



GOVERNMENT COLLEGE OF ENGINEERING, SALEM

(NAAC Accredited with A⁺, An Autonomous Institution, Affiliated to Anna University, Chennai)

POSTGRADUATE CURRICULUM

(Applicable to the students admitted in M.E. Programme, from the Academic Year 2026-2027)

Programme: M.E. Computer Aided Design

Regulations: 2026

Overview of Credits

Sem	BS	ES(PC)	ES(PE)	SD	MC	AC	Total
I	4	11		1	3	0	19
II		17	6			0	23
III			6	8			14
IV				14			14
Total	4	28	12	23	3	0	70
% of Category	5.71	40.00	17.14	32.86	4.29	0	100

Abbreviations:

Course Type:

- T** - Theory
- L** - Laboratory
- PW** -Project Work

Category :

- BS** - Basic Science
- ES** - Engineering Science [Programme Core(**PC**)
Programme Elective(**PE**)]
- SD** - Skill Development
- MC** - Mandatory Course
- AC** - Audit Course

Others :

- TCP** -Total Contact Periods
- L** - Lecture
- T** - Tutorial
- P** - Practical

Semester I											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26MPC01	Advanced Mathematical Methods in Engineering	T	45	15	0	60	4	BS	40	60
2.	26CD101	Concepts of Engineering Design	T	45	0	0	45	3	ES(PC)	40	60
3.	26CD102	Computer Graphics	T	45	0	0	45	3	ES(PC)	40	60
4.	26CD103	Advanced Mechanics of Materials	T	45	0	0	45	3	ES(PC)	40	60
5.	26MLC01	Research Methodology and IPR	T	45	0	0	45	3	MC	40	60
6.	26CD104	Computer Aided Design and Modelling Laboratory	L	0	0	60	60	2	ES(PC)	60	40
7.	26CD105	Technical Seminar	-	0	0	30	30	1	SD	100	0
8.	26AC00X	Audit Course - I	T	30	0	0	30	0	AC	100	0
Total							360	19			

Semester II											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26CD201	Finite Element Methods in Design	T	45	15	0	60	4	ES(PC)	40	60
2.	26CD202	Mechanical Vibrations and Acoustics	T	45	0	0	45	3	ES(PC)	40	60
3.	26CD203	Industrial Robotics and AI	T	45	0	0	45	3	ES(PC)	40	60
4.	26CD204	Digital Twin and Industry 5.0	T	45	0	0	45	3	ES(PC)	40	60
5.	26CDEXX	Programme Elective - I	T	45	0	0	45	3	ES(PE)	40	60
6.	26CDEXX	Programme Elective - II	T	45	0	0	45	3	ES(PE)	40	60
7.	26CD205	Finite Element Analysis Laboratory	L	0	0	60	60	2	ES(PC)	60	40
8.	26CD206	CAM & Robotics Laboratory	L	0	0	60	60	2	ES(PC)	60	40
9.	26AC00X	Audit Course - II	T	30	0	0	30	0	AC	100	0
Total							435	23			

Semester III											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26CDEXX	Programme Elective - III	T	45	0	0	45	3	ES(PE)	40	60
2.	26CDEXX	Programme Elective - IV	T	45	0	0	45	3	ES(PE)	40	60
3.	26CD301	Dissertation Phase – I	PW	0	0	240	240	8	SD	60	40
Total							330	14			
Semester IV											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26CD401	Dissertation Phase – II	PW	0	0	420	420	14	SD	60	40
Total							420	14			
Total Credits for the Programme = 19 +23+14+14							70				

Programme Electives

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
Programme Elective - I (Semester II)											
1.	26CDE01	Advanced Kinematics of Mechanisms	T	45	0	0	45	3	ES(PE)	40	60
2.	26CDE02	Advanced Composite Materials	T	45	0	0	45	3	ES(PE)	40	60
3.	26CDE03	Product Lifecycle Management	T	45	0	0	45	3	ES(PE)	40	60
4.	26CDE04	Advanced Engineering Materials	T	45	0	0	45	3	ES(PE)	40	60
5.	26CDE05	Experimental Stress Analysis	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - II (Semester II)											
6.	26CDE06	Optimization Techniques in Design	T	45	0	0	45	3	ES(PE)	40	60
7.	26CDE07	Advanced Tool Design	T	45	0	0	45	3	ES(PE)	40	60
8.	26CDE08	Mechatronics System Design	T	45	0	0	45	3	ES(PE)	40	60
9.	26CDE09	Mechanics of Fracture	T	45	0	0	45	3	ES(PE)	40	60
10.	26CDE10	Computational Fluid Dynamics	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - III (Semester III)											
11.	26CDE11	Productivity Management and Re-engineering	T	45	0	0	45	3	ES(PE)	40	60
12.	26CDE12	Theory of Plates and Shells	T	45	0	0	45	3	ES(PE)	40	60
13.	26CDE13	CAD/CAM tools	T	45	0	0	45	3	ES(PE)	40	60
14.	26CDE14	Design for Manufacturing and Assembly	T	45	0	0	45	3	ES(PE)	40	60
15.	26CDE15	Solid Freeform Manufacturing	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - IV (Semester III)											
16.	26CDE16	Experimental Techniques and Data analysis	T	45	0	0	45	3	ES(PE)	40	60
17.	26CDE17	Quality concepts in design	T	45	0	0	45	3	ES(PE)	40	60
18.	26CDE18	Contact Mechanics	T	45	0	0	45	3	ES(PE)	40	60
19.	26CDE19	Advanced Automotive Systems	T	45	0	0	45	3	ES(PE)	40	60
20.	26CDE20	Design of Material Handling Equipment	T	45	0	0	45	3	ES(PE)	40	60

Audit Courses

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26AC001	English for Research paper writing	T	30	0	0	30	0	AC	100	0
2.	26AC002	Disaster Management	T	30	0	0	30	0	AC	100	0
3.	26AC003	Sanskrit for Technical Knowledge	T	30	0	0	30	0	AC	100	0
4.	26AC004	Value Education	T	30	0	0	30	0	AC	100	0
5.	26AC005	Constitution of India	T	30	0	0	30	0	AC	100	0
6.	26AC006	Pedagogy Studies	T	30	0	0	30	0	AC	100	0
7.	26AC007	Stress Management by Yoga	T	30	0	0	30	0	AC	100	0
8.	26AC008	Personality Development through Life Enlightenment Skills	T	30	0	0	30	0	AC	100	0
9.	26AC009	Sustainable Development Goals	T	30	0	0	30	0	AC	100	0

26MPC01	ADVANCED MATHEMATICAL METHODS IN ENGINEERING		SEMESTER		I		
Prerequisites			Category	BS	Credits	4	
Basic knowledge of matrices, vector calculus, differential equations and probability concepts is required.			Hours/ Semester	L	T	P	TH
				45	15	0	60
COURSE OBJECTIVES							
1.	To understand vector spaces, linear transformations and the rank–nullity theorem.						
2.	To formulate and solve second order partial differential equations using standard methods.						
3.	To apply Fourier transform techniques for solving diffusion, wave and Laplace equations.						
4.	To perform hypothesis testing using normal, t, chi-square and F distributions.						
5.	To analyze experimental data using ANOVA and standard design of experiments.						
UNIT - I		LINEAR ALGEBRA					12
Vector Spaces – Linear Dependence and Independence of Vectors – Basis and Dimension – Linear Transformations (Maps) – Range and Kernel of Linear Transformations – Rank and Nullity – Inverse of Linear Transformations – Rank–Nullity Theorem – Composition of Linear Maps – Matrix Associated with a Linear Map.							
UNIT - II		PARTIAL DIFFERENTIAL EQUATIONS					12
Classification of second order PDE – Solution of PDE by separation of variables – Solution of Parabolic, Elliptic and Hyperbolic equations in cylindrical and spherical coordinates – Initial and Boundary value problems for Two-dimensional wave equation by the Eigenfunction Method – D'Alembert's Solution for the wave equation.							
UNIT - III		FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS					12
Fourier Transform: Definition – Properties – Fourier Transforms of Elementary Functions – Solution of Diffusion, Wave and Laplace Equations Using Fourier Transform Techniques.							
UNIT - IV		TESTING OF HYPOTHESIS					12
Sampling distributions – Small and large samples – Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions – Analysis of $r \times c$ Contingency Tables – Goodness-of-Fit Tests – Tests for Independence of Attributes.							
UNIT - V		ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS					12
Analysis of variance – One way and Two-way classifications – Principles of Design of Experiments – Standard Experimental Designs (Completely Randomized Design, Randomized Block design and Latin square design).							
L:45, T:15, Total:60 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:					
1.	Gilbert Strang, "Linear Algebra and its applications", Cengage Learning, New Delhi, 4th edition, 2006.				
2.	K.Sankara Rao, "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.				
3.	Veerarajan.T, "Probability, Statistics and Random process", Tata McGraw- Hill publications, second edition, New Delhi, 2002.				
4.	Gupta, S.C. and Kapur, V.K., "Fundamentals of Mathematical Statistics", S.Chand and Sons, New Delhi, 11th Edition 2014				
5.	Grewal, B.S., "Higher Engineering Mathematics", 43rd edition, Khanna Publishers, New Delhi 2014.				
E-RESOURCES:					
1.	NPTEL Linear Algebra https://nptel.ac.in/courses/111/106/111106051				
2.	NPTEL Partial Differential Equations https://nptel.ac.in/courses/111/106/111106100				
3.	NPTEL – Fourier Transforms & Their Applications https://nptel.ac.in/courses/111/102/111102114				
4.	NPTEL – Probability & Statistics https://nptel.ac.in/courses/111/105/111105041				
5.	Khan Academy – Hypothesis Testing and Distributions https://www.khanacademy.org/math/statistics-probability				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain vector spaces, linear transformations, classification of PDEs, Fourier transforms, hypothesis testing, ANOVA and design of experiments.		PO3	PSO1	
CO2	Apply linear algebra concepts, separation of variables, eigenfunction methods, Fourier transforms, and hypothesis testing tools for solving engineering problems.		PO1, PO3	PSO1	
CO3	Analyze engineering systems and data using linear transformations, PDEs, Fourier transforms, statistical distributions, hypothesis tests, and rxc table analysis for decision making.		PO1, PO3	PSO1, PSO2	
CO4	Evaluate ANOVA results and assess suitable experimental designs such as CRD, RBD and Latin square design for engineering studies.		PO1, PO3	PSO2	
CO5	Develop mathematical models using linear algebra, PDE solution techniques, Fourier transforms and statistical tools, and present conclusions through reports.		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	3	2	1
CO2	3	-	3	3	2
CO3	3	-	3	3	2
CO4	3	-	3	2	3
CO5	3	3	3	3	3
AVERAGE	2.4	0.6	3	2.6	2.2

Activities:	
1.	Verify vector space properties, determine basis and dimension, compute rank and nullity, and analyze linear transformations and their matrix representations.
2.	Solve second order PDE by classification and separation of variables and apply eigen function method and D'Alembert's solution for wave equation.
3.	Compute Fourier transform of elementary functions and solve diffusion, wave and Laplace equations using Fourier transform technique.
4.	Perform hypothesis testing using normal, t, chi-square and F distributions, including $r \times c$ tables, goodness-of-fit tests and tests for independence of attributes.
5.	Perform one-way and two-way ANOVA and apply CRD, RBD and Latin square design for experimental data analysis.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Statistical Methods and Experimental Designs	10	Demonstrates strong understanding of statistical methods and experimental designs and their applicability	Shows adequate understanding with minor gaps	Demonstrates limited understanding
2.	Selection and Justification of Statistical Test/Experimental Design	10	Appropriate statistical test or experimental design is selected with clear justification	Suitable test/design selected with minor issues	Incorrect or unclear test/design selection
3.	Application of Statistical Procedures	10	Statistical procedures are correctly applied using appropriate methods and assumptions	Minor errors in applying statistical procedures	Major errors in applying statistical procedures
4.	Accuracy, Validity and Interpretation of Statistical Analysis	10	Statistical analysis is accurate, valid, and appropriately interpreted	Minor computational or statistical analysis errors	Major computational, analytical, or interpretation errors
5.	Technical Presentation and Communication of Results	10	Results are critically analyzed and clearly presented in a systematic, organized, and professional manner	Interpretation and presentation are acceptable with minor issues	Poor analysis, interpretation, and presentation
	Total	50			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Formulation and Mathematical Modelling	10	Engineering problem is clearly formulated with an appropriate mathematical model	Minor issues in formulation or modelling	Problem formulation and modelling are unclear
2.	Selection of Mathematical Method	10	Appropriate mathematical method is selected with clear justification	Suitable method selected with minor issues	Inappropriate or unclear method selection
3.	Development of Solution Procedure	10	Mathematical method and solution procedure are correctly developed and systematically presented	Methodology is adequate with minor errors	Incorrect or incomplete methodology
4.	Solution Accuracy and Validation	10	Solutions are accurate and properly verified or validated	Validation is adequate with minor issues	Poor or incomplete validation of solutions
5.	Analysis, Engineering Interpretation and Technical Presentation	10	Results are effectively analyzed, related to engineering applications, and communicated through clear, organized, and technically sound reports and presentations	Interpretation and presentation are acceptable with minor issues	Poor interpretation of results and inadequate presentation/documentation
	Total	50			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD101	CONCEPTS OF ENGINEERING DESIGN		SEMESTER		I		
Prerequisites			Category	ES(PC)	Credits	3	
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To learn the engineering codes and standards to design the product						
2.	To design the customer-oriented product with the concern of ergonomics aspect as well as environmental friendly.						
3.	To learn the various design methods to create the complicated engineering product.						
4.	To select the materials based on various design methodology.						
5.	To optimize the design based on quality and reliability						
UNIT - I		DESIGN FUNDAMENTALS					9
Design process – Consideration of good design - Morphology of design – Drawings – Computer Aided Engineering – Designing to codes and Standards – Concurrent Engineering – Product life cycle – Technological Forecasting – Market Identification – Competition Bench marking – Systems Engineering – Life Cycle Engineering – Human Factors in industrial Design							
UNIT - II		CUSTOMER - ORIENTED DESIGN & SOCIETAL CONSIDERATIONS					9
Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications - Human Factors in Design –Ergonomics and Aesthetics, Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society.							
UNIT - III		DESIGN METHODS					9
Creativity and problem solving–Creativity methods – TRIZ: Theory of Inventive Problem Solving – Axiomatic Design– Decision Making - Evaluation methods - Embodiment Design - Product Architecture - Configuration Design - Parametric Design. Role of models in Engineering design - Mathematical Modeling – Simulation.							
UNIT - IV		MATERIALS SELECTION					9
Material Selection process - Performance characteristics of materials _ Material selection in conceptual, embodiment and detail design - Economics - Material Performance indices - Decision Matrices - Pugh method and weighted property Index - recycling in material selection - Design with materials - Design for Manufacturing - Design for Assembly - Design for Castings, Forgings, Machining, Metal forming							
UNIT - V		RELIABILITY AND QUALITY ENGINEERING					9
Reliability Theory – Design for Reliability – Failure Mode and Effect Analysis (FMEA) Defects and Failure Modes - Design for Safety - Reliability Centered Maintenance - Total Quality Concept – Quality Control and Assurance – Statistical Process Control – Taguchi Method – Robust Design – Optimization methods.							
L:45, Total:45 Hours							

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	Dieter George E, "Engineering Design - A Materials and Processing Approach", McGraw Hill International Editions, Singapore, 2000.
2.	Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", 4th Edition, McGraw Hill, 2008.
3.	Pahl, G, and Beitz, W., "Engineering Design", Springer – Verlag, NY. 2007
4.	Suh, N.P., "The principles of Design", Oxford University Press, NY.1990
5.	Ray M.S., "Elements of Engineering Design", Prentice Hall Inc. 1985
6.	A.K. Govil, "Reliability Engineering", Tata McGraw-Hill Publishing Co. Ltd., 1983.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me83
2.	https://youtube.com/playlist?list=PLyqSpQzTE6M88PUx4AtV1WWNeKYVIVPAI&si=V6CZ0gTnHxBx5oqY
3.	https://youtube.com/playlist?list=PLbRMhDVUMnge4kBc_codYLdsBVdsS9mLU&si=8Ef3NVKUUpuBZI7BD

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamentals of engineering design, customer-oriented design principles, design methodologies, material selection concepts, and reliability and quality engineering practices.		
CO2	Apply design processes, customer requirement analysis, creativity techniques, material selection methods, and quality engineering tools to engineering product development.	PO1	PSO2
CO3	Analyze design alternatives using systematic design methods, modeling and simulation techniques, material performance indices, and reliability assessment approaches.	PO1	PSO1
CO4	Evaluate engineering designs considering customer needs, societal and ethical factors, manufacturability, sustainability, reliability, and quality requirements.	PO2, PO3	PSO1, PSO2
CO5	Develop innovative and optimized engineering design solutions by integrating advanced design methodologies, material selection strategies, manufacturing considerations, and quality engineering principles.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				2
CO3	3			2	
CO4		3	3	2	2
CO5	3	3	3	3	3
AVERAGE	3	3	3	2.3	2.3

Activities:

1.	Engineering Product Evaluation Case Study
2.	Innovative Product Design Project

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Customer Need Analysis	20	Comprehensive identification and interpretation of customer needs	Adequate analysis	Limited analysis
2.	Societal, Ethical & Environmental Assessment	20	Thorough and justified evaluation	Partial evaluation	Minimal consideration
3.	Manufacturability & Sustainability Assessment	20	Clear and detailed assessment	Moderate assessment	Poor assessment
4.	Reliability & Quality Evaluation	20	Accurate and insightful evaluation	Adequate evaluation	Incomplete evaluation
5.	Report & Presentation	20	Professional report and presentation	Acceptable quality	Poor documentation
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification & Concept Generation	20	Innovative and well-defined solution concepts	Adequate concepts	Limited originality
2.	Application of Design Methodologies	20	Effective use of TRIZ/design tools	Partial application	Minimal application
3.	Material Selection & Manufacturing Consideration	20	Appropriate and justified selection	Reasonably justified	Weak justification
4.	Optimization, Reliability & Quality Integration	20	Comprehensive optimization and quality focus	Moderate integration	Poor integration
5.	Design Documentation & Presentation	20	Excellent technical report and presentation	Adequate presentation	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD102	COMPUTER GRAPHICS		SEMESTER			I
Prerequisites		Category	ES(PC)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To provide a strong foundation in computer graphics principles, algorithms, and engineering visualization techniques.					
2.	To develop knowledge in 2D and 3D graphics, scan-conversion methods, and geometric transformations used in computer-aided design.					
3.	To enable students to model curves, surfaces, and solids using analytical, synthetic, and advanced techniques such as NURBS.					
4.	To impart skills in visibility determination, rendering, and realistic visualization techniques for engineering applications.					
5.	To introduce assembly modeling, tolerance analysis, and product lifecycle management concepts for integrated product design and simulation.					
UNIT - I		Fundamentals of Computer Graphics and Scan Conversion				9
Introduction to Computer Graphics, Scan-conversion of Lines: Digital Differential Analyzer (DDA) Algorithm, Bresenham’s Line Drawing Algorithm, Scan-conversion of Circles and Ellipses: Bresenham’s Circle Drawing Method, Midpoint Circle Algorithm, Drawing Ellipses and Other Conics						
UNIT - II		2D and 3D Transformations and Clipping				9
Introduction to 2D and 3D Transformations, Transformation Matrix, 2D Transformations: Identity, Scaling, Rotation, Translation, Reflection, Shear, Rotation about Arbitrary Point, Combined Transformations. Clipping Techniques: 2D Clipping: Point, Line, Polygon Clipping, 3D Viewing and Clipping, Text Clipping						
UNIT - III		Curve and Surface Modeling				9
Introduction to Curves: Analytical Curves: Line, Circle, Conics, Synthetic Curves: Hermite Cubic Spline, Bézier Curve, B-Spline Curve, Curve Manipulations, Introduction to Surfaces: Analytical Surfaces: Plane, Ruled, Revolution, Tabulated Cylinder, Synthetic Surfaces: Hermite Bicubic, Bézier, B-Spline, Surface Manipulations						
UNIT - IV		Nurbs and Solid Modeling Techniques				9
NURBS Basics: Curves, Lines, Arcs, Circle, Bilinear Surface, Solid Modeling Techniques: Regularized Boolean Set Operations, Primitive Instancing, Sweep Representations, Boundary 10 Representations, Constructive Solid Geometry (CSG) Comparison of Solid Representations, User Interface for Solid Modeling						
UNIT - V		Assembly Modeling and Product Lifecycle				9
Assembly of Parts: Design for Manufacture (DFM), Design for Assembly (DFA), Computer-Aided DFMA, Position & Orientation Inferences, Tolerance Analysis, Center of Gravity & Mass Property Calculation, Mechanism Simulation, Product Lifecycle Management (PLM): Product Development and Management, Models for New Product Development, Graphics & Computing Standards, Data Exchange Standards						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Boothroyd, G. (1991). Assembly automation and product design. Marcel Dekker				
2.	Chitale, A. K., & Gupta, R. C. (2023). Product design and manufacturing (7th ed.). PHI Learning Private Limited				
3.	Rogers, D. F., & Adams, J. A. (2017). Mathematical elements for computer graphics (2nd ed.). Tata McGraw-Hill.				
4.	Hearn, D. D., & Baker, M. P. (1997). Computer graphics C version (2nd ed.). Prentice Hall.				
5.	Zeid, I. (2006). Mastering CAD/CAM (2nd ed.). McGraw Hill				
E-RESOURCES:					
1.	Bhattacharya, S. (2025). Computer Graphics [NPTEL Online Course]. Indian Institute of Technology Guwahati. Retrieved from https://onlinecourses.nptel.ac.in/noc25_cs133				
2.	Indian Institute of Technology Delhi, Department of Computer Science & Engineering. (2023). Introduction to Computer Graphics [NPTEL Course No. 106102065]. National Programme on Technology Enhanced Learning (NPTEL). Retrieved from https://nptel.ac.in/courses/106/102/10610_2065				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the fundamental concepts of computer graphics, geometric transformations, curve and surface modeling, solid modeling techniques, and product lifecycle management.				
CO2	Apply scan-conversion algorithms, transformation techniques, clipping methods, curve and surface generation procedures, and assembly modeling concepts in computer graphics applications.		PO1	PSO1	
CO3	Analyze graphical models using transformation operations, geometric representations, solid modeling approaches, tolerance analysis, and product development methodologies.		PO1	PSO1, PSO2	
CO4	Evaluate computer graphics and modeling techniques considering accuracy, manufacturability, assembly requirements, data exchange standards, and product lifecycle considerations.		PO2, PO3	PSO1	
CO5	Develop integrated graphical and engineering design solutions by combining advanced modeling techniques, assembly analysis, simulation tools, and product lifecycle management concepts.		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3			3	
CO3	3			2	2
CO4		3	2	3	
CO5	3	3	3	3	2
AVERAGE	3	3	2.5	2.75	2

Activities:					
1.	Graphics Model Evaluation and Product Analysis				
2.	Integrated Product Modeling and Simulation Project				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Geometric Modeling Evaluation	20	Accurate and comprehensive analysis	Minor omissions	Limited analysis
2.	Manufacturability & Assembly Assessment	20	Thorough evaluation with justification	Adequate evaluation	Weak assessment
3.	Tolerance & Mass Property Analysis	20	Correct and detailed analysis	Minor errors	Incomplete analysis
4.	Standards & PLM Considerations	20	Excellent understanding and application	Partial application	Minimal consideration
5.	Report & Presentation	20	Professional documentation and presentation	Adequate quality	Poor presentation
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	CAD Modeling (Curves, Surfaces, Solids)	20	Highly accurate and complete model	Adequate model	Incomplete model
2.	Assembly Design & Constraint Definition	20	Correct and optimized assembly	Minor issues	Poor assembly definition
3.	Simulation & Analysis	20	Accurate simulation with meaningful interpretation	Partial analysis	Limited analysis
4.	Integration of PLM & Engineering Design Concepts	20	Comprehensive integration	Moderate integration	Minimal integration
5.	Innovation, Documentation & Presentation	20	Excellent innovation and communication	Adequate effort	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note:Purely as anExample: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD103	ADVANCED MECHANICS OF MATERIALS		SEMESTER		I	
Prerequisites		Category	ES(PC)	Credits	3	
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To learn the concepts of the theory of elasticity in three-dimensional stress system.					
2.	To study the shear-Centre of various cross-sections and deflections in beams subjected to unsymmetrical bending.					
3.	To learn the stresses on flat plates and curved members					
4.	To study the torsional stress of non-circular sections.					
5.	To learn about the contact stresses and finite element method.					
UNIT - I		ELASTICITY				9+3
Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, Differential equations of equilibrium - compatibility - boundary conditions - Representation of three-dimensional stress of a tension generalized Hooke's law - St. Venant's principle - plane stress - Airy's stress function - Energy methods.						
UNIT - II		SHEAR CENTRE AND UNSYMMETRICAL BENDING				9+3
Location of shear-Centre for various thin sections, curved beams - shear flows. Bending stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section.						
UNIT - III		STRESSES IN FLAT PLATES AND CURVED MEMBERS				9+3
Stresses in Flat plate of various shapes - problems – Stress strain temperature Relation – Strain Energy of Plate – various end conditions – Stresses in curved beams - circumference and radial stresses – deflections of curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks.						
UNIT - IV		TORSION OF NON-CIRCULAR SECTIONS				9+3
Torsion of rectangular cross section - St.Venants theory, semi inverse method – prandtl’s elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin walled tubes.						
UNIT - V		CONTACT STRESSES AND FINITE ELEMENT METHOD				9+3
Methods of computing contact stress-deflection of bodies in point and line Contact applications. Finite Element Method – Plane Elasticity – Bilinear rectangle – Linear Isoparametric quadrilateral – plane frame element.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Arthur P Boresi, Richard J.Schmidt, "Advanced Mechanics of Materials", Wiley India Pvt. Ltd., 2009.				
2.	Srinath. L.S., "Advanced Mechanics of Solids", Tata McGraw Hill, 2009.				
3.	Hibbeler. R.C., "Mechanics of Materials", Prentice-Hall, 2018.				
4.	Robert D.Cook, Warren C.Young, "Advanced Mechanics of Materials", Prentice Hall, 1999.				
5.	Timoshenko and Goodier, "Theory of Elasticity", Tata McGraw Hill, 2010.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112101095				
2.	https://nptel.ac.in/courses/105106049				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Explain the fundamental principles of elasticity, unsymmetrical bending, stress analysis in plates and curved members, torsion of non-circular sections, contact stresses, and finite element methods.				
CO2	Apply elasticity theories, stress–strain relationships, bending principles, torsion analysis, and finite element techniques to solve engineering mechanics problems.			PO1	PSO2
CO3	Analyze stress distributions, deformation characteristics, shear center locations, contact stresses, and finite element models for structural and machine components.			PO1	PSO1, PSO2
CO4	Evaluate the behavior and performance of engineering components subjected to complex loading conditions using elasticity, energy methods, torsion theories, and finite element analysis.			PO2, PO3	PSO1
CO5	Develop and validate engineering solutions for advanced stress analysis problems by integrating elasticity concepts, structural analysis techniques, and finite element modeling approaches.			PO1, PO2, PO3	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	3	–	–	–	2
CO3	3	–	–	2	2
CO4	–	3	3	2	–
CO5	3	3	3	3	2
AVERAGE	3	3	3	2.3	2
Activities:					
1.	Advanced Stress Analysis and Component Evaluation				
2.	Finite Element Modeling and Validation Project				

Rubrics for evaluation: C04					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Formulation and Assumptions	20	Appropriate assumptions and clear problem definition	Minor omissions	Incomplete formulation
2.	Stress and Deformation Analysis	20	Accurate and comprehensive analysis	Minor computational errors	Limited analysis
3.	Application of Advanced Mechanics Concepts	20	Correct use of elasticity, torsion, bending, and energy methods	Partial application	Weak application
4.	Evaluation and Interpretation of Results	20	Insightful interpretation with engineering justification	Adequate interpretation	Poor interpretation
5.	Technical Report and Presentation	20	Professional documentation and presentation	adequate quality	Poor presentation
	Total	100			
Rubrics for evaluation: C05					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Geometry Creation and FEM Model Development	20	Accurate and well-structured model	Minor modeling issues	Incomplete model
2.	Boundary Conditions and Mesh Quality	20	Appropriate conditions and optimized mesh	Minor deficiencies	Poor setup
3.	Stress, Strain and Deformation Analysis	20	Accurate results with detailed analysis	Partial analysis	Limited analysis
4.	Validation and Design	20	Strong validation and meaningful recommendations	Moderate validation	Weak validation
5.	Innovation, Documentation and Presentation	20	Excellent technical communication and presentation	Adequate communication	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

REFERENCE BOOKS:					
1.	Kothari.C.R, Research Methodology – Methods and Techniques, New age Publications, New Delhi, 2009				
2.	Stuart Melville and Wayne Goddard, "Research methodology: An introduction for science & Engineering students"				
3.	Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"				
4.	Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"				
5.	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007				
6.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in the New Technological Age", 2016.				
7.	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/121106007				
2.	https://nptel.ac.in/courses/109106137				
3.	https://nptel.ac.in/courses/110106081				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the fundamental concepts of research methodology, literature review techniques, technical documentation, intellectual property rights, and patent systems.				
CO2	Apply research approaches, data collection methods, hypothesis testing, research ethics, and documentation practices in engineering research problems.	PO1	PSO2		
CO3	Analyze research problems, evaluate literature findings, validate research outcomes, and examine intellectual property and patenting procedures.	PO1	PSO2		
CO4	Assess the effectiveness of research methodologies, technical reports, research proposals, and patent protection strategies for engineering applications.	PO2, PO3	PSO1		
CO5	Develop research proposals, technical reports, and innovative intellectual property solutions by integrating research methodology and patenting concepts.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	-	-	2
CO3	3	-	-	-	2
CO4	-	3	2	2	-
CO5	3	3	3	2	2
AVERAGE	3	3	2.5	2	2

Activities:

1.	Evaluation of Research Methodologies, Technical Reports, and Patent Case Studies through Self-Learning Activities and Report Submission
2.	Development of Research Proposals, Technical Reports, and Innovative Patent Concepts through Self-Learning Activities and Technical Presentation.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Selection of Research Paper and Patent	20	Highly relevant and appropriate selection	Relevant selection	Basic selection
2.	Analysis of Research Methodology	20	Comprehensive evaluation with critical insights	Adequate evaluation	Limited evaluation
3.	Assessment of Patent Protection Strategy	20	Thorough assessment with clear justification	Good assessment	Basic assessment
4.	Technical Report Preparation	20	Well-structured and professionally documented	Good organization with minor errors	Basic documentation
5.	Conclusions and Recommendations	20	Insightful conclusions with strong recommendations	Relevant conclusions	Basic conclusions
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification and Objective Formulation	20	Clearly defined problem and objectives	Adequately defined problem and objectives	Basic problem identification
2.	Research Proposal Development	20	Comprehensive and feasible proposal	Good proposal with minor gaps	Basic proposal
3.	Innovation and Patent Concept Development	20	Highly innovative and patentable concept	Moderately innovative concept	Limited innovation
4.	Technical Report Documentation	20	Professional and well-organized report	Good report with minor deficiencies	Basic report preparation
5.	Technical Presentation and Defence	20	Excellent presentation with strong justification	Good presentation and justification	Satisfactory presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note:Purely as anExample: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD104	COMPUTER AIDED DESIGN AND MODELLING LABORATORY		SEMESTER		I
Prerequisites		Category	ES(PC)	Credits	2
		Hours/ Semester	L	T	P
			0	0	60
COURSE OBJECTIVES					
1.	To impart knowledge on the commercially available computer-aided drafting software's and their features.				
2.	To learn the modeling of 2D part drawings.				
3.	To model the 3D mechanical components.				
4.	To assemble the 3D parts and drafting it using software assistance.				
5.	To generate part drawings from the assembly.				
LIST OF EXPERIMENTS					
MODULE I	LIST OF SOLIDWORKS EXPERIMENTS				
1.	Valves - Safety and non-return valves				
2.	Couplings – Flange ,Oldham's , Muff, Gear couplings				
3.	Joints – Universal, Knuckle , Sleeve & Cotter joints				
4.	Engine parts - Piston, connecting rod, Stuffing box & Multi-plate clutch				
5.	Machine components – Screw Jack, Machine vice, Lathe Tail stock				
MODULE II	LIST OF CATIA EXPERIMENTS				
6.	Surface Design Exercises: • Car Fender • Car Door Panel • Bottle Surface • Plastic Cover • Computer Mouse • Soap Case • Helmet • Fan Blade				
Total=60 Periods					
Weightage: Continuous Assessment 60% End Semester Examinations 40%					

REFERENCE BOOKS:					
1.	David C. Planchard, Engineering Graphics with SOLIDWORKS 2024: A Step-by-Step Project-Based Approach, SDC Publications, 2024.				
2.	Randy H. Shih, SOLIDWORKS 2024 and Engineering Graphics: An Integrated Approach, 1st Edition, SDC Publications, 2024.				
3.	Sham Tickoo, CATIA V5-6R2020 for Designers, CADCIM Technologies, 2020.				
4.	Ronald E. Barr, Davor Juricic, Thomas J. Krueger and Alejandro Reyes, Design Workbook Using SOLIDWORKS 2024: Design, Detailing, Assembly & Analysis Basics, SDC Publications, 2024.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/106103224				
2.	https://nptel.ac.in/courses/112102101				
3.	https://nptel.ac.in/courses/112104252				
4.	https://nptel.ac.in/courses/112102101				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the features, commands, and workflow of commercial CAD software such as SolidWorks and CATIA for engineering drafting and modeling.				
CO2	Create accurate 2D sketches and engineering drawings of machine elements using CAD tools		PO1	PSO2	
CO3	Develop parametric 3D part models of mechanical components using feature-based modeling techniques.		PO1	PSO2	
CO4	Assemble multiple components, evaluate fit and constraints, and generate detailed manufacturing drawings.		PO2, PO3	PSO1	
CO5	Produce integrated CAD models, assemblies, and documentation suitable for engineering design and manufacturing applications		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1		1	1
CO2	3			2	2
CO3	3			3	2
CO4		3	3	3	3
CO5	3	3	3	3	3
AVERAGE	2.75	2.33	3.00	2.40	2.00

Activities:					
1.	CAD Modeling and Drawing Assignment				
2.	Assembly and Manufacturing Documentation Project				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Assembly Modeling Accuracy	20	Correct constraints and fully functional assembly	Minor assembly issues	Major assembly errors
2.	Use of Constraints and Mates	20	Appropriate and optimized use	Partially optimized	Incorrect or incomplete use
3.	Generation of Exploded Views and BOM	20	Complete and professional output	Adequate output	Incomplete output
4.	Manufacturing Drawing Quality	20	Accurate dimensions, tolerances, and annotations	Minor omissions	Poor documentation
5.	Presentation and Report	20	Professional presentation and documentation	Adequate presentation	Poor presentation
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	2D Sketch and Part Modeling	20	accurate and fully defined sketches/models	Minor errors	Incomplete models
2.	Feature-Based Modeling and Parametric Design	20	Effective and reusable parametric model	Partially parametric	Limited feature use
3.	Assembly Integration	20	Seamless integration of all components	Minor fit issues	Major integration problems
4.	Drawing and Documentation Standards	20	Professional engineering documentation	Adequate documentation	Poor documentation
5.	Innovation, Completeness, and Presentation	20	Complete, innovative, and professionally presented	Adequate completeness	incomplete and weak presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Evaluation of Student Work, Observation of Record and Model Test	Activities		
CO1	20	20	20	2
CO2	20	20	20	2
CO3	20	20	20	2
CO4	20	20	20	2
CO5	20	20	20	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD105		TECHNICAL SEMINAR		SEMESTER			I
Prerequisites			Category	SD	Credits		1
			Hours/ Semester	L	T	P	TH
				0	0	30	30
COURSE OBJECTIVES							
1.	To work on a specific technical topic in Engineering design related topics to acquire the skills of oral presentation						
2.	To acquire technical writing abilities for seminars and conferences.						
3.	To identify and compare technical and practical issues related to the area of course specialization.						
4.	To outline annotated bibliography of research demonstrating scholarly skills						
5.	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting						
MODULES							
1.	The students will work for two hours per week guided by a group of staff members.						
2.	They will be asked to talk on any topic of their choice related to Engineering design, and search relevant journal paper/white paper on the selected topics for presentation and to engage in dialogue with the audience.						
3.	A brief copy of their talk also should be submitted.						
4.	Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic along with the journal reference copy.						
5.	They will also answer the queries on the topic. The students as the audience also should interact.						
6.	Evaluation will be based on the technical presentation and their report and also on the interaction during the seminar using the specific rubrics.						
Total=30 Periods							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
REFERENCE BOOKS:							
1.	Meenakshi Raman and Sangeeta Sharma, Technical Communication, 4th Edition, Oxford University Press, 2022.						
2.	C. Muralikrishna and Sunita Mishra, Communication Skills for Engineers, 2nd Edition, Pearson, 2011.						
3.	Stuart G. Walesh, The Communicative Engineer: How to Ask, Listen, Write, Speak, and Use Visuals, 1st Edition, Wiley, 2024.						
E-RESOURCES:							
1.	https://nptel.ac.in/courses/109105110						
2.	https://nptel.ac.in/courses/109106094						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the selected engineering design topic and its technical background using appropriate literature sources		
CO2	Collect, review, and summarize technical information from journals, conference papers, and industry reports.	PO1	PSO2
CO3	Analyze and compare technical approaches, practical issues, and recent developments related to the selected topic.	PO1	PSO2
CO4	Evaluate research findings, identify gaps, and respond to technical queries during seminar discussions.	PO2, PO3	PSO1
CO5	Prepare and deliver a professional technical seminar report and presentation demonstrating communication, documentation, and scholarly skills.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1		1	1
CO2	3			1	2
CO3	3	2		2	2
CO4		3	2	2	
CO5	3	3	3	2	2
AVERAGE	2.75	2.25	2.50	1.60	1.75

Activities:

1.	Literature Review and Annotated Bibliography
2.	Technical Seminar Presentation and Discussion

Rubrics for evaluation: 1

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Topic Selection and Relevance	20	Highly relevant and current topic	Relevant topic	Limited relevance
2.	Literature Search Quality	20	Comprehensive and credible sources	Adequate sources	Few or weak sources
3.	Annotated Bibliography	20	Clear, concise, and analytical summaries	Adequate summaries	Minimal analysis
4.	Technical Understanding	20	Strong understanding of the topic	Moderate understanding	Limited understanding
5.	Documentation and Formatting	20	Professional and error-free	Minor formatting issues	Poor formatting
	Total	100			

Rubrics for evaluation: 2

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Technical Content and Accuracy	20	Highly accurate and in-depth	Generally accurate	Superficial content
2.	Organization and Clarity	20	Excellent flow and clarity	Adequate organization	Poor organization
3.	Presentation Skills	20	Confident, engaging, professional delivery	Adequate delivery	Weak delivery
4.	Response to Questions	20	Accurate and insightful responses	Adequate responses	Unable to answer satisfactorily
5.	Report Quality and Referencing	20	Well-structured report with proper references	Adequate report	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component		Percentage allocation	Mapping Strength
	Review 1	Review 2		
CO1	10	10	10	2
CO2	10	10	10	2
CO3	10	10	10	2
CO4	35	35	35	3
CO5	35	35	35	3
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD201		FINITE ELEMENT METHODS IN DESIGN		SEMESTER		II	
Prerequisites			Category	ES(PC)	Credits	4	
			Hours/ Semester	L	T	P	TH
				45	15	0	60
COURSE OBJECTIVES							
1.	To understand the fundamental concepts, procedures, and engineering applications of the Finite Element Method (FEM).						
2.	To formulate and solve one-dimensional and two-dimensional boundary value problems using variational and weighted residual methods.						
3.	To develop finite element models for structural and thermal engineering problems using appropriate element formulations and meshing techniques.						
4.	To apply isoparametric formulation and numerical integration methods in finite element analysis.						
5.	To analyze dynamic and nonlinear engineering systems using finite element techniques and interpret the obtained results effectively.						
UNIT – I		Fundamentals of Finite Element Analysis and 1D Problems					12
Historical background – Basic concepts of FEM – Weighted residual methods – Variational formulation of boundary value problems – Ritz method – Finite element modeling – Element equations – Linear and higher-order shape functions – Bar and beam elements – Applications to one-dimensional heat transfer problems.							
UNIT – II		2D Finite Element Problems and Elasticity					12
Boundary value problems in two dimensions – Linear and higher-order triangular and quadrilateral elements – Poisson’s and Laplace’s equations – Weak formulation – Element matrices and vectors – Scalar variable problems – Introduction to theory of elasticity – Plane stress, plane strain, and axisymmetric formulation – Principle of virtual work – Energy method for matrix formulation.							
UNIT – III		Isoparametric Formulation and Numerical Integration					12
Natural coordinate systems – Lagrangian interpolation polynomials – Isoparametric formulation – Shape functions for 1D and 2D elements – Serendipity elements – Jacobian transformation – Numerical integration using Gauss quadrature – Onepoint, two-point, and three-point integration.							
UNIT – IV		Eigenvalue					12
Dynamic analysis – Equations of motion – Consistent and lumped mass matrices – Free vibration of bars, beams, and shafts – Eigenvalue problem solutions – Introduction to transient field problems.							
UNIT – V		Nonlinear Finite Element Analysis					12
Nonlinear analysis: solution techniques – Material nonlinearity (plasticity, visco-plasticity) – Geometric nonlinearity – Contact problems – Stress stiffening – Meshing strategies: free and mapped – Mesh quality and error estimation.							
L:45, T:15, Total:60 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:	
1.	Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.
2.	David Hutton, "Fundamentals of Finite Element Analysis", Tata Mc Graw Hill, 2005.
3.	Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, Butterworth Heinemann, 2018.
4.	Reddy, J.N. "Introduction to the Finite Element Method", 4th Edition, Tata Mc Graw Hill, 2018.
5.	Seshu.P, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., New Delhi, 2012.
6.	Tirupathi R.Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.

E-RESOURCES:	
1.	https://nptel.ac.in/courses/112104193
2.	https://nptel.ac.in/courses/112104115
3.	https://nptel.ac.in/courses/112104193
4.	https://innovationspace.ansys.com/courses/mapping-aic-nptel-courses/

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the fundamental concepts of finite element analysis, variational methods, elasticity formulations, isoparametric elements, dynamic analysis, and nonlinear finite element techniques.		
CO2	Apply finite element formulations, interpolation functions, numerical integration methods, elasticity principles, and dynamic analysis techniques to solve engineering problems.	PO1	PO1
CO3	Analyze one-dimensional and two-dimensional engineering systems using finite element models, eigenvalue analysis, mesh generation strategies, and error estimation techniques.	PO1	PSO1, PSO2
CO4	Evaluate the accuracy and effectiveness of finite element solutions for structural, thermal, dynamic, and nonlinear engineering applications using appropriate modeling and validation approaches.	PO2, PO3	PSO1
CO5	Develop finite element models and innovative computational solutions for complex engineering problems by integrating advanced element formulations, dynamic analysis, and nonlinear simulation techniques.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	3	–	–	3	–
CO3	3	–	–	2	2
CO4	–	3	3	2	–
CO5	3	3	3	3	2
AVERAGE	3	3	3	2.5	2

Activities:					
1.	To evaluate the accuracy and effectiveness of finite element solutions for structural or thermal engineering problems through modeling, simulation, and validation.				
2.	To develop and analyze a finite element model involving dynamic or nonlinear behavior and propose engineering improvements based on simulation results.				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem formulation and mathematical modeling	20	Accurate formulation with appropriate assumptions	Minor formulation errors	Incomplete formulation
2.	FEM implementation and element selection	20	Appropriate element selection and model development	Adequate implementation	basic implementation
3.	Validation and comparison with analytical solutions	20	Excellent agreement and detailed validation	Moderate validation	Limited validation
4.	Error estimation and result interpretation	20	Comprehensive error analysis and interpretation	Adequate interpretation	Basic interpretation
5.	Technical report and presentation	20	Excellent documentation and presentation	Good documentation	Basic documentation
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Engineering problem selection and objectives	20	Well-defined complex engineering problem	Appropriate problem definition	Basic problem definition
2.	FEM model development and meshing strategy	20	Robust model with optimized mesh strategy	Adequate model development	Basic model development
3.	Application of advanced FEM concepts	20	Effective use of dynamic/nonlinear/ isoparametric formulations	Moderate application	Limited application
4.	Analysis, optimization and innovation	20	Innovative solution with clear engineering improvements	Good analysis and recommendations	Basic analysis

5.	Report quality and presentation	20	Professional-quality report and presentation	Good report quality	Basic report quality	
	Total	100				
The Internal Assessment Matrix (IAM) for the defined COs:						
CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	
Note:Purely as anExample: Strength = 3 (if percentage >20%); Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);						

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1. Rao, S.S., "Mechanical Vibrations," Addison Wesley Longman, 2005.
2. Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 2000.
3. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2010.
4. A.H.Church, "Mechanical Vibrations", 2nd Edition, John Wiley & Sons Inc, 1973.
5. Srinivasan, "Mechanical Vibration Analysis", 2nd Edition, McGraw Hill, 1982.
6. Kewal Pujara, "Vibration and Noise for Engineers", Dhanpat Rai & Co

E-RESOURCES:

1. <https://nptel.ac.in/courses/112107212>
2. <https://nptel.ac.in/courses/11210109>
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me101
4. <https://nptel.ac.in/courses/112104026>

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamental concepts of vibration systems, multi-degree freedom systems, continuous systems, vibration measurement techniques, and noise and acoustics.		
CO2	Apply vibration analysis methods, modal analysis techniques, transient and random vibration concepts, and vibration measurement tools to engineering systems.	PO1	PSO2
CO3	Analyze the dynamic behavior of mechanical systems using mathematical models, numerical methods, vibration response functions, and acoustic analysis techniques.	PO1	PSO1, PSO2
CO4	Evaluate vibration control strategies, machine condition monitoring methods, balancing techniques, and noise control measures for engineering applications.	PO2, PO3	PSO1
CO5	Develop innovative solutions for vibration reduction, dynamic system optimization, condition monitoring, and acoustic performance improvement using advanced engineering approaches.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	3	–	–	–	3
CO3	3	–	–	2	2
CO4	–	3	3	2	–
CO5	3	3	3	3	2
AVERAGE	3	3	3	2.33	2.33

Activities:					
1.	Vibration Measurement, Balancing and Condition Monitoring of Rotating Machines				
2.	Design Project on Vibration and Noise Reduction				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of vibration measurement techniques	20	Demonstrates complete understanding and proper application of measurement techniques	Good understanding with minor errors	Basic understanding with significant gaps
2.	Data acquisition and analysis	20	Accurate data collection and comprehensive analysis using FFT/signal processing tools	Moderate accuracy and analysis	Limited analysis and interpretation
3.	Identification of vibration problems and balancing	20	Correct identification of faults and balancing procedures	Minor errors in diagnosis and balancing	Limited ability to identify vibration issues
4.	Recommendation of vibration control measures	20	Highly effective and justified control strategies	Adequate control measures with reasonable justification	Basic recommendations with weak justification
5.	Report quality and presentation	20	Professional report, clear presentation, excellent communication	Good report and presentation	Basic report with limited clarity
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and formulation	20	Clearly defines engineering problem with appropriate objectives	Problem adequately defined	Problem definition lacks clarity
2.	Design and innovation of solution	20	Innovative and technically sound solution developed	Reasonably effective solution	Basic solution with limited innovation
3.	Application of vibration/acoustic concepts	20	Excellent application of relevant theories and principles	Adequate application of concepts	Limited application of concepts

4.	Performance evaluation and validation	20	Comprehensive analysis and validation of results	Moderate validation and evaluation	Minimal evaluation of results
5.	Technical report and presentation	20	Excellent documentation and presentation skills	Good documentation and presentation	Basic documentation and presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD203	INDUSTRIAL ROBOTICS AND AI		SEMESTER		II	
Prerequisites		Category	ES(PC)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To develop the ability to design, program, and control industrial robotic systems for automated manufacturing applications.					
2.	To integrate vision systems, sensors, and automation tools for enhanced perception and control in robotic systems.					
3.	To apply artificial intelligence and machine learning techniques for autonomous decision-making and problem-solving in industrial robotics.					
UNIT – I	Introduction to Robotics and Artificial Intelligence					9
Overview of Robotics: History, types, architecture of robots, robot components and structure, robot coordinate systems and workspace, sensors and actuators, applications. Overview of Artificial Intelligence (AI): Evolution of AI, types of AI, basic concepts in AI, relationship between robotics and AI, applications and impact on various industries.						
UNIT – II	Robot Kinematics, Dynamics, Vision Systems and Sensors					9
Kinematics of Robots: Forward kinematics, inverse kinematics. Robot Dynamics: Newton-Euler and Lagrange methods, dynamic equations of motion. Trajectory Planning: Path planning techniques, motion control. Introduction to Machine Vision: Concept and image processing techniques. Vision Systems for Robots: Camera calibration, 3D vision, object recognition and tracking. Integration of Sensors: Types of sensors (proximity, tactile, ultrasonic), sensor fusion techniques, applications.						
UNIT – III	Robot Programming and Control					9
Robot Programming Languages: Programming languages (e.g., Python, C/C++, ROS), programming paradigms (teach-pendant, offline programming, online programming). Control Systems for Robots: Types of control (open and closed loop), PID control, advanced control techniques (adaptive, robust, model predictive control). Simulation and Modeling Tools: Software tools, simulation techniques.						
UNIT – IV	Machine Learning					9
Introduction to Machine Learning: Supervised, unsupervised, and reinforcement learning, key algorithms (decision trees, SVM, neural networks). Deep Learning in Robotics: Convolutional neural networks (CNNs), recurrent neural networks (RNNs), applications in perception and control.						
UNIT – V	Applications of Robotics and AI					9
AI Techniques for Robotics: Planning and decision-making, natural language processing (NLP) in human-robot interaction, AI in autonomous systems. Applications of Robotics and AI: Robotic assembly and welding, material handling and logistics, surgical robots, rehabilitation and assistive robots, domestic robots, professional service robots (cleaning, delivery), emerging applications in agriculture, space exploration, and disaster response.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:

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

E-RESOURCES:

1.	MIT OpenCourseWare – Robotics https://ocw.mit.edu Offers free lecture notes, assignments, and video lectures on robotics and AI topics from MIT courses
2.	Coursera – Robotics Specialization (by University of Pennsylvania) https://www.coursera.org/specializations/robotics A comprehensive series covering robot mechanics, mobility, perception, and planning with hands-on projects
3.	ROS Tutorials – The Robot Operating System (ROS): .ROS/Tutorials - ROS Wiki Tutorials Official tutorials and documentation for learning robot programming and control using ROS, a widely used robotics middleware

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamental concepts of robotics, artificial intelligence, robot kinematics, control systems, machine learning techniques, and industrial applications of robotics and AI.		
CO2	Apply robot kinematic and dynamic principles, sensor integration methods, robot programming techniques, and machine learning algorithms for engineering applications.	PO1	PSO2
CO3	Analyze robotic systems using motion planning, vision systems, control strategies, simulation tools, and AI-based decision-making techniques.	PO1	PSO1, PSO2
CO4	Evaluate the performance of robotic and AI systems considering control methodologies, machine learning models, sensor fusion approaches, and industrial requirements.	PO2, PO3	PSO1
CO5	Develop intelligent robotic solutions by integrating advanced AI techniques, machine learning models, robot programming, vision systems, and autonomous decision-making for real-world applications.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3			1	2
CO3	2			3	2
CO4		3	2	2	1
CO5	3	2	3	3	2
AVERAGE	2.67	2.50	2.5	2.25	1.75

Activities:					
1.	Performance Evaluation of a Robotic System Using Sensors and AI Techniques				
2.	Design and Development of an AI-Based Robotic Solution				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of robotic and AI concepts	20	Demonstrates comprehensive understanding of robotics, sensors, control, and AI concepts	Good understanding with minor gaps	Basic understanding with significant gaps
2.	Analysis of control and sensing systems	20	Thorough evaluation of control methods and sensor integration	Adequate analysis with minor errors	Limited analysis and interpretation
3.	Evaluation of AI/ML techniques	20	Critically evaluates AI models and their effectiveness	Reasonable evaluation with some justification	Basic evaluation with limited justification
4.	Performance assessment and comparison	20	Uses appropriate metrics and provides detailed assessment	Moderate assessment with acceptable metrics	Limited assessment and comparison
5.	Technical report and presentation	20	Excellent documentation, presentation, and communication skills	Good report and presentation quality	Basic report with limited clarity
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and requirement analysis	20	Clearly identifies and defines a real-world problem with well-defined objectives	Problem adequately defined	Problem definition lacks clarity
2.	Design of robotic architecture and system integration	20	Well-structured and technically sound robotic system design	Adequate design with minor shortcomings	Basic design with limited integration
3.	Application of AI/ML and vision techniques	20	Effectively integrates suitable AI/ML and vision techniques	Appropriate use with moderate effectiveness	Limited use of AI/ML techniques
4.	Innovation, feasibility and implementation strategy	20	Highly innovative, feasible, and practical solution	Reasonably innovative and feasible	Limited innovation and practicality

5.	Project report, demonstration and presentation	20	Excellent documentation, demonstration, and communication	Good documentation and presentation	Basic documentation and presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD204	DIGITAL TWIN AND INDUSTRY 5.0		SEMESTER			II
Prerequisites		Category	ES(PC)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the basics concepts in digital twin					
2.	To introduce the concepts in digital twin in a discrete Industry					
3.	To introduce the concepts in digital twin in a process Industry					
4.	To obtain the knowledge in industry 5.0					
5.	To know about the advantages in industry 5.0					
UNIT – I	INTRODUCTION					9
Digital twin – Definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin – Virtual CAD Models – control Parameters- Real time systems – control Parameters – Handshaking Through Internet – cyber physical systems						
UNIT – II	DIGITAL TWIN IN A DISCRETE INDUSTRY					9
Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection & analysis for product & production improvements, Automation simulation, Digital Enterprise						
UNIT – III	DIGITAL TWIN IN A PROCESS INDUSTRY					9
Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise						
UNIT – IV	INDUSTRY 5.0					9
Industrial Revolutions, Industry 5.0 – Definition, principles, Application of Industry 5.0 in process & discrete industries, Benefits of Industry 5.0, challenges in Industry 5.0, Smart manufacturing, Internet of Things 5.0, Industrial Gateways, Basics of Communication requirements – cognitive systems 5.0						
UNIT – V	ADVANTAGES OF DIGITAL TWIN					9
Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing the Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2018				
2.	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019				
3.	Uthayan Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press, 2022.				
4.	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress., United States, 2015.				
5.	Christoph Jan Bartodziej, "The Concept Industry 4.0 an Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017.				
6.	Ibrahim Garbie, "Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0", Springer., Switzerland, 2016.				
7.	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/127101872				
2.	https://nptel.ac.in/courses/106105195				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					
CO1	Explain the fundamentals of Digital Twin technology, Digital Thread, Industry 5.0 concepts, cyber-physical systems, and their applications in process and discrete industries.				
CO2	Apply Digital Twin tools, data acquisition methods, automation simulation techniques, and Industry 5.0 technologies for industrial applications.	PO1	PSO2		
CO3	Analyze product, production, and process data using Digital Twin frameworks to improve operational efficiency, safety, and industrial performance.	PO1	PSO1, PSO2		
CO4	Evaluate Digital Twin and Industry 5.0 implementations with respect to productivity, quality improvement, process optimization, communication systems, and smart manufacturing requirements.	PO2, PO3	PSO1		
CO5	Develop innovative Digital Twin-based solutions for intelligent manufacturing, process optimization, predictive analysis, and industrial transformation using Industry 5.0 concepts.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	2			2	3
CO3	3			2	2
CO4		2	3	3	
CO5	3	3	2	2	3
AVERAGE	2.67	2.5	2.5	2.25	2.67

Activities:					
1.	Evaluation of Digital Twin and Industry 5.0 Implementation in an Industrial System				
2.	Design of a Digital Twin-Based Smart Manufacturing Solution				
Rubrics for evaluation: C04					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Digital Twin and Industry 5.0 concepts	20	Demonstrates comprehensive understanding of Digital Twin architecture, Digital Thread, and Industry 5.0 principles	Good understanding with minor gaps	Basic understanding with significant gaps
2.	Analysis of industrial system and data flow	20	Thorough analysis of industrial processes, communication systems, and data integration	Adequate analysis with minor errors	Limited analysis and interpretation
3.	Evaluation of productivity, quality and efficiency improvement	20	Provides comprehensive evaluation using relevant performance indicators	Reasonable evaluation with adequate justification	Limited evaluation and supporting evidence
4.	Assessment of Industry 5.0 implementation and feasibility	20	Critically evaluates sustainability, resilience, human-centricity, and feasibility aspects	Moderate assessment with acceptable justification	Basic assessment with limited justification
5.	Technical report and presentation	20	Excellent documentation, presentation, and communication skills	Good report and presentation quality	Basic report with limited clarity
	Total	100			
Rubrics for evaluation: C05					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and requirement analysis	20	Clearly defines industrial problem and objectives with strong justification	Problem adequately defined	Problem definition lacks clarity
2.	Design of Digital Twin architecture	20	Well-structured and technically sound Digital Twin framework	Adequate design with minor shortcomings	Basic framework with limited integration

3.	Integration of Industry 5.0 technologies	20	Effectively integrates IoT, CPS, predictive analytics, AI, and smart manufacturing concepts	Appropriate integration with moderate effectiveness	Limited integration of technologies
4.	Innovation, feasibility and optimization strategy	20	Highly innovative, feasible, and practically implementable solution	Reasonably innovative and feasible	Limited innovation and practicality
5.	Project report, demonstration and presentation	20	Excellent documentation, visualization, and communication	Good documentation and presentation	Basic documentation and presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD205	FINITE ELEMENT ANALYSIS LABORATORY		SEMESTER		II	
Prerequisites		Category	ES(PC)	Credits		2
		Hours/ Semester	L	T	P	TH
			0	0	60	60
COURSE OBJECTIVES						
1.	To impart knowledge of Finite Element method using Analysis Software					
2.	To solve simple static structural analysis and calculating stresses					
3.	To know the Steady-state Thermal Analysis of different shapes					
4.	To understand the Transient state of Thermal Analysis					
5.	To recognize the CFD/ Coupled field analysis.					
LIST OF EXPERIMENTS						
FE Analysis using ANSYS Package for different structures that can be discretized with 1-D, 2-D & 3-D elements to perform the following analysis:						
1.	Force and Stress analysis using link elements in Trusses, cables etc.					
2.	Stress and deflection analysis in beams with different support conditions.					
3.	Stress analysis of flat plates and simple shells.					
4.	Stress analysis of axisymmetric components.					
5.	Analysis of bracket using ANSYS.					
6.	Buckling analysis of linear materials using ANSYS					
7.	Vibration analysis of spring-mass systems.					
8.	Modal analysis of Beams.					
9.	Thermal stress and heat transfer analysis of plates.					
10.	Thermal stress analysis of cylindrical shells					
11.	Thermal analysis of temperature distribution in a 2-D fin cooled electronic components.					
12.	Temperature distribution in a 3-D fin cooled electronic component.					
13.	Heat flux analysis of a composite slab.					
14.	Heat flux analysis of a cylindrical rod.					
15.	CFD Analysis of a circular tube.					
16.	Coupled structural / Thermal analysis.					
Total=60 Periods						
Weightage:						
Continuous Assessment 60%						
End Semester Examinations 40%						

REFERENCE BOOKS:					
1.	Saeed Moaveni, Finite Element Analysis: Theory and Application with ANSYS, 4th Edition, Pearson, 2015.				
2.	O. C. Zienkiewicz, R. L. Taylor and J. Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, 7th Edition, Butterworth-Heinemann, 2013.				
3.	H. K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition, Pearson, 2007.				
4.	J. P. Holman, Heat Transfer, 10th Edition, McGraw-Hill, 2010.				
5.	Daryl L. Logan, A First Course in the Finite Element Method, 6th Edition, Cengage Learning, 2017.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112104116				
2.	https://nptel.ac.in/courses/112104116				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					
		Mapping POs	Mapping PSOs		
CO1	Explain the fundamentals of finite element modeling, meshing techniques, boundary conditions, and analysis procedures using ANSYS.				
CO2	Apply finite element techniques to perform structural, thermal, vibration, and buckling analyses of engineering components.	PO1	PSO2		
CO3	Analyze stress distribution, deformation, temperature fields, heat flux, and dynamic behavior of engineering systems using ANSYS.	PO1	PSO1, PSO2		
CO4	Evaluate simulation results and validate engineering designs through structural, thermal, vibration, and CFD analyses.	PO2, PO3	PSO1		
CO5	Develop finite element models and integrated multiphysics solutions for real-world engineering applications using ANSYS tools.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				3
CO3	3			2	2
CO4		3	3	2	
CO5	3	3	3	3	2
AVERAGE	3.0	3.0	3.0	2.33	2.33
Activities:					
1.	Validation and Evaluation of FEA Results				
2.	Integrated Multi physics Analysis using ANSYS				

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Model development and meshing	20	Accurate geometry creation and appropriate mesh selection	Minor errors in modeling/meshing	Basic model with significant errors
2.	Application of boundary conditions	20	Correct and realistic application of loads and constraints	Minor inaccuracies	Incomplete or incorrect application
3.	Analysis and interpretation of results	20	Comprehensive interpretation of simulation outputs	Moderate interpretation	Limited interpretation
4.	Analysis and interpretation of results	20	Excellent comparison with theory and error analysis	Adequate validation	Limited validation
5.	Technical report and presentation	20	Professional report and excellent presentation	Good documentation	Basic documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem formulation and model development	20	Well-defined engineering problem and robust FE model	Adequate model development	Basic model with limitations
2.	Application of multiphysics / coupled analysis	20	Correct and effective implementation of coupled-field analysis	Minor implementation issues	Limited implementation
3.	Engineering analysis and optimization	20	Comprehensive analysis with design improvements	Moderate analysis	Basic analysis
4.	Innovation and practical applicability	20	Highly practical and innovative engineering solution	Reasonably practical solution	Limited practical relevance
5.	Report, documentation and presentation	20	Excellent documentation and communication	Good documentation	Basic documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Evaluation of Student Work, Observation of Record and Model Test	Activities		
CO1	10	10	10	2
CO2	10	10	10	2
CO3	20	20	20	2
CO4	30	30	30	2
CO5	30	30	30	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD206	CAM & ROBOTICS LABORATORY		SEMESTER			II
Prerequisites		Category	ES(PC)	Credits		2
		Hours/ Semester	L	T	P	TH
			0	0	60	60
COURSE OBJECTIVES						
1.	To understand Features and Selection of CNC machines.					
2.	To learn CNC programming for a variety of products using APT language.					
3.	To impart CNC part programming skills for turning and milling applications.					
4.	To give a good exposure of CAM software in order to perform Simulation and to generate CL data.					
5.	To learn robot programming and simulation of machining processes.					
LIST OF EXPERIMENTS						
MODULE I	LIST OF CNC EXPERIMENTS					
Features and selection of CNC Turning and Milling centers						
Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles mentioned below:						
CNC Turning						
1.	CNC machine setup and tool offset.					
2.	Facing, straight turning and step turning.					
3.	Taper and contour turning.					
4.	Grooving, threading and parting operations.					
5.	Drilling, boring and canned cycles.					
6.	Subprogram and macro programming.					
7.	CAM-based toolpath generation, simulation and NC code verification.					
CNC Milling						
1.	Linear & circular interpolation					
2.	Profile, slot and contour milling.					
3.	Rectangular and circular pocket milling.					
4.	Drilling, tapping and boring cycles.					
5.	Pattern machining (mirroring, rotation and scaling).					
6.	CAM toolpath generation, simulation and post-processing.					
MODULE II	LIST OF ROBOTICS EXPERIMENTS					
Practice in Robot programming and its languages						
1.	Introduction to online programming.					
2.	Motion control					
3.	Pick & Place					
4.	Interface with external equipment					
Total=60 Periods						

Weightage:

Continuous Assessment 60%

End Semester Examinations 40%

REFERENCE BOOKS:

1.	Peter Smid, CNC Programming Handbook, 3rd Edition, Industrial Press, 2008.
2.	Mike Lynch, CNC Programming: Principles and Applications, 3rd Edition, McGraw-Hill, 2015.
3.	M. P. Groover, Computer Numerical Control: Machining and Programming, 1st Edition, Prentice Hall, 2008.
4.	Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson, 2015.
5.	Mikell P. Groover et al., Industrial Robotics: Technology, Programming, and Applications, 2nd Edition, McGraw-Hill, 1986.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112108093
2.	https://nptel.ac.in/courses/112102101

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the features, functions, and operating principles of CNC machines, CAM systems, and industrial robots.		
CO2	Apply CNC programming techniques, machining cycles, and robot programming methods for manufacturing and automation applications.	PO1	PSO2
CO3	Analyze machining operations, tool paths, CAM simulations, and robotic motion control for industrial tasks.	PO1	PSO1, PSO2
CO4	Evaluate CNC machining performance, CAM-generated tool paths, robotic programs, and automation strategies for manufacturing applications.	PO2, PO3	PSO1
CO5	Develop CNC programs, CAM simulations, and robotic automation solutions for real-world manufacturing problems.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				3
CO3	3			2	2
CO4		3	3	2	
CO5	3	3	3	3	2
AVERAGE	3.0	3.0	3.0	2.33	2.33

Activities:

1.	CNC Machining and CAM Simulation Evaluation
2.	Robot Programming and Automation Project

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	CNC program development	20	Accurate and optimized CNC program with no errors	Minor programming errors	Basic program with significant errors
2.	CAM model and tool path generation	20	Appropriate tool selection and optimized tool paths	Adequate tool path generation	Limited optimization and errors
3.	Simulation and machining analysis	20	Comprehensive simulation and performance evaluation	Moderate analysis	Basic analysis only
4.	Machining efficiency and optimization	20	Excellent evaluation of cycle time, quality, and productivity	Adequate evaluation	Limited evaluation
5.	Technical report and presentation	20	Professional documentation and presentation	Good documentation	Basic documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem definition and work-cell design	20	Well-defined automation problem and efficient layout	Adequate design	Basic design with limitations
2.	Robot programming and motion planning	20	Accurate and optimized robot program	Minor programming issues	Basic programming with errors
3.	Simulation and task execution	20	Successful implementation and validation	Moderate implementation	Limited execution
4.	Innovation and industrial applicability	20	Highly innovative and industrially relevant solution	Reasonably practical solution	Limited practical relevance
5.	Demonstration, report and presentation	20	Excellent communication and documentation	Good documentation	Basic documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Evaluation of Student Work, Observation of Record and Model Test	Activities		
C01	10	10	10	2
C02	10	10	10	2
C03	20	20	20	2
C04	30	30	30	2
C05	30	30	30	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD301	DISSERTATION PHASE - I		SEMESTER			III
Prerequisites		Category	SD	Credits		8
		Hours/ Semester	L	T	P	TH
			0	0	240	240
COURSE OBJECTIVES						
1.	To develop the ability to solve a specific problem right from its identification and literature review until the successful solution of the same.					
2.	To train the students in preparing project reports and to face reviews and viva voce examination.					
CONTENTS						
1.	Each student shall undertake an individual technical project on a topic approved by the Head of the Division under the guidance of a faculty member with expertise in the selected domain. The selected topic shall be relevant to the field of Computer Aided Design and may involve theoretical investigations, analytical studies, simulation-based research, or engineering case studies.					
2.	The student shall formulate a well-defined engineering problem with clearly stated objectives, scope, and expected outcomes. A comprehensive literature review shall be conducted to analyze existing research, identify knowledge gaps, and establish the technical background for the proposed work.					
3.	An appropriate research methodology shall be developed, including problem formulation, design approach, analytical methods, computational tools, simulation techniques, or experimental procedures, as applicable. The work shall demonstrate the application of engineering principles, design methodologies, analytical reasoning, and technical problem-solving skills.					
4.	The student shall present and defend the work through a technical seminar and viva-voce examination before a panel of examiners, including one external examiner, to assess technical competence, analytical ability, presentation skills, and understanding of the chosen topic. The evaluation shall be based on the quality of problem identification, literature survey, and technical methodology, originality of work, report quality, presentation, and viva-voce performance.					
5.	The candidate has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.					
Total= 240 Periods						
Weightage: Continuous Assessment 60% End Semester Examinations 40%						

REFERENCE BOOKS:	
1.	C. R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition, New Age International, 2019.
2.	Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 5th Edition, SAGE Publications, 2019.
3.	George E. Dieter and Linda C. Schmidt, Engineering Design, 5th Edition, McGraw-Hill, 2013.
4.	Blessing and Chakrabarti, DRM: A Design Research Methodology, 1st Edition, Springer, 2009.
5.	Clive L. Dym, Patrick Little, Elizabeth J. Orwin and R. E. Spjut, Engineering Design: A Project-Based Introduction, 4th Edition, Wiley, 2014

E-RESOURCES:

1.	https://nptel.ac.in/courses/110105091
2.	https://nptel.ac.in/courses/121106007

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the research problem, background, objectives, and relevant engineering concepts through comprehensive literature review.		
CO2	Apply research methodologies, analytical tools, and engineering principles for problem formulation and investigation.	PO1	PSO2
CO3	Analyze existing literature, identify research gaps, and formulate appropriate approaches to solve engineering problems.	PO1	PSO1, PSO2
CO4	Evaluate alternative methodologies, technical feasibility, and preliminary results for addressing the identified research problem.	PO2, PO3	PSO1
CO5	Develop a structured dissertation proposal including problem statement, objectives, methodology, work plan, and preliminary findings.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				3
CO3	3			2	2
CO4		3	3	3	
CO5	3	3	3	3	2
AVERAGE	3.0	3.0	3.0	2.67	2.33

Activities:

1.	Research Gap Identification and Literature Survey
2.	Dissertation Proposal Development

Rubrics for evaluation: 1

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and relevance	20	Clearly defined, novel, and significant research problem	Relevant problem with minor limitations	Basic problem formulation
2.	Literature survey quality	20	Extensive review of high-quality journals and recent literature	Adequate literature review	Limited literature survey
3.	Research gap identification	20	Clearly identifies research gaps and opportunities	Reasonable gap identification	Limited gap analysis
4.	Technical understanding	20	Excellent understanding of the domain and concepts	Good understanding	Basic understanding
5.	Review presentation and communication	20	Excellent presentation and discussion skills	Good communication	Limited communication
	Total	100			

Rubrics for evaluation: 2

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Research objectives and scope	20	Well-defined and achievable objectives	Adequately defined objectives	Objectives lack clarity
2.	Methodology selection	20	Appropriate and technically sound methodology	Adequate methodology	Limited methodology justification
3.	Feasibility and resource planning	20	Comprehensive feasibility assessment	Moderate feasibility study	Basic planning
4.	Preliminary investigation/results	20	Meaningful preliminary work and analysis	Partial investigation completed	Minimal progress
5.	Review presentation and technical discussion	20	Excellent presentation and response to queries	Good presentation	Limited discussion
	Total	100			

Rubrics for evaluation: 3

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Dissertation proposal quality	20	Comprehensive and professionally prepared proposal	Good proposal structure	Basic proposal

2.	Technical progress achieved	20	Significant progress with validated outcomes	Moderate progress	Limited progress
3.	Analysis and interpretation	20	Strong analytical approach and interpretation	Adequate analysis	Basic analysis
4.	Work plan and future scope	20	Realistic and well-defined execution plan	Adequate planning	Limited planning
5.	Presentation, report and viva voce	20	Excellent communication and defense of work	Good presentation	Basic presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component			Percentage allocation	Mapping Strength
	Review 1	Review 2	Review 3		
CO1	40			10	2
CO2	30	10		20	2
CO3	20	30		20	2
CO4	10	40	20	25	3
CO5		20	80	25	3
Total	100	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CD401	DISSERTATION PHASE - II			SEMESTER		IV	
Prerequisites			Category	SD	Credits		14
			Hours/ Semester	L	T	P	TH
				0	0	420	420
COURSE OBJECTIVES							
1.	To develop the ability to solve a specific problem right from its identification and literature review until the successful solution of the same.						
2.	To train the students in preparing project reports and to face reviews and viva voce examination						
CONTENTS							
1.	Each student shall undertake an individual technical project on a topic approved by the Head of the Division under the guidance of a faculty member with expertise in the selected domain. The selected topic shall be relevant to the field of Computer Aided Design and may involve theoretical investigations, analytical studies, simulation-based research, or engineering case studies.						
2.	The student shall formulate a well-defined engineering problem with clearly stated objectives, scope, and expected outcomes. A comprehensive literature review shall be conducted to analyze existing research, identify knowledge gaps, and establish the technical background for the proposed work.						
3.	An appropriate research methodology shall be developed, including problem formulation, design approach, analytical methods, computational tools, simulation techniques, or experimental procedures, as applicable. The work shall demonstrate the application of engineering principles, design methodologies, analytical reasoning, and technical problem-solving skills.						
4.	The student shall present and defend the work through a technical seminar and viva-voce examination before a panel of examiners, including one external examiner, to assess technical competence, analytical ability, presentation skills, and understanding of the chosen topic. The evaluation shall be based on the quality of problem identification, literature survey, and technical methodology, originality of work, report quality, presentation, and viva-voce performance.						
5.	The candidate has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.						
Total=420 Periods							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
REFERENCE BOOKS:							
1.	C. R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition, New Age International, 2019.						
2.	Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 5th Edition, SAGE Publications, 2019.						
3.	George E. Dieter and Linda C. Schmidt, Engineering Design, 5th Edition, McGraw-Hill, 2013.						
4.	Lucienne T. M. Blessing and Amaresh Chakrabarti, DRM: A Design Research Methodology, 1st Edition, Springer, 2009.						
5.	Clive L. Dym, Patrick Little, Elizabeth J. Orwin and R. E. Spjut, Engineering Design: A Project-Based Introduction, 4th Edition, Wiley, 2014						

E-RESOURCES:					
1.	https://nptel.ac.in/courses/110105091				
2.	https://nptel.ac.in/courses/121106007				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Explain the research problem, methodology, experimental procedures, and technical concepts related to the dissertation work				
CO2	Apply advanced engineering principles, computational tools, experimental techniques, and research methodologies to solve the identified problem.			PO1	PSO2
CO3	Analyze experimental, simulation, or analytical results and interpret findings to validate the proposed research objectives.			PO1	PSO1, PSO2
CO4	Evaluate the effectiveness, feasibility, and significance of the developed solution through validation, comparison, and performance assessment.			PO2, PO3	PSO1
CO5	Develop and successfully demonstrate an innovative engineering solution, dissertation report, technical publication, and research presentation.			PO1, PO2, PO3	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				3
CO3	3			2	2
CO4		3	3	3	
CO5	3	3	3	3	2
AVERAGE	3.0	3.0	3.0	2.67	2.33
Activities:					
1.	Research Paper Preparation and Publication Review				
2.	Prototype / Simulation Demonstration and Thesis Preparation				
Rubrics for evaluation: 1					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Progress against proposed objectives	20	Significant progress achieved as per plan	Moderate progress	Limited progress
2.	Methodology implementation	20	Effective implementation with technical rigor	Adequate implementation	Partial implementation
3.	Technical competence	20	Strong understanding and execution capability	Good understanding	Basic understanding

4.	Documentation of work	20	Well-maintained records and technical documentation	Adequate documentation	Limited documentation
5.	Review presentation and discussion	20	Excellent presentation and response to queries	Good presentation	Basic presentation
	Total	100			

Rubrics for evaluation: 2

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Experimental / Simulation results	20	Comprehensive and reliable results obtained	Adequate results	Limited results
2.	Analysis and interpretation	20	Strong analytical interpretation and insight	Moderate analysis	Basic analysis
3.	Validation and comparison	20	Thorough validation with literature/theory/exp experiments	Adequate validation	Limited validation
4.	Novelty and technical contribution	20	Significant research contribution and originality	Moderate contribution	Limited novelty
5.	Review presentation and technical defense	20	Excellent technical defense and communication	Good communication	Basic communication
	Total	100			

Rubrics for evaluation: 3

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Achievement of objectives and outcomes	20	All objectives successfully achieved and validated	Most objectives achieved	Partial achievement
2.	Quality of dissertation report	20	Professional, publication-quality dissertation	Good report quality	Basic report quality
3.	Innovation and engineering contribution	20	Significant contribution with strong originality	Moderate contribution	Limited contribution
4.	Results, conclusions and future scope	20	Comprehensive conclusions and meaningful future work	Adequate conclusions	Limited conclusions

5.	Final presentation and viva voice	20	Excellent presentation, confidence, and technical defense	Good presentation	Basic presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component			Percentage allocation	Mapping Strength
	Review 1	Review 2	Review 3		
CO1	40			10	2
CO2	30	20		20	2
CO3	20	40	20	20	2
CO4	10	30	60	25	3
CO5		10	20	25	3
Total	100	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE01	ADVANCED KINEMATICS OF MECHANISMS		SEMESTER		II	
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To analyze the motion of mechanisms, the design of mechanisms to produce motion and the forces in machines.					
2.	To become familiar with a variety of complex mechanisms involving motion in complex curvature.					
3.	To synthesize four-bar and slider crank mechanisms.					
4.	To analyze the spatial mechanism related to motion of robots.					
5.	To study the coupler curve theory.					
UNIT - I		INTRODUCTION				9
Basic Concepts - Definitions and assumptions - planar and spatial mechanisms - kinematic pairs - Degree of freedom - equivalent mechanisms - Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanism - analysis of complex mechanisms by the normal acceleration and auxiliary-point methods.						
UNIT - II		CURVATURE THEORY				9
Fixed and moving centrodes - inflection circle - Euler-Savary equation - Bobillier constructions, cubic of stationary curvature - Ball's point - Applications in dwell mechanisms.						
UNIT - III		SYNTHESIS OF MECHANISMS				9
Number synthesis-degrees of freedom of planar kinematic chains, dimensional synthesis graphical methods -pole and relative pole of four bar and slider crank mechanism - design of slider crank and four bar mechanism, analytical method Chebyshev's spacing of accurate points - function generation by mechanism - Freudenstein equation for four bar slider crank chain for three accuracy points, mechanism for position guidance - body guidance - Bloch's method - cognate linkages.						
UNIT - IV		SPATIAL MECHANISMS AND KINEMATICS OF ROBOT				9
Introduction – Mobility - Position analysis - Velocity analysis - Acceleration analysis - Eulerian angles – Denavit - Hartenberg parameters – Kinematic analysis of spatial RSSR mechanism- Forward and inverse kinematics of robotic manipulators - Study and use of Mechanism using simulation software packages.						
UNIT - V		COUPLER CURVES				9
Four bar linkage - Equation of coupler curve - double points and symmetry - Robert-Chebyshev theorem - straight line mechanism - approximate and exact.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	R.L. Norton , "Design of Machinery", Tata McGraw Hill, 2004				
2.	J. J.Uicker, G. R. Pennock & J.E.Shigley, "Theory of Machines and Mechanisms", Oxford University Press, New York, 2003				
3.	R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, New York, 1980.				
4.	J. Kenneth, Waldron, L.Gary & Kinzel, "Kinematics, Dynamics and Design of machinery", John Wiley& Sons, 2003.				
5.	J.S. Rao, "The Theory of Machines Through Solved Problems", New Age International Publishers, 2006				
6.	N.G. Sandor& G.A. Erdman, "Advanced Mechanism Design", Volume-I, Prentice Hall India Pvt. Ltd, 2001				
7.	Michael J.Rider, "Design and analysis of Mechanism", John Wiley & Sons,2015				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112105268				
2.	https://onlinecourses-archive.nptel.ac.in				
3.	https://nptel.ac.in/courses/112105236				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					
		Mapping POs	Mapping PSOs		
CO1	Explain the fundamental concepts of planar and spatial mechanisms, kinematic pairs, degree of freedom, curvature theory, and robotic kinematics.				
CO2	Analyze the velocity, acceleration, centrode motion, and curvature characteristics of planar and spatial mechanisms using graphical and analytical methods.	PO3	PSO2		
CO3	Apply synthesis techniques and kinematic principles to design four-bar, slider-crank, and position-guiding mechanisms for specified motion requirements.	PO1, PO3	PSO1, PSO2		
CO4	Evaluate the performance of planar, spatial, and robotic mechanisms through kinematic analysis, curvature theory, and simulation-based studies.	PO1	PSO1, PSO2		
CO5	Design and develop innovative mechanisms and robotic systems for function generation, motion guidance, and industrial applications using advanced synthesis methods and simulation tools.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3	3		2	3	2
CO4	3			2	3
CO5	3	2	3	3	2
AVERAGE	2.25	2	2.67	2.67	2.5

Activities:

1.	To evaluate the kinematic performance of planar, spatial, or robotic mechanisms using analytical and simulation techniques.
2.	Design and Synthesis of a Mechanism or Robotic System for a Specific Motion Requirement

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of kinematic principles and mechanism behavior	20	Comprehensive understanding with accurate analysis	Adequate understanding	Limited understanding
2.	Analytical kinematic calculations	20	Accurate and complete calculations	Minor errors	Significant errors
3.	Simulation modeling and validation	20	Excellent simulation with proper validation	Adequate validation	Limited validation
4.	Performance evaluation and interpretation	20	Detailed engineering assessment	Moderate assessment	Basic assessment
5.	Report and presentation	20	Professional and technically sound	Adequate documentation	Poor documentation
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Design problem formulation and innovation	20	Highly innovative and well-defined design problem	Moderately innovative	Basic design concept
2.	Application of synthesis techniques	20	Excellent use of advanced synthesis methods	Adequate application	Limited application
3.	Mechanism/robot design and modeling	20	Technically sound and optimized design	Acceptable design	Incomplete design
4.	Simulation, validation and performance analysis	20	Comprehensive validation and analysis	Moderate validation	Limited validation
5.	Technical report and presentation	20	Professional communication and documentation	Adequate presentation	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note:Purely as anExample: Strength = 3 (if percentage >20%);

Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE02	ADVANCED COMPOSITE MATERIALS		SEMESTER		II	
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand composite material, reinforcements, and their selection.					
2.	To develop and processing of metal - matrix, ceramic - matrix and carbon- carbon Composites.					
3.	To understand engineering mechanics, analysis and design, micro mechanics and fabrication techniques of composites.					
4.	To understand and analyze the properties and performance of composite.					
5.	To understand the basics of nano-composite materials.					
UNIT - I	INTRODUCTION					9
Definition and Classification of Composites, MMC, PMC, CMC. Reinforcing fibres- Natural fibres (cellulose, jute, coir etc), boron, carbon, ceramic glass, aramids etc. Particulate fillers-importance of particle shape and size. Matrix resins-thermoplastics and thermosetting matrix resins. Coupling agents-surface treatment of fillers and fibres, significance of interface in composites. Short and continuous fibre reinforced composites, critical fibre length, and anisotropic behaviour.						
UNIT - II	PROPERTIES AND PERFORMANCE					9
Properties and microstructure of high-strength fiber materials (glass, carbon, polymer, ceramic fibers) and matrix materials (polymer, metal, ceramic, and carbon matrices). Specific strength and stiffness of high-performance composites. Rule of mixtures. Stress, strain transformations.						
UNIT - III	MECHANICS AND MANUFACTURING					9
Engineering mechanics- analysis and design- concepts of Isotropy vs. Anisotropy, composite micromechanics (effective stiffness/strength predictions, load-transfer mechanisms), Classical Lamination Plate Theory (CLPT). Fabrication techniques - pultrusion, filament winding, prepreg technology, injection and compression moulding, bag moulding, resin transfer moulding, reaction injection moulding.						
UNIT - IV	FAILURE CRITERIA AND APPLICATIONS					9
Hydrothermal stresses, bending of composite plates, analysis of sandwich plates, buckling analysis of laminated composite plates, inter-laminar stresses, First Order Shear Deformation Theory (FSDT). Applications: Industrial, aerospace, automobile, house hold etc.						
UNIT - V	NANO COMPOSITIES					9
Introduction - Types of Nano-composites (i.e., metal oxide, ceramic, glass and polymer based) - Core-Shell structured nanocomposites - Super hard nano-composite - Synthesis and applications.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Mallick P.K., "Fiber-Reinforced Composites: Materials - Manufacturing and Design", Maneel Dekker Inc, 1993.				
2.	Krishan K. Chawla, Composite Materials, Science and Engineering, Springer, 2001.				
3.	Steven L.Donaldson, ASM Handbook Composites Volume 21, 2001.				
4.	Nanocomposite Science and Technology – P.M. Ajayan, L.S. Schadler, P.V. Braun, Wiley, New York, 2003.				
5.	Suresh G. Advani, E. Murat Sozer, Process Modelling in Composites Manufacturing, 2nd Ed. CRC Press, 2009.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112104249				
2.	https://www.coursera.org/learn/ceramics-and-composites				
3.	https://nptel.ac.in/courses/101104010				
4.	https://nptel.ac.in/courses/112107217				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Explain the classification, constituents, reinforcement mechanisms, interface characteristics, and anisotropic behavior of composite and nanocomposite materials.				
CO2	Analyze the properties, microstructure, stress-strain behavior, and performance characteristics of fiber-reinforced composite materials using the rule of mixtures and transformation relations.			PO3	PSO2
CO3	Apply composite mechanics, lamination theories, and manufacturing techniques for the design and fabrication of composite structures and components.			PO1, PO3	PSO1, PSO2
CO4	Evaluate the structural behavior, failure mechanisms, buckling characteristics, and service performance of laminated and sandwich composite structures under different loading conditions.			PO1	PSO1, PSO2
CO5	Design and develop advanced composite and nanocomposite systems for engineering applications by integrating material selection, processing methods, and performance requirements.			PO1, PO2, PO3	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3	3		2	3	2
CO4	3			2	3
CO5	3	2	3	3	2
AVERAGE	2.25	2	2.67	2.67	2.5

Activities:

1.	To evaluate the behavior, failure mechanisms, and performance of composite structures under different loading conditions.
2.	To design an engineering component using advanced composite or nanocomposite materials based on performance requirements.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of composite structural behavior	20	Comprehensive understanding with accurate interpretation	Adequate understanding	Limited understanding
2.	Analysis of stresses, buckling, and failure mechanisms	20	Detailed and technically accurate analysis	Moderate analysis	Basic analysis
3.	Performance evaluation and comparison	20	Thorough evaluation with strong engineering justification	Reasonable evaluation	Limited evaluation
4.	Interpretation of results and conclusions	20	Insightful conclusions supported by analysis	Acceptable conclusions	Weak conclusions
5.	Report and presentation	20	Professional, organized, and technically sound	Adequate documentation	Poor documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Product design concept and innovation	20	Highly innovative and technically feasible design	Moderately innovative	Basic design concept
2.	Material and process selection	20	Excellent selection with strong engineering justification	Appropriate selection	Weak selection
3.	Design methodology and performance evaluation	20	Comprehensive and technically sound methodology	Adequate methodology	Incomplete methodology
4.	Application of composite/nanocomposite principles	20	Effective integration of composite design concepts	Moderate application	Limited application

5.	Technical report and presentation	20	Professional communication and documentation	Adequate presentation	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE03	PRODUCT LIFECYCLE MANAGEMENT		SEMESTER			II
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand history, concepts, and terminology of PLM.					
2.	To learn functions and features of PLM/PDM.					
3.	To study different modules offered in commercial PLM/PDM tools.					
4.	To learn PLM/PDM implementation approaches.					
5.	To study integration of PLM/PDM with other applications.					
UNIT - I	HISTORY, CONCEPTS AND TERMINOLOGY OF PLM					9
Introduction to PLM, Need for PLM, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement, Threads of PLM- Computer aided design (CAD), Engineering Data Management (EDM), Product data management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.						
UNIT - II	PRODUCT LIFE CYCLE ENVIRONMENT					9
Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Developing a PLM strategy, Strategy identification and selection, PLM System Architecture (2tier/3tier/4tier etc). Concept of cloud PLM.						
UNIT - III	ROLE OF PLM IN INDUSTRIES					9
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance						
UNIT - IV	PRODUCT DATA MANAGEMENT (PDM)					9
Product Data Management (PDM) Concepts, Benefits and Terminology, reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.						
UNIT - V	CUSTOMISATION / INTEGRATION OF PDM/PLM SOFTWARE					9
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP, Case study examples based on top few commercial PLM/PDM tools.						
L:45, Total:45Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Antti Saaksvuori and Ansel miImmonen, "Product Lifecycle Management", Springer Publisher (3 rd Edition), 2008.				
2.	Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.				
3.	John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.				
4.	John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realization", Springer Publisher (2 nd Edition), 2011.				
5.	Michael Grieves (2006), "Product Life Cycle Management", Tata McGraw Hill, 2006.				
6.	International Journal of Product Lifecycle Management, Inderscience Publishers.				
7.	Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", Taylor & Francis, 2006.				
E-RESOURCES:					
1.	https://www.sw.siemens.com/en-US/teamcenter/				
2.	https://www.ptc.com/en/products/windchill				
3.	https://www.coursera.org/learn/what-is-product-lifecycle-management				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Explain the concepts, terminology, infrastructure, architecture, and lifecycle aspects of Product Lifecycle Management (PLM) and Product Data Management (PDM) systems.				
CO2	Analyze product data, workflow management, PLM strategies, system architectures, and cloud-based PLM environments for effective product development.			PO3	PSO2
CO3	Apply PLM and PDM methodologies, implementation strategies, and change management practices to support industrial product development processes.			PO1, PO3	PSO1, PSO2
CO4	Evaluate the feasibility, benefits, barriers, and organizational impact of PLM/PDM implementation in various industrial sectors through case studies.			PO1	PSO2
CO5	Design and integrate customized PLM/PDM solutions with enterprise systems such as CAD, ERP, and legacy databases to enhance product lifecycle management.			PO1, PO2,	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3	3		2	3	2
CO4	3				3
CO5	3	2	3	3	2
AVERAGE	3	2	2.67	3	2.5

Activities:					
1.	To evaluate the feasibility, benefits, challenges, and organizational impact of PLM/PDM implementation in industrial sectors.				
2.	To design an integrated PLM/PDM solution that supports product development and enterprise-wide information management.				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of PLM/PDM concepts and implementation strategy	20	Comprehensive understanding with detailed analysis	Adequate understanding	Limited understanding
2.	Evaluation of benefits, barriers, and feasibility	20	Thorough and evidence-based evaluation	Moderate evaluation	Basic evaluation
3.	Organizational and business impact assessment	20	Insightful analysis with strong justification	Reasonable analysis	Limited assessment
4.	Recommendations and improvement strategies	20	Practical and innovative recommendations	Acceptable recommendations	Minimal recommendations
5.	Report and presentation	20	Professional and well-organized	Adequate documentation	Poor documentation
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	PLM/PDM architecture design	20	Comprehensive and technically sound architecture	Adequate architecture	Incomplete architecture
2.	Integration of CAD, ERP, databases, and workflows	20	Excellent integration strategy with strong justification	Moderate integration	Limited integration
3.	Data management and workflow design	20	Efficient and well-defined workflow management	Adequate workflow design	Weak workflow design
4.	Customization and implementation planning	20	Detailed and practical implementation roadmap	Reasonable planning	Limited planning

5.	Technical report and presentation	20	Professional communication and documentation	Adequate presentation	Poor presentation	
	Total	100				
The Internal Assessment Matrix (IAM) for the defined COs:						
	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	
Note:Purely as anExample: Strength = 3 (if percentage >20%); Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);						

26CDE04	ADVANCED ENGINEERING MATERIALS			SEMESTER		II	
Prerequisites			Category	ES(PE)	Credits	3	
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To identify fundamental issues and establish directions for investigation of materials.						
2.	To familiarize various types of characterization tools used in material study.						
3.	To understand structure-properties properties relationships.						
4.	To impart knowledge about the fundamentals of micro/Nano, smart materials, devices and electronics, in particular those related to the development of smart s						
5.	To increase the skills, knowledge and motivation in the design, analysis and manufacturing of smart structures and products.						
UNIT - I		INTRODUCTION					9
Introduction- advanced metallic materials - ceramic materials and polymeric materials - processing of materials - interaction between materials characteristics – applications - effects of processing on their subsequent structure and properties- design for use.							
UNIT - II		CHARACTERIZATION OF MATERIALS					9
Particle / material interactions & wave / material interactions - experimental process- crystallography- defects- reciprocal space & diffraction. Instrumentation- vacuum systems- electron sources and detectors etc., with the techniques of SEM- TEM- XRD- XRF and XPS. Surface analysis techniques and ion beam techniques - Aspects of sample preparation.							
UNIT - III		HIGH STRENGTH, LOW AND TEMPERATURE MATERIALS					9
Methods of strengthening of alloys - Materials available for high strength applications - Properties required for high strength materials - Applications of high strength materials. Properties required for low and high temperature applications - Requirements of materials and materials availability for low and high Temperature applications.							
UNIT - IV		SMART MATERIALS					9
Overview of Smart Materials - Physical Properties - Piezoelectric Materials - Electro-restrictive Materials – Magneto-restrictive Materials –Magneto-electric Materials –Magneto-rheological Fluids – Electro-rheological Fluids- Shape Memory Materials - Sensor Arrays - Smart Actuators.							
UNIT - V		NANOMATERIALS					9
Definition - Types of nanomaterials, nanocomposites – Synthesis methods of nano materials - Physical and mechanical properties - Applications of nanomaterials.							
L:45, Total:45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:

1.	D. R. Askeland and P. P. Phule, "The Science and Engineering of Materials", Thomson Publication, 2015.
2.	Gregory Tirp, "Nano Technology", Springer Publication 2012.
3.	Van Vlack, "Elements Of Material Science And Engineering", Pearson Education India 1989.
4.	A.V. Srinivasan, "Smart Structures Analysis and Design", Cambridge University Press, Cambridge, 2001.
5.	V.D. Kodgire, "Material science and Metallurgy", Everest Publishing House 2002.

E-RESOURCES:

1.	https://nptel.ac.in/courses/115103030
2.	https://nptel.ac.in/courses/112104251
3.	https://nptel.ac.in/courses/113107081

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the classification, processing, structure-property relationships, and applications of advanced metallic, ceramic, polymeric, smart, and nanomaterials.		
CO2	Analyze material characteristics using crystallography, diffraction principles, and advanced characterization techniques such as SEM, TEM, XRD, XRF, and XPS.	PO3	PSO2
CO3	Apply material selection principles and characterization data to evaluate high-strength, low-temperature, and high-temperature materials for engineering applications.	PO1, PO3	PSO1, PSO2
CO4	Evaluate the performance of advanced materials, smart materials, and nanomaterials based on their physical, mechanical, and functional properties for specific engineering requirements.	PO1	PSO1, PSO2
CO5	Design innovative engineering solutions through the selection, development, and integration of advanced, smart, and nanomaterials for industrial applications.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3	3		2	3	2
CO4	3			2	3
CO5	3	2	3	3	2
AVERAGE	3	2	2.67	2.67	2.5

Activities:

1.	To evaluate the suitability of advanced materials for specific engineering applications based on their physical, mechanical, thermal, and functional properties.
2.	To develop innovative engineering solutions through the integration of advanced materials, smart materials, or nanomaterials.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of material properties and processing	20	Comprehensive understanding with accurate interpretation	Adequate understanding	Limited understanding
2.	Material characterization and comparison	20	Detailed and technically sound comparison	Reasonable comparison	Basic comparison
3.	Application-based material selection	20	Well-justified selection using engineering criteria	Adequately justified	Weak justification
4.	Analysis and interpretation of results	20	Insightful analysis with practical relevance	Moderate analysis	Limited analysis
5.	Report and presentation	20	Professional and well-organized	Adequate documentation	Poor documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Product concept and innovation	20	Highly innovative and technically feasible design	Moderately innovative	Basic concept
2.	Selection and integration of advanced materials	20	Excellent material selection with strong justification	Appropriate selection	Poor selection
3.	Design methodology and technical feasibility	20	Comprehensive and realistic design approach	Adequate methodology	Incomplete methodology
4.	Engineering analysis and performance evaluation	20	Thorough evaluation and validation	Moderate evaluation	Limited evaluation
5.	Report, presentation and communication	20	Professional and effective communication	Adequate communication	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage > 20%);

Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE05		EXPERIMENTAL STRESS ANALYSIS		SEMESTER		II							
Prerequisites				Category		ES(PE)		Credits		3			
				Hours/ Semester		L		T		P		TH	
						45		0		0		45	
COURSE OBJECTIVES													
1.		To use indicial notation to represent the compatibility, equilibrium, and constitutive equations of mechanics.											
2.		To use alternate definitions of strain to solve problems involving large deformations											
3.		To compute bending stresses in circular plate											
4.		To perform stress calculations in thick walled cylinders and rotating disk											
UNIT - I		THEORY OF ELASTICITY										9	
Analysis of stress – Analysis of stain - Elasticity problems in two dimension and three dimensions - Mohr’s circle for three dimensional stresses - Stress tensor - Airy’s stress function in rectangular and polar coordinates - Energy method for analysis of stress - Strain and deflection - The three theorem’s - Theorem of virtual work - Theorem of least work - Castigliano’s theorem - Rayleigh Ritz method - Galerkin’s method - Elastic behaviour of anisotropic materials like fiber reinforced composites.													
UNIT - II		THEORY OF TORSION										9	
Torsion of prismatic bars of solid section and thin walled section - Analogies for torsion - Membrane analogy - Fluid flow analogy and electrical analogy - Torsion of conical shaft, bar of variable diameter - Thin walled members of open cross section in which some sections are prevented from warping - Torsion of noncircular shaft.													
UNIT - III		UNSYMMETRICAL BENDING										9	
Concept of shear centre in symmetrical and unsymmetrical bending - Stress and deflections in beams subjected to unsymmetrical bending - Shear centre for thin wall beam cross section - Open section with one axis of symmetry- General open section and closed section.													
UNIT - IV		PLATE BENDING										9	
Bending of plate to cylindrical surface - Bending of a long uniformly loaded rectangular plate - Pure bending in two perpendicular directions - Bending of circular plates loaded symmetrically w.r.t center - Bending of circular plates of variable thickness - Circular plate with circular hole at centre symmetrically loaded and load distributed along inner and outer edges.													
UNIT - V		PRESSURIZED CYLINDERS AND ROTATING DISCS										9	
Governing equations - Stress in thick walled cylinder under internal and external pressure - Shrink fit compound cylinders. Stresses in rotating flat solid disc - Flat disc with central hole -Disc with variable thickness - Disc of uniform strength - Plastic action in thick walled cylinders and rotating disc.													
L:45, Total:45 Hours													
Weightage: Continuous Assessment 40% End Semester Examinations 60%													

REFERENCE BOOKS:					
1.	Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill, 1970.				
2.	Timoshenko, "Advanced Strength of Materials", Vol. 1, 2, CBS publishers, 2004.				
3.	Den Harteg, "Advanced Strength of Materials", Dover Publications Inc., 1987.				
4.	Dally & Riley, "Experimental Stress Analysis", McGraw-Hill College, 1991.				
5.	Timoshenko, "Theory of Plates and Shells", McGraw Hill, 1964.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112106068				
2.	https://nptel.ac.in/courses/112106247				
3.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_me23				
4.	https://nptel.ac.in/courses/112101298				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Describe the principles of elasticity, stress-strain relationships, energy methods, torsion, bending phenomena, and stress analysis in engineering structures.				
CO2	Examine the behavior of isotropic and anisotropic materials subjected to complex stress systems, torsional loading, and deformation using elasticity theories and analytical methods.			PO3	PSO2
CO3	Determine the stresses, strains, deflections, and shear center locations in structural members subjected to torsion, unsymmetrical bending, and plate loading conditions.			PO1, PO3	PSO1, PSO2
CO4	Assess the structural response of plates, thick cylinders, rotating discs, and composite materials under various loading and boundary conditions.			PO1	PSO1, PSO2
CO5	Develop analytical solutions and structural designs for engineering components by integrating advanced theories of elasticity, torsion, bending, and pressure vessel analysis.			PO1, PO2, PO3	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3	3		2	3	2
CO4	3			2	3
CO5	3	2	3	3	2
AVERAGE	3	2	2.67	2.67	2.50

Activities:

1.	To assess the structural response of engineering components subjected to complex loading and boundary conditions.
2.	To develop analytical solutions and optimized structural designs using elasticity, torsion, bending, and pressure vessel theories.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem formulation and theoretical understanding	20	Complete and accurate formulation	Minor deficiencies	Incomplete understanding
2.	Stress and deformation analysis	20	Accurate calculations and interpretations	Moderate accuracy	Significant errors
3.	Evaluation of structural response	20	Comprehensive assessment with engineering insight	Reasonable assessment	Limited assessment
4.	Validation/comparison of results	20	Thorough comparison and validation	Acceptable comparison	Minimal validation
5.	Report and presentation	20	Professional and well-structured	Adequate documentation	Poor documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Application of elasticity and energy methods	20	Excellent application with technical accuracy	Adequate application	Limited application
2.	Design calculations and analytical solutions	20	Accurate and complete solutions	Minor errors	Significant errors
3.	Structural design and safety evaluation	20	Comprehensive design assessment	Acceptable assessment	Limited assessment
4.	Design improvement and optimization	20	Innovative and technically justified improvements	Moderate improvements	Minimal improvements
5.	Technical report and presentation	20	Professional presentation and communication	Adequate presentation	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note:Purely as anExample: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE06	OPTIMIZATION TECHNIQUES IN DESIGN (Use of approved Data Book and Charts may be permitted)		SEMESTER		II		
Prerequisites			Category	ES(PE)	Credits	3	
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To create awareness about optimization techniques.						
2.	To understand and apply optimization techniques to real life problems.						
3.	To learn to geometric programming problems with constrained optimization problems						
4.	To understand the fundamentals constrained and un constrained optimization and their static and dynamic application.						
5.	To develop the optimal solution or design for engineering problems.						
UNIT - I		INTRODUCTION					9
General Characteristics of mechanical elements- adequate and optimum design- principles of optimization- formulation of objective function- design constraints – Classification of optimization problem.							
UNIT - II		UNCONSTRAINED OPTIMIZATION					9
Single variable and multivariable optimization- Techniques of unconstrained minimization – Golden section- pattern and gradient search methods – interpolation methods.							
UNIT - III		CONSTRAINED OPTIMIZATION					9
Optimization with equality and inequality constraints – Indirect methods using penalty functions- Lagrange multipliers- Geometric programming- Constrained- mixed inequality and unconstrained minimization- Genetic algorithms.							
UNIT - IV		STATIC APPLICATIONS					9
Structural applications – Design of simple truss members. Design applications – Design of simple axial-transverse loaded members for minimum cost- maximum weight – Design of shafts and torsionally. loaded members – Design of springs.							
UNIT - V		DYNAMIC APPLICATIONS					9
Dynamic Applications – Optimum design of single- two degree of freedom systems- vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.							
L:45, Total:45Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Singiresu.S.Rao, "Engineering Optimization Theory and Practice", New Age International (P) Limited, 1996.						
2.	Johnson Ray C, "Optimum design of mechanical elements", Wiley John & Sons, 1990.						

3.	Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt, 1995.
4.	Goldberg D.E, "Genetic algorithms in search- optimization and machine", Barnen Addison-Wesley New York, 1989.
5.	Saravanan.R, "Manufacturing optimization through intelligent techniques", Taylor and Francis Publications, CRC Press, 2006.

E-RESOURCES:

1.	https://doi.org/10.1080/03052159908941377
2.	https://docs.scipy.org/doc/scipy/reference/optimize.html
3.	https://www.mathworks.com/products/optimization.htm

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Describe the principles of optimization, objective functions, design variables, constraints, and classification of optimization problems in engineering design.		
CO2	Examine unconstrained and constrained optimization techniques for solving engineering design problems using analytical and numerical approaches.	PO3	PSO2
CO3	Determine optimal solutions for engineering systems using classical optimization methods, penalty function methods, geometric programming, and evolutionary algorithms.	PO1, PO3	PSO1, PSO2
CO4	Assess the effectiveness of optimization techniques in the design of structural members, shafts, springs, and other static engineering components.	PO1	PSO1, PSO2
CO5	Develop optimized designs for dynamic systems and mechanisms by integrating advanced optimization methods with engineering design requirements.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		2
CO3	2		3	3	2
CO4	3		2	2	3
CO5	3	3	2	3	2
AVERAGE	2.67	3	2.5	2.67	2.25

Activities:

1.	To assess the effectiveness of optimization techniques in minimizing weight, cost, or material usage of static mechanical components.
2.	To develop optimized designs for dynamic systems and mechanisms using advanced optimization methods.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem formulation and constraint identification	20	Complete and technically accurate formulation	Minor deficiencies	Incomplete formulation
2.	Selection and application of optimization technique	20	Appropriate method with correct implementation	Acceptable implementation	Incorrect or incomplete application
3.	Analysis of optimized design	20	Comprehensive evaluation with justified conclusions	Moderate analysis	Limited analysis
4.	Comparison with conventional design	20	Detailed and meaningful comparison	Reasonable comparison	Minimal comparison
5.	Report and presentation	20	Professional and well-structured	Adequate documentation	Poor documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Mathematical modeling of dynamic system / mechanism	20	Accurate and complete model development	Minor errors	Incomplete model
2.	Selection and implementation of optimization method	20	Appropriate and correctly implemented	Adequate implementation	Poor implementation
3.	Optimization results and validation	20	Accurate results with strong validation	Moderate validation	Limited validation
4.	Engineering interpretation of results	20	Excellent technical reasoning and analysis	Acceptable interpretation	Weak interpretation
5.	Report, presentation and technical communication	20	Professional and effective presentation	Adequate presentation	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE07	ADVANCED TOOL DESIGN			SEMESTER		II	
Prerequisites			Category	ES(PE)	Credits	3	
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To enable the student to make the complete design of tooling, based on the design of a product.						
2.	To understand the design of tools based on various machining processes.						
3.	To know about the various standards available in data book and usage of tool design data book.						
4.	To improve the design of tools relevant to vibrations induced in the machining process.						
5.	To improve the design of tools for manual machining as well as NC and automatic screw cutting machines.						
UNIT - I		TOOL-DESIGN METHODS					9
Introduction – Design Procedure – Statement of the problem –Needs Analysis — Tentative Design Solutions – Finished Design – Drafting and Design – drafting practice - Tool making Practice - Tools of the Toolmaker - Screws and Dowels – Hole location – Jig-boring practice– Punch and Die Manufacture – Electro-discharge machining for cavity.							
UNIT - II		TOOL MATERIALS AND DESIGN OF CUTTING TOOLS					9
Properties of Materials – Ferrous Tooling Materials – Nonferrous Tooling Materials - Nonmetallic Tooling Materials. Design of Metal-cutting Tools – Single-point cutting tools – Milling cutters – Drill, Tap, Reamer, Jigs and Fixtures: Design Consideration - the selection of carbide cutting tools and its inserts - advanced heat treatment methods for composite materials, cryo treatment of steels, plasma equipment.							
UNIT - III		DESIGN OF SPINDLES AND SPINDLE BEARINGS					9
Design of Spindles, Bearing and Power Screws: Design of spindles subjected to combined bending and torsion. The layout of bearings. Pre-loading. Anti-friction slideways. Rolling contact, hydrodynamic, hydrostatic, aerostatics and magnetic bearings, their relative performance. Hydrodynamic design of journal bearings. Power Screws, Recirculating ball screws.							
UNIT - IV		MACHINE TOOL VIBRATIONS					9
Effect of vibration on the machine tool; Forced vibrations. Machine tool chatter. Self-excited vibration and dynamic stability single and two-degree freedom analysis. Completely coefficient. Elimination of vibration. Vibration analysis of machine tool structures							
UNIT - V		TOOL DESIGN FOR NC MACHINES					9
Introduction to numerical control machine tools - Fixture design for numerically controlled machine tools – Cutting tools and Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction to Automatic Screw machine and its tooling – General explanation of the Brown and sharp machine. Concepts of aesthetic and ergonomics applied to machine tools - latest trends in Machine Tool Design							
L:45, Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:					
1.	Cyril Donaldson, George H.LeCain and V.C. Goold, "Tool Design", Tata McGraw Hill, 2000				
2.	Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000				
3.	Mehta- N.K, "Machine Tool Design", Tata McGraw Hill, 1989.				
4.	Koenisbergaer F, "Design Principles of Metal Cutting Machine Tools", Pergamon Press, 1964.				
5.	Acherkan N, "Machine Tool Design- Vol. 3 & 4", MIR Publishers, Moscow, 1968.				
6.	Sen. G and Bhattacharya A, "Principles of Machine Tools Vol.2", NCB, Calcutta, 1973.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112105306				
2.	https://nptel.ac.in/courses/112105233				
3.	https://nptel.ac.in/courses/112102015				
4.	https://nptel.ac.in/courses/112107212				
5.	https://nptel.ac.in/courses/112105211				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Interpret the fundamentals of tool design procedures, tooling practices, tool materials, and manufacturing methods used in machine tool applications				
CO2	Investigate the selection of tool materials, cutting tools, inserts, heat treatment processes, and tooling systems for machining applications.		PO3	PSO1	
CO3	Apply machine tool design principles for spindles, bearings, power screws, jigs, fixtures, and NC tooling systems.		PO1, PO3	PSO1, PSO2	
CO4	Evaluate the performance of machine tool structures under vibration, stability, chatter, and dynamic loading conditions.		PO1, PO2	PSO2	
CO5	Formulate innovative machine tool solutions incorporating NC technology, automation, ergonomics, aesthetics, and modern tooling practices.		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	3	
CO3	3		2	3	2
CO4	2	3			3
CO5	3	2	3	2	3
AVERAGE	2.67	2.5	2.33	2.67	2.67
Activities:					
1.	To evaluate the dynamic performance and stability of machine tools under vibration and chatter conditions.				
2.	To design an innovative tooling solution for NC/CNC machining applications incorporating automation, ergonomics, and modern manufacturing practices.				

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of vibration and chatter concepts	20	Comprehensive understanding with strong technical reasoning	Adequate understanding	Limited understanding
2.	Analysis of machine tool dynamics	20	Accurate and detailed analysis	Moderate analysis	Basic analysis
3.	Stability evaluation and interpretation	20	Thorough evaluation with justified conclusions	Reasonable interpretation	Minimal evaluation
4.	Vibration control recommendations	20	Practical and technically sound solutions	Acceptable solutions	Limited recommendations
5.	Report and presentation	20	Professional and well-organized	Adequate documentation	Poor documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Tooling system and fixture design	20	Innovative and complete design	Adequate design	Incomplete design
2.	Selection of cutting tools and tool holders	20	Appropriate and well justified	Partially justified	Inappropriate selection
3.	Application of automation and NC concepts	20	Excellent integration of NC/CNC features	Moderate integration	Limited integration
4.	CAD model, drawings and calculations	20	Accurate and professional documentation	Minor deficiencies	Significant deficiencies
5.	Design presentation and technical justification	20	Strong engineering justification and communication	Adequate explanation	Weak explanation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE08	MECHATRONICS SYSTEM DESIGN		SEMESTER		II	
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To provide the interdisciplinary concepts of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems.					
2.	To know the basic working principle of sensors and transducers of use for manufacturing system.					
3.	To know the features, modules and interfaces of microprocessors.					
4.	To understand the concept of PLC system in industrial applications.					
5.	To gain the knowledge of integration of mechatronic systems in automation of modern manufacturing systems.					
UNIT - I	INTRODUCTION					9
Introduction to Mechatronics - Systems - Mechatronics in Products – Measurement Systems - Control Systems - Traditional design and Mechatronics Design- Advanced applications in Mechatronics -Measurement systems Control Systems- PID Controllers.						
UNIT - II	SENSORS AND TRANSDUCERS					9
Introduction - Performance Terminology - Displacement- Position and Proximity -Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors -Selection of sensors - Signal processing - Servo systems.						
UNIT - III	MICROPROCESSORS IN MECHATRONICS					9
Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters – Applications - Temperature control - Stepper motor control - Traffic light controller						
UNIT - IV	PROGRAMMABLE LOGIC CONTROLLERS					9
Introduction - Basic structure - Input and Output processing - Programming –Mnemonics Timers- Internal relays and counters - Data handling - Analog input and output - Selection of PLC.						
UNIT - V	MECHATRONICS SYSTEMS AND APPLICATIONS					9
Intelligent Manufacturing – Condition Monitoring and Control - Robot for Automatic Assembly Process- Robot Vision – Material Handling and Inspection- Automotive Mechatronics: Electronic Ignition System – ABS – EBD – Automatic Cruise Control						
L:45, Total:45Hours						
Weightage: Continuous Assessment 40% End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Michael B.Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw Hill International Editions, 1999.				
2.	Bradley- D.A, Dawson D, Buru N.C and Loader A J, "Mechatronics", Chapman and Hall, 1993.				
3.	Ramesh.S Gaonkar, "Microprocessor Architecture- Programming and Applications", Wiley Eastern, 1998.				
4.	Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering- An Introduction to Mechatronics", Prentice Hall, 2000.				
5.	Ghosh- P.K. and Sridhar- P.R. "0000 to 8085- Introduction to Microprocessors for Engineers and Scientists", 2 nd Edition, Prentice Hall, 1995.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112107298				
2.	https://nptel.ac.in/courses/112101304				
3.	https://nptel.ac.in/courses/112106065				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the concepts of mechatronics systems, sensors, transducers, microprocessors, PLCs, and control systems.				
CO2	Analyze the performance of sensors, signal processing units, servo systems, and control elements used in mechatronic applications		PO3	PSO2	
CO3	Apply microprocessor and PLC programming techniques for automation, monitoring, and industrial control systems.		PO1, PO3	PSO1, PSO2	
CO4	Evaluate the effectiveness of mechatronic systems used in manufacturing, robotics, process monitoring, and automotive applications.		PO2, PO3	PSO2	
CO5	Design integrated mechatronic systems for intelligent manufacturing, robotic vision, material handling, inspection, and automotive control applications.		PO1, PO2	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		2
CO3	3		2	3	2
CO4		3	2		3
CO5	3	2		3	2
AVERAGE	3	2.5	2.33	3	2.25

Activities:

1.	To evaluate the effectiveness of mechatronic systems used in manufacturing, robotics, process monitoring, and automotive applications.
2.	To design a complete mechatronic system integrating sensors, actuators, controllers, and software for an industrial application.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of selected mechatronic system	20	Complete and accurate understanding	Adequate understanding	Limited understanding
2.	Analysis of sensors, actuators and controllers	20	Comprehensive analysis	Moderate analysis	Basic analysis
3.	Performance evaluation and interpretation	20	Detailed and technically sound evaluation	Reasonable evaluation	Limited evaluation
4.	System documentation and presentation	20	Well-organized and professional	Adequately organized	Poorly organized
5.	Technical discussion and conclusions	20	Strong engineering justification	Moderate justification	Weak justification
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	System design and architecture	20	Innovative and complete design	Adequate design	Incomplete design
2.	Selection of sensors, actuators and controllers	20	Appropriate and justified selection	Partially justified selection	Inappropriate selection
3.	Control logic/program development	20	Correct and efficient implementation	Minor errors	Major errors
4.	Integration and functionality	20	Excellent integration and operation	Acceptable integration	Poor integration
5.	Report, demonstration and presentation	20	Professional documentation and presentation	Adequate documentation	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note:Purely as anExample: Strength = 3 (if percentage >20%);

Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE09	MECHANICS OF FRACTURE				SEMESTER		II
Prerequisites			Category	ES(PE)	Credits		3
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand about the fundamental of fracture mechanics and fatigue.						
2.	To understand about the fundamental of LEFM.						
3.	To consider fatigue and fracture aspects in design.						
4.	To consider failure regimes for fatigue and creep crack.						
5.	To know the test methods to measure material fracture toughness.						
UNIT - I	INTRODUCTION						9
Theory of Elasticity - Stress Concentration Factor – Notch Strengthening – External variables affecting fracture – Nomenclature of the fracture process - Griffith Crack Theory – Irwin’s modification - Strain-Energy Release Rate – Crack resistance curves, Plane stress and plane strain cases - Crack stability and instability conditions - Grain-Size Refinement.							
UNIT - II	LINEAR ELASTIC FRACTURE MECHANICS						9
Modes of Loading – Crack tip stress (mode I, II, III) –Stress Intensity Factor –Crack tip plasticity – Fracture Toughness – Fatigue crack growth – Crack growth life Integration – Mean stress effect – Cyclic Plastic zone – Crack Closure –Irwin’s correction - Small fatigue cracks and LEFM limitations							
UNIT - III	ELASTIC-PLASTIC FRACTURE MECHANICS						9
Plastic zone models – J integral – crack tip opening displacement - Path independence, Stress-Strain relation, Engineer Approach. Crack Tip Plasticity – Crack tip opening displacement Relationship between CTOD, KI, GI for small scale yielding, Equivalence between CTOD and J integral							
UNIT - IV	FATIGUE CRACK AND CREEP CRACK						9
Fatigue regimes – S-N, P-S-N curves – Fatigue crack growth models – crack initiation, crack propagation - effect of overload, variable amplitude fatigue load - Paris law –Fracture Toughness. Dynamics of moving crack tip, process zone size, crack speed – crack path instabilities. Creep crack growth, failure at high temperatures.							
UNIT - V	EXPERIMENTAL METHODS AND NUMERICAL APPROACHES						9
Test methods to measure material fracture toughness and critical J integral value –Correlations between impact energy and fracture toughness - Finite element modelling of crack and evaluation of J integral and stress intensity parameter-Direct and indirect methods.							
L:45, Total:45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:

1.	T.L. Anderson, "Fracture mechanics: Fundamentals and Applications", 4th Edition. CRC Press, Taylors& Francis, 2017.
2.	Kare Hellan, "Introduction of Fracture Mechanics", McGraw Hill Book Company, 1985.
3.	Richard W.Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials" John wiley& sons, Inc., 1996
4.	Nestor Perez, "Fracture Mechanics", Kluwer Academic Publishers, 2004
5.	David Broek, "Elementary Engineering Fracture Mechanics", Sijthoff and Noordhoff International Publisher, 1978.
6.	M.F. Kanninen and C.H. Popelar, Advanced Fracture Mechanics, Oxford Press, 1985.
7.	S. Murakami, Continuum Damage Mechanics, Springer Netherlands, Dordrecht, 2012.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc23_mm31/preview
2.	https://youtu.be/-eBRqhfdGrU?si=hFF_-pbN5Z02D1wj
3.	https://youtu.be/cbcOX3gBWAU?si=QeMuJa7wdrWNbB94
4.	https://nptel.ac.in/courses/112107241

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamentals of fracture mechanics, crack behavior, stress concentration effects, fracture theories, and material strengthening mechanisms		
CO2	Analyze crack tip stresses, stress intensity factors, fracture toughness, and fatigue crack growth using linear elastic fracture mechanics concepts.	PO3	PSO2
CO3	Apply elastic-plastic fracture mechanics principles to evaluate crack tip plasticity, J-integral, CTOD, and fracture behavior under yielding conditions.	PO1, PO3	PSO1, PSO2
CO4	Evaluate fatigue and creep crack growth behavior, crack propagation mechanisms, and fracture performance of materials under complex loading conditions.	PO2, PO3	PSO2
CO5	Design fracture assessment methodologies using experimental techniques and numerical approaches for predicting structural integrity and failure.	PO1, PO2	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3	3		2	3	2
CO4		3	2		3
CO5	3	2		3	2
AVERAGE	3.0	2.5	2.33	3.0	2.5

Activities:

1.	To Fatigue and Creep Crack Growth Analysis of Engineering Materials
2.	To assess fracture behavior using fracture toughness testing concepts and finite element analysis.

Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of fatigue and creep concepts	20	Demonstrates comprehensive understanding	Demonstrates adequate understanding	Limited understanding
2.	Crack growth analysis and calculations	20	Accurate analysis and calculations	Minor errors present	Significant errors
3.	Interpretation of crack propagation behavior	20	Insightful interpretation with engineering relevance	Reasonable interpretation	Basic interpretation only
4.	Data presentation and graphical analysis	20	Well-organized and technically correct	Adequately presented	Poor presentation
5.	Report and presentation	20	Professional, clear and complete	Acceptable quality	Incomplete or poorly organized
	Total	100			

Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of fracture toughness testing methods	20	Complete understanding and justification	Adequate understanding	Limited understanding
2.	Development of numerical/FEA model	20	Accurate and well-developed model	Minor deficiencies	Major deficiencies
3.	Evaluation of K and J parameters	20	Accurate computation and interpretation	Moderate accuracy	Significant errors
4.	Comparison and validation of results	20	Thorough comparison and validation	Reasonable comparison	Minimal validation
5.	Technical report and presentation	20	Excellent documentation and communication	Acceptable documentation	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:						
	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE10	COMPUTATIONAL FLUID DYNAMICS		SEMESTER		II	
Prerequisites		Category	ES(PE)	Credits	3	
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the basics of computational fluid dynamics and governing equation					
2.	To develop finite difference and finite volume discretized forms of the CFD equations					
3.	To formulate explicit and implicit algorithms for solving the Euler and Navier Stokes Equations					
4.	To formulate and solve conduction type problems using appropriate CFD technique.					
5.	To gain knowledge on different turbulence model and its practical applications.					
UNIT - I	GOVERNING EQUATIONS				9	
Basics of computational fluid dynamics–Governing equations of fluid dynamics–Continuity, Momentum and Energy equations– Chemical species transport–Physical boundary conditions–Time-averaged equations for Turbulent Flow–Turbulent–Kinetic Energy Equations–Mathematical behaviour of PDEs on CFD–Elliptic, Parabolic and Hyperbolic equations.						
UNIT - II	FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION				9	
Derivation of finite difference equations–Simple Methods–General Methods for first and second order accuracy– Finite volume formulation for steady state One, Two and Three – dimensional diffusion problems–Parabolic equations–Explicit and Implicit schemes–Example problems on elliptic and parabolic equations–Use of Finite Difference and Finite Volume methods.						
UNIT - III	CONDUCTION AND CONVECTIVE HEAT TRANSFER				9	
One-dimensional and Two-dimensional Steady and Unsteady Heat Conduction – Convection–Diffusion Equation – Discretization of Diffusion and Convection Terms – Central, Upwind and Hybrid Differencing Schemes – Solution of One-dimensional and Two-dimensional Convection–Diffusion Problems – Introduction to Finite Element Method (FEM) – Solution of Steady Heat Conduction using FEM – CFD Simulation of Heat Transfer Problems.						
UNIT - IV	FLUID FLOW				9	
Governing Equations, Stream Function – Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach, Finite volume methods-Representation of the pressure gradient term and continuity equation–Staggered grid– Momentum equations–Pressure and Velocity corrections– Pressure Correction equation, SIMPLE algorithm and its variants–PISO Algorithms.						
UNIT - V	TURBULENCE MODELS				9	
Algebraic Models – One equation model, K - ε Models, Standard, Reynolds number models, Prediction of fluid flow.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.				
2.	Ghoshdasdar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.				
3.	An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition, Pearson Education, 2007.				
4.	Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.				
5.	Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier Stock Equation", Pineridge Press Limited, U.K., 1981.				
6.	Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer "Hemisphere Publishing Corporation, Newyork, USA, 1984.				
7.	Donald R. Honra, "Co-ordinate measurement and reverse Engineering", American Gear Manufacturers Association.1997.				
8.	Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/101104450				
2.	https://nptel.ac.in/courses/101105085				
3.	https://www.youtube.com/playlist?list=PLbRMhDVUMngcFmWiK1YBhAbsYo8mYvPKJ				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the governing equations, boundary conditions, turbulence concepts, and mathematical foundations used in Computational Fluid Dynamics.				
CO2	Analyze fluid flow and heat transfer problems using finite difference and finite volume discretization techniques.		PO3	PSO2	
CO3	Apply numerical methods for solving conduction, convection-diffusion, and fluid flow problems using CFD formulations and finite element concepts.		PO1, PO3	PSO1, PSO2	
CO4	Evaluate the performance of CFD algorithms such as SIMPLE, PISO, and pressure-velocity coupling methods for engineering flow simulations.		PO2, PO3	PSO2	
CO5	Design computational models incorporating turbulence models and numerical schemes for predicting complex fluid flow and heat transfer phenomena.		PO1, PO2	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			3		3
CO3	3		2	3	2
CO4		3	2		3
CO5	3	2		2	3
AVERAGE	3	2.5	2.33	2.5	2.75

Activities:

1.	Implementation of Pressure–Velocity Coupling Algorithms
2.	Comparative Study of Turbulence Models for Engineering Flows

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem formulation & boundary conditions	20	Completely correct and justified	Minor errors	Incomplete
2.	CFD model setup	20	Accurate model development	Acceptable setup	Significant errors
3.	Algorithm implementation	20	Correct implementation and convergence	Partial implementation	Poor implementation
4.	Analysis of results	20	Comprehensive interpretation	Moderate interpretation	Limited analysis
5.	Report & presentation	20	Professional and clear	Adequate	Poor documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Geometry & mesh generation	20	High-quality mesh and setup	Acceptable mesh	Poor mesh quality
2.	Selection of turbulence model	20	Appropriate model selection with justification	Partially justified	Inappropriate selection
3.	Simulation execution	20	Correct and efficient execution	Minor issues	Major errors
4.	Result validation & comparison	20	Detailed comparison and validation	Moderate comparison	Limited validation
5.	Technical report & presentation	20	Excellent documentation and communication	Adequate documentation	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE11	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING		SEMESTER			III
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing/service firms.					
2.	To develop skills necessary to effectively analyze and synthesize the many inter-relationships inherent in complex socioeconomic productive systems					
3.	To ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy					
4.	To understand the managerial responsibility for operations, even when production is outsourced, or performed in regions far from corporate headquarters					
5.	To recognize the significance of organizational change and the issues associated with its implementation.					
UNIT - I	PRODUCTIVITY					9
Productivity Concepts - Macro and Micro factors of productivity - Dynamics of Productivity - Productivity Cycle Productivity Measurement at International - National and Organization level - Productivity measurement models.						
UNIT - II	SYSTEMS APPROACH TO PRODUCTIVITY MANAGEMENT					9
Conceptual framework, Management by Objectives (MBO) - Performance objectives- Productivity (POP) - Methodology and application to manufacturing and service sector.						
UNIT - III	ORGANISATIONAL TRANSFORMATION					9
Elements of Organizational Transformation and Reengineering-Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, LMI CIP Model – DSMC Q and PMP model.						
UNIT - IV	RE-ENGINEERING PROCESS AND IMPROVEMENT MODELS					9
PMI models - PASIM Model - Moen and Nolan Strategy for process improvement - LMICIP Model - NPRDC Model.						
UNIT - V	TOOLS FOR RE-ENGINEERING					9
Analytical and process tools and techniques - Information and Communication Technology-Implementation of Reengineering Projects – Success Factors and common implementation Problem - Cases.						
L:45, Total:45Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Handbook on Industrial Engineering equations, formulas and calculations, Adedeji B. Badiru and Olufemi A. Omitaomu, 2011, CRC Press.				
2.	"Industrial Engineering and Management", O.P.Khanna, 17 th edition, DhanpatRai publications.				
3.	"Productivity Engineering and Management', Sumanth, D.J. TMH, New Delhi, 1994				
4.	"Organisational Transformation and Process Re-engineering", Edosomwan, J.A.,LibraryCataloging in Pub.Data, 1995.				
5.	"Productivity Management – A, Systems Approach", Premvrat, Sardana, G.D. and Sahay, B.S., Narosa Publishing House. New Delhi, 1998.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112107142				
2.	https://nptel.ac.in/courses/110105141				
3.	https://doi.org/10.1108/IJQRM-05-2024-0134				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain productivity concepts, productivity measurement models and factors influencing productivity at organizational, national and international levels.				
CO2	Apply systems approaches, Management by Objectives (MBO) and productivity through Objectives (POP) methodologies to improve organizational performance		PO1, PO2	PSO1	
CO3	Analyze organizational transformation and business process re-engineering principles for enhancing operational effectiveness.		PO2, PO3	PSO1, PSO2	
CO4	Evaluate various process improvement and re-engineering models for productivity enhancement in manufacturing and service organizations.		PO2, PO3	PSO2	
CO5	Apply analytical tools, information technology and implementation strategies for successful re-engineering projects and organizational change management.		PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	1
CO2	3	3	2	2	2
CO3	3	3	3	2	2
CO4	3	3	3	3	2
CO5	3	2	3	3	3
AVERAGE	3.0	2.6	2.4	2.4	2.0
Activities:					
1.	Business Process Re-engineering (BPR) Model Analysis				
2.	Case Study on Productivity Improvement and Re-engineering				

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Identification of Productivity Problems	20	Complete and accurate	Minor deficiencies	Incomplete
2.	Identification of Productivity Problems	20	Accurate and professional	Adequate	Poor quality
3.	Analysis and Application of Model	20	Efficient and appropriate	Moderate application	Limited application
4.	Evaluation of Improvement Potential	20	Comprehensive analysis	Adequate analysis	Limited analysis
5.	Report and Presentation	20	Excellent quality	Satisfactory quality	Poor quality
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Re-engineering Tools	20	Thorough understanding	Good understanding	Basic understanding
2.	Application of ICT and Analytical Techniques	20	Comprehensive evaluation	Adequate evaluation	Limited evaluation
3.	Analysis of Success Factors and Challenges	20	Detailed and accurate	Moderate accuracy	Limited analysis
4.	Organizational Impact Assessment	20	Excellent interpretation	Adequate interpretation	Poor interpretation
5.	Technical report & viva-voice	20	Professional presentation	Satisfactory presentation	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as anExample: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE12	THEORY OF PLATES AND SHELLS (Use of approved Data Book and Charts may be permitted)			SEMESTER		III
Prerequisites			Category	ES(PE)	Credits	3
			Hours/ Semester	L	T	P
				45	0	0
COURSE OBJECTIVES						
1.	To understand the concepts of rectangular plates, shells and frames and their analysis with various techniques					
2.	To apply the FEM in analyzing the Plates and shells.					
3.	To understand the creation of Frames with basic principle.					
4.	To gain knowledge about the shells and membrane theory					
5.	To understand the creation of Frames with basic principle.					
UNIT - I		INTRODUCTION				9
Thin Plates with small deflection. Laterally loaded thin plates- governing differential equation - various boundary conditions						
UNIT - II		PLATES				9
Rectangular plates. Simply supported rectangular plates- Navier solution and Levy's method - Rectangular plates with various edge conditions- plates on elastic foundation. Symmetrical bending of circular plates.						
UNIT - III		ANALYSIS METHODS				9
Energy methods - Finite difference and Finite element methods – Plates and Shells						
UNIT - IV		SHELLS				9
Classification of shells- types of shells- structural action- membrane theory- shells of revolution and shells of translation- examples limitations of membrane theory. Folded Plate structures- structural behavior- types- design by ACI - ASCE Task Committee method.						
UNIT - V		FRAMES				9
Space frames - configuration - types of nodes - general principles of design philosophy - behavior.						
L:45, Total:45 Hours						
Weightage: Continuous Assessment 40% End Semester Examinations 60%						
REFERENCE BOOKS:						
1.	Szilard R, "Theory and Analysis of Plates", Prentice Hall Inc., 1995.					
2.	Timoshenko S and Krieger S.W, "Theory of Plates and Shells", McGraw Hill Book Company - New York 1990					
3.	Timoshenko S, "Theory of Plates and Shells", McGraw Hill, 1990.					
4.	Wilhelm Flügge, "Stresses in shells", Springer, Verlag.					
5.	Ramasamy G.S, "Design and Construction of Concrete Shells Roofs", CBS Publishers, 1986.					

E-RESOURCES:

- | | |
|----|---|
| 1. | https://onlinecourses.nptel.ac.in/noc23_ce103/preview |
| 2. | https://nptel.ac.in/courses/112108312 |
| 3. | https://youtube.com/playlist?list=PLKZIPALGW-7SFhq1xgf4LUbmM4q56MMLe&si=bRIcDdsGcQDkUWZK |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamental theories of thin plates, governing differential equations and boundary conditions for plate bending problems.		
CO2	Analyze rectangular and circular plates subjected to various loading and support conditions using classical analytical methods.	PO1, PO2	PSO1
CO3	Apply energy methods, finite difference methods and finite element methods for the analysis of plates and shells.	PO2, PO3	PSO1, PSO2
CO4	Analyze shell structures using membrane theory and evaluate the behavior of shells of revolution, shells of translation and folded plate structures.	PO2, PO3	PSO2
CO5	Evaluate the structural behavior, design philosophy and applications of space frame systems and their components.	PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	1
CO2	3	3	2	2	2
CO3	3	3	3	2	2
CO4	3	3	3	3	2
CO5	3	2	3	3	3
AVERAGE	3.0	2.6	2.4	2.4	2.0

Activities:

- | | |
|----|---|
| 1. | Analysis of Shell and Folded Plate Structures |
| 2. | Design Study of Space Frame Structures |

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Shell Geometry and Classification	20	Complete and accurate	Good understanding	Basic understanding

2.	Application of Membrane Theory	20	Accurate and comprehensive	Minor errors	Limited application
3.	Structural Analysis and Calculations	20	Detailed and correct	Adequate analysis	Incomplete analysis
4.	Interpretation of Structural Behavior	20	Excellent interpretation	Satisfactory interpretation	Limited interpretation
5.	Technical Report & Presentation	20	Professional quality	Acceptable quality	Poor quality
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Identification of Frame Configuration	20	Comprehensive and accurate	Adequate	Limited
2.	Analysis of Node Arrangement and Connectivity	20	Detailed analysis	Good analysis	Basic analysis
3.	Structural Behavior and Load Transfer Evaluation	20	Excellent understanding	Adequate understanding	Limited understanding
4.	Design Philosophy and Feasibility Assessment	20	Well justified	Moderately justified	Poor justification
5.	Documentation and Presentation	20	Professional and detailed	Satisfactory	Poor
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE13	CAD/CAM TOOLS		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits	3	
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the basics of industrial automation.					
2.	To understand nature & significance of Machine tools					
3.	To develop skills for programming skills required for manufacturing.					
4.	To gain knowledge about CMM and its features					
5.	To develop new techniques of RE					
UNIT - I		COMPUTER AIDED MANUFACTURING				9
Manufacturing Processes – Removing, Forming, Deforming and joining – Integration Requirements. Integrating CAD, NC and CAM – Machine tools – Point to point and continuous path machining, NC, CNC and DNC – NC Programming – Basics, Languages, G Code, M Code, APT – Tool path generation and verification – CAD/CAM NC Programming – Production Control – Cellular Manufacturing.						
UNIT - II		CAD/CAM HARDWARE				9
Introduction – Types of systems – CAD/CAM system evaluation criteria – Input devices – Output devices – Hardware integration and Networking – Programmable logic controllers – Hardware trends.						
UNIT - III		INSPECTION METHODS				9
Engineering Tolerances – Need for Tolerances – Conventional Tolerances – FITS and LIMITS – Tolerance Accumulation and Surface quality – Geometric Tolerances – Tolerances Practices in design, Drafting and manufacturing – Tolerance Analysis – Tolerance synthesis – Computer Aided Quality control – Contact Inspection Methods – Non Contact Inspection Methods - Non optical.						
UNIT - IV		REVERSE ENGINEERING				9
Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE – Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software’s and its application – CMM and its feature capturing – surface and solid modeling.						
UNIT - V		DATA MANAGEMENT				9
Strategies for Reverse Engineering Data management – Software application – software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised 1 st Edition, Tata McGraw Hill Publication, 2007.				
2.	Catherine A. Ingle, "Reverse Engineering", Tata McGraw Hill Publication, 1994.				
3.	Ibrahim Zeid, "Mastering CAD/CAM", special Indian Edition, Tata McGraw Hill Publication, 2007.				
4.	David D. Bedworth, Mark R. Henderson and Philp M. Wolfe, "Computer Integrated Design and Manufacturing", McGraw Hill International series, 1991.				
5.	Linda Wills, "Reverse Engineering", Kluwer Academic Press, 1996.				
6.	Donald R. Honra, "Co-ordinate measurement and reverse Engineering", American Gear Manufacturers Association.1997.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112105910				
2.	https://nptel.ac.in/courses/112104031				
3.	https://nptel.ac.in/courses/112104250				
4.	https://nptel.ac.in/courses/112104249				
5.	https://nptel.ac.in/courses/106105182				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the fundamentals of CAD/CAM integration, CNC systems, NC programming and computer-aided manufacturing processes.				
CO2	Analyze CAD/CAM hardware components, networking requirements, PLCs and system integration techniques used in manufacturing automation.		PO1, PO2	PSO1	
CO3	Apply tolerance analysis, geometric dimensioning and computer-aided quality control methods for inspection and manufacturing applications.		PO2, PO3	PSO1, PSO2	
CO4	Develop reverse engineering models using digitization techniques, CMM data acquisition, surface modeling and solid modeling tools.		PO2, PO3	PSO2	
CO5	Evaluate reverse engineering data management strategies, software tools and assembly reconstruction techniques for product development.		PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	1
CO2	3	3	2	2	2
CO3	3	3	3	2	2
CO4	3	3	3	3	2
CO5	3	2	3	3	3
AVERAGE	3.0	2.6	2.4	2.4	2.0

Activities:

- | | |
|----|--|
| 1. | Reverse Engineering of a Mechanical Component |
| 2. | Reverse Engineering Data Management and Analysis |

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Geometry Capture and Data Collection	20	Complete and accurate	Minor deficiencies	Incomplete
2.	Surface and Solid Model Development	20	Accurate and professional	Adequate	Poor quality
3.	Application of RE Tools	20	Efficient and appropriate	Moderate application	Limited application
4.	Accuracy Evaluation and Validation	20	Comprehensive analysis	Adequate analysis	Limited analysis
5.	Structural Analysis and Calculations	20	Detailed and correct	Adequate analysis	Incomplete analysis
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Data Management Concepts	20	Thorough understanding	Good understanding	Basic understanding
2.	Analysis of Software Tools	20	Comprehensive evaluation	Adequate evaluation	Limited evaluation
3.	Assembly Reconstruction and RE Methods	20	Detailed and accurate	Moderate accuracy	Limited analysis
4.	Technical Interpretation	20	Excellent interpretation	Adequate interpretation	Poor interpretation
5.	Technical Report & Viva Voce	20	Professional presentation	Satisfactory presentation	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

- | | |
|----|--|
| 1. | Boothroyd G, "Product design for Manufacture and Assembly", First Edition, Marcel Dekker Inc., New York, 2010. |
| 2. | George E Deiter, "Engineering Design", McGrawHill, International, 2012. |
| 3. | A K Chitale and R C Gupta, "Product Design and Manufacturing", PHI, New Delhi, 2013. |

E-RESOURCES:

- | | |
|----|---|
| 1. | https://nptel.ac.in/courses/107103012 |
| 2. | https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_me49 |
| 3. | https://youtube.com/playlist?list=PLyqSpQzTE6M_1kARI-8O0ZJjTwD9bAsRe&si=7G-qdWwK78q9d_sI |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Describe the design rules and principles for economical production and select the materials.		
CO2	Use Design for Manufacture and Assembly tools for minimizing effort and cost in manufacturing a product by machining processes	PO1, PO2	PSO1
CO3	Apply design considerations to minimize difficulty in fabrication of components by welding	PO2, PO3	PSO1, PSO2
CO4	Apply the design considerations to minimize difficulty in fabrication of components by casting	PO2, PO3	PSO2
CO5	Design components taking into consideration the environmental impact it have while manufacturing and during its lifecycle	PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	-	-	-
CO2	2	2	-	2	-
CO3	-	2	2	2	2
CO4	-	2	2	-	2
CO5	-	-	3	2	2
AVERAGE	1.33	1.40	1.75	1.50	1.50

Activities:

- | | |
|----|---|
| 1. | Reverse Engineering and Casting/Forging Component Design Analysis |
| 2. | Design for Assembly (DFA) and Environmental Impact Assessment |

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Geometry Capture and Data Collection	20	Innovative and comprehensive	Adequate alternatives	Limited concepts
2.	Surface and Solid Model Development	20	Systematic and accurate	Minor deficiencies	Poor methodology
3.	Application of RE Tools	20	Comprehensive and reliable	Adequate analysis	Limited analysis
4.	Accuracy Evaluation and Validation	20	Excellent justification	Acceptable justification	Weak justification
5.	Structural Analysis and Calculations	20	Professional and detailed	Satisfactory	Poor quality
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Data Management Concepts	20	Complete and accurate	Adequate	Incomplete
2.	Analysis of Software Tools	20	Excellent architecture	Good architecture	Basic architecture
3.	Assembly Reconstruction and RE Methods	20	Comprehensive analysis	Moderate analysis	Limited analysis
4.	Technical Interpretation	20	Highly feasible and innovative	Adequate	Limited feasibility
5.	Technical Report & Viva Voce	20	Professional quality	Satisfactory	Poor quality
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE15	SOLID FREEFORM MANUFACTURING		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To acquaint the students with the evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM).					
2.	To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.					
3.	To acquaint with polymerization and sheet lamination processes and their applications.					
4.	To acquaint with material extrusion and powder bed fusion processes.					
5.	To gain knowledge on jetting and direct energy deposition processes and their applications.					
UNIT - I		INTRODUCTION				9
Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect- Operative aspect.						
UNIT - II		DESIGN FOR ADDITIVE MANUFACTURING				9
Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies						
UNIT - III		VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES				9
Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications. Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.						
UNIT - IV		MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES				9
Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM. Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. MultiJet Fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.						
UNIT - V		JETTING AND DIRECT ENERGY DEPOSITION PROCESSES				9
Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications. Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations. Laser Engineered Net Shaping (LENS): Process - Materials- Advantages - Limitations and Applications. Case Studies.						
L:45, Total:45 Hours						

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications Munchen, Germany, 2015. ISBN: 978-1-56990-582-1.
2.	Ben Redwood, Brian Garret, Filemon Schöffer, and Tony Fadel, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs B.V., Netherland, 2017. ISBN-13: 978-9082748505.
3.	Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer - New York, USA, 2nd Edition, 2015. ISBN13: 978-1493921126.
4.	Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.
5.	Milan Brandt. "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications", Woodhead Publishing, UK, 2016. ISBN- 9780081004333.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/noc24_me130/preview
2.	https://onlinecourses.nptel.ac.in/noc22_me74/preview
3.	https://youtube.com/playlist?list=PLwdnzlV3ogoWI8QEu4hsT-n_r8UbWbquy&si=FS_SG_uhuR7vYakP

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the fundamentals, classifications, applications, supply chain aspects and economics of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM).		
CO2	Apply Design for Additive Manufacturing (DFAM) principles, CAD modeling, support generation, slicing and tool path generation for AM applications.	PO1, PO2	PSO1
CO3	Analyze vat polymerization and sheet lamination processes such as SLA, DLP, LOM and UAM for engineering applications.	PO2, PO3	PSO1, PSO2
CO4	Evaluate material extrusion and powder bed fusion processes including FDM, SLS, SLM and EBM for manufacturing functional components.	PO2, PO3	PSO2
CO5	Analyze jetting and direct energy deposition processes such as Binder Jetting, Material Jetting and LENS for advanced manufacturing applications.	PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	1
CO2	3	3	2	2	2
CO3	3	3	2	3	2
CO4	3	3	3	3	2
CO5	3	2	3	3	3
AVERAGE	3.0	2.6	2.2	2.6	2.0

Activities:	
1.	Design and Fabrication using FDM / Powder Bed Fusion Concepts
2.	Case Study on Advanced Additive Manufacturing Processes

Rubrics for evaluation: C04					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	CAD Model and Design Preparation	20	Complete and optimized	Adequate	Incomplete
2.	Process Selection and Parameter Identification	20	Highly appropriate	Acceptable	Poor selection
3.	Technical Analysis of AM Process	20	Comprehensive analysis	Moderate analysis	Limited analysis
4.	Evaluation of Product Quality	20	Accurate and detailed	Adequate	Insufficient
5.	Report and Presentation	20	Professional quality	Satisfactory	Poor quality
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Process Principles	20	Thorough understanding	Good understanding	Basic understanding
2.	Materials and Application Analysis	20	Comprehensive analysis	Adequate analysis	Limited analysis
3.	Comparative Evaluation	20	Excellent comparison	Acceptable comparison	Poor comparison
4.	Industrial Relevance and Innovation	20	Strong industrial insight	Moderate insight	Limited insight
5.	Technical Report & Viva Voce	20	Excellent presentation	Satisfactory presentation	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE16	EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits	3	
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the working principle of instruments used for cutting forces, temperature measurement and metallurgical studies.					
2.	To familiar to collection and analysis of data with scientific approach.					
3.	To understand the concept of design of experiment and Taguchi method					
4.	To know about uncertainty analysis					
5.	To understand about RSM					
UNIT - I		MEASUREMENT OF CUTTING FORCES				9
Strain gauge and piezoelectric transducers – characteristics - Dynamometer construction, Bridge circuits - Instrumentation and calibration - Displacement and strain measurements by photo elasticity - Holography, interferometer, Moir techniques, strain gauge rosettes – Calibration of instruments.						
UNIT - II		TEMPERATURE AND FLOW MEASUREMENT				9
Circuits and instrumentation for different transducers - bimetallic, expanding fluid, electrical resistance, thermistor, thermocouples and pyrometers. Flow Measurement - Transducers for Non-compressible and compressible fluids - Obstruction and drag methods - Vortex shredding flow meters - Ultrasonic, Laser Dopler and Hotwire anemometer - Flow visualization techniques - Shadow graphs, Schlieren photography, Interferometer						
UNIT - III		CHARACTERIZATION TECHNIQUES				9
Optical and electron microscopy - X-Ray diffraction, Bragg’s Law and its application for studying crystal structure and residual stresses - Electron spectroscopy, electron microprobe. Surface Measurements - Micro hardness, roughness, accuracy of dimensions and forms - 3-D co-ordinate measuring machines – Scanning Electron Microscope.						
UNIT - IV		EXPERIMENT DESIGN AND DATA ANALYSIS				9
Statistical methods - Randomized block design, Latin and orthogonal squares, factorial design - Replication and randomization - Data Analysis - Deterministic and random data, uncertainty analysis - Tests for significance - Chi- square, student’s ‘t’ test - Regression modeling - direct and interaction effects - ANOVA, F-test - Time Series analysis - Autocorrelation and autoregressive modeling – RSM Technique.						
UNIT - V		DESIGN OF EXPERIMENTS				9
Types of Experiments – Experiment Design Factor – Experiment design protocol and examples. Taguchi Methods - Experiment design and planning with Orthogonal arrays and linear graphs - Additive cause effect model - Optimization of response level - Identification of Design and noise factors - Performance evaluation and Optimization by signal to noise ratios - Concept of loss function and its application. Introduction to Response surface methodology (RSM).						
L:45, Total:45 Hours						

Weightage: Continuous Assessment 40% End Semester Examinations 60%					
REFERENCE BOOKS:					
1.	Holman, J.P., "Experimental Methods for Engineers", McGraw Hill Int., New York.				
2.	Venkatesh, V.C., and Chandrasekharan, "Experimental Methods in Metal Cutting", Prentice Hall of India, Delhi.				
3.	Davis, O.V., "The Design and Analysis of Industrial Experiments", Longman, London.				
4.	Box and Jenkins; "Time Series analysis, Forecasting and control", Holden Day, Sanfrancisco				
5.	Dove and Adams, "Experimental stress analysis and motion measurement", Prentice Hall of India, Delhi.				
E-RESOURCES:					
1.	https://nptel.ac.in/courses/112106247				
2.	https://www.mathworks.com/products/statistics.html				
3.	https://doi.org/10.1016/j.procir.2024.08.361				
4.	https://www.jstor.org/stable/2990258				
5.	https://nptel.ac.in/courses/112104250				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the principles, instrumentation, calibration and applications of cutting force, displacement and strain measurement techniques.				
CO2	Analyze temperature, flow measurement and flow visualization techniques using appropriate transducers and instrumentation systems.		PO1, PO2	PSO1	
CO3	Apply characterization techniques such as optical microscopy, SEM, XRD and surface measurement methods for material analysis.		PO2, PO3	PSO1, PSO2	
CO4	Design experiments and perform statistical data analysis using DOE, ANOVA, regression, uncertainty analysis and time-series modeling techniques.		PO2, PO3	PSO2	
CO5	Apply Taguchi methods and Response Surface Methodology (RSM) for process optimization and quality improvement.		PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	1
CO2	3	3	2	2	2
CO3	3	3	2	3	2
CO4	3	3	3	3	2
CO5	3	2	3	3	3
AVERAGE	3.0	2.6	2.4	2.8	2.4

Activities:

1. Experimental Data Analysis using Statistical Tools
2. Taguchi Design and Response Surface Methodology

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Definition and Experimental Planning	20	Complete and systematic	Minor deficiencies	Inadequate planning
2.	Data Collection and Organization	20	Accurate and complete	Acceptable	Incomplete
3.	Statistical Analysis (ANOVA, Regression, F-Test)	20	Accurate and comprehensive	Minor errors	Significant errors
4.	Interpretation of Results	20	Excellent analytical skills	Adequate interpretation	Limited interpretation
5.	Technical Report & Presentation	20	Professional quality	Satisfactory quality	Poor quality
Total		100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Selection of Factors and Experimental Design	20	Highly appropriate	Adequate	Poor selection
2.	Orthogonal Array and S/N Ratio Analysis	20	Accurate and complete	Minor errors	Major errors
3.	Optimization and Model Development	20	Excellent optimization	Acceptable optimization	Limited optimization
4.	Interpretation of Results	20	Comprehensive understanding	Moderate understanding	Basic understanding
5.	Report, Presentation & Viva Voce	20	Excellent communication	Adequate communication	Poor communication
Total		100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE17	QUALITY CONCEPTS IN DESIGN		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits	3	
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To impart knowledge on engineering design principles, material selection and manufacturing processes					
2.	To learn the principles of implementing quality in a product or services using different tools					
3.	To enhance the quality of the product by the use of failure mode effect analysis and implementing methods to uphold the status of six sigma					
4.	To develop a robust product or service using various strategies of design of experiments.					
5.	To maintain the product quality through the use of statistical tools and enforcing methods to improve the product reliability.					
UNIT - I		DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION				9
Morphology of Design –Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding.						
UNIT - II		DESIGN FOR QUALITY				9
Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders- Measures and MatricesDesign of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.						
UNIT - III		FAILURE MODE EFFECTS ANALYSIS AND DESIGN FOR SIX SIGMA				9
Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist-Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling - Basis of SIX SIGMA – Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.						
UNIT - IV		STATISTICAL CONSIDERATION AND RELIABILITY				9
Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi’s approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios						
UNIT - V		DESIGN OF ENVIRONMENT				9
Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams- Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts – Matrix plots and 3-D plots.-Reliability-Survival and Failure- Series and parallel systems-Mean time between failure-Weibull distribution						
L:45, Total:45 Hours						

Weightage:
Continuous Assessment 40%
End Semester Examinations 60%

REFERENCE BOOKS:	
1.	George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw Hill Education Pvt. Ltd., 2013
2.	Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development, ,TataMcgraw-Hill Education, 2015
3.	Amitava Mitra, "Fundamentals of Quality control and improvement", John Wiley & Sons, 2016
4.	Kevin N. Otto and Kristin L. Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Prentice Hall, 2001.
5.	Montgomery, D.C., "Design and Analysis of experiments", John Wiley and Sons, 2017.
6.	Phillip J. Ross, "Taguchi techniques for quality engineering", Tata McGraw Hill, 2005

E-RESOURCES:	
1.	https://nptel.ac.in/courses/112106249
2.	https://nptel.ac.in/courses/110105039
3.	https://nptel.ac.in/courses/112106249
4.	https://nptel.ac.in/courses/102106051
5.	https://nptel.ac.in/courses/112104230

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain engineering design methodologies, material selection criteria, manufacturing considerations and design principles for quality products.		
CO2	Apply quality engineering tools such as Quality Function Deployment (QFD), House of Quality and Design of Experiments (DOE) in product development.	PO1, PO2	PSO1
CO3	Analyze product and process failures using FMEA and implement Six Sigma methodologies for quality improvement.	PO2, PO3	PSO1, PSO2
CO4	Design and conduct experiments using statistical methods, ANOVA, factorial designs and Taguchi techniques for robust product development.	PO2, PO3	PSO2
CO5	Evaluate product reliability and process performance using statistical quality control tools and reliability engineering concepts.	PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	1
CO2	3	3	2	2	2
CO3	3	3	3	2	2
CO4	3	3	3	3	2
CO5	3	2	3	3	3
AVERAGE	3.0	2.6	2.4	2.4	2.0

Activities:	
1.	Design of Experiments (DOE) and Taguchi Analysis
2.	Reliability and Statistical Quality Analysis

Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Identification of Factors and Objectives	20	Complete and accurate	Minor omissions	Incomplete identification
2.	Experimental Design Development	20	Appropriate and systematic	Adequate design	Poor design
3.	Statistical Analysis (ANOVA/Taguchi)	20	Accurate and comprehensive	Minor errors	Significant errors
4.	Interpretation of Results	20	Excellent interpretation	Acceptable interpretation	Limited interpretation
5.	Report and Presentation	20	Professional and detailed	Adequate	Poor
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Data Collection and Organization	20	Complete and accurate	Minor deficiencies	Incomplete
2.	Application of Quality Tools	20	Correct and effective	Adequate	Limited
3.	Reliability Analysis	20	Comprehensive and accurate	Moderate accuracy	Poor accuracy
4.	Statistical Interpretation	20	Excellent understanding	Adequate understanding	Basic understanding
5.	Technical Report & Viva Voce	20	Excellent presentation	Satisfactory	Limited performance
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

- | | |
|----|--|
| 1. | Fischer Cripps and Anthony C, "Introduction to Contact Mechanics", 2nd Edition, Springer Mechanical Engineering series, 2007. |
| 2. | Johnson.K.L, "Contact Mechanics", Cambridge University Press, Cambridge, 1985. |
| 3. | Valentin L. Popov, "Contact Mechanics and Friction", 2 nd Edition, Springer Mechanical Engineering series, 2007. |
| 4. | I.G.Goryacheva, "Contact Mechanics in Tribology", Springer-Science+Business Media, B.V.1998. |
| 5. | K.L. Johnson, K. Kendall, A.D. Roberts, "Surface Energy and the Contact of Elastic Solid", Proc. R. Soc.London, Ser. A 1971, 324, 301-313 |
| 6. | M.K. Chaudhury, T. Weaver, C.Y. Hui and E.J. Kramer "Adhesive contact of Cylindrical lens and a Flat Sheet", J. Appl. Phys. 1996, 80(1), 30-37 |

E-RESOURCES:

- | | |
|----|--|
| 1. | MIT open course ware solid mechanics |
| 2. | NPTEL Tribology and contact mechanics course |
| 3. | Springer link contact mechanics Resources |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the mechanical properties of materials, elasticity, plasticity, stress analysis and failure criteria used in contact mechanics.		
CO2	Analyze linear elastic fracture mechanics, stress intensity factors and brittle fracture behavior of engineering materials.	PO1, PO2	PSO1
CO3	Apply Hertzian contact theory to determine stress distribution, deformation and contact pressure in elastic indentation problems.	PO2, PO3	PSO1, PSO2
CO4	Analyze elastic-plastic indentation behavior and evaluate fracture toughness using various indenter geometries.	PO2, PO3	PSO2
CO5	Evaluate depth-sensing indentation testing methods and interpret hardness, compliance and material property measurements.	PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	-	2	-
CO2	3	3	-	2	1
CO3	3	3	2	3	2
CO4	2	3	3	3	3
CO5	2	3	3	2	3
AVERAGE	2.6	2.8	1.6	2.4	1.8

Activities:

- | | |
|----|--|
| 1. | Analysis of Elastic–Plastic Indentation Behavior using Different Indenter Geometries |
| 2. | Depth-Sensing Indentation Testing and Hardness Evaluation |

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of indentation theory	20	Complete understanding and accurate interpretation	Minor conceptual errors	Limited understanding
2.	Stress field and contact analysis	20	Accurate calculations and analysis	Moderate accuracy	Basic analysis only
3.	Comparison of indenter geometries	20	Comprehensive comparison with justification	Adequate comparison	Limited comparison
4.	Fracture toughness evaluation	20	Correct application and interpretation	Minor errors	Basic evaluation
5.	Report and presentation quality	20	Excellent organization and communication	Good presentation	Poor documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of testing methodology	20	Complete understanding of Nano indentation principles	Minor conceptual gaps	Limited understanding
2.	Load-displacement curve analysis	20	Accurate interpretation and calculations	Moderate accuracy	Basic interpretation
3.	Hardness and compliance evaluation	20	Correct determination and discussion	Minor errors	Basic calculations
4.	Application of standards and data analysis	20	Excellent application of standards	Adequate application	Limited application
5.	Technical report and presentation	20	Professional and comprehensive	Good quality	Needs improvement
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note:Purely as anExample: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

REFERENCE BOOKS:					
1.	David A.Crolla, "Automotive Engineering, Powertrain, Chassis System and Vehicle Body", 2009.				
2.	William B. Ribbens, "Understanding Automotive Electronics", 1998.				
3.	Lukin P Gasparyants G and Rodionov V, "Automobile Chassis Design and Calculations", Mir Publishers, 1989.				
4.	Heinz Heisier, "Vehicle and Engine technology", SAE New York, 1999.				
5.	Gillespie T D, "Fundamentals of Vehicle Dynamics", SAE Inc. New York, 1992.				
6.	Schwaller A E, "Motor Automotive Technology", 3 rd Edition, Delman Publishers, New York.				
E-RESOURCES:					
1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_de03				
2.	https://nptel.ac.in/courses/107106080				
3.	https://youtube.com/playlist?list=PLyqSpQzTE6M9G2SNxKfsVEjcM9MIJau4F&si=sLEmeudzs6fshcqP				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the layout, chassis construction, frame design, loading conditions and performance characteristics of automobiles.				
CO2	Analyze and design various engine components such as cylinder, piston, connecting rod, crankshaft, valves, springs and flywheel.		PO1, PO2	PSO1	
CO3	Design and evaluate clutch and braking systems, including friction clutches, drum brakes, disc brakes and anti-lock braking systems.		PO2, PO3	PSO1, PSO2	
CO4	Analyze and design transmission, suspension and steering systems for automotive applications.		PO2, PO3	PSO2	
CO5	Evaluate automotive electronic systems, sensors, actuators, engine management systems and vehicle safety systems.		PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	1
CO2	3	3	3	2	2
CO3	3	3	3	2	2
CO4	3	3	3	3	2
CO5	3	2	2	3	3
AVERAGE	3.0	2.6	2.4	2.4	2.0
Activities:					
1.	Design and Analysis of Transmission / Suspension System				
2.	Study of Automotive Electronic Systems				

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification and Requirement Analysis	20	Complete understanding	Minor deficiencies	Limited understanding
2.	Design Calculations	20	Accurate and systematic	Few errors	Major errors
3.	Component Selection	20	Appropriate and optimized	Acceptable	Inappropriate
4.	CAD Model / Drawing	20	Detailed and professional	Adequate	Poor quality
5.	Technical Report & Interpretation	20	Excellent analysis	Moderate analysis	Limited analysis
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Sensors and Actuators	20	Thorough understanding	Adequate understanding	Basic understanding
2.	System Analysis	20	Comprehensive analysis	Moderate analysis	Limited analysis
3.	Application of Automotive Electronics	20	Correct and innovative	Acceptable	Incomplete
4.	Presentation and Documentation	20	Professional and clear	Satisfactory	Poor
5.	Viva Voce Performance	20	Excellent responses	Adequate responses	Limited responses
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26CDE20	DESIGN OF MATERIAL HANDLING EQUIPMENT (Use of approved Data Book and Charts may be permitted)			SEMESTER		III
Prerequisites			Category	ES(PE)	Credits	3
			Hours/ Semester	L	T	P
				45	0	0
COURSE OBJECTIVES						
1.	To study different types of material handling systems used for engineering and process industries.					
2.	To design of various hoisting gears and brakes for different material handling applications.					
3.	To design various type of surface and overhead transportation equipment's.					
4.	To design of elevators for various manufacturing and service applications.					
5.	To development of conveyer systems for material flow in different industrial production systems					
UNIT - I		FLEXIBLE HOISTING APPLIANCES				9
Type- selection and applications of material handling equipment- choice of material handling equipment – hoisting equipment – components and theory of hoisting equipment – chain and ropes – selection of ropes-pulleys- pulley systems- sprockets and drums.						
UNIT - II		LOAD HANDLING EQUIPMENTS AND BRAKES				9
Forged standard hooks – forged Ramshorn hooks – solid triangular eye hooks –crane grabs- electric lifting magnetic– grabbing attachments for loose materials. Arresting gear – brakes: shoe- band and cone types – elements of shoe brakes –thermal calculation in shoe brakes.						
UNIT - III		SURFACE AND OVERHEAD TRANSPORTATION EQUIPMENTS				9
Hand operated trucks – powered trucks – tractors – electronically controlled tractors - hand truck on rails – industrial railroad equipments: locomotives - winches – capstans – turntables – monorail conveyors –pipe rail systems – flat bar monorails. Rail traveling mechanism- cantilever and monorail cranes- cogwheel drive-monocable tramways-reversible tramways.						
UNIT - IV		ELEVATING EQUIPMENTS				9
Continuous-motion vertical conveyors – reciprocating-motion vertical conveyors – stackers – work levelers and tail gates – industrial lifts – passenger lifts – freight elevators – mast type elevators – vertical skip hoist elevators- bucket elevators: design- loading and bucket arrangements.						
UNIT - V		CONVEYING EQUIPMENTS				9
Belt conveyors - chain conveyors – apron conveyors – escalators – flight conveyors – roller conveyors - oscillating conveyors - design of belt conveyors- screw conveyors and pneumatic conveyors						
L:45, Total:45 Hours						
Weightage: Continuous Assessment 40% End Semester Examinations 60%						
REFERENCE BOOKS:						
1.	Rudenko. N, "Materials Handling Equipment", MIR Publishers, 1969.					
2.	Spivakovsky. A.O and Dyachkov. V.K, "Conveying Machines- Volume I and II", MIR Publishers, 1985					
3.	Alexandrov M, "Materials Handling Equipments", MIR Publishers, 1981					
4.	Boltzharol A, "Materials Handling Handbook", The Ronald Press Company, 1958.					

5.	P.S.G Tech, "Design Data Book", KalaikathirAchchagam, 2008.
6.	Lingaiah. K and NarayanaIyengar, "Machine Design Data Hand Book- Vol. 1 & 2", Suma Publishers, 1983.

E-RESOURCES:

1.	https://nptel.ac.in/courses/112105124
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COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the selection, construction and working principles of flexible hoisting appliances such as chains, ropes, pulleys, sprockets and drums used in material handling systems.		
CO2	Design load handling equipment, hooks, grabs and braking systems for various industrial lifting applications.	PO1, PO2	PSO1
CO3	Analyze and design surface and overhead transportation equipment including trucks, cranes, monorails and tramways.	PO2, PO3	PSO1, PSO2
CO4	Design and evaluate elevating equipment such as lifts, elevators, stackers and bucket elevators for industrial applications.	PO2, PO3	PSO2
CO5	Design and develop conveyor systems including belt, chain, screw and pneumatic conveyors for material transportation.	PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	1	2	1
CO2	3	3	2	2	2
CO3	3	3	3	2	2
CO4	3	2	3	3	2
CO5	3	2	3	3	3
AVERAGE	3.0	2.4	2.4	2.4	2.0

Activities:

1.	Design of Bucket Elevator
2.	Design of Belt Conveyor System

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification	20	Complete understanding	Minor errors	Poor understanding
2.	Design Calculations	20	Accurate calculations	Few errors	Many errors

3.	Component Selection	20	Appropriate selection	Acceptable selection	Incorrect selection
4.	Drawing & Presentation	20	Professional and neat	Moderate quality	Poor presentation
5.	Report & Interpretation	20	Excellent analysis	Partial analysis	Limited analysis
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Data Collection & Assumptions	20	Complete and correct	Minor omissions	Incomplete
2.	Design Calculations	20	Accurate and systematic	Few mistakes	Major mistakes
3.	Selection of Components	20	Optimum selection	Acceptable selection	Incorrect selection
4.	CAD Drawing / Layout	20	Detailed and neat	Moderate quality	Poor quality
5.	Technical Report & Viva	20	Excellent explanation	Adequate explanation	Poor explanation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26AC001	ENGLISH FOR RESEARCH PAPER WRITING M.E. (Common to all Branches)			SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
Basic proficiency in English and familiarity with academic and technical writing.			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To develop awareness of the importance of English in academic and research communication.						
2.	To familiarize learners with the structure and organization of research papers.						
3.	To improve learners’ ability to use appropriate academic language and expressions in research writing.						
4.	To help learners avoid common language errors and improve the quality of their research papers.						
5.	To enable learners to write and present research work using accepted academic conventions.						
UNIT - I	FUNDAMENTALS OF RESEARCH AND ACADEMIC WRITING						6
Research and its significance. Purpose, characteristics, and structure of a research paper. Types of research publications. Identifying research problems and defining objectives. Features of academic English, including formal and objective style. Academic vocabulary, clear and concise sentence construction, and avoidance of redundancy and common grammatical errors. Selection of appropriate journals and conferences for publication.							
UNIT - II	LANGUAGE PATTERNS IN RESEARCH WRITING						6
Common phrases for introducing research problems, stating objectives, describing methods, and presenting results. Use of active and passive voice. Appropriate tense forms in research writing. Cohesion and coherence through linking words and transitions.							
UNIT - III	IMPROVING RESEARCH WRITING						6
Hedging in academic writing. Paraphrasing and summarizing techniques. Plagiarism and ethical writing practices. Identifying and correcting common language mistakes. Editing and proof reading strategies.							
UNIT - IV	REVIEW WRITING AND REVIEW OF LITERATURE						6
Purpose and structure of review articles. Review of Literature (RoL): literature search, synthesis of findings, and identification of research gaps. Citation practices and avoidance of plagiarism. Practical exercises in organizing literature and drafting literature review sections.							
UNIT - V	WRITING RESEARCH PAPER SECTIONS						6
Writing effective titles, abstracts, introductions and conclusions. Presenting findings and discussions clearly. Language for oral presentation of research. Useful phrase banks for different sections of a research paper and research presentations.							
L:30, Total:30 Hours							
Weightage: Continuous Assessment - 100%							

REFERENCE BOOKS:

1.	Wallwork, Adrian. English for Writing Research Papers. 3 rd ed., Springer, 2023.
2.	Swales, John M., and Christine B. Feak. Academic Writing for Graduate Students: Essential Tasks and Skills. 4 th ed., University of Michigan Press, 2020.
3.	Glasman-Deal, Hilary. Science Research Writing for Non-Native Speakers of English. 2 nd ed., Imperial College Press, 2020.
4.	Cargill, Margaret, and Patrick O'Connor. Writing Scientific Research Articles: Strategy and Steps. 3 rd ed., Wiley-Blackwell, 2021.
5.	Day, Robert A., Barbara Gastel, and Michelle Prince. How to Write and Publish a Scientific Paper. 9 th ed., Greenwood, 2022.

E-RESOURCES:

1.	Author Academy – https://authoracademy.springernature.com
2.	Researcher Academy – https://researcheracademy.elsevier.com
3.	Learn English (British Council) - https://learnenglish.britishcouncil.org/skills/writing
4.	Academic Phrase bank – https://www.phrasebank.manchester.ac.uk
5.	Committee on Publication Ethics (COPE) – https://publicationethics.org

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the significance of research communication and describe the structure, purpose, and types of research publications.	PO1, PO2	
CO2	Apply appropriate academic vocabulary, sentence structures, and language conventions in research writing.	PO1, PO2	
CO3	Use academic language patterns, cohesive devices, and appropriate grammatical structures to communicate research ideas effectively.	PO1, PO2	
CO4	Analyze research papers to identify writing styles, language patterns, and common grammatical error	PO1, PO2	
CO5	Demonstrate ethical research writing practices through effective paraphrasing, citation, referencing, and avoidance of plagiarism.	PO1, PO2	

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2			
CO2	3	3			
CO3	2	3			
CO4	2	3			
CO5	3	3			

Activities:

1.	(i) Assignment 1: Research Paper Analysis and Language Evaluation Select a published research paper from your discipline and analyze its structure, purpose, and major components. Evaluate the use of academic vocabulary, sentence structures, language patterns, cohesive devices, and grammatical conventions. Comment on the effectiveness of the writing and identify areas for improvement. (ii) Assignment 2: Academic Rewriting and Editing Choose a technical text or an excerpt from a research article and revise it using appropriate academic vocabulary, formal style, cohesive devices, and correct grammatical structures. Explain the revisions made and discuss how they improve the quality and clarity of research communication. (iii) Assignment 3: Review of Literature and Research Gap Identification Select a research topic related to your specialization and review at least five recent research articles. Summarize the major findings using appropriate academic language and transitions, compare the studies, identify research gaps, and present the review in a coherent academic format. (iv) Assignment 4: Analysis of Research Writing Conventions Analyze two published research papers from your discipline and compare their writing conventions, language patterns, organization, and presentation of research findings. Examine the use of academic expressions, cohesion, citation practices, and ethical writing principles. Suggest improvements where necessary.
2.	PRESENTATION: (i) Presentation 1: Ethical Issues in Research Writing Discuss plagiarism, self-plagiarism, authorship issues, citation ethics, and the responsibilities of researchers in academic publishing. Illustrate the discussion with examples from published research articles and explain strategies for maintaining academic integrity. (ii) Presentation 2: Paraphrasing, Citation, and Referencing in Research Writing Present effective techniques for paraphrasing and summarizing research literature. Demonstrate the use of citation and referencing styles commonly adopted in academic publications and discuss methods for avoiding plagiarism. (iii) Presentation 3: Review of Literature and Research Gap Identification Select a research topic from your area of specialization and present a brief review of relevant literature. Summarize key findings from published studies, compare their contributions, identify research gaps, and explain how ethical citation practices are followed in the review process. (iv) Presentation 4: Presenting Research Paper Sections Prepare and present the title, abstract, introduction, methodology, findings, and conclusion of a selected research paper. Highlight the language conventions, organization, and presentation strategies used for effective research communication. (v) Presentation 5: Research Conference and Poster Presentation Design and deliver a short conference-style or poster presentation based on a research article or review paper. Demonstrate effective presentation techniques, audience engagement, response to questions, and adherence to ethical practices in reporting and acknowledging sources.

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Understanding and Application of Concepts	25	Shows excellent understanding of the topic	Shows good understanding with minor gaps	Shows basic understanding with several gaps

2.	Analysis and Critical Observation	25	Presents clear and relevant analysis	Adequate analysis with minor omissions	Limited analysis and observations
3.	Organization, Clarity and Coherence	25	Well-organized and easy to follow	Generally organized with minor issues	Organization is weak or inconsistent
4.	Academic Language and Accuracy	25	Accurate academic language with minimal errors	Few language errors that do not affect clarity	Frequent language errors but meaning is understandable
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Assignment	Presentation	Percentage allocation	Mapping Strength
CO1	25		12.5	2
CO2	25		12.5	2
CO3	25		12.5	2
CO4	25		12.5	2
CO5		50	50	3
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26AC002		DISASTER MANAGEMENT			SEMESTER		I/II
Prerequisites				Category	AC	Credits	
				Hours/ Semester	L	T	P
					30	0	0
COURSE OBJECTIVES							
1.	To have a critical understanding of key concepts in disaster risk reduction and humanitarian response and critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations and evaluate the strengths and weaknesses of disaster management approaches. Planning and programming in different countries, particularly their home country or the countries they work in.						
UNIT - I		INTRODUCTION					6
Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Disaster Prone Areas in India: Study of Seismic Zones; Area Prone to floods and droughts, Landslides and avalanches; Areas prone to cyclonic and coastal hazards with special reference to Tsunami; Post- Disaster diseases and epidemics.							
UNIT - II		REPERCUSSIONS OF DISASTERS AND HAZARDS					6
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.							
UNIT - III		DISASTER PREPAREDNESS AND MANAGEMENT					6
Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.							
UNIT - IV		RISK ASSESSMENT					6
Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.							
UNIT - V		DISASTER MITIGATION					6
Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.							
L: 30, Total: 30 Hours							
Weightage:							
Continuous Assessment - 100%							

REFERENCE BOOKS:

- | | |
|----|---|
| 1. | R. Nishith, Singh AK 2012 Disaster Management in India: Perspectives, issues and strategies New Royal Book Company, Lucknow |
| 2. | Sahni, PardeepEt.Al. (Eds.) 2002 Disaster Mitigation Experiences and Reflections. Prentice Hall Of India, New Delhi |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs****CO1**

Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2

Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3

develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations

CO4

Critically understand the strengths and weaknesses of disaster management approaches

26AC003	SANSKRIT FOR TECHNICAL KNOWLEDGE			SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To get a working knowledge in illustrious Sanskrit, the scientific language in the world. Learning Sanskrit to improve brain functioning. Learning Sanskrit to develop logic in mathematics, science & other subjects enhances the memory power. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.						
UNIT - I		ALPHABETS					10
Alphabets in Sanskrit –Past/Present/Future Tense –Simple Sentences							
UNIT - II		LITERATURE					10
Order –Introduction of roots –Technical information about Sanskrit Literature							
UNIT - III		CONCEPTS					10
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics							
L: 30, Total: 30 Hours							
Weightage:							
Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	“AbhyasaPustakam”- Dr.Vishwas, Samskrita- Bharati Publication, New Delhi						
2.	“Tech Yourself Sanskrit” PrathamaDeeksha-Vempatikutumbshastri, Rashtriya Sanskrit Sansthan, New Delhi Publication						
3.	India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Understanding basic Sanskrit language.						
CO2	Ancient Sanskrit literature about science & technology can be understood.						
CO3	Being a logical language will help to develop logic in students						

26AC004		VALUE EDUCATION		SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To understand the Importance of value education and self-development. To imbibe good values in students and also know about the importance of character.						
UNIT - I		BASIC VALUES					7
Values and self-development- Social values and individual attitudes-Work ethics, Indian vision of Humanism Moral and Non Moralvaluation-Standards and principles-Value judgments.							
UNIT - II		CONFIDENCE					7
Importance of cultivation of values- Sense of Duty-Devotion-Self-reliance-Confidence-Concentration-Truthfulness-CleanlinesHonesty-Humanity-Power of faith-National Unity-Patriotism-Love for nature-Discipline.							
UNIT - III		PERSONALITY DEVELOPMENT					8
Personality and Behavior Development-Soul and Scientific attitude - Positive – Thinking - Integrity and discipline -Punctuality – Love and Kindness - Avoid fault Thinking - Free from anger - Dignity of labor - Universal brotherhood and religious tolerance –True friendship –Happiness Vs. suffering –love for truth – Aware of self-destructive habits- Association and Cooperation –Doing best for saving nature.							
UNIT - IV		LOVE AND COMPASSION					8
Character and Competence –Holy books Vs. Blind faith –Self –management and Good health – Science of reincarnation –Equality – Non Violence –Humility -Role of Women –All religions and same message –Mind your Mind –Self -control –Honesty –Studying effectively.							
L: 30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	Chakraborty, S.K. "Values and Ethics for Organization Theory and Practice", Oxford University Press, New Delhi, 1998.						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Knowledge of self-development.						
CO2	Learn the importance of Human values.						
CO3	Developing the overall personality.						

26AC005		CONSTITUTION OF INDIA		SEMESTER		I/II
Prerequisites			Category	AC	Credits	0
			Hours/ Semester	L	T	P
				30	0	0
COURSE OBJECTIVES						
1.	Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.					
UNIT - I		HISTORY OF MAKING OF INDIAN CONSTITUTION				5
History, Drafting Committee (Composition & working)						
UNIT - II		PHILOSOPHY OF THE INDIAN CONSTITUTION				5
Preamble, Salient Features						
UNIT - III		CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES				5
Fundamental rights, right to equality, right to freedom, right against exploitation, right to freedom of religion, cultural and education rights, right to constitutional remedies, directive principles of state policy, fundamental duties.						
UNIT - IV		ORGANS OF GOVERNANCE				5
Parliament, composition, qualifications and disqualifications, powers and functions, executive, president, governor, council of ministers, judiciary, appointment and transfer of judges, qualifications, powers and functions.						
UNIT - V		LOCAL ADMINISTRATION				5
Districts administration head: role and importance, municipalities: introduction, mayor and role of elected representative, CEO of municipal corporation. Panchayati raj: introduction, PRI: zila panchayat. Elected officials and their roles, CEO zila panchayat: position and role. Block level: organizational hierarchy (different departments), village level: role of elected and appointed officials, importance of grass root democracy.						
UNIT - VI		ELECTION COMMISSION				5
Election Commission: role and functioning. Chief election commissioner and election commissioners. State election commission: role and functioning. Institute and bodies for the welfare of SC/ST/OBC and women.						
L: 30, Total: 30 Hours						
Weightage: Continuous Assessment - 100%						
REFERENCE BOOKS:						
1.	The Constitution of India, 1950 (Bare Act), Government Publication					
2.	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.					
3.	M. P. Jain, Indian Constitution Law, 7th Edn., LexisNexis, 2014.					
4.	D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015					

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
C01	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics		
C02	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.		
C03	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution		
C04	Discuss the passage of the Hindu Code Bill of 1956		

26AC006		PEDAGOGY STUDIES			SEMESTER		I/II	
Prerequisites				Category	AC	Credits		0
				Hours/ Semester	L	T	P	TH
					30	0	0	30
COURSE OBJECTIVES								
1.	To Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers. Identify critical evidence gaps to guide the development.							
UNIT - I		INTRODUCTION AND METHODOLOGY						6
Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching								
UNIT - II		THEMATIC OVERVIEW						6
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.								
UNIT - III		EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES						6
Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.								
UNIT - IV		PROFESSIONAL DEVELOPMENT						6
Alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes.								
UNIT - V		RESEARCH GAPS AND FUTURE DIRECTIONS						6
Research design, Contexts, pedagogy, teacher education, curriculum and assessment, dissemination and research impact.								
L: 30, Total: 30 Hours								
Weightage: Continuous Assessment - 100%								

REFERENCE BOOKS:			
1.	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.		
2.	Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3) 361-379.		
3.	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID		
4.	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic math and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282.		
5.	Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?		
CO2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?		
CO3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?		

26AC007		STRESS MANAGEMENT BY YOGA			SEMESTER		I/II	
Prerequisites				Category	AC	Credits		0
				Hours/ Semester	L	T	P	TH
					30	0	0	30
COURSE OBJECTIVES								
1.	To create a healthy, strong willed and intelligent young society through yoga practices							
UNIT - I		PHYSICAL AND MENTAL HEALTH						6
Pain and disease - free life, Simplified Physical Exercise- Pranayama. Concentration on Pituitary gland- Practical, Goal fixing								
UNIT - II		REJUVENATION OF LIFE FORCE AND WILL POWER						6
Principle of kayakalpa yoga, mind, life force and Biomagnetism, Practical, Concentration on Muladhara- Practical, Analysis of thought –Will power								
UNIT - III		DEVELOPMENT OF VIRTUES						6
Activation of Dormant Brain cells- Practical, Moralization of dezire and its classification, Neutralization of Anger, Results of anger								
UNIT - IV		STREAM LINING OF MIND						6
Definition of Mind-Worries, Eradication of Worries. The science behind blessings. Blessing techniques. Benefits, five basic duties								
UNIT - V		CAUSE AND EFFECT SYSTEM						6
Law of nature, Hereditary Imprints, Fivefold and Two-fold culture, good values and Resolution for world peace								
L: 30, Total: 30 Hours								
Weightage: Continuous Assessment - 100%								
REFERENCE BOOKS:								
1.	"Thirukkural" , Pearls of Inspiration, Translation by Rajaram, Publisher :RUPA							
2.	"Bharathiyar Poems", Amazon Asia – Pacific Holdings Private Limited							
3.	"Yoga for Humane Excellence" ,Vethathiri Maharishi, Vision for Wisdom, Vethathiri Publications							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					Mapping POs		Mapping PSOs	
CO1	Maintain good Physical health.							
CO2	Develop will power.							
CO3	Take quick and right decisions.							
CO4	Maintain good relationship with everyone around them his creating a Health Society							

26AC008	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS			SEMESTER		I/II
Prerequisites			Category	AC	Credits	0
			Hours/ Semester	L	T	P
				30	0	0
TH						
30						
COURSE OBJECTIVES						
1.	To learn to achieve the highest goal happily,					
2.	To become a person with stable mind, pleasing personality and determination,					
3.	To awaken wisdom in students.					
UNIT - I						
UNIT - I		NEETISATAKAM – HOLISTICS DEVELOPMENT OF PERSONALITY				6
Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)						
UNIT - II		NEETISATAKAM — HOLISTIC DEVELOPMENT OF PERSONALITY (CONT'D)				6
Verses 52, 53, 59 (don'ts) - Verses 71.73.75 & 78 (do's) - Approach to day to day works and duties.						
UNIT - III		INTRODUCTION TO BHAGAVADGEETHA FOR PERSONALITY DEVELOPMENT				6
Shrimad Bhagavadgeetha: Chapter 2 — Verses 41, 47, 48 - Chapter 3 — Verses 13,21,27,35 - Chapter 6 - Verses 5,13,17,23,35 - Chapter 18 - Verses 45,40,48 Chapter - 6: Verses 5, 13, 17, 23, 35; Chapter - 18: Verses 45, 46, 48						
UNIT - IV		STATEMENTS OF BASIC KNOWLEDGE - SHRIMAD BHAGAVADGEETHA				6
Chapter 2- Verses 56, 62,68 - Chapter 12 — Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.						
UNIT - V		ROLE OF BHAGAVADGEETHA IN THE PRESENT SCENARIO				6
Chapter 2 — Verses 17 - Chapter 3 — Verses 36, 37, 42 - Chapter 4 — Verses 18, 38, 39 - Chapter 18 — Verses 37, 38, 63.						
L: 30, Total: 30 Hours						
Weightage: Continuous Assessment - 100%						
REFERENCE BOOKS:						
1.	"Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata					
2.	Bhartrihari's Three Sataskam (Niti- Sringar – Vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.					

E-RESOURCES:

1. NTPEL: <http://nptel.ac.in/downloads/109104115>

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Develop their personality and achieve their highest goal of life.		
CO2	Lead the nation and mankind to peace and prosperity.		
CO3	Practice emotional self-regulation.		
CO4	Develop a positive approach to work and duties.		
CO5	Develop a versatile personality.		

26AC009	SUSTAINABLE DEVELOPMENT GOALS		SEMESTER		I/II		
PREREQUISITES			Category	AC	Credits	0	
			Hours/ Semester	L	T	P	TCP
				30	0	0	30
COURSE OBJECTIVES							
1.	To understand the concepts of Sustainable Development Goals						
2.	To study sustainability assessment methods, education for sustainable development						
3.	To analyze the problems and solution in environmental management.						
4.	To analyze the issues related to resource utilization.						
5.	To explore knowledge about life cycle assessment.						
UNIT - I		INTRODUCTION TO SUSTAINABLE DEVELOPMENT					6
Need and Importance of Sustainable Development - Historical & Policy perspectives of Sustainable Development - Sustainable Development: World and India Perspective - Introduction to 17 SDGs - Specific learning objectives for different SDGs - Challenges & strategies of attaining SDGs in developed and developing nations.							
UNIT - II		SDG QUALITY EDUCATION					6
Focus of NEP-2020 on SDG - Education for Sustainable Development - Berlin Declaration 2021 on ESD - Integration of ESD - Tools, Systems, and Innovation for Sustainability - Measuring Sustainability.							
UNIT - III		SUSTAINABLE COMMUNITIES AND RESOURCE CONSERVATION					6
Circular economy (basic model of reuse, recycle, and reduce) - Rural & urban Problems & Challenges - Sustainable production and consumption - Renewable energy - Health & Hygiene, water, sanitation & water management - Waste Management.							
UNIT - IV		CLIMATE CHANGE, ENERGY AND SUSTAINABLE DEVELOPMENT					6
The greenhouse effect: Causes and Consequences - Climate Change: A Threat to Sustainable Development - Adaptation to Current and Future Climate Regimes - Consequences: crop failure - Solutions technology and lifestyle changes - Mitigating Climate Change.							
UNIT - V		SUSTAINABLE BUSINESS PRACTICES					6
Corporate Social Responsibility - Sustainable products and services - Business and Environment - Corporations and Ecological Sustainability - Life Cycle Assessment: LCA Overview and Application - World peace and justice: United nations goals for peace and justice - World Government for peace.							
L:30, Total:30 Hours							
Weightage:							
Continuous Assessment - 100%							

REFERENCE BOOKS:	
1.	Onyeka Osuji, "Corporate Social Responsibility in Developing and Emerging Markets", Cambridge, 2022.
2.	Ram Kumar, Ch Lakshmi, Sandee, Janaki, "Smart Cities for Sustainable Development", Springer Switzerland, 2022.
3.	Surender Kumar and Shunsuke Managi, "The Economics of Sustainable Development: The Case of India (Natural Resource Management and Policy)", Springer Switzerland, 2009.
4.	Sushma Goyal, "Management of Resources for Sustainable Devpt", The Orient Blackswan, 2016.
5.	S. Ramaswamy Sathis G. Kumar, "Energy, Environment and Sustainable Development: Issues and Policies", Regal Publications, 2009.
E-RESOURCES:	
1.	https://www.un.org/sustainabledevelopment/
2.	https://www.aiu.ac.in/documents/AIU_Publications/UN-SDG goals
3.	https://www.unesco.org/en/education-sustainable-development
4.	https://onlinecourses.nptel.ac.in/noc23_hs57/preview
5.	https://www.iau-hesd.net/news/5180-berlin-declaration-education-sustainable development-adopted-unesco-esd-conference-17-19
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to	
CO1	Explain the concepts of Sustainable Development and United Nations Sustainable Development Goals (SDGs), sustainability assessment methods, and their significance in national and global contexts.
CO2	Apply the challenges related to resource utilization, circular economy, renewable energy, sustainable production and consumption, environmental management, climate change, and their impact on society and sustainable development.
CO3	Analyze the sustainable business practices, corporate social responsibility, ecological sustainability, life cycle assessment, and global initiatives for achieving environmental protection, social equity, peace, and sustainable growth.
CO4	Design and develop a sustainability assessment project, case study, field survey, or community-based solution for a selected SDG.
CO5	Demonstrate professional competency through technical seminar presentations/group discussions, or preparation of technical reports on emerging trends, innovations, policies, and best practices related to SDG.