics
	D25104A3	Computational Fluid Dynamics
	D25104A4	NPTEL/SWAYAM MOOCs Course with 12 Weeks Duration
#PE-II	D25104B0	MEMS: Design and Manufacturing
	D25104B1	Design for Manufacturing & Assembly
	D25104B2	Fracture Mechanics
	D25104B3	Smart Materials
	D25104B4	NPTEL/SWAYAM MooCs Course with 12 Week Duration

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2510401	**PC**	**3**	**1**	**--**	**4**	**40**	**60**	**3 Hrs.**

ADVANCED FINITE ELEMENT METHODS

(For CAD / CAM)

Course Objectives:

1.	To familiarize students with the basics of FEM formulations and variational methods.
2.	To develop student understanding of FEM models for 1D and 2D problems, iso-parametric elements, and convergence.
3.	To enable students to apply FEM in dynamics, heat transfer, and nonlinear problems.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** variational and weighted residual methods to formulate finite element models with boundary conditions.	K3
2.	**Solve** and analyse problems involving one-dimensional axially loaded bars, trusses, beams and frames.	K4
3.	**Solve** and analyse two dimensional CST and axi-symmetric problems subjected to various boundary conditions.	K4
4.	**Apply** iso-parametric elements and convergence methods to finite element problems	K3
5.	**Analyze** dynamic, heat transfer, and nonlinear problems using finite element methods.	K4

SYLLABUS

UNIT-I (10Hrs)	**Formulation Techniques:** Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions
UNIT-II (9 Hrs)	**One-Dimensional Problems:** Bar, trusses, beams and frames, displacements, stresses and temperature effects.
UNIT-III (9 Hrs)	**Two Dimensional Problems:** CST, Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions.
UNIT-IV (10 Hrs)	**Iso-Parametric Formulation:** Concepts, sub-parametric, super parametric elements, numerical integration, LST, four-nodded and eight-nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. **Convergence**: Requirements for convergence, h-refinement and p-refinement, complete and incomplete

	interpolation functions, pascal’s triangle, Patch test
UNIT-V (10 Hrs)	**Dynamic Problems:** Analysis, Eigen value problems, and their solution methods. **Heat Transfer problems:** Conduction and convection, examples: - One & two-dimensional fin. Introduction to non-linear problems.

Textbooks:	
1.	Finite element methods by Chandrupatla & Belegundu.
2.	Finite Element Analysis by P. Seshu, PHI learning private limited, New Delhi.
Reference Books:	
1.	J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press,1994.
2.	Zienckiwicz O.C. and R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
3.	K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.
4.	Concepts and applications of finite element analysis, R.D.Cook et al. Wiley.
5.	
e-Resources	
1.	https://nptel.ac.in/courses/112106130
2.	https://onlinecourses.nptel.ac.in/noc22_me43/preview

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2510402	**PC**	**3**	**1**	**--**	**4**	**40**	**60**	**3 Hrs.**

ADVANCED CAD

(For CAD / CAM)

Course Objectives:

1.	Understand the basic principles of CAD tools, graphics standards, and the requirements for 3D geometric modeling.
2.	Explain and apply 2-D and 3-D geometric transformations (e.g., translation, rotation) and various projection and rendering techniques
3.	Analyze and manipulate wireframe (curve representation), surface modeling, and solid modeling using methods like Bezier/B-Spline, Boundary Representation (BRep), and Constructive Solid Geometry (CSG).

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Illustrate** the fundamental tools of CAD, graphics standards, and the basic requirements of geometric 3D modeling.	K3
2.	**Apply** 2D and 3D geometric transformations, projections, and rendering techniques to solve modeling problems.	K3
3.	**Analyze** wireframe entities and curve representation methods, including parametric and synthetic curves like Bezier and B-Splines.	K4
4.	**Construct** various surface models using analytic and synthetic representation methods such as ruled surfaces and NURBS.	K3
5.	**Evaluate** solid modeling techniques, including Boundary Representation (B-Rep) and Constructive Solid Geometry (CSG), for creating complex 3D features.	K4

SYLLABUS

UNIT-I (09Hrs)	**CAD Tools:** Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD Efficient use of CAD software. Basics of Geometric Modeling: Requirement of geometric 3D Modeling, Geometric models, Geometric construction methods, Modeling facilities desired
UNIT-II (10 Hrs)	**Transformations:** 2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface removal, shading, rendering. Evaluation Criteria: Evaluation criteria of CAD software, Data exchange formats: GKS, IGES, PHIGS, CGM, STEP Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Regardless of feature size

	(RFS).
UNIT-III (10 Hrs)	**Geometric Modeling:** 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
UNIT-IV (12 Hrs)	**Surface Modeling:** Classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, Parametric representation of synthetic curves: Hermite cubic surface, Bezier surface, B-Spline surface, Blending surface, Surface manipulations
UNIT-V (09 Hrs)	**Solid Modeling:** Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling.

Textbooks:

1.	CAD/CAM Concepts and Applications/ Alavala/ PHI.
2.	Mastering CAD/CAM / IbrhimZeid / McGraw Hill International.
3.	CAD/CAM Principles and Applications/ P.N. Rao/TMH/3rd Edition REFERENCE BOOKS:

Reference Books:

1.	CAD/CAM /Groover M.P./ Pearson education
2.	CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
3.	Principles of Computer Aided Design and Manufacturing/ FaridAmirouche/ Pearson
4.	Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson
5.	

e-Resources

1.	https://www.youtube.com/playlist?list=PLrOFa8sDv6jei84vimiCoGvuqLh4Fobq2

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2510403	PC	3	1	--	4	40	60	3 Hrs.

AI & ML FOR MECHANICAL ENGINEERING

(For CAD / CAM)

Course Objectives:

1.	To impart the basic concepts of artificial intelligence and the principles of knowledge representation and reasoning.
2.	To introduce the machine learning concepts and supervised learning methods
3.	To enable the students gain knowledge in unsupervised learning method and Bayesian algorithms.
4.	To make the students learn about neural networks and genetic algorithms.
5.	To understand machine learning analytics and applications of deep learning techniques to mechanical engineering.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Illustrate** the basic concepts of artificial intelligence, machine learning and principles of supervised learning methods.	K3
2.	**Apply** the concepts of unsupervised learning method and Bayesian algorithms	K3
3.	**Illustrate** the concept of neural networks and genetic algorithms.	K3
4.	**Apply** the concepts of Deep Learning and Machine Learning Algorithm Analytics	K3
5.	**Apply** machine learning analytics and deep learning techniques to mechanical engineering applications.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and Environments; Good Behaviour - concept of rationality, the nature of environments, structure of agents. **Introduction to Machine Learning (ML):** Definition, Evolution, Need, applications of ML in industry and real-world, regression and classification problems, performance metrics, differences between supervised and unsupervised learning paradigms, bias, variance, overfitting and under fitting. **Supervised Learning:** Linear regression, logistic regression, Distance-based methods, Nearest-Neighbours, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.
UNIT-II (9 Hrs)	**Unsupervised Learning:** Clustering, K-means, Dimensionality Reduction, PCA and Kernel.

	Bayesian and Computational Learning: Bayes theorem, concept learning, maximum likelihood of normal, binomial, exponential, and Poisson distributions, minimum description length principle, Naïve Bayes Classifier, Instance-based Learning- K-Nearest neighbour learning.
UNIT-III (9 Hrs)	**Neural Networks and Genetic Algorithms:** Neural network representation, problems, perceptron, multilayer networks and backpropagation, steepest descent method, Convolutional neural networks and their applications, Local vs Global optima, Introduction to Genetic algorithms.
UNIT-IV (10 Hrs)	**Deep Learning:** Recurrent Neural Networks and their applications, LSTM, Deep generative models, Deep auto-encoders, Applications of Deep Networks. **Machine Learning Algorithm Analytics:** Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods - Boosting, Bagging, and Random Forests.
UNIT-V (10 Hrs)	**Overview of Applications to Mechanical Engineering:** Introduction to Machine learning packages, preparation of dataset for machine learning (cleansing and featuring) Design of 1D mechanical structures, Crack detection, fatigue life and creep estimation, Defect detection in casting and welding, Tool wear and Surface roughness prediction in CNC machining, Heat exchanger design optimization, fault classification.

Textbooks:

1.	Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
2.	Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
3.	EthemAlpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.

Reference Books:

1.	Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
2.	Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.

e-Resources

1.	https://www.tpointtech.com/artificial-intelligence-ai
2.	https://onlinecourses.nptel.ac.in/noc22_me43/preview

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25104A0	**PE**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

MECHANICAL BEHAVIOR OF MATERIALS & CHARACTERIZATION

(For CAD / CAM)

Course Objectives:

1.	To provide students with a comprehensive understanding of the mechanical properties and behaviour of engineering materials.
2.	To enable students to understand the principles, instrumentation, working procedures, applications, and limitations of modern material characterization techniques such as Energy Dispersive Spectroscopy (EDS) and Thermal Analysis methods including DTA and DSC.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** the concepts of various theories such as Von-mises and Tresca criteria in analyzing the elastic behavior of metals.	K3
2.	**Analyze** the failure criteria of metals under different loading and environmental conditions by applying the principles and theories such as Griffith's theory, Larson – Miller parameter etc..	K4
3.	**Apply** fatigue concepts, crack propagation laws, failure analysis procedures, and material selection criteria to solve engineering problems.	K3
4.	**Distinguish** between various imaging techniques such as OM, XRD, SEM, and TEM.	K3
5.	**Apply** various techniques to identify material composition, detect thermal transitions, and analyze material behavior	K3

SYLLABUS

UNIT-I (10Hrs)	Elasticity in metals, mechanism of plastic deformation, slip and twinning, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behaviour, super plasticity, Yield criteria: Von-mises and Tresca criteria.
UNIT-II (08Hrs)	Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.
UNIT-III (10 Hrs)	Fatigue, fatigue limit, features of fatigue fracture, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and Paris Law, Effect of surface and metallurgical

	parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis. Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep
UNIT-IV (10Hrs)	Optical Microscopy, XRD, SEM, TEM: Introduction, principles, Instrumentation, Specimen preparation-metallographic principles, Imaging Modes, Applications and Limitations.
UNIT-V (10Hrs)	Energy Dispersive Spectroscopy: Instrumentation, working procedure, Applications and Limitations. Thermal Analysis: Instrumentation, experimental parameters, Differential thermal analysis, Differential Scanning Calorimetry, Basic principles, Instrumentation, working principles, Applications and Limitations

Textbooks:	
1.	Mechanical Behaviour of Materials/Thomas H. Courtney/ McGraw Hill/2nd Edition/2000.
2.	Mechanical Metallurgy/George E. Dieter/McGraw Hill, 1998.
3.	Material Science and Engineering/William D Callister/John Wiley and Sons
4.	Yang Leng: Materials Characterization-Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd., 2008
Reference Books:	
1.	Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2.	Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson.
3.	Robert F. Speyer: Thermal Analysis of Materials, Marcel Dekker Inc., New York, 1994.
4.	V. T. Cherapin and A. K. Mallik: Experimental Techniques in Physical Metallurgy, Asia Publishing House, 1967 .
e-Resources	
1.	https://nptel.ac.in/courses/113104104
2.	https://nptel.ac.in/courses/113104105

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25104A1	**PE**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

OPTIMIZATION AND RELIABILITY

(For CAD / CAM)

Course Objectives:

1.	Import knowledge of Micro-manufacturing and Scaling Laws.
2.	To train the students to gain the skill in Mechanical micromachining, Advanced micromachining processes and associated computer/laboratory work.
3.	To create awareness on Metrology, Micro-machine tool system, machining essentials including part registration and micro-manufacturing case studies.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** classical optimization techniques to minimize or maximize single and multi-variable optimization problems without or with constraints and arrive at an optimal solution	K3
2.	**Formulate** engineering design problems as mathematical optimization problems and solve them by using suitable optimization techniques	K3
3.	**Analyze** GA/GP operators to solve optimization problems and multi-objective solutions using Pareto fronts**.**	K4
4.	**Apply** optimization techniques to design and manufacturing systems for the optimization of process parameters.	K3
5.	**Evaluate** system reliability and probabilistic performance measures.	K4

SYLLABUS

UNIT-I (10Hrs)	**Classical Optimization Techniques:** Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization technique.
UNIT-II (10 Hrs)	**Numerical Methods for Optimization:** Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods.
UNIT-III (12Hrs)	**Genetic Algorithm (GA)** : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization,

	draw backs of GA. **Genetic Programming (GP):** Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP. **Multi-Objective GA:** Pareto's analysis, non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems.
UNIT-IV (09 Hrs)	**Applications of Optimization in Design and Manufacturing Systems:** Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.
UNIT-V (07 Hrs)	**Reliability:** Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, and hazard analysis.

Textbooks:

1.	Optimization for Engineering Design – Kalyan Moy Deb, PHI Publishers.
2.	Engineering Optimization – S. S. Rao, New Age Publishers.
3.	Reliability Engineering by L. S. Srinath.
4.	Multi objective genetic algorithm by Kalyan Moy Deb, PHI Publishers

Reference Books:

1.	Genetic algorithms in Search, Optimization, and Machine learning – D. E. Goldberg, Addison-Wesley Publishers.
2.	Multi objective Genetic algorithms - Kalyan Moy Deb, PHI Publishers.
3.	Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers.
4.	An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009
5.	Reliability Theory and Practice by I Bazovsky, Dover Publications, 2013

e-Resources

1.	https://www.iitg.ac.in/rkbc/CE602/ce602_2024.htm
2.	https://onlinecourses.nptel.ac.in/noc26_ma46/preview
3.	https://onlinecourses.nptel.ac.in/noc26_ge28/preview
4.	https://www.ist.ucf.edu/wp-content/uploads/sites/10/2024/04/UCF-Syllabus_Computational-Optimization-Models-and-Methods-Final.pdf?utm_source=chatgpt.com

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25104A2	PE	3	--	--	3	40	60	3 Hrs.

MECHATRONICS

(For CAD / CAM)

Course Objectives:

1.	To impart the basic knowledge and importance on Mechatronics in Engineering Fields among the students.
2.	To create awareness on Mechatronics in Research and Application area.
3.	To impart the knowledge about the application and utility of Mechatronics used in various sectors and fields.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Apply** the interpretation of a block diagram to illustrate how sensors, actuators, controllers, and the mechanical structure interact within a mechatronics system.	K3
2.	**Demonstrate** the use of solid-state electronic devices, diodes, amplifiers, and related components to implement mechatronic systems and MEMS designs.	K3
3.	**Illustrate** the applications of various hydraulic, pneumatic, mechanical, electrical actuating systems and valves in designing the mechatronic systems**.**	K3
4.	**Analyze** and differentiate the logical sequences required to formulate PLC ladder programming for creating real-time mechatronic systems.	K4
5.	**Examine** dynamic models produced via system interfacing and data acquisition methods to distinguish design approaches for future mechatronics applications.	K4

SYLLABUS

UNIT-I (10Hrs)	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, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.
UNIT-II (10 Hrs)	Solid state electronic devices, P-N junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.
UNIT-III (12 Hrs)	Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydropneumatics, electro-hydraulic servo systems, Mechanical actuating systems and electrical actuating systems.
UNIT-IV	Digital electronics and systems, digital logic control, microprocessors and micro

(09 Hrs)	controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.
UNIT-V (07 Hrs)	System and interfacing and data acquisition, DAQS, SCADA, Analogue to Digital and Digital to Analogue conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends. Modeling and analysis of mechatronics systems (case studies).

Textbooks:

1.	MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijayaraghavan/WILEY India Edition/2008.
2.	Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

Reference Books:

1.	Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
2.	Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
3.	Mechatronics System Design / Devdasshetty / Richard / Thomson.
4.	Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton.
5.	Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print.

e-Resources

1.	https://onlinecourses.nptel.ac.in/noc26_me83/preview
2.	https://onlinecourses.nptel.ac.in/noc25_me179/preview

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25104A3	**PE**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

COMPUTATIONAL FLUID DYNAMICS

(For CAD / CAM)

Course Objectives:

1.	To impart the basic knowledge and importance on Mechatronics in Engineering Fields among the students.
2.	To create awareness on Mechatronics in Research and Application area.
3.	To impart the knowledge about the application and utility of Mechatronics used in various sectors and fields.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Describe** the governing principles of fluid dynamics including conservation, continuity, momentum, and energy equations.	K2
2.	**Apply** finite difference methods to solve elliptical, parabolic, and hyperbolic partial differential equations.	K3
3.	**Apply** the finite volume method to discretize diffusion and convective-diffusion equations and demonstrate the solution methodology.	K3
4.	**Solve** steady and unsteady flow problems by discretizing the governing equations using the finite volume method	K3
5.	**Compute** simple one-dimensional steady and unsteady problems in fluid flow and heat transfer using FEM discretization strategies.	K3

SYLLABUS

UNIT-I (10Hrs)	A brief overview of the basic conservation equations for fluid flow and heat transfer, Boundary Conditions, classification of partial differential equations and pertinent physical behaviour, parabolic, elliptic and hyperbolic equations, role of characteristics. Over-View of Finite Element, Finite Difference and Finite Volume Methods. **Finite Difference Method:** Derivation of Finite Difference Equations, Accuracy of Finite Difference Equations. Numerical Errors: Round-off, Truncation and Discretization Errors. Solution of discretized equations: Direct and Indirect or iterative methods, TDMA algorithm. **Elliptical Equations:** Finite Difference Formulations, Iterative Solution Methods, Examples. **Parabolic Equations:** Explicit Schemes and Von-Neumann Stability Analysis, Implicit Schemes, ADI Schemes, Approximate Factorization, Fractional Step Methods, Examples.
UNIT-II	**Hyperbolic Equations:** Explicit schemes and Von-Neumann stability analysis, Implicit

(10 Hrs)	schemes, multi-step methods, nonlinear problems, order one-dimensional wave equations, Examples. **In-compressible Viscous Flows via FDM:** Artificial Compressibility Method, Pressure Correction Methods and Vortex Methods, Examples
UNIT-III (12 Hrs)	**Finite volume method -i: Diffusion problems:** Solutions for 1-D and 2-D steady-state diffusion problems. **Convection-Diffusion Problems:** Solutions using Central Differencing Scheme, Upward differencing scheme, Hybrid differencing Scheme, Power Law scheme, Higher order differencing schemes, TVD schemes.
UNIT-IV (09 Hrs)	**Finite volume method-ii: Steady flows:** Staggered grid, SIMPLE, SIMPLER, SIMPLEC and PISO algorithms. **Unsteady flows:** Solutions for Transient 1-D and 2-D Heat Conduction, Transient convection-diffusion problems, QUICK Scheme, Solutions using Transient SIMPLE and Transient PISO algorithms
UNIT-V (07 Hrs)	**Finite element method:** Introduction, Weighted residual and variational formulations. Interpolation in one-dimensional case. Application of FEM to ID steady and unsteady problems in fluid flow and heat transfer

Textbooks:

1.	Chung, T. J., 2010, Computational Fluid Dynamics, 2nd ed., Cambridge University Press.
2.	Versteeg, H.K., and Malalasekera.W.,2007, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd ed., Pearson Education Limited.
3.	Gartling.D., and Reddy, J.N., 2010, The Finite Element Method in Heat Transfer and Fluid Dynamics, CRC Press.

Reference Books:

1.	Patankar, S. V., 2017, Numerical Heat Transfer and Fluid Flow, Special Indian ed., CRC Press.
2.	Muralidhar K., and Sundararajan T. (Editors), 2017, Computational Fluid Flow and Heat Transfer, 2nd ed. tenth reprint, Narosa.
3.	AndersonJr.,J.D.,2017, Computational Fluid Dynamics: The Basics with Applications, Indian ed., McGraw Hill Education.
4.	Donea.J, and Huerta, A., 2003, Finite Element Methods for Flow Problems, John Wiley & Sons, Ltd.
5.	Zienkiewicz O.C, Nithiarasu.P, and Taylor.R.L, 2013, The Finite Element Method for Fluid Dynamics, 7th ed., Butterworth-Heinemann Ltd.

e-Resources

1.	https://onlinecourses.nptel.ac.in/noc26_ch39/preview
2.	https://onlinecourses.nptel.ac.in/noc25_me103/preview
3.	https://onlinecourses.nptel.ac.in/noc25_ae22/preview

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25104B0	**PE**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

MEMS: DESIGN AND MANUFACTURING

(For CAD / CAM)

Course Objectives:

1.	Basic knowledge on overview of MEMS (Micro electromechanical System) and various fabrication techniques.
2.	To design, analysis, fabrication and testing the MEMS based components.
3.	To find various opportunities in the emerging field of MEMS. about the application and utility of Mechatronics used in various sectors and fields.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** the fundamental principles of MEMS and Microsystems to explain how miniaturization influences device performance.	K3
2.	**Apply** the concepts of atomic structure, ions, and ionization to analyze material behavior and electrical characteristics in microsystem fabrication.	K3
3.	**Apply** core mechanics principles to evaluate the structural behavior of microsystems.	K3
4.	**Apply** MEMS design principles and material properties to develop mechanically reliable microsystem components.	K3
5.	**Apply** microsystem fabrication techniques to develop and analyze MEMS structures and devices.	K3

SYLLABUS

UNIT-I (10Hrs)	**Overview and working principles of MEMS and Microsystems:** MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & miniaturization, Applications of MEMs in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators, Micro accelerometers, Micro fluidics
UNIT-II (10 Hrs)	**Engineering Science for Microsystems Design and Fabrication:** Atomic structure of Matter, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics.
UNIT-III (12 Hrs)	**Engineering Mechanics for Microsystems Design:** Static Bending of Thin- plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview of Finite Element Stress Analysis.

UNIT-IV (09 Hrs)	Design Considerations, Process Design Mechanical Design, Mechanical design using FEM, Design of a Silicon Die for a Micro pressure sensor. **Materials for MEMS:** Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers and Applications
UNIT-V (07 Hrs)	**Microsystems and their fabrication:** Introduction to Micro systems Photolithography, Ion implantation, Diffusion and oxidation, Chemical and Physical vapor deposition, etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process and Applications.

Textbooks:	
1.	Tia-Ran Hsu, MEMS & Microsystems. Design & Manufacturing, TMH 2002
2.	Foundation of MEMS/ Chang Liu/Pearson, 2012
Reference Books:	
1.	An Introduction to Micro electro mechanical Systems Engineering by Maluf M., Artech House, Boston 2000
2.	Micro robots and Micromechanical Systems by Trimmer, W.S.N., Sensors & Actuators, Vol 19, 1989.
3.	Applied Partial Differential Equations by Trim, D.W., PWS-Kent Publishing, Boston, 1990.
e-Resources	
1.	https://nptel.ac.in/courses/117105082
2.	https://nptel.ac.in/courses/113104012

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25104B1	PE	3	--	--	3	40	60	3 Hrs.

DESIGN FOR MANUFACTURING & ASSEMBLY

(For CAD / CAM)

Course Objectives:

1.	To identify the manufacturing constraints that influences the design of parts and part systems.
2.	To introduce the Design for Manufacturability (DFM) methodology.
3.	To understand infeasible or impractical designs.
4.	To know automatic assembly transfer system.
5.	To understand design of manual assembly.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** the basic concepts of DFMA, their applications and design rules to manual assembly.	K3
2.	**Illustrate** the design rules for ease of machining and the design recommendations for machined parts.	K3
3.	**Analyze** the selection, simulation, and design rules of casting processes, and the design considerations for extruded sections and various forming processes.	K4
4.	**Use** the design considerations and effect of thermal stresses in welded joints and the design factors for forging.	K3
5.	**Apply** the design considerations for automatic assembly and do quantitative analysis of assembly systems.	K3

SYLLABUS

UNIT-I (10Hrs)	Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA during Product Design, Typical DFMA Case Studies, Overall Impact of DFMA on Industry. Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight onHandling Time, Effects of Combinations of Factors, Application of the DFA Methodology.
UNIT-II (10 Hrs)	**Machining processes:** 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.
UNIT-III (10 Hrs)	**Metal casting:** Appraisal of various casting processes, selection of casting process, general design considerations for casting-casting tolerance-use of solidification, simulation

	in casting design-product design rules for sand casting. Extrusion & Sheet metal work: Design guidelines extruded sections-design principles for punching, blanking, bending, deep drawing- Keeler Goodman forging line diagram – component design for blanking
UNIT-IV (10 Hrs)	**Metal joining:** Appraisal of various welding processes factors in design of weldments – general design guidelines-pre and post treatment of welds effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies– drop forging die design – general design recommendations.
UNIT-V (09Hrs)	**Design for Assembly Automation:** Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

Textbooks:	
1.	Product Design for Manufacture and Assembly, Geoffrey Boothroyd , Peter Dewhurst, Winston A. Knight, CRC Press, Third Edition,2010.
2.	Design for Manufacturability Handbook, James G. Bralla, The McGraw-Hill Companies, Inc. 2nd edition, 1999.
Reference Books:	
1.	ASM Hand book, ASM International, 1997.
2.	A Text Book of PRODUCTION TECHNOLOGY (Manufacturing Processes), P. C. Sharma, S. Chand Publishing, 2007.
3.	Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.
4.	Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000.
5.	Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel and Dekken, N.Y. 1990.
e-Resources	
1.	https://nptel.ac.in/courses/112106249

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25104B2	**PE**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

FRACTURE MECHANICS

(For CAD / CAM)

Course Objectives:

1.	Provide an understanding of the mechanics and micro-mechanisms of elastic and plastic deformation, creep, fracture, and fatigue failure, as applied to metals, ceramics, composites, thin film and biological materials.
2.	Provide a thorough introduction to the principles of fracture mechanics.
3.	Provide practical examples of the application of fracture mechanics to design and life prediction methods and reporting.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Apply** the principles of mechanical failure mechanisms, fracture surface characteristics, Griffith's theory, and R-curve concepts to predict fracture behaviour in materials.	K3
2.	**Apply** the principles of linear elastic fracture mechanics (LEFM) and applicability limits to predict fracture behaviour of materials.	K3
3.	**Apply** the principles of elastic–plastic fracture mechanics and relate microstructural effects on fracture mechanisms to evaluate factors that improve material toughness.	K3
4.	**Apply** the principles of fatigue behavior to evaluate fatigue life and recommend methods for enhancing fatigue resistance using total life and damage-tolerant approaches.	K3
5.	**Apply** the principles of creep deformation to evaluate material performance under long-term loading conditions.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction**: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, the ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature. **Griffiths analysis:** Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves.
UNIT-II (10 Hrs)	Linear Elastic Fracture Mechanics, (LEFM). Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor.

	The effect of Constraint, definition of plane stress and plane strain and the effect of component thickness. The plasticity at the crack tip and the principles behind the approximate derivation of plastic zone shape and size. Limits on the applicability of LEFM.
UNIT-III (10 Hrs)	Elastic-Plastic Fracture Mechanics; (EPFM). The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use. The effect of Microstructure on fracture mechanism and path, cleavage and ductile failure, factors improving toughness.
UNIT-IV (10 Hrs)	**Fatigue:** definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodmans rule and Miners rule. Micro-mechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.
UNIT-V (10 Hrs)	**Creep deformation:** the evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep power law dependence. Comparison of creep performance under different conditions extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

Textbooks:

1.	T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2.	J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973).
3.	G. E. Dieter, Mechanical Metallurgy, McGraw Hill, (1988)
4.	S. Suresh, Fatigue of Materials, Cambridge University Press, (1998)

Reference Books:

1.	B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.
2.	J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials
3.	H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984).
4.	L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press,(2003).

e-Resources

1.	https://nptel.ac.in/courses/112106065

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25104B3	PE	3	--	--	3	40	60	3 Hrs.

SMART MATERIALS

(For CAD / CAM)

Course Objectives:

1.	Understand how piezoelectric, magneto strictive materials, IPMCs, shape memory alloys, and smart fluids work and how they are used as sensors and actuators in various applications.
2.	Learn about different sensors and actuators and their roles in health monitoring and vibration control.
3.	Apply self-sensing and self-healing concepts to design smart systems.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** piezoelectric and magneto strictive principles to explain how smart materials work.	K3
2.	**Use** the characteristics of electro-active polymers, shape memory alloys/polymers, ER/MR fluids, and IPMCs to select suitable smart materials for specific engineering applications.	K3
3.	**Apply** piezoelectric, magneto strictive, shear, and delay-line sensing methods to select suitable smart sensors for structural health monitoring.	K3
4.	**Demonstrate** the modelling and operation of piezoelectric, magneto strictive and polymeric actuators to solve actuation and vibration control problems.	K3
5.	**Use** ideas of self-sensing materials, energy harvesting, self-healing polymers, and smart system design to suggest solutions using smart materials,	K3

SYLLABUS

UNIT-I (10Hrs)	Introduction to Smart Materials, Principles of Piezoelectricity, Perovskyte Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magneto strictive materials, Giant Magnetostriction and Magneto-resistance Effect.
UNIT-II (10 Hrs)	Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rheological Fluids.
UNIT-III (12 Hrs)	Piezoelectric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magneto strictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors.
UNIT-IV	Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External

(09 Hrs)	Amplifications, Magneto strictive Actuation, Joule Effect, Wiedemann Effect, Magneto volume Effect, Magneto strictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control.
UNIT-V (07 Hrs)	Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design.

Textbooks:	
1.	Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2.	Functional and Smart materials by Z L Wang and Z C Kang, Plenium Press
3.	Gauenzi, P., Smart Structures, Wiley, 2009
Reference Books:	
1.	Cady, W. G., Piezoelectricity, Dover Publication
2.	Smart materials: Integrated design, Engineering approaches and potential applications
3.	AncaFilimon, Apple Academic Press
e-Resources	
1.	https://nptel.ac.in/courses/112104173
2.	https://nptel.ac.in/courses/112104251

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2510404	**PC**	**--**	**1**	**2**	**2**	**40**	**60**	**3 Hrs.**

MATERIAL PROCESSING & CHARACTERIZATION LAB

(For CAD / CAM)

Course Objectives:

1.	To impart the knowledge of metal joining and forming process.
2.	To familiarize with operating material characterization testing equipment and to interpret the results for further analysis.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Illustrate** the parameters and operation of various process	K3
2.	**Apply** the different manufacturing operations and processes to develop/machine components	K4
3.	**Investigate** the mechanical properties, Surface characteristics, etc. of engineering materials using various equipment.	K4

SYLLABUS

Perform the following experiments during the laboratory duration:
(48 Hrs) (Any 12 experiments from the following)

1.	To prepare the cup/ hole shape from the given work piece using deep drawing press.
2.	Study of cutting ratio/chip thickness ratio in orthogonal cutting with different materials
3.	Determination of cutting Forces and roughness on machined surface inorthogonal cutting with different materials
4.	Study of arc, and spot-welding processes.
5.	Study of TIG, MIG welding and Friction stir welding processes.
6.	Study of sintered density and relative density of given samples using Archimedes principle
7.	Study and preparation of simple parts in 3D printing.
8.	Study of MRR and roughness on Wire EDM
9.	Estimation of particle size using top-down approaches and image analyzer
10.	To find the ultimate tensile strength of given specimen using UTM.
11.	To find the Vickers/ Rockwell hardness of given specimen using hardnesstester
12.	To find the wear rate of a given specimen using Pin-on Disc apparatus
13.	Study of roughness on machines surfaces for different materials using abrasive flow finishing.
14.	To find the fatigue strength of a given specimen using fatigue-testing machine
15.	To find the crystallite size and miller indices planes of a given specimen using X-ray diffractometer.
16.	Study of Raman/FTIR spectroscopy

Reference Books:	
1.	Mechanical Behaviour of Materials/Thomas H. Courtney/ McGraw Hill/2nd Edition/2000.
2.	Mechanical Metallurgy/George E. Dieter/McGraw Hill, 1998.
3.	Yang Leng: Materials Characterization-Introduction to Microscopic andSpectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd., 2008
4.	Manufacturing Engineering & Technology by Kalpak Jain, Addition Wesley Edition.

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2510405	**PC**	**--**	**1**	**2**	**2**	**40**	**60**	**3 Hrs.**

ADVANCED CAE LAB

(For CAD/CAM)

Course Objectives:

1	To achieve a fundamental understanding of software for modelling and analysing.
2	To comprehend the various types of analysis and use the fundamental ideas to determine the stress and other relevant characteristics of bars and beams loaded under loading circumstances.
3	Learn how to implement fundamental concepts to perform dynamic and thermal analysis to determine the natural frequencies and temperature distribution throughout the processes.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1	**Formulate** problems, generate geometry, discretize problems, apply boundary conditions, and solve problems of bars, trusses, beams, and plates to determine stress under different loading scenarios by using the fundamental knowledge of an analysis package and contemporary tools.	K4
2	**Create** shear force and bending moment diagrams, further apply and analyse the deflection of beams under point, uniformly distributed, and varying loads.	K6
3	**Perform** dynamic analysis to evaluate the natural frequencies for different boundary conditions and force function analysis.	K5
4	**Apply** the fundamental principles to analyse and interpret the results for 1D, 2D, and 3D problems subjected to heat transfer with conduction and convection boundary conditions.	K3

SYLLABUS

I (10 Hrs) STRUCTURAL ANALYSIS:

1	Static Analysis
2	Modal Analysis
3	Harmonic Analysis
4	Spectrum Analysis
5	Buckling Analysis
6	Analysis of Composites

7	Fracture mechanics.
II (05Hrs) THERMAL ANALYSIS:	
1	Steady state thermal analysis
2	Transient thermal analysis
III (05Hrs) TRANSIENT ANALYSIS: Using any FEA Package for different structures that can be discretized with 1D, 2D & 3D elements discrete.	
Reference Books:	
1.	"Finite Elements: Computational Engineering Sciences" by A. J. Baker
2.	Computer Aided Engineering Design by Anupam Saxena

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2510406	**PR**	**--**	**--**	**2**	**1**	**100**	**--**	**3 Hrs.**

SEMINAR -I

(For CAD / CAM)

A student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, supervisor/mentor and two other senior faculty members of the department. For Seminar, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful

Regulation: R25	I - M.Tech. II - Semester

CAD/CAM

COURSE STRUCTURE
(With effect from 2025-26 admitted Batch onwards)

Course Code	Course Name	Category	L	T	P	Cr	C.I.E.	S.E.E.	Total Marks
D2520401	Robotics & UAV Systems	PC	3	1	0	4	40	60	100
D2520402	Advanced Manufacturing Processes	PC	3	1	0	4	40	60	100
D2520403	Computer Aided Manufacturing	PC	3	1	0	4	40	60	100
#PE-III	Program Elective -III	PE	3	0	0	3	40	60	100
#PE-IV	Program Elective -IV	PE	3	0	0	3	40	60	100
D2520404	Robotics & UAV Systems Lab	PC	0	1	2	2	40	60	100
D2520405	Advanced CAM Lab	PC	0	1	2	2	40	60	100
D2520406	Seminar-II	PR	0	0	2	1	100	--	100
		TOTAL	**15**	**5**	**6**	**23**	**380**	**420**	**800**

	Course Code	Course Name
#PE-III	D25204A0	Precision Engineering
	D25204A1	Theory of Elasticity and Plasticity
	D25204A2	Entrepreneurship & Design of Business Models
	D25204A3	Additive Manufacturing
	D25204A4	NPTEL/SWAYAM MooCs Course with 12 Week Duration
#PE-IV	D25204B0	Introduction to Embedded systems
	D25204B1	Modeling and Simulation of Manufacturing Systems
	D25204B2	Smart Manufacturing
	D25204B3	Introduction to Quantum Technologies
	D25204B4	NPTEL/SWAYAM MooCs Course with 12 Week Duration

Note: Students are informed to complete Summer Internship (duration 8-10 weeks) at the end of the II Semester.

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2520401	**PC**	**3**	**1**	**--**	**4**	**40**	**60**	**3 Hrs.**

ROBOTICS & UAV SYSTEMS

(For CAD / CAM)

Course Objectives:

1.	Students will understand the fundamental concepts of robotics and automation, including robot anatomy, configurations, drive systems, control components, sensors, and performance characteristics of robotic systems.
2.	Students will develop the ability to analyse and apply spatial transformations, mathematical models, and kinematic principles required for forward kinematics, inverse kinematics, Jacobian evaluation, and robot arm dynamics.
3.	Students will gain comprehensive knowledge of robot end effectors and machine vision **systems**, including gripper mechanisms, selection criteria, imaging devices, digitization, segmentation, feature extraction, and object recognition for robotic applications.
4.	Students will become familiar with robot programming methodologies, including lead-through programming, textual robot languages, motion interpolation, signal commands, branching, and program structuring for automated operations.
5.	Students will acquire the ability to understand and evaluate robot cell layouts**,** work design considerations, interlocks, work-cell control, industrial robot applications, and emerging drone technologies in real-world manufacturing systems.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** the concepts of automation, robot anatomy, configuration, drive systems, control systems, sensory devices, and performance measures of robotic systems.	K3
2.	**Apply** spatial transformations, homogeneous matrices, forward/inverse kinematics, Jacobian analysis, and basic robot arm dynamics to solve robot motion and control problems.	K3
3.	**Analyze** the functioning, design considerations, and force analysis of robot end effectors, and evaluate machine vision techniques such as digitization, segmentation, feature extraction, and object recognition.	K4
4.	**Develop** robot programming solutions using lead-through methods, robot languages, motion interpolation, WAIT/SIGNAL/DELAY commands, branching, and program structuring.	K4
5.	**Evaluate** robot cell layouts, design work-cell control strategies, assess robotic applications in material handling, assembly, inspection, and explore drone technologies and their engineering applications.	K4

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** Overview of automation and robotics, Robot anatomy, configurations, motion types, and joint notation schemes, Work volume and workspace characteristics, Robot drive mechanisms and control systems, Dynamic performance and precision of robot movement. **Control Systems and Components:** Basic concepts of motion controllers, Control system analysis for robot operation, Actuation methods and feedback components. Sensors: Desired characteristics of sensors, Tactile, proximity, and range sensors, Applications of position sensors, velocity sensors, actuators, and power transmission elements in robotics
UNIT-II (10 Hrs)	**Motion Analysis and Control:** Fundamentals of manipulator kinematics, Position representation techniques, Forward and inverse transformations, Homogeneous transformation matrices **Manipulator Control Concepts:** Manipulator path control, Basic robotic arm dynamics, Configuration and design of robot controllers, Concepts of robot joint control design.
UNIT-III (12 Hrs)	**End Effectors:** Types of grippers and their operation, Mechanical structure and mechanisms of grippers, Force analysis for gripping tasks, Tools as end effectors, Design considerations and criteria for gripper selection. **Machine Vision for Robotics:** Machine vision functions and applications, Sensing and digitizing: imaging devices and lighting techniques, Analog-to-digital conversion and image storage, Image processing and analysis: Data reduction, Segmentation, Feature extraction, Object recognition, Training and integrating vision systems for robotic applications.
UNIT-IV (09 Hrs)	**Robot Programming:** Lead-through programming concepts, Robot programs as spatial paths, Motion interpolation methods, WAIT, SIGNAL, and DELAY commands, Branching and logic functions, Capabilities and limitations of lead-through techniques. **Robot Languages:** Text-based robot languages, Generations of robot programming languages, Syntax, structure, and essential elements of robot languages.
UNIT-V (07 Hrs)	**Robot Cell Design and Control:** Types of robot cell layouts: robot-centered and in-line cells, Considerations in designing robotic work systems, Work handling and control in robotic environments, Interlocks, error detection, and work-cell controllers. **Industrial Applications of Robotics:** Applications in material transfer and machine loading/unloading, Processing operations, assembly tasks, and inspection systems, Emerging robotic applications, Introduction to drone technologies and their engineering applications.

Textbooks:

1.	Industrial Robotics / Groover M P /Pearson Edu.
2.	Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.

Reference Books:	
1.	Robotics / Fu K S/ McGraw Hill.
2.	Robotic Engineering / Richard D. Klafter, Prentice Hall.
3.	Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.
4.	Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley
5.	Introduction to Robotics by SK Saha, TheMcGrah Hill Company, 6th, 2012.
e-Resources	
1.	https://www.youtube.com/watch?v=rYWJdZ5qg6M&list=PLbRMhDVUMngcdUbBySzyzcPiFTYWr4rV_
2.	https://youtube.com/playlist?list=PL65CC0384A1798ADF&si=Ypmd5ZReD1tlB8_K

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2520402	PC	3	1	--	4	40	60	3 Hrs.

ADVANCED MANUFACTURINGPROCESSES

(For CAD / CAM)

Course Objectives:

1.	To make acquainted the various unconventional manufacturing processes.
2.	To know about the applications of advanced manufacturing processes (which are exceptional).
3.	To encourage the students to develop the models of Advanced Manufacturing Processes.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** suitable advanced machining processes and their process parameters to machine different materials based on the required accuracy, surface finish and shape.	K3
2.	**Use** appropriate additive manufacturing methods and process parameters to produce components based on material, geometry and application requirements.	K3
3.	**Apply** suitable surface treatment and ceramic processing methods to improve the performance of engineering materials for different industrial applications.	K3
4.	**Analyze** different robot programming techniques and processing methods for composites and nanomaterials to determine the most suitable approach for specific manufacturing applications.	K4
5.	**Use** appropriate fabrication steps such as crystal growth, film deposition, lithography and packaging to develop microelectronic devices and printed circuit boards.	K3

SYLLABUS

UNIT-I (10Hrs)	**Advanced Machining Processes:** Introduction, Need, AJM, WJM, Wire- EDM, ECM & Ultrasonic Machining– Principle, working, advantages, limitations, Process Parameters & capabilities and applications.
UNIT-II (10 Hrs)	LBM, EBM, PAM – Principle, working, advantages, limitations, Process Parameters & capabilities and applications. **Introduction to Additive Manufacturing:** Working Principles, Methods, Stereo Lithography, LENS, LOM, Laser Sintering, Fused Deposition Method, 3DP Applications and Limitations.
UNIT-III (12 Hrs)	**Surface Treatment:** Scope, Cleaners, Methods of cleaning, Surface coating types, Electro forming, Chemical vapour deposition, Physical vapour deposition, thermal spraying methods, Ion implantation, diffusion coating, ceramic and organic methods of coating, and cladding methods. Processing of Ceramics: Applications, characteristics, classification

	Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.
UNIT-IV (09 Hrs)	**Robot Programming:** Lead through programming, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching, Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, processing methods for MMC, CMC, Polymer matrix composites. **Processing of Nanomaterials:** Introduction, Top-down Vs Bottom-up techniques-Ball milling, Lithography, Plasma Arc Discharge, Pulsed Laser Deposition, Sputtering, Sol-Gel, Molecular beam Epitaxy.
UNIT-V (07 Hrs)	**Fabrication of Microelectronic Devices:** Crystal growth and wafer preparation, Film Deposition, oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, surface mount technology, Integrated circuit economics.

Textbooks:	
1.	Manufacturing Engineering and Technology, Kalpakijian /Adisson Wesley, 1995.
2.	Process and Materials of Manufacturing / R. A. Lindburg /11th edition, PHI 1990.
Reference Books:	
1.	Microelectronic packaging handbook/Rao. R. Thummala and Eugene, J. Rymaszewski/Van Nostrand Renihold,
2.	MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH.
3.	Advanced Machining Processes / V.K.Jain / Allied Publications.
4.	Introduction to Manufacturing Processes / John A ScheyIMcGraw Hill.
5.	Introduction to Nanoscience and NanoTechnology/ Chattopadhyay K.K/A.N.Banerjee/ PHI.
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc26_mm15/preview
2.	https://nptel.ac.in/courses/112107078

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2520403	PC	3	1	--	4	40	60	3 Hrs.

COMPUTER AIDED MANUFACTURING

(For CAD / CAM)

Course Objectives:

1.	Understand the fundamentals, advantages, and applications of NC/CNC/DNC systems and CAD/CAM in manufacturing.
2.	Analyze and describe the construction and control features of CNC machine tools.
3.	Develop and apply CNC part programs for various manufacturing operations using manual and automated methods
4.	Comprehend the concept, structure, and integration of Computer Integrated Manufacturing (CIM) systems.
5.	Understand and evaluate automatic identification and data capture technologies and their role in intelligent manufacturing

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** CNC and CAD/CAM technology concepts in manufacturing processes.	K3
2.	**Analyze** CNC machine tool components and control systems for operation.	K4
3.	**Develop** CNC part programs for basic machining operations.	K3
4.	**Analyze** the components, data flow, and benefits of CIM for manufacturing system integration.	K4
5.	**Identify** and explain modern AID technologies and their manufacturing role.	K3

SYLLABUS

UNIT-I (10Hrs)	CNC Technology: An overview: Introduction, Classification, Advantage, Disadvantages and applications of NC/CNC/DNC and Machine Tool, product cycle and automation in CAD/CAM, Need of CAD/CAM, Computer Aided Process Planning (CAPP), Basic concepts of process planning.
UNIT-II (10 Hrs)	Design Of CNC: Constructional features of CNC machine tools, Designation ofaxis in CNC systems, NC coordinate system, positional control, system devices; drives, ball screws, transducers, feedback devices.
UNIT-III (10 Hrs)	Part Programming: CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc...), Special part programming, Advanced part programming, APT programming, macros, fixed cycles, CAM software
UNIT-IV	CIM: Introduction to CIM, Data flow in CIM, CIM wheel, Process involved in CIM, Need

(10 Hrs)	for CIM, Advantages & disadvantages of CIM, CIM integration, Challenges, Sub systems in CIM, Present Scenario, Future prospects; Production system: automation in production systems, Manual labour in production systems, Automation principles and strategies
UNIT-V (10 Hrs)	Automatic Identification and Data Capture: Introduction, Reasons for AIDC, bar code, RFID and other AID technologies, CAQC- Inspection metrology, CMM, Machine Vision, other optical inspection methods, Non optical Non-contact inspection technologies, Material handling and identification, computers in manufacturing industry - current scenario AL, ML,DL, Digital manufacturing, IOT, Cloud based manufacturing).

Textbooks:

1.	Yoram Koren, "Computer Control of Manufacturing Systems", Tata McGraw Hill Book Co..2005
2.	Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing', Pearson Education; Fourth edition, 2016

Reference Books:

1.	P Radhakrishnan "CAD/CAM/CIM", New Age International Pvt Ltd; Fourth edition, 2018
2.	John Stenerson, K e 11y Curran, Operation and Programming, PHI, New Delhi, 2009.
3.	TC Chang, RAWysk and HPWang, Computer Aided Manufacturing PHI,New Delhi, 2009
4.	Ibrahim Zeid and Sivasubramanian, R. CAD/CAM Theory and Practice, Tata McGraw Hill Publications, New Delhi,2009

e-Resources

1.	https://nptel.ac.in/courses/112105211
2.	https://nptel.ac.in/courses/112102102

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25204A0	**PE**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

PRECISION ENGINEERING

(For CAD / CAM)

Course Objectives:

1.	Understanding of accuracy and precision and learn how to test and improve machine tool alignment and overall part accuracy.
2.	Learn different precision manufacturing methods and surface finishing techniques.
3.	Understand of the various measurement instruments and methods used to assess dimensional accuracy and surface finish.
4	Learn the basics of nanotechnology and its applications in manufacturing tiny parts and materials.
5	Understand how to use fits, tolerances, and geometric dimensioning to design and assemble parts correctly.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Evaluate** the part and machine tool accuracies.	K4
2.	**Apply** the principles of ultra-precision machining, micro-manufacturing methods, and additive manufacturing	K3
3.	**Use** advanced metrology tools and techniques to measure and analyze components with high precision.	K3
4.	**Apply** the techniques of nanotechnology to develop and analyze nanoscale materials and devices for various applications	K3
5.	**Design** and apply fits and tolerances using principles of dimensional chains for individual features for parts and assemblies according to ISO standards.	K4

SYLLABUS

UNIT-I (10Hrs)	**Accuracy and Precision:** Introduction - Accuracy and precision – Need – Application of precision machining- Alignment testing of machine tools, Accuracy of numerical control system, Accuracy specification of parts and assemblies.
UNIT-II (10 Hrs)	**Precision Manufacturing:** Micro machining processes-Diamond machining - Micro engraving - Micro replication techniques-Forming, Casting, Injection molding - Micro embossing. Methods of obtaining high quality surfaces, Lapping, Honing, Super finishing and Burnishing processes
UNIT-III (10 Hrs)	**Precision Metrology-** In situ measurement- In process measurement of position of processing Point-Post process and online measurement of dimensional features-

	Mechanical measuring systems- Optical Measuring Systems- Optical Interferometry, Laser Scanning, White Light Interferometry Confocal Microscopy, Electron beam measuring Systems-Scanning Tunnelling-Atomic Force Microscope and X-ray Computed Tomography. Surface Metrology Surface Roughness and Measurement.
UNIT-IV (10 Hrs)	**Quality assurance Nano precision technology:** Fundamentals of nanotechnology, Nano physical processing of atomic-bitunits Nano chemical and electrochemical atomic-bit processing. –Nano-Grating systems –Nano lithography, Electron beam lithography – Mirror grinding of ceramics, Focused Ion Beam (FIB) Milling, Atomic Layer Deposition (ALD), Nano processing of materials for super high-density ICs-Nano-mechanical parts, Nano machines-NEMS, Applications- Nanoelectronics, Nanocomposites and nano coatings
UNIT-V (10 Hrs)	**Geometric Dimensioning and Tolerancing:** Tolerance and fits, Hole and shaft basis system, Types of fits- Types of assemblies-probability of clearance and interference fits in transitional fits, Concept of dimensional chain or tolerance stack. Dimensioning of stepped shaft and holes assigning tolerances on the constituent dimensions. Tolerance zone conversions-surfaces, Datum - Datum feature of representation-form controls, Logical approach to tolerancing datum systems, Geometrical tolerances.

Textbooks:

1.	Precision Engineering in Manufacturing, R.L.Murty, New Age International Publishers, 1996.
2.	V.K. Jain, Advanced Machining Processes, 12th reprint, Allied Publishers Ltd, 2010.
3	James, D. and Meadow, S., "Geometric Dimensioning and Tolerancing", Marcel Dekker Inc.,1995.

Reference Books:

1.	V.Kovan, "Fundamentals of Process Engineering", Foreign Languages Publishing House, Moscow, 1975
2.	J.L.Gadjala, "Dimensional control in Precision Manufacturing", McGraw Hill Publishers.
3.	Norio Tanigichi "Nano Technology", oxford university press, 2003.
4.	Venkatesh, V.C. and Sudin, I., "Precision Engineering", Tata McGraw Hill Co., NewDelhi, 2007.
5.	Liangchi Zhang, "Precision Machining of Advanced Materials", Trans Tech Publications Ltd., Switzerland, 1st Edition, 2001.

e-Resources

1.	https://www.pertecnica.net/precision-measuring-instruments-course/?utm_source=chatgpt.com
2.	https://gaugehow.com/engineering-metrology-3d-measurement/
3	https://nitw.ac.in/api/static/files/Materials_and_Systems_Engineering_Design_2023-10-26-16-29-51.pdf?utm_source=chatgpt.com

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25204A1	**PE**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

THEORY OF ELASTICITY AND PLASTICITY

(For CAD / CAM)

Course Objectives:

1.	To impart fundamental knowledge of stress–strain behavior, elastic constants, and governing equations of elasticity for 2D and 3D problems
2.	To develop analytical skills for solving elasticity problems in rectangular and polar coordinates, including bending, torsion, and complex loading conditions.
3.	To introduce the principles of plasticity, yield criteria, and material behavior beyond the elastic range for analyzing failure and deformation mechanisms.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Illustrate** the concepts of stress, strain, Hooke's law, plane stress, plane strain, and formulate equilibrium and compatibility equations for elastic bodies.	K3
2.	**Solve** two-dimensional elasticity problems in rectangular and polar coordinates using stress functions, Fourier series, and polynomial methods.	K3
3.	**Analyze** three-dimensional states of stress and strain, determine principal stresses, maximum shear stresses, and apply general theorems of elasticity.	K4
4.	**Evaluate** torsion problems for prismatic bars using St. Venant's warping function, Prandtl's stress function, and membrane analogy for various cross-sections.	K5
5.	**Apply** theories of plasticity, including yield criteria, plastic flow rules, and strain hardening, to predict material behavior under complex loading.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** Elasticity –Notation for forces and stresses – Components of stresses – components of strain –Hooke's law. **Plane Stress and Plane Strain Analysis:** Plane stress-plane strain –Differential equations of equilibrium–Boundary conditions– Compatibility equations–stress function–Boundary conditions.
UNIT-II (10 Hrs)	**Two Dimensional Problems in Rectangular Coordinates:** Solution by polynomials–Saint Venant's principle–Determination of displacements–bending of simple beams–Application of Fourier series for two dimensional problems – gravity loading. **Two Dimensional Problems in Polar Coordinates:** General Equation in polar coordinates–stress distribution symmetrical about an axis–Pure bending of curved bars – strain components in polar coordinates – Displace ments for symmetrical stress distributions–simple symmetric and asymmetric problems – General solution of two

	dimensional problem in polar coordinates – Application of the general solution of two dimensional problem in polar coordinates – Application of the general solution in polar coordinates.
UNIT-III (12 Hrs)	**Analysis of Stress and Strain in Three Dimensions:** Principle stress – ellipsoid and stress – director surface – Determination of principle stresses – Maximum shear stresses– Homogeneous deformation–principle axis of strain rotation. **GENERAL THEOREMS:** Balance laws –Differential equations of equilibrium–conditions of compatibility – Determination of displacement– Equations of equilibrium in terms of displacements–principle of superposition–Uniqueness of solution –the Reciprocal theorem.
UNIT-IV (09 Hrs)	**Torsion of Prismatic Bars:** General solution of problems by displacement (St. Venant's warping function) & force (Prandtl's stress function) approaches– Membrane analogy – Torsion of circular and non-circular (elliptic and rectangular) sections – Torsion of thin rectangular section and hollow thin- walled section – Single and multi-celled sections
UNIT-V (07 Hrs)	**Theory of Plasticity:** Stress-strain curve – Theories of strength and failure – Yield Criteria–Yield Surface–Plastic Flow–Plastic Work–Plastic Potential – Strain hardening.

Textbooks:

1.	Timoshenko, S., Theory of Elasticity and Plasticity, MC Graw Hill Book company.
2.	Sadhu Singh, Theory of Elasticity and Plasticity, Khanna Publishers.

Reference Books:

1.	Popov, Advanced Strength of materials, MC Graw Hill Book Company.
2.	Chen,W.F.and Han,D.J, Plasticity for structural Engineers, Springer-Verlag, New York.
3.	Lubliner,J., Plasticity Theory, MacMillan Publishing Co., NewYork.
4.	Y.C.Fung., Foundations of Solid Mechanics, Prentice Hall India.

e-Resources

1.	https://nptel.ac.in/courses/105105177
2.	Link: *MIT OCW – Mechanics & Materials II*

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25204A2	PE	3	--	--	3	40	60	3 Hrs.

ENTREPRENUERSHIP & DESIGN OF BUSINESS MODELS

(For CAD / CAM)

Course Objectives:

1.	Understand what entrepreneurship is, the traits of successful entrepreneurs and the skills needed.
2.	Learn about the business environment and the support systems available for entrepreneurs.
3.	Understand government policies and regulations affecting industries and international business.
4.	Learn how to prepare a business plan, including product selection, feasibility studies and project evaluation.
5.	Understand how to start and manage a small business, including finance, marketing and growth strategies.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Use** entrepreneurial attributes, understanding, and competencies to explore entrepreneurship as a feasible and long-term career opportunity.	K3
2.	**Model** the entrepreneurial ecosystem by integrating factors related to business, family, society and institutional supports.	K3
3.	**Apply** the essential aspects of Industrial Policies and Regulatory frameworks in relevant entrepreneurial contexts.	K3
4.	**Solve** business planning issues through systematic selection, budgeting and project profiling methodologies.	K3
5.	**Apply** structured approaches for launching, monitoring and sustaining small enterprises through effective evaluation and timely corrective actions.	K3

SYLLABUS

UNIT-I (10Hrs)	**ENTREPRENEURAL COMPETENCE:** Entrepreneurship concept - Entrepreneurship as a Career - Entrepreneurial Personality - Characteristics of Successful Entrepreneur - Knowledge and Skills of Entrepreneur.
UNIT-II (10 Hrs)	**ENTREPRENEURAL ENVIRONMENT:** Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organizational Services
UNIT-III (12 Hrs)	**INDUSTRIAL POLACIES:** Central and State Government Industrial Policies and Regulations - International Business.
UNIT-IV	**BUSINESS PLAN PREPARATION:**

(09 Hrs)	Sources of Product for Business - Prefeasibility Study - Criteria for Selectionof Product - Ownership - Capital - Budgeting Project Profile Preparation -Matching Entrepreneur with the Project - Feasibility Report Preparation andEvaluation Criteria.
UNIT-V (07 Hrs)	**LAUNCHING OF SMALL BUSINESS:** Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching - Incubation, Venture capital, IT startups. Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units - Effective Management of small Business.

Textbooks:

1.	Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.
2.	S.S. Khanka, Entrepreneurial Development, S. Chand and Company Limited, New Delhi, 2001.

Reference Books:

1.	Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra, 2nd Edition, 2005.
2.	Prasanna Chandra, Projects - Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
3.	P. Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai, 1997.
4.	Arya Kumar, Entrepreneurship, Pearson, 2012.
5.	Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective, Cengage Learning, 2012.

e-Resources

1.	https://archive.nptel.ac.in/courses/127/105/127105007
2.	https://archive.nptel.ac.in/courses/110/106/110106141

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25204A3	**PE**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

ADDITIVE MANUFACTURING

(For CAD / CAM)

Course Objectives:

1.	To provide comprehensive knowledge of the wide range of additive manufacturing processes, capabilities and materials
2.	To understand the software tools and techniques used for additive manufacturing
3.	To create physical objects that facilitates product development/prototyping requirements

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Demonstrate** the fundamentals, evolution, classifications, and materials of various Additive Manufacturing (AM) processes.	K3
2.	**Determine** the working principles, process parameters, benefits, and limitations of Vat Photo polymerization, Material Jetting, Binder Jetting, and Extrusion-based AM processes.	K3
3.	**Apply** the working principles of bonding and powder fusion mechanisms.	K3
4.	**Illustrate** the additive manufacturing process considering material delivery, heat input, deposition characteristics, and component requirements.	K3
5.	**Demonstrate** the ability to select appropriate AM processes and post-processing techniques for product development and functional component fabrication.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to Additive Manufacturing**: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM. **VAT Photo polymerization AM Processes:**Stereo lithography (SL), Materials, Process Modelling, SL resin curing process, SL scan patterns, Micro-stereo lithography, Mask Projection Processes, Two-Photon vat photo polymerization, Process Benefits and Drawbacks, Applications of Vat Photo
UNIT-II (10 Hrs)	**Material Jetting AM Processes:** Evolution of Printing as an Additive Manufacturing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Processes. **Binder Jetting AM Processes:** Materials, Process Benefits and Drawbacks, Research achievements in printing deposition, technical challenges in printing, Applications of Binder Jetting Processes. **Extrusion-Based AM Processes**: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, Bio-Extrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes, case studies.

UNIT-III (12 Hrs)	**Sheet Lamination AM Processes:** Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications, case studies. **Powder Bed Fusion AM Processes**: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, **Electron Beam melting (EBM):**Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes, case studies.
UNIT-IV (09 Hrs)	**Directed Energy Deposition AM Processes:** Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. **Friction stir additive manufacturing**: process, parameters, advantages, limitations and applications, Additive friction stir deposition process: principle, parameters, applications, functionally graded additive manufacturing components, Case studies. **Wire Arc Additive Manufacturing**: Process, parameters, applications, advantages and disadvantages, case studies.
UNIT-V (07 Hrs)	**Materials science for AM-** Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship, case studies. **Post Processing of AM Parts:** Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques, case studies. **Guidelines for Process Selection:** Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

Textbooks:

1.	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.
2.	3D Printing and Additive Manufacturing: Principles & Applications, Chua CheeKai, Leong Kah Fai, World Scientific, 2015, 4th Edition.

Reference Books:

1.	Rapid Prototyping: Laser-based and Other Technologies, Patri K. VenuVinod and Weiyin Ma, Springer, 2004.
2.	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
3.	Rapid Prototyping: Principles and Applications in Manufacturing, RafiqNoorani, John Wiley & Sons, 2006.
4.	Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020.
5.	Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A. N. Junoop, McGraw Hill, 2021.

e-Resources	
1.	Phttps://www.nist.gov/additive-manufacturing
2.	https://www.metal-am.com/
3	http://additivemanufacturing.com/basics/
4	https://www.3dprintingindustry.com/
5	https://www.thingiverse.com/
6	https://reprap.org/wiki/RepRap

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25204B0	PE	3	--	--	3	40	60	3 Hrs.

INTRODUCTION TO EMBEDDED SYSTEMS

(For CAD / CAM)

Course Objectives:

1.	This course emphasizes on comprehensive treatment of embedded hardware and real time operating systems along with case studies, in tune with the requirements of Industry.
2.	The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** fundamental concepts of embedded system components such as sensors, actuators, interfaces, and firmware to build simple embedded applications.	K3
2.	**Analyze** and compare ARM-v7-M (Cortex-M3) and ARM-v7-R (Cortex-R4) architectures for their suitability in specific embedded design situations.	K4
3.	**Demonstrate** configuration and usage of serial and wireless communication protocols (e.g., SPI, I2C, CAN, USB, Bluetooth) in practical embedded systems.	K3
4.	**Analyze** the structure of embedded software for ARM-v7 platforms and interpret multi-threading, device drivers, and real-time routines for efficient application development.	K4
5.	**Analyze** real-time operating system concepts including scheduling, inter-process communication, and memory management using µCOS-II or Linux, assessing their impact on embedded application performance.	K4

SYLLABUS

UNIT-I (10Hrs)	**Fundamentals of Embedded System:** Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power – supply (Battery technology, Solar), PC Band Passive components, Safety and reliability, environmental issues. Ethical practice. Characteristics and quality attributes (Design Metric) of embedded system., Real time system's requirements, real time issues, interrupt latency. Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net UML.
UNIT-II (10 Hrs)	**Embedded Hardware and Design:** IntroductiontoARM-v7-M (Cortex- M3),ARM-v7-R(CortexR4) and comparison in between them.

UNIT-III (09 Hrs)	**Embedded Serial Communication:** Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network.
UNIT-IV (10 Hrs)	**Embedded Software, Firmware Concepts and Design**: Embedded C- programming concepts (from embedded system point of view): Optimizing for Speed/Memory needs, Interrupt service routines, macros, functions, modifiers, data types, device drivers, Multi-threading programming. (Laboratory work on J2ME Java mobile application). Basic embedded C programs/applications for ARM-v7, using ARM-GCC- tool-chain, Emulation of ARM-v7 (e.g., using QEMU), and Linux porting onARM-v7 (emulation) board. **Case study:** (a) Medical monitoring systems, (b) Process control system(temp, pressure), (c) Soft real time: Automated vending machines and (d) Communication: Wireless (sensor) networks.
UNIT-V (09 Hrs)	**Real time operating system**: POSIX Compliance, Need of RTOS in Embedded system software, Foreground/Background systems, multi-tasking, context switching, IPC, Scheduler policies, Architecture of kernel ,task scheduler, ISR, Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS. Introduction to µCOS - IIRTOS, study of kernel structure of µCOS-II, Synchronization in µCOS-II, Inter-task communication in µCOS-II, Memory management inµCOS-II, porting of RTOS on ARM-v7 (emulation) board, Application developments using µCOS-II. Introduction Linux OS, Linux IPC usage, basic device (drivers) usage.

Textbooks:

1.	Introduction to Embedded Systems :Shibu K. V. (TMH).
2.	Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley).

Reference Books:

1.	Embedded Systems: Rajkamal(TMH)
2.	Embedded Systems: L.B.Das(Pearson)
3.	Embedded System design: S.Heath(Elsevier)
4.	Embedded microcontroller and processor design: G.Osborn(Pearson)
5.	EmbeddedSystems:FrankVahid,WileyIndia,2002

e-Resources

1.	https://nptel.ac.in/courses/108102045
2.	https://nptel.ac.in/courses/106105159

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25204B1	PE	3	--	--	3	40	60	3 Hrs.

MODELING AND SIMULATION OF MANUFACTURING SYSTEMS

(For CAD / CAM)

Course Objectives:

1.	Understand basic system concepts, types of systems, and the role of simulation in Manufacturing.
2.	Learn probability distributions and random number generation techniques used in simulation.
3.	Study tests for random numbers, random variate generation, and validate simulation models.
4.	Analyze simulation output data, explore simulation languages, and design simulation experiments.
5.	Understand queueing models, Markov chains, and their applications in manufacturing systems.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** the concepts of systems, modeling, and simulation applications in manufacturing.	K3
2.	**Apply** probability distributions and random number generation methods in simulations.	K3
3.	**Perform** tests for randomness and validate simulation models.	K4
4.	**Analyze** output data from simulations and develop models using simulation languages.	K4
5.	**Apply** queueing and Markov chain models for manufacturing systems analysis.	K3

SYLLABUS

UNIT-I (10Hrs)	Introduction to System and simulation: Concept of system and elements of system, Discrete and continuous system, Models of system and Principles of modeling and simulation, Monte carlo simulation, Types of simulation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system.
UNIT-II (10 Hrs)	Review of statistics and probability: Types of discrete and continuous probability distributions such as Geometric, Poisson, Uniform, Normal, Exponential distributions with examples. Random numbers: Need for RNs, Technique for Random number generation such as Mid product method, Mid square method, and Linear congruential method with examples.

UNIT-III (10 Hrs)	Test for Random numbers: Uniformity - Chi square test or Kolmogorov Smirnov test, Independency- Auto correlation test. Random Variate Generation: Technique for Random variate generation such as Inverse transforms technique or Rejection method Analysis of simulation data: Input data analysis, Verification and validation of simulation models.
UNIT-IV (10 Hrs)	Output data analysis. Simulation languages: History of simulation languages, Comparison and selection of simulation languages. Design and evaluation of simulation experiments: Development and analysis of simulation models using simulation language with different manufacturing systems.
UNIT-V (10 Hrs)	Queueing models: Introduction, M/M/1 and M/M/m Models with examples, Open Queueing and Closed queueing network with examples. Markov chain models and others: Discrete time markov chain with examples, Continues time markov chain with examples, stochastic process in manufacturing, Game theory.

Textbooks:

1.	J.Banks, J.S. Carson, B. L. Nelson and D.M. Nicol, Discrete Event System Simulation", PHI, New Delhi, 2009.
2.	A.M. Law, W.D.Kelton, Simulation Modeling and Analysis, Tata McGraw Hill Ltd, New Delhi, 2008.

Reference Books:

1.	N. Viswanadham, Y. Narahari, Performance Modeling of Automated Manufacturing Systems", PHI, New Delhi, 2007.
2.	Law, A. M., & Kelton, W. D. (2000). Simulation, Modeling and Analysis (3rd ed.).
3.	Pritsker, A. A. B. (1986). Introduction to Simulation and SLAM II (3rd ed.).
4.	Smith, J. S. (2003). Survey on the use of simulation for manufacturing system design and operation. Journal of Manufacturing Systems, 22(1), 1-14.

e-Resources

1.	https://onlinecourses.nptel.ac.in/noc23_me19/preview
2.	https://onlinecourses.nptel.ac.in/noc23_mg18/preview

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25204B2	PE	3	--	--	3	40	60	3 Hrs.

SMART MANUFACTURING

(For CAD / CAM)

Course Objectives:

1.	To understand the key concepts of Industry 4.0, smart manufacturing, IoT, and cyber-physical systems.
2.	To analyze and integrate hardware, software, communication protocols, cloud, and AI/ML tools for intelligent manufacturing
3.	To apply Industry 4.0 technologies for IoT implementation, predictive maintenance, and productivity improvement.

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** Industry 4.0 concepts for smart manufacturing and analyze related challenges.	K3
2.	**Identify** hardware, software, and IoT layers and evaluate their role in designing smart interfaces.	K3
3.	**Explain** CPS architecture and apply CPS principles to improve machine productivity.	K3
4.	**Analyze** cloud-based IoT platforms and apply AI/ML for predictive maintenance.	K4
5.	**Demonstrate** the use of hardware, communication protocols, IoT platforms, and ML tools for IoT-enabled Industry 4.0 solutions.	K3

SYLLABUS

UNIT-I (10Hrs)	**Concepts of Smart Manufacturing:** Definition and key characteristics of smart manufacturing, corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing Six big losses in manufacturing with Industry 4.0, and their benefits.
UNIT-II (10 Hrs)	**Smart Machines and Smart Sensors:** Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Sensing for Manufacturing Process in IIoT, Block Diagram of alloT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces.
UNIT-III (10 Hrs)	**Architecture of Cyber- Physical system (CPS):** Functions of CPS, 5C Architecture; Smart Connection Level, Data-to- Information Level, Cyber Level, Cognition Level,

	Configuration Level. Design of PHM based CPS systems. Comparison of today's factory and Industry 4.0 factory by the implementation of 5C CPS architecture.
UNIT-IV (10 Hrs)	**Digital Twin:** Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology. **Predictive Maintenance:** Introduction of predictive maintenance, difference between preventive and predictive maintenance, working and various components of predictive maintenance, benefits and tools of predictive maintenance. Common approaches to IoT predictive maintenance; Rule-based (condition monitoring) and AI (artificial intelligence) based predictive maintenance. **Augmented Reality in Maintenance (Electrical & Mechanical).**
UNIT-V (10 Hrs)	**IoT connectivity for Industry 4.0:** Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity protocol.

Textbooks:

1.	Industry 4.0 The Industrial Internet of Things by Alasdair Gilchrist, Apress.
2.	Industrial Internet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Houbing Song Danda B. Rawat, Springer

Reference Books:

1.	Smart Manufacturing Systems: Integration of IoT, AI, and Robotics in Mechanical Engineering ,Dr. V. Senthilkumar (Author), Dr. A. Nagadeepan
2.	Smart Manufacturing Factory: Artificial-Intelligence-Driven Customized Manufacturing, Jiafu Wan, Baotong Chen, Shiyong Wang, CRC Press
3.	Handbook of Smart Manufacturing: Forecasting the Future of Industry 4.0, Ajay, Hari Singh, Parveen, Bandar AlMangour, CRC Press
4.	Introduction to Industrial Internet of Things and Industry 4.0., S. Misra, C. Roy, and A. Mukherjee, 2020. CRC Press.

e-Resources

1.	https://onlinecourses.nptel.ac.in/noc25_cs146/preview
2.	https://www.udemy.com/course/smart-manufacturing/?srsltid=AfmBOoqRjDRsWTRQffn_Jx4Td9o8iFz_jmLFDVnspXX5AiTt9aIfxTZE&couponCode=CP251118BG1n

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D25204B3	PE	3	--	--	3	40	60	3 Hrs.

INTRODUCTION TO QUANTUM TECHNOLOGIES

(For CAD / CAM)

Course Objectives:

1.	To introduce the fundamental principles of quantum mechanics and quantum information
2.	To develop the ability to apply quantum computational methods and algorithms
3.	To explain and evaluate quantum communication protocols and emerging quantum technologies

Course Outcomes: At the end of the course student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** core principles of quantum mechanics and their technological implications	K3
2.	**Analyze** quantum phenomena like superposition and entanglement.	K4
3.	**Apply** mathematical tools to model and solve quantum systems.	K3
4.	**Demonstrate** understanding of quantum algorithms and quantum circuits.	K4
5.	**Evaluate** potential applications and challenges in quantum communication and sensing.	K3

SYLLABUS

UNIT-I (10Hrs)	Fundamentals of Quantum Mechanics: Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrodinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.
UNIT-II (10 Hrs)	Quantum Information Theory: Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory)
UNIT-III (10 Hrs)	Quantum Computing: Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover’s search algorithm, Oracle and amplitude amplification; Shor’s factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip,

	phase-flip, Introduction to quantum programming: Qiskit(overview)
UNIT-IV (10 Hrs)	Quantum Communication: Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise)
UNIT-V (10 Hrs)	Quantum Technologies and Applications: Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era.
Textbooks:	
1.	"Quantum Computation and Quantum Information" by Michael A. Nielsen and IsaacL. Chuang
2.	"Quantum Mechanics: Concepts and Applications" by Nouredine Zettili
Reference Books:	
1.	"Quantum Information Processing and Quantum Error Correction"By Ivan B. Djordjevic
2.	"Fundamentals of Quantum Information: Quantum Computation"edited by Dieter Heiss
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc25_ph33/preview
2.	https://onlinecourses.nptel.ac.in/noc26_ph24/preview
3.	https://onlinecourses.nptel.ac.in/noc26_cs89/preview

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2520404	**PC**	**--**	**1**	**2**	**2**	**40**	**60**	**3 Hrs.**

ROBOTICS & UAV SYSTEMS LAB

(For CAD/CAM)

Course Objectives:

1	To demonstrate the functional knowledge of robot structures, workspace operations, and spatial transformations involved in robotic motion.
2	To develop skills in robot programming, trajectory planning, motion control, and execution of industrial tasks such as pick-and-place, welding, and machining.
3.	To demonstrate the knowledge of basic drone technologies, including components, sensing mechanisms, maneuvering, and prototype development.

Course Outcomes:

S.No	Outcome	Knowledge Level
1	**Demonstrate** the functional operation of robotic subcomponents and perform robot jogging, calibration, and workspace manipulation.	K3
2	**Apply** robot programming methods to execute trajectory planning for operations such as pick-and-place, loading, unloading, and path contouring.	K3
3	**Develop** and simulate robot motions using spline programming, external TCP, loops, conditional stops, and subprogram structures.	K3
4	**Demonstrate** automation processes using robotics for welding, machining, and flexible manufacturing systems.	K3
5.	**Identify** and operate drone components, analyze maneuvering principles (roll, pitch, yaw), and build a basic prototype drone for imaging applications.	K3

SYLLABUS

20Hrs.	Robotics Lab experiment
1	Study of robot jogging in world, tool, and base coordinate systems.
2	Study and demonstration of tool calibration using pen tool and gripper (2-point method).
3	Study of base/table calibration using 3-point method and jogging in base frame.
4	Demonstration of executing robot programs – loading, running, and controlling program flow.
5	Study of Continuous Path (CP) motion and approximate positioning in robots.
6	Study of path contouring operations using spline blocks.
7	Study of spline motion programming for smooth robot trajectory generation.
8	Study and demonstration of gripper operations for handling panels and pens.
9	Study of external tool and workpiece calibration and jogging with fixed tools.
10	Demonstration of programming external TCP motions for robot-guided tasks.
11	Study of subprogram creation and execution in robotic programming.

12	Study of advanced motion control features – loops, conditional stops, constant velocity, and external automatic mode.
13	Demonstration of robotic automation processes such as pick-and-place, arc welding, and spot welding.
14	Demonstration of flexible manufacturing system (FMS) for machining and automated operations.
	UAV (drone) Lab Experiments
1	Study of drone components and their functions, including frame, motors, ESCs, propellers, and controller modules.
2	Demonstration of drone maneuvering – study of roll, pitch, yaw, and force generation during flight.
3	Study of drone sensors and power systems, including IMU, GPS, battery management, and safety protocols.
4	Demonstration and development of a prototype drone, including capturing photos and videos through onboard camera.
Recommended Reference Links for Robotics & UAV Laboratory	
1	**ATL Equipment Manual** https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2	**ATL Equipment Usage & Safety Guide** https://atl.aim.gov.in/ATL-Equipment-Manual/
3	**ATL Curriculum – Level 1** https://aim.gov.in/pdf/Level-1.pdf
4	**ATL Curriculum – Level 2** https://aim.gov.in/pdf/Level-2.pdf
5	**ATL Curriculum – Level 3** https://aim.gov.in/pdf/Level-3.pdf
6	**ATL Drone Module** https://aim.gov.in/pdf/ATL_Drone_Module.pdf
7	**ATL Equipment Manual** https://aim.gov.in/pdf/equipment-manual-pdf.pdf
8	**ATL Equipment Usage & Safety Guide** https://atl.aim.gov.in/ATL-Equipment-Manual/

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2520405	PC	--	1	2	2	40	60	3 Hrs.

ADVANCED CAM LAB

(For CAD/CAM)

Course Objectives:

1	To learn software like Z-Cast Pro, AFDEX and NX-II
2	To apply basic concept to drawing and editing to develop 3D Modelling.
3	To make 3D modelling, Assembling, modification & manipulation along with detailing.
4	To learn and prepare the part programming for the simulation of various machining processes.

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

S. No	Outcome	Knowledge Level
1	**Analyze** and simulate casting and metal forming processes including sand casting, die casting, cold and hot forging to optimize manufacturing parameters.	K4
2	**Develop** and simulate CNC part programs for turning, facing, taper turning, milling, threading, and drilling operations in CAM software.	K4
3	**Evaluate** machining simulations to ensure accuracy of tool paths and improve process efficiency using CAM packages.	K4
4	**Apply** software tools to validate manufacturing processes and part programs for enhanced production planning and control.	K4

SYLLABUS

(24Hrs)	**CYCLE-I: Casting and Metal Forming processes:**
	Simulate and analyses the following processes using a software package.
1	Sand Casting, Cyclic Casting & Die Casting
2	Two stage & Multi-stage Cold Forging
3	Two stage Hot Forging
4	Trimming
5	Piercing, Drawing & Extrusion
(24Hrs)	**CYCLE-II: CAM Packages:**
6	To write and simulate the plain turning and facing part program for a given component.
7	To write and simulate the step turning & taper turning part program for a given component.
8	To write and simulate the circular interpolation & threading part program for a given component.
9	To write and simulate the face milling & contour milling part program for a given component

10	To write and simulate the pocket drilling part program for a given component.
Reference Books:	
1	"CAD/CAM: Computer-Aided Design and Manufacturing" by Mikell P. Groover and Emory W. Zimmers Jr.
2	"CNC Programming Handbook" by Peter Smid
3	"Manufacturing Engineering and Technology" by Serope Kalpakjian and Steven R. Schmid

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2520406	**PR**	**--**	**--**	**2**	**1**	**100**	**--**	**3 Hrs.**

SEMINAR -II

(For CAD / CAM)

A student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, supervisor/mentor and two other senior faculty members of the department. For Seminar, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful

Regulation: R25	**II - M.Tech. I - Semester**								
CAD/CAM									
COURSE STRUCTURE (With effect from 2025-26 admitted Batch onwards)									
Course Code	**Course Name**	**Category**	**L**	**T**	**P**	**Cr**	**C.I.E.**	**S.E.E.**	**Total Marks**
D2530401	Research Methodology and IPR/ Swayam 12 Week MOOC Course		3	0	0	3	40	60	100
D2530402	Evaluation of Summer Internship/Industrial Training (8-10 Weeks)	PR	--	--	--	3	100	--	100
D2530403	Comprehensive Viva	PR	--	--	--	2	100	--	100
D2530404	Dissertation Part – A	PR	--	--	20	10	100	--	100
		TOTAL	**3**	**-**	**20**	**18**	**340**	**60**	**400**

Dissertation – Part A, internal assessment

Course Code	Category	L	T	P	C	CIE	SEE	Exam
D2530401	**PC**	**3**	**--**	**--**	**3**	**40**	**60**	**3 Hrs.**

RESEARCH METHODOLOGY AND IPR

(For CAD/CAM)

Course Objectives:

1.	To bring awareness on Research Methodology and research ethics.
2.	Familiarize the concepts of IPR.

Course Outcomes:

S.No	Course Outcome	Knowledge Level
1.	Identify the research problem through effective literature review and data analysis	**K3**
2.	Develop a technical paper with essential sections	**K3**
3.	Choose the patents, trade, and copyrights for protecting intellectual creations	**K3**
4.	Identify patents rights and transfer of technology	**K3**
5.	Identify appropriate IPR mechanism for protecting various types of intellectual creations.	**K3**

SYLLABUS

UNIT-I (10Hrs)	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations
UNIT-II (12Hrs)	Effective literature studies approaches, analysis Plagiarism, Research ethics, 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-III (12Hrs)	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-IV (12Hrs)	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.
UNIT-V (12Hrs)	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbooks:	
1.	Stuart Melville and Wayne Goddard, ―Research methodology: an introduction for science & engineering students'
2.	Wayne Goddard and Stuart Melville, ―Research Methodology: An Introduction
3.	Ranjit Kumar, 2nd Edition, ―Research Methodology: A Step by Step Guide for beginners
Reference Books:	
1.	Halbert, ―Resisting Intellectual Property‖, Taylor & Francis Ltd, 2007.
2.	Mayall, ―Industrial Design‖, McGraw Hill, 1992.
3.	Niebel, ―Product Design‖, McGraw Hill, 1974.
4.	Asimov, ―Introduction to Design‖, Prentice Hall, 1962
5.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, ― Intellectual Property in New Technological Age, 2016.
6.	T. Ramappa, ―Intellectual Property Rights Under WTO‖, S. Chand, 2008

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2530402	**PR**	**--**	**--**	**--**	**3**	**100**	**--**	**3 Hrs.**

SUMMER INTERNSHIP

(For CAD / CAM)

Students shall undergo mandatory summer internship / industrial training for a minimum of eight weeks duration at the end of second semester of the Programme/Summer Break. A student will be required to submit a summer internship/industrial training report to the concerned department and appear for an oral presentation before the committee. The Committee comprises of a Professor of the department and two faculty. The report and the oral presentation shall carry 40% and 60% weightages respectively. For summer internship / industrial training, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2530403	PR	--	--	--	2	100	--	3 Hrs.

COMPREHENSIVE VIVA

(For CAD / CAM)

The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Engineering/Specialization in the PG program. Viva will be conducted in 3rd semester. The duration of the viva will be around 30 min. The examination committee will be constituted by the HoD and consist of Professor of the department and two faculty. For comprehensive viva-voce, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2530404	PR	--	--	20	10	100	--	3 Hrs.

DISSERTATION PART – A

(For CAD / CAM)

The Student has to register for Dissertation-I / Industrial project in III semester. Student has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The student can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

Continuous assessment of Dissertation-I during the III-Semester will be monitored by the PRC.

Dissertation-Part A will be only internal evaluation by PRC for 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

The candidate shall submit a status report to the PRC in two stages, each accompanied by an oral presentation, with a minimum interval of three months between the two

Regulation: R25			**II - M.Tech. II - Semester**						
CAD/CAM									
COURSE STRUCTURE (With effect from 2025-26 admitted Batch onwards)									
Course Code	**Course Name**	**Category**	**L**	**T**	**P**	**Cr**	**C.I.E.**	**S.E.E.**	**Total Marks**
D2540401	Dissertation Part – B	PR	--	--	32	16	--	100	100
		TOTAL	**--**	**--**	**32**	**16**	**--**	**100**	**100**

External Assessment

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
D2540401	**PR**	**--**	**--**	**32**	**16**	**--**	**100**	**3 Hrs.**

DISSERTATION PART B
(Main Project)

(For CAD / CAM)

The student has to continue his/her work from Dissertation Part-A to complete Dissertation Part-B in IV semester.

Continuous assessment of Dissertation Part-B during IV-Semester will be monitored by the PRC.

Dissertation Part-B is evaluated for 100 external marks based on Review and Viva Voce.

Review and Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work for 100 marks.

If the report of the Viva-Voce is unsatisfactory (ie, < 50 marks), the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, the candidate has to reregister for the project and complete the project within the stipulated time after taking the approval from the College.