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||Jai Sri Gurudev||

Sri Adichunchanagiri Shikshana Trust (R.)

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

AICTE Approved, Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF(151-300) in 2023,Gold Rated by QS I-Gauge

P.B. No.20, B.B Road, Chikkaballapur - 562 101, Karnataka

Estd : 1986

I & II Semester
Scheme & Syllabus of M.Tech Programme
Machine Design
(2026 Scheme)

Core Values

Spiritual, **J**udicious, **C**ommitment, **I**ntegrity, **T**rustworthy



NATIONAL INSTITUTIONAL RANKING FRAMEWORK 151-300

A+ NAAC

QS I-GAUGE GOLD

INSTITUTION'S INNOVATION COUNCIL (Ministry of HRD Initiative) 4-Star Rating



||jai sri gurudev||
Sri Adichunchanagiri Shikshana Trust (R.)
SJC INSTITUTE OF TECHNOLOGY
(An Autonomus Institute Under VTU Belagavi & Approved by AICTE, New Delhi)
Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF (151-300), QS-I Gauge GOLD Rated
Post Box #20, B.B. Road, Chikkaballapur - 562 101, Karnataka
Estd.:1986

Scheme of Teaching and Examinations (2026)

M.Tech.(Machine Design)

Choice-Based Credit System (CBCS) and Outcome-Based Education (OBE)

I SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching and Learning Scheme					Examination				Credits
					Classroom Instruction (CI) hours per semester		Laboratory Instruction (LI) hours Per semester	Term work s self -learning in hours	Teaching -Learning hours per semester = CI +LI+TW+SL	Duration in h ours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	TW+SL						
1	MAT/PCC	1MMAT101	Computational Mathematics		42	0	0	48	90	3	50	50	100	3
2	PCC	1MME102	Advanced Materials and Processing		42	0	0	48	90	3	50	50	100	3
3	PCC	1MME103	Advanced Mechanics of Solids		42	0	0	48	90	3	50	50	100	3
4	IPCC	1Mxx104x	Integrated Professional Core Course-I		42	0	28	50	120	3	50	50	100	4
5	PEC	1Mxx105x	Professional Elective Course-I		42	0	0	48	90	3	50	50	100	3
6	PEC	1Mxx106x	Professional Elective Course-II		42	0	0	48	90	2	50	50	100	3
7	PCCL	1MxxL107x	Professional Core Courses Labs		--	--	28	2	30	03	50	50	100	1
8	NCMC	1MRMI108	Research Methodology and IPR		Online course (online.vtu.ac.in)									PP
									Total	**600**	--	**350**	**350**	**700**	**20**

Professional Elective Courses (PECs): Professional Elective Courses – PEC–I and PEC–II – are common to all branches of specialization within a particular Engineering stream. Students may choose the most appropriate elective based on their field of specialization and academic requirements. Note: The number of courses listed under each PEC group may exceed four, depending on the specializations under one stream.

Integrated Professional Core Courses (IPCC): The 1Mxx104x Group comprises specialization-specific core courses that are integrated with a practical component, ensuring application-oriented learning aligned with industry and research needs. The number of courses in the group depends on the number of specializations offered under a particular engineering stream.

Integrated Professional Core Course (IPCC)	
Code	**Title of the Course**
1MME104A	Advanced Design and Structural Analysis
1MME104B	Advanced Manufacturing Processes & Digital Factory
1MME104C	Computational Fluid Dynamics & Energy Systems
1MME104D	Advanced Materials Engineering & Characterization
1MME104E	Robotics, Ai, And Mechatronic Systems
1MME104F	Press Tool Design

Professional Elective Courses-I	
Code	**Title of the Course**
1MME105A	Advanced Structural Dynamics and Vibration Control
1MME105B	Micro And Nano Manufacturing Technologies
1MME105C	Advanced Combustion and Emission Control
1MME105D	Nanostructured Materials and Surface Engineering
1MME105E	Cyber-Physical Systems In Mechanical Engineering
1MME105F	Jigs & Fixtures Design
1MME105G	Industrial Internet of Things

Professional Elective Courses-II	
Code	**Title of the Course**
1MME106A	Design For Reliability and Lifecycle Engineering
1MME106B	Lean Manufacturing and Sustainable Production Systems
1MME106C	Heat Transfer In Multiphase and Micro-Scale Systems
1MME106D	High-Temperature Materials and Creep Mechanics
1MME106E	Biomechanics and Biomedical Applications
1MME106F	Gauges & Measurements

Professional Core Courses Lab (PCCL)	
Code	**Title of the Course**
1MMEL107A	Ai and Robotics Laboratory
1MMEL107B	Manufacturing Automation Lab (CNC/CIM)
1MMEL107C	Product Design Visualization Engineering Lab
1MMEL107D	Engineering Computational Lab
1MMEL107E	Tool Design Engineering Lab - 1

Semester: I						
Computational Mathematics						
Course Code	**:**	1MMAT101		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand vector spaces, orthogonality, eigen concepts and matrix decomposition techniques.
CLO2	Apply probability concepts to analyze multiple random variables and their distributions.
CLO3	Use PCA and factor analysis for dimensionality reduction and data interpretation.
CLO4	Formulate and solve engineering optimization problems using suitable optimization techniques.
CLO4	Apply numerical methods to obtain solutions of differential and partial differential equations.

Module – 1	**08 Hrs**
Vector Spaces and Orthogonality: Vector spaces and subspaces, linear independence, basis and dimension, four fundamental subspaces, change of basis. Inner product, orthogonal vectors, orthogonal projections, orthogonal bases. Eigen subspaces, Gram-Schmidt orthogonalization process, QR factorization and singular value decomposition.	
Module – 2	**08 Hrs**
Multiple Random variables: Joint probability mass functions and probability density functions, marginal density function, conditioning of random variables, statistical independence, correlation and covariance functions, covariance and correlation matrices, transformation of random variables, Markov and Chebyshev inequalities, Gaussian distribution-Multivariate normal density and its properties	
Module – 3	**08 Hrs**
Principal component analysis and Factor analysis: Overview of principal component analysis and factor analysis, eigen structure of covariance or correlation matrix. Principal component-standardized variables, covariance matrices. Factor model-principal component method, maximum likelihood method, factor scores, factor rotation.	
Module – 4	**08 Hrs**

Engineering optimization: Engineering applications of optimization, statement of an optimization problem design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, constraint qualification.	
Module – 5	**08 Hrs**
Numerical solution of differential equations: Boundary value problems–finite difference method for linear and nonlinear problems, shooting method and Galerkin method. Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Illustrate the fundamental concepts of distributions, linear algebra, differential equations and optimization arising in various fields engineering.
CO2	Derive the solution by applying the acquired knowledge and skills of statistical/numerical/optimization techniques to solve problems of probability distributions, linear algebra and differential equations.
CO3	Evaluate the solution of the problems using appropriate statistical numerical and optimization techniques to the real world problems arising in many practical situations
CO4	Compile the overall knowledge of probability distributions, linear algebra and optimization methods gained to engage in life – long learning.

Text Books	
1	Richard A Johnson and Dean W Wichern, “Applied Multivariate Statistical Analysis”, Pearson Prentice Hall, 6th Edition, 2007,, ISBN-13: 978-0-13-187715-3, ISBN-10: 0-13-187715-1.
2	Gilbert Strang, “Linear Algebra and its Applications”, Cengage Learning, 4th Edition, 2006, ISBN 9780980232

Reference Books	
1	Edgar G. Goodaire “Linear Algebra: Pure & Applied Kindle Edition”, World Scientific, 1st Edition, 2013, ISBN-13: 978-9814508360.
2	M K Jain, S. R. K. Iyengar, R. K. Jain; Numerical methods for scientific and engineering computation; New Age International Publishers; 6th edition; 2012; ISBN-13: 978-81-224-2001-2.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**	**2**	**2**	
CO2	**3**	**3**	**2**	**3**	**2**	
CO3	**3**	**3**	**3**	**3**	**3**	
CO4	**3**	**3**	**3**	**2**	**2**	
CO5	**3**	**3**	**3**	**3**	**3**	

Semester: I						
Advanced Materials and Processing						
Course Code	**:**	1MME102		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	50		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the structure, properties, and applications of advanced materials and alloys.
CLO2	Explain various metal processing, casting, forming, and heat treatment techniques.
CLO3	Describe the structure, properties, and processing methods of ceramics, glasses, and polymers.
CLO4	Analyze composite and hybrid materials, their manufacturing techniques, and engineering applications.
CLO5	Identify emerging smart, nanomaterials, and sustainable materials for eco-friendly engineering applications.

Module – 1	**08 Hrs**
Structure and Properties of Advanced Materials: Crystal structures, defects, and Mechanical, thermal, and optical properties. Advanced alloys (superalloys, shape memory alloys). Case studies: aerospace and biomedical applications.	
Module – 2	**08 Hrs**
Processing of Metals and Alloys: and casting Powder metallurgy and additive manufacturing, treatments (forging, rolling, extrusion), Heat treatment and surface engineering.	
Module – 3	**08 Hrs**
Ceramics and Polymers: Structure and properties of ceramics and glasses, Ceramic processing: sintering, hot pressing, sol-gel. Polymers: thermoplastics, thermosets, elastomers, Processing methods: injection molding, extrusion, 3D printing.	
Module – 4	**08 Hrs**
Composite and Hybrid Materials: Classification: fiber-reinforced, particle-reinforced, laminated composites. techniques: lay-up, pultrusion, resin transfer molding. Hybrid materials and functionally graded materials, Applications in automotive, aerospace, and construction.	
Module – 5	**08 Hrs**
Emerging Materials and Sustainability: Nanomaterials: synthesis, characterization, applications. Smart materials: piezoelectric, magnetostrictive, shape-memory polymers. Bio-materials and eco-friendly materials. Sustainability in material processing: recycling, green manufacturing.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the structure, properties, and applications of advanced engineering materials.
CO2	Analyze processing techniques for composites, ceramics, polymers, and smart materials.
CO3	Evaluate the role of nanomaterials and smart materials in engineering applications.
CO4	Apply material selection principles for industrial design and manufacturing.
CO5	Assess sustainability and emerging trends in advanced material processing.

Text Books	
1	Callister, W.D., Materials Science and Engineering: An Introduction, Wiley, 2018, 10th Edition, ISBN 9781119405498.
2	Ashby, M.F., Materials Selection in Mechanical Design, Butterworth-Heinemann, 2017, 5th Edition, ISBN 9780081005996.

Reference Books	
1	Shackelford, J.F., Introduction to Materials Science for Engineers, Pearson, 2015, 8th Edition, ISBN 9780133826654
2	Dieter, G.E., Mechanical Metallurgy, McGraw-Hill, 1986, 3rd Edition, ISBN 9780070168930.
3	Chawla, K.K., Composite Materials: Science and Engineering, Springer, 2012, 3rd Edition, ISBN 9780387743646.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**	**2**	**1**	**1**	**-**
CO2	**3**	**3**	**3**	**2**	**2**	**-**
CO3	**3**	**3**	**2**	**2**	**1**	**-**
CO4	**3**	**2**	**3**	**2**	**2**	**-**
CO5	**3**	**2**	**3**	**3**	**3**	**2**

Semester: I						
Advanced Mechanics of Solids						
Course Code	**:**	**1MME103**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Analyze stress components, principal stresses, and stress invariants in three-dimensional stress systems.
CLO2	Evaluate strain components, principal strains, strain invariants, and compatibility conditions.
CLO3	Apply stress–strain relations and yield criteria to analyze elastic and plastic deformation of materials.
CLO4	Apply energy methods and bending theories to solve structural mechanics problems.
CLO5	Analyze torsion of prismatic and thin-walled sections and evaluate thermal stresses in engineering components.

Module – 1	**08 Hrs**
Theories of Stress: Body Force, Surface Force and Stress Vector, The state of stress at a point, normal and shear stress, rectangular stress components, stress components on an arbitrary plane, principal stresses, **Stress Invariants**, Mohr's circle for the Three-Dimensional Stress condition, Octahedral stresses. Decomposition into Hydrostatic and Pure Shear States, Equilibrium equations for plane stress state in Cartesian coordinate system.	
Module – 2	**08 Hrs**
Theories of Strain: Deformation in the neighborhood of a point, change in length of a linear element, change in length of linear element – linear components, Rectangular Strain Components, **State of Strain** at a Point, Principal Strains and strain invariants, Plane State of Strain, Strain Deviator and its Invariants. Compatibility Conditions.	
Module – 3	**08 Hrs**
Stress–Strain Relations: Generalised statement of hook's law, Stress – strain relation for isotropic materials, Relation between the elastic constants.	

Ideally Plastic Solids: The Deviatoric Plane or the π Plane, General Nature of the Yield Locus, Yield Surfaces of Tresca and Von Mises, Stress–Strain Relations (Plastic Flow), Prandtl–Reuss Equations, Saint Venant–Von Mises Equations.	
Module – 4	**08 Hrs**
Energy Methods: Work done by forces and elastic strain energy stored, Reciprocal relation. Maxwell-Betti-Rayleigh reciprocal theorem, First Theorem of Castigliano, Expressions for Strain Energy, superposition of elastic energies. **Bending of Beams**: Introduction, Straight Beams and Asymmetrical Bending, Regarding Euler–Bernoulli Hypothesis, Shear Centre or Centre of Flexure.	
Module – 5	**08 Hrs**
Linear elastic solutions: Torsion of General Prismatic Bars–Solid Section, Prandtl elastic membrane (Soap-Film) analogy, Torsion of Thin-Walled Tubes, Torsion of Thin-Walled Multiple-Cell Closed Sections, Centre of Twist and Flexural Centre. **Thermal stresses**: Thermo-elastic Stress–Strain relations, Equations of Equilibrium, Strain Displacement relations, Some General Results.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the stress-strain relations in elastic and plastic conditions.
CO2	Examine bodies subjected to three dimensional stresses for the onset of failure based on failure criteria.
CO3	Analyze deflections in beams subjected to different types of loads for elastic, elastoplastic and plastic conditions.
CO4	Evaluate stresses in bars subjected to torsion for elastic, elastoplastic and plastic conditions.

Text Books	
1	L. S. Srinath, Advanced Mechanics of solids, 2000, Tata Mc. Graw Hill, ISBN-13: 978-0070702608, 2009
2	S. P. Timoshenko, Theory of Elasticity, Mc. Graw Hill, 3rd edition, ISBN 978-0-13-223319-3, 1972
3	Dr Sadhu Singh, Strength of materials" Khanna Publication, 1st edition

Reference Books	
1	M. A. Kazimi, Solid Mechanics, Tata McGraw-Hill, 2001, 0074517155, 9780074517154
2	Boresi & Sidebottom, "Advanced Mechanics of materials, Wiley International, 6th edition

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**				
CO2	**3**	**3**				
CO3	**3**	**3**	**2**			
CO4	**3**	**3**	**2**			
CO5	**3**	**3**	**2**			

Semester: I						
Advanced Design and Structural Analysis						
Course Code	**:**	**1MME104A**		**Credits**	**:**	04
Hours/Week(L:T:P)	**:**	3:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	42 T + 28 P		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand advanced concepts of structural and mechanical design.
CLO2	Analyze beams, frames, trusses, columns, and machine components under various loading conditions.
CLO3	Apply Finite Element Analysis (FEA) concepts for structural analysis and design.
CLO4	Evaluate dynamic, vibration, fatigue, and stability aspects of engineering structures.
CLO5	Use CAD/CAE tools and optimization techniques for efficient engineering design.

Module – 1	**10 Hrs**
Fundamentals of Advanced Design: Review of stress-strain relationships. Failure theories and design criteria. Reliability-based design.	
Module – 2	**10 Hrs**
Structural Analysis Concepts: Analysis of beams, frames, and trusses. Deflection methods and energy principles. Stability of columns and structural members.	
Module – 3	**10 Hrs**
Finite Element Analysis (FEA): Introduction to FEA. Discretization, shape functions, and stiffness matrices. Applications in structural mechanics.	
Module – 4	**10 Hrs**
Advanced Topics in Structural Design: Dynamic analysis of structures. Vibration and fatigue considerations. Optimization in structural design.	
Module – 5	**10 Hrs**
Case Studies and Applications: Design of machine components under complex loading. Structural design in aerospace, automotive, and civil engineering. Integration of CAD/CAE tools.	

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS
1. Stress analysis of beams using strain gauges. 2. Deflection measurement in cantilever and simply supported beams.

3. Buckling test on columns.
4. Modal analysis of vibrating structures.
5. Finite element modeling and validation using ANSYS/ABAQUS.
6. Fatigue testing of structural specimens.
7. Case study-based mini project (design + analysis).

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply advanced design principles to mechanical and structural systems.
CO2	Analyze stresses, deflections, and stability in complex structures.
CO3	Use finite element methods for structural analysis and optimization.
CO4	Integrate design standards and codes in engineering practice.
CO5	Conduct laboratory experiments to validate theoretical models and design solutions.

Text Books	
1	Budynas, R.G. and Nisbett, J.K., Shigley's Mechanical Engineering Design, McGraw-Hill, 2015, 10th Edition, ISBN 9780073398211.
2	Logan, D.L., A First Course in the Finite Element Method, Cengage Learning, 2016, 6th Edition, ISBN 9781305635111.

Reference Books	
1	Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw-Hill, 1961, 2nd Edition, ISBN 9780070858206.
2	Rao, S.S., Mechanical Vibrations, Pearson, 2017, 6th Edition, ISBN 9780134361307.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**	**3**	**2**	**1**	
CO2	**3**	**3**	**3**	**3**	**2**	
CO3	**3**	**3**	**3**	**3**	**3**	
CO4	**3**	**3**	**3**	**3**	**2**	
CO5	**3**	**3**	**3**	**3**	**3**	**1**

Semester: I						
Advanced Manufacturing Process & Digital Factory						
Course Code	**:**	**1MME104B**		**Credits**	**:**	04
Hours/Week(L:T:P)	**:**	3:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	42 T + 28 P		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	**Understand** advanced and non-traditional manufacturing processes and their applications.
CLO2	**Explain** additive manufacturing and micro/nano fabrication techniques.
CLO3	**Apply** Industry 4.0, digital twin, IoT, and smart manufacturing concepts.
CLO4	**Analyze** automation, robotics, CNC, and AI-based manufacturing systems.
CLO5	**Evaluate** sustainable manufacturing practices and industrial case studies.

Module – 1	**10 Hrs**
Advanced Manufacturing Processes: Evolution of manufacturing technologies. Non-traditional machining: EDM, ECM, laser machining, ultrasonic machining. Hybrid processes.	
Module – 2	**10 Hrs**
Additive Manufacturing & Micro/Nano Fabrication: Principles of additive manufacturing (3D printing). Materials for AM: polymers, metals, ceramics. Micro/nano fabrication techniques: lithography, MEMS, nanomaterials.	
Module – 3	**10 Hrs**
Digital Factory Concepts: Industry 4.0 and cyber-physical systems. Digital twins and simulation. Smart sensors, IoT integration, and cloud manufacturing.	
Module – 4	**10 Hrs**
Automation and Robotics in Manufacturing: CNC, robotics, and flexible manufacturing systems. Intelligent automation and AI in manufacturing. Case studies in automotive, aerospace, and healthcare.	
Module – 5	**10 Hrs**
Sustainable Manufacturing & Case Studies: Green manufacturing and energy-efficient processes. Recycling and remanufacturing. Case studies: digital factory implementation in global industries.	

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS
1. EDM machining of a sample workpiece..

2. Laser cutting/engraving demonstration.
3. Additive manufacturing (3D printing of a prototype).
4. CNC machining and tool path simulation.
5. Digital twin modeling using CAD/CAE software.
6. IoT-enabled monitoring of a manufacturing process.
7. Mini project on digital factory integration.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain advanced manufacturing processes and their applications in modern industries.
CO2	Analyze digital factory concepts, Industry 4.0 technologies, and cyber-physical systems.
CO3	Apply additive manufacturing, micro/nano fabrication, and sustainable processing methods.
CO4	Integrate automation, robotics, and IoT in digital manufacturing environments.
CO5	Conduct laboratory experiments to validate advanced manufacturing techniques and digital factory models.

Text Books	
1	Groover, M.P., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley, 2019, 7th Edition, ISBN 9781119474234.
2	Kalpakjian, S. and Schmid, S.R., Manufacturing Engineering and Technology, Pearson, 2014, 7th Edition, ISBN 9780133128741.

Reference Books	
1	Gibson, I., Rosen, D.W., and Stucker, B., Additive Manufacturing Technologies, Springer, 2015, 2nd Edition, ISBN 9781493921133.
2	Xu, X., Digital Factory for Industrial Production, Springer, 2008, ISBN 9781848003010.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**	**3**	**2**	**2**	
CO2	**3**	**2**	**3**	**2**	**3**	
CO3	**3**	**2**	**3**	**2**	**3**	
CO4	**3**	**3**	**3**	**3**	**3**	
CO5	**3**	**2**	**3**	**3**	**2**	

Semester: I						
Computational Fluid Dynamics & Energy Systems						
Course Code	**:**	**1MME104C**		**Credits**	**:**	04
Hours/Week(L:T:P)	**:**	3:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	42 T + 28 P		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamental principles and governing equations of fluid dynamics and energy systems.
CLO2	Apply numerical discretization, meshing, stability, and convergence techniques in CFD.
CLO3	Analyze heat transfer, combustion, renewable energy, and HVAC systems using CFD.
CLO4	Understand turbulence, multiphase flows, reacting flows, and optimization techniques.
CLO5	Use CFD software to simulate, validate, and analyze engineering energy-system problems.

Module – 1	**10 Hrs**
Fundamentals of Fluid Dynamics & Energy Systems: Governing equations: continuity, momentum, and energy. Boundary conditions and assumptions. Energy conversion systems overview.	
Module – 2	**10 Hrs**
Numerical Methods in CFD: Discretization techniques: finite difference, finite volume, finite element. Grid generation and mesh quality. Stability and convergence analysis.	
Module – 3	**10 Hrs**
Applications in Heat Transfer & Energy Systems: Conduction, convection, and radiation modeling. CFD in combustion and renewable energy systems. Case studies in power plants and HVAC systems.	
Module – 4	**10 Hrs**
Turbulence Modeling & Advanced Topics: Turbulence models: RANS, LES, DNS. Multiphase flows and reacting flows. Optimization in energy systems.	
Module – 5	**10 Hrs**
Simulation Tools & Case Studies: Introduction to CFD software (ANSYS Fluent, OpenFOAM). Validation and verification of CFD models. Case studies: automotive aerodynamics, wind energy, thermal management.	

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS

1. Laminar flow simulation in a pipe using CFD software.
2. Heat transfer analysis in a finned surface.
3. Turbulent flow modeling using RANS.
4. Combustion simulation in an energy system.
5. CFD analysis of wind turbine blade.
6. Validation of CFD results with experimental data.
7. Mini project on energy system optimization.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply governing equations of fluid dynamics and energy systems to engineering problems.
CO2	Analyze fluid flow and heat transfer using numerical methods.
CO3	Implement CFD techniques for solving industrial problems.
CO4	Evaluate energy system performance using simulation tools.
CO5	Conduct laboratory experiments and simulations to validate CFD models.

Text Books	
1	Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson, 2007, 2nd Edition, ISBN 9780131274983.
2	Anderson, J.D., Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill, 1995, ISBN 9780070016859.

Reference Books	
1	Patankar, S.V., Numerical Heat Transfer and Fluid Flow, CRC Press, 1980, ISBN 9780891165224.
2	Tannehill, J.C., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, CRC Press, 1997, 2nd Edition, ISBN 9780891165224.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**	**1**		
CO2	**3**	**3**	**2**	**2**	**3**	
CO3	**3**	**3**	**3**	**3**	**2**	**1**
CO4	**3**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**3**	**3**	**3**	**3**	**1**

Semester: I						
Advanced Materials Engineering & Characterization						
Course Code	**:**	**1MME104D**		**Credits**	**:**	04
Hours/Week(L:T:P)	**:**	3:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	42 T + 28 P		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the classification, structure, properties, processing, and applications of advanced materials.
CLO2	Apply mechanical characterization techniques to evaluate material strength, deformation, fatigue, and failure.
CLO3	Analyze thermal and electrical properties of advanced materials using appropriate characterization techniques.
CLO4	Interpret microstructural, crystallographic, and spectroscopic characterization results of materials.
CLO5	Evaluate advanced and smart materials, surface coatings, and their applications in aerospace, biomedical, and automotive fields.

Module – 1	**10 Hrs**
Fundamentals of Advanced Materials: Classification: metals, ceramics, polymers, composites, nanomaterials. Structure-property relationships. Processing and applications.	
Module – 2	**10 Hrs**
Mechanical Characterization: Tensile, compression, hardness, impact, fatigue, and creep testing. Fracture mechanics and failure analysis. Case studies in structural materials.	
Module – 3	**10 Hrs**
Thermal and Electrical Characterization: Thermal conductivity, expansion, and DSC/TGA analysis. Electrical conductivity, dielectric properties, and impedance spectroscopy. Applications in energy systems and electronics.	
Module – 4	**10 Hrs**
Microstructural Characterization: Optical microscopy, SEM, TEM. X-ray diffraction (XRD) and crystallography. Spectroscopy techniques: FTIR, Raman, EDS.	
Module – 5	**10 Hrs**
Advanced Topics and Case Studies: Nanomaterials and smart materials characterization. Surface engineering and coatings. Case studies: aerospace, biomedical, and automotive materials.	

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS

1. Tensile and hardness testing of metals.
2. Impact and fatigue testing.
3. Thermal analysis using DSC/TGA.
4. Microstructural analysis using optical microscopy.
5. SEM/TEM demonstration and analysis.
6. XRD analysis of crystalline materials.
7. Mini project on advanced material characterization.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the structure, properties, and classification of advanced engineering materials.
CO2	Apply characterization techniques to evaluate microstructure, mechanical, thermal, and electrical properties.
CO3	Analyze the role of nanomaterials, composites, and smart materials in engineering applications.
CO4	Use advanced instrumentation (SEM, TEM, XRD, DSC, etc.) for material characterization.
CO5	Conduct laboratory experiments to validate theoretical knowledge and material performance.

Text Books	
1	Callister, W.D. and Rethwisch, D.G., Materials Science and Engineering: An Introduction, Wiley, 2018, 10th Edition, ISBN 9781119405498.
2	Cullity, B.D. and Stock, S.R., Elements of X-Ray Diffraction, Pearson, 2014, 3rd Edition, ISBN 9780131786622.

Reference Books	
1	Shackelford, J.F., Introduction to Materials Science for Engineers, Pearson, 2015, 8th Edition, ISBN 9780133826654.
2	Leng, Y., Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Wiley, 2008, ISBN 9780470823040.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**	**1**	**1**	
CO2	**3**	**3**	**2**	**3**	**2**	
CO3	**3**	**3**	**2**	**3**	**2**	**1**
CO4	**3**	**3**	**2**	**3**	**2**	
CO5	**3**	**3**	**3**	**2**	**2**	**2**

Semester: I						
Robotics, AI, and Mechatronic Systems						
Course Code	**:**	**1MME104E**		**Credits**	**:**	04
Hours/Week(L:T:P)	**:**	3:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	42 T + 28 P		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals and components of robotic and mechatronic systems.
CLO2	Apply kinematics, dynamics and trajectory planning to robotic systems.
CLO3	Understand and apply AI techniques such as machine learning and computer vision in robotics.
CLO4	Design and integrate sensors, actuators, microcontrollers and embedded systems.
CLO5	Analyze advanced robotic applications and Industry 4.0 case studies.

Module – 1	**10 Hrs**
Fundamentals of Robotics and Mechatronics: Introduction to robotics and mechatronic systems. Components: sensors, actuators, controllers. Applications in manufacturing, healthcare, and automation.	
Module – 2	**10 Hrs**
Kinematics and Dynamics of Robots: Forward and inverse kinematics. Dynamics of robotic manipulators. Trajectory planning and motion control.	
Module – 3	**10 Hrs**
AI in Robotics: Machine learning basics for robotics. Computer vision and image processing. Intelligent control and decision-making.	
Module – 4	**10 Hrs**
Mechatronic System Design: Embedded systems and microcontrollers. Integration of sensors and actuators. Case studies in mechatronic product design.	
Module – 5	**10 Hrs**
Advanced Applications and Case Studies: Collaborative robots (cobots). Autonomous mobile robots and drones. AI-enabled predictive maintenance. Case studies in Industry 4.0.	

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS
1. Kinematic analysis of a robotic arm. 2. Path planning and trajectory control.

3. Vision-based object detection using AI.
4. Integration of sensors and actuators in a mechatronic system.
5. Programming a mobile robot for navigation.
6. Embedded system-based robotic control..
7. Mini project on AI-enabled mechatronic application.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of robotics, AI, and mechatronic systems.
CO2	Analyze kinematics, dynamics, and control of robotic manipulators.
CO3	Apply AI techniques (machine learning, computer vision, intelligent control) to robotics.
CO4	Integrate sensors, actuators, and embedded systems in mechatronic applications.
CO5	Conduct laboratory experiments and projects involving robotics and AI-enabled mechatronic systems

Text Books	
1	Craig, J.J., Introduction to Robotics: Mechanics and Control, Pearson, 2017, 4th Edition, ISBN 9780133489796.
2	Bishop, R.H., Mechatronics: Principles and Applications, CRC Press, 2006, ISBN 9780849319862.

Reference Books	
1	Siciliano, B. and Khatib, O., Springer Handbook of Robotics, Springer, 2016, 2nd Edition, ISBN 9783319325521.
2	Russell, S. and Norvig, P., Artificial Intelligence: A Modern Approach, Pearson, 2021, 4th Edition, ISBN 9780134610991.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**		**2**	
CO2	**3**	**3**	**3**	**2**	**2**	
CO3	**3**	**3**	**3**	**3**	**3**	
CO4	**3**	**3**	**3**	**2**	**3**	
CO5	**2**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Press Tool Design						
Course Code	**:**	**1MME104F**		**Credits**	**:**	04
Hours/Week(L:T:P)	**:**	3:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	42 T + 28 P		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand press tool types,
CLO2	Knowledge of design and press tool operations which makes them aware of type applications,
CLO3	To know the force calculations in drawing,
CLO4	Awareness' of lubrications in drawing
CLO5	Knowledge of typical design of form tools.

Module – 1	**10 Hrs**
Introduction: Elements of press tools, classification of press, High speed presses, press brakes, shearing theory, cutting force, elements of press tool, clearance between punch and die, shut height and daylight, press tonnage calculation. **Strip Layout:** Basic rules, economic layout, bridge size, calculation of plug point/center of pressure. **Press Tool Operations**: Piercing, blanking, slitting, cropping, trimming, shaving, lancing, bending, curling, calibrating, drawing, embossing, coining, flanging, fine blanking.	
Module – 2	**10 Hrs**
Design of Press Tool Elements: Die plates, punches, punch holder plates, stripper plates, and calculation of stripping force, bolster plates, pilots, ejectors, shedders, materials ops, pillar, bush, slender punches, stock guides, stock feeding device and die sets. **Types of Press Tools:** Progressive tools, stage tools, compound tools, combination tools, cam actuated die, horn dies, sub press dies, inverted dies, bulging dies, levering dies, trimming dies, shaving dies, riveting dies, assembly dies, lamination dies. **Extrusion:** Forward, backward, combined extrusion, modem metal forming techniques.	
Module – 3	**10 Hrs**
Bending and Forming Dies: Theory of bending, development of bend, spring back, correcting spring back, bending tools, U - bending, V -bending, forming tools, bending on press brake, bending force calculation.	
Module – 4	**10 Hrs**

Bending and Forming Dies: Theory of bending, development of bend, spring back, correcting spring back, bending tools, U - bending, V -bending, forming tools, bending on press brake, bending force calculation.	
Module – 5	**10 Hrs**
Preparation and Presentation of Typical Designs in the Form of Drawings for the Following 1. Piercing & blanking tool. 2. Progressive tool 3. Stage tool 4. Bending tool 5. Compound tool.	

PRACTICAL COMPONENTS OF IPCC

FIXED SET OF EXPERIMENTS
1. Design, Assembly & Drafting of a Simple Stage Tool. 2. Design, Assembly & Drafting of a Progressive Tool. 3. Design, Assembly & Drafting of a Compound Tool. 4. Design, Assembly & Drafting of a Bends & Forming Tool. 5. Design, Assembly & Drafting of a Blank & Draw Tool.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the press tool types,
CO2	Discuss the press tool design and operations which makes them aware of type applications
CO3	Calculate the force in drawing.
CO4	Describe the awareness of lubrications in drawing.
CO5	Exhibit the knowledge of typical design of form tools.

Text Books	
1	Basic die design, D. Eugene Ostergaard, McGraw Hill, 1963
2	Die Design Fundaments, J. R. Paquin, R.E Crowley Industrial Press Inc. 2nd edition
3	Press Tools, Prakash. H Joshi Wheeler Publisher

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**1**	**1**	**1**	**2**	**1**
CO2	**3**	**1**	**1**	**2**	**2**	**1**
CO3	**3**	**1**	**1**	**2**	**2**	**1**
CO4	**3**	**1**	**1**	**2**	**2**	**1**
CO5	**3**	**1**	**1**	**1**	**2**	**1**

Semester: I						
Advanced Structural Dynamics and Vibration Control						
Course Code	**:**	**1MME105A**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the fundamentals of structural dynamics, vibrations, damping, and resonance.
CLO2	Analyze multi-degree-of-freedom systems using modal analysis and numerical methods..
CLO3	Apply approximate methods to analyze vibrations in continuous structural systems.
CLO4	Evaluate passive, active, and hybrid vibration control techniques.
CLO5	Apply vibration control principles, smart materials, and adaptive structures to engineering problems.

Module – 1	**08 Hrs**
Fundamentals Of Structural Dynamics: Free and forced vibration of single-degree-of-freedom systems. Damping models and resonance phenomena. Applications in mechanical and civil structures.	
Module – 2	**08 Hrs**
Multi-Degree-0f-Freedom Systems: Equations Of motion for MDOF systems. Modal analysis and orthogonality of modes. Numerical methods for dynamic response.	
Module – 3	**08 Hrs**
Continuous Systems: Vibration of beams, plates, and shells. Wave propagation in structures. Approximate methods: Rayleigh—Ritz, Galerkin.	
Module – 4	**08 Hrs**
Vibration Control Techniques: Passiv•e control: tuned mass dampers, viscoelastic dampers. Active control: sensors, actuators, feedback systems. Semi-active and hybrid control strategies.	
Module – 5	**08 Hrs**

Advanced Applications and Case Studies: Vibration control in aerospace, automotive, and civil engineering. Smart materials and adaptive structures. Case studies: earthquake-resistant design, noise reduction.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply principles of structural dynamics to analyze vibration behavior of engineering systems.
CO2	Model single and multi-degree-of-freedom systems under dynamic loading..
CO3	Evaluate damping mechanisms and vibration control strategies.
CO4	Use computational tools for dynamic analysis and vibration suppression.
CO5	Integrate vibration control methods in aerospace automotive and civil engineering applications

Text Books	
1	Chopra, A.K„ Dynamics OT Structures: Theory and Applications to Earthquake Engineering, Pearson, 2017, 5th Edition.
2	Meirovitch, L, Elements of Vibration Analysis, McGraveHill, 1986, 2nd Edition.

Reference Books	
1	Rao, SS, Mechanical Vibrations, Pearson, 2017, 6th Edition.
2	Den Hartog, I.P., Mechanical Vibrations, Dover Publications, 1985.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**1**				
CO2	**3**	**3**	**1**	**2**	**2**	
CO3	**3**	**3**	**2**	**2**	**2**	
CO4	**2**	**3**	**3**	**2**	**2**	
CO5	**2**	**3**	**3**	**2**	**2**	**2**

Semester: I						
Micro and Nano Manufacturing Technologies						
Course Code	**:**	**1MME105B**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals of micro and nano manufacturing technologies.
CLO2	Explain lithography and patterning techniques used in micro/nano fabrication.
CLO3	Understand etching and deposition processes for micro/nano structures.
CLO4	Apply micro/nano fabrication techniques in MEMS and NEMS development.
CLO5	Analyze applications of micro/nano manufacturing in advanced engineering fields.

Module – 1	**08 Hrs**
Introduction to Micro and Nano Manufacturing: Evolution of manufacturing technologies. Fundamentals of micro/nano scale physics. Applications in electronics, biomedical, and energy.	
Module – 2	**08 Hrs**
Lithography and Patterning Techniques: Photolithography, electron-beam lithography, nanoimprint lithography. Mask design and resolution limits. Case studies in semiconductor fabrication.	
Module – 3	**08 Hrs**
Etching and Deposition Processes: Wet and dry etching techniques. Chemical vapor deposition (CVD), physical vapor deposition (PVD). Atomic layer deposition (ALD).	
Module – 4	**08 Hrs**
Micro/Nano Fabrication for MEMS and NEMS: Fabrication of micro-electromechanical systems (MEMS). Nano-electromechanical systems (NEMS). Integration with sensors and actuators.	
Module – 5	**08 Hrs**
Applications and Case Studies: Nanoelectronics, nanophotonics, and nanomedicine. Energy harvesting and storage devices. Case studies: lab-on-chip, biomedical implants, nano-coatings.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the principles of micro and nano manufacturing processes.
CO2	Analyze fabrication techniques for MEMS, NEMS, and nanostructures.
CO3	Apply lithography, etching, and deposition methods in micro/nano fabrication.
CO4	Evaluate applications of micro/nano manufacturing in electronics, biomedical, and energy systems.
CO5	Integrate sustainability and advanced instrumentation in micro/nano manufacturing.

Text Books	
1	Madou, M.J., Fundamentals of Microfabrication and Nanotechnology, CRC Press, 2018, 3rd Edition, ISBN 9781498717847.
2	Campbell, S.A., The Science and Engineering of Microelectronic Fabrication, Oxford University Press, 2008, 2nd Edition, ISBN 9780195330847.

Reference Books	
1	Rai-Choudhury, P., Handbook of Microlithography, Micromachining, and Microfabrication, SPIE Press, 1997, ISBN 9780819422526.
2	Bhushan, B., Springer Handbook of Nanotechnology, Springer, 2017, 4th Edition, ISBN 9783319472133.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**	**1**	**2**	
CO2	**3**	**3**	**2**	**2**	**3**	
CO3	**3**	**3**	**3**	**2**	**3**	
CO4	**3**	**3**	**3**	**3**	**3**	
CO5	**3**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Advanced Combustion and Emission Control						
Course Code	**:**	**1MME105C**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand combustion thermodynamics, kinetics, flame structure and stability
CLO2	Analyze pollutant formation and environmental impacts of combustion emissions.
CLO3	Understand emission measurement, optical diagnostics and computational modeling techniques.
CLO4	Evaluate in-cylinder and after-treatment technologies for emission control.
CLO5	Analyze sustainable combustion technologies, alternative fuels and industrial case studies.

Module – 1	**08 Hrs**
Fundamentals of Advanced Combustion: Thermodynamics and chemical kinetics of combustion. Flame structure, ignition, and stability. Combustion in IC engines and gas turbines.	
Module – 2	**08 Hrs**
Pollutant Formation in Combustion Systems: Formation of NOx, CO, HC, SOx, and particulate matter. Mechanisms of soot and smoke formation. Environmental impact of emissions.	
Module – 3	**08 Hrs**
Emission Measurement and Diagnostics: Experimental techniques: gas analyzers, smoke meters, particle counters. Optical diagnostics: laser-induced fluorescence, spectroscopy. Computational modeling of combustion and emissions.	
Module – 4	**08 Hrs**
Emission Control Technologies: In-cylinder control: EGR, lean burn, stratified charge. After-treatment systems: catalytic converters, particulate filters, SCR. Emerging technologies: plasma-assisted combustion, low temperature combustion.	
Module – 5	**08 Hrs**
Sustainable Combustion and Case Studies: Alternative fuels: biofuels, hydrogen, synthetic fuels. Combustion in renewable energy systems. Case studies: automotive emission control, power plant combustion optimization.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain advanced combustion processes and their thermodynamic principles.
CO2	Analyze pollutant formation mechanisms in combustion systems.
CO3	Evaluate emission control technologies for IC engines, gas turbines, and industrial furnaces.
CO4	Apply computational and experimental methods for combustion diagnostics.
CO5	Integrate sustainable and clean combustion strategies in energy systems.

Text Books	
1	Turns, S.R., An Introduction to Combustion: Concepts and Applications, McGraw-Hill, 2012, 3rd Edition, ISBN 9780073380193.
2	Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988, ISBN 9780070286374

Reference Books	
1	Glassman, I., Yetter, R.A., and Glumac, N.G., Combustion, Academic Press, 2014, 5th Edition, ISBN 9780124078383.
2	Kuo, K.K., Principles of Combustion, Wiley, 2005, 2nd Edition, ISBN 9780471727897.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**	**1**	**1**	
CO2	**3**	**3**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	
CO4	**3**	**3**	**3**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Semester: I						
Nanostructured Materials and Surface Engineering						
Course Code	**:**	**1MME105D**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals and types of nanostructured materials.
CLO2	Explain various physical, chemical and green synthesis methods.
CLO3	Understand surface engineering techniques and their applications.
CLO4	Apply characterization techniques to analyze nanostructures and surfaces.
CLO5	Analyze applications of nanomaterials in aerospace, automotive, biomedical and energy sectors.

Module – 1	**08 Hrs**
Introduction to Nanostructured Materials: Fundamentals of nanoscience and nanotechnology. Classification: nanoparticles, nanowires, nanotubes, thin films. Structure-property relationships at the nanoscale	
Module – 2	**08 Hrs**
Synthesis of Nanostructured Materials: Physical methods: ball milling, vapor deposition. Chemical methods: sol-gel, hydrothermal, chemical vapor deposition. Biological and green synthesis approaches.	
Module – 3	**08 Hrs**
Surface Engineering Techniques: Surface modification: ion implantation, laser treatment. Coatings: PVD, CVD, thermal spraying, electroplating. Applications in tribology, corrosion resistance, and biomedical devices.	
Module – 4	**08 Hrs**
Characterization of Nanostructures and Surfaces: Microscopy: SEM, TEM, AFM. Spectroscopy: XPS, Raman, FTIR. X-ray diffraction and surface profilometry.	
Module – 5	**08 Hrs**
Applications and Case Studies: Nanostructured coatings in aerospace and automotive. Biomedical implants and drug delivery. Energy applications: batteries, fuel cells, solar cells.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of nanostructured materials and their unique properties.
CO2	Analyze synthesis techniques for nanomaterials and thin films.
CO3	Apply surface engineering methods for wear resistance, corrosion protection, and functional coatings.
CO4	Evaluate characterization techniques for nanostructures and engineered surfaces.
CO5	Integrate nanostructured materials in advanced engineering applications

Text Books	
1	Bhushan, B., Springer Handbook of Nanotechnology, Springer, 2017, 4th Edition, ISBN 9783319472133.
2	Ghosh, C.K., Nanostructured Materials: Processing, Properties, and Applications, CRC Press, 2019, ISBN 9780367331580.

Reference Books	
1	Cao, G., Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, World Scientific, 2011, 2nd Edition, ISBN 9789814324557.
2	Ohring, M., Materials Science of Thin Films, Academic Press, 2001, 2nd Edition, ISBN 9780125249751.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**		**2**	
CO2	**3**	**3**	**2**	**2**	**3**	
CO3	**3**	**3**	**3**	**2**	**3**	
CO4	**3**	**3**	**2**	**3**	**3**	
CO5	**2**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Cyber-Physical Systems in Mechanical Engineering						
Course Code	**:**	**1MME105E**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals, architecture, and components of Cyber-Physical Systems.
CLO2	Understand sensors, actuators, embedded systems, and real-time controllers used in CPS.
CLO3	Apply communication, networking, IoT protocols, and edge computing concepts in CPS.
CLO4	Analyze CPS applications in smart manufacturing, robotics, energy, and predictive maintenance.
CLO5	Understand CPS safety, cybersecurity, reliability, and fault-tolerant design.

Module – 1	**08 Hrs**
Introduction to Cyber-Physical Systems: Definition, architecture, and components of CPS. Role of CPS in mechanical engineering and Industry 4.0. Case studies in automation and robotics.	
Module – 2	**08 Hrs**
Sensors, Actuators, and Embedded Systems: Smart sensors and transducers. Actuator technologies and integration. Embedded controllers and real-time operating systems	
Module – 3	**08 Hrs**
Communication and Networking in CPS: IoT protocols: MQTT, CoAP, OPC-UA. Wireless communication: Wi-Fi, ZigBee, LoRaWAN, 5G. Edge computing and gateways.	
Module – 4	**08 Hrs**
CPS Applications in Mechanical Engineering: Smart manufacturing and digital factory. Robotics and autonomous systems. CPS in energy systems and predictive maintenance.	
Module – 5	**08 Hrs**
Safety, Security, and Case Studies: Cybersecurity in CPS. Reliability and fault-tolerant design. Case studies: automotive CPS, healthcare devices, smart grids.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of cyber-physical systems (CPS) and their role in mechanical engineering.
CO2	Analyze integration of sensors, actuators, and embedded systems in CPS.
CO3	Apply communication protocols, IoT, and cloud computing in CPS applications.
CO4	Evaluate CPS applications in smart manufacturing, robotics, and energy systems.
CO5	Design CPS solutions considering safety, reliability, and sustainability

Text Books	
1	Rajkumar, R., Lee, I., Sha, L., and Stankovic, J., Cyber-Physical Systems: Foundations, Principles, and Applications, Springer, 2016, ISBN 9783319331652.
2	Alur, R., Principles of Cyber-Physical Systems, MIT Press, 2015, ISBN 9780262029117.

Reference Books	
1	Lee, E.A., Introduction to Embedded Systems: A Cyber-Physical Systems Approach, MIT Press, 2017, 2nd Edition, ISBN 9780262533812.
2	Gilchrist, A., Industry 4.0: The Industrial Internet of Things, Apress, 2016, ISBN 9781484220467.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**	**1**	**2**	**1**
CO2	**3**	**3**	**3**	**2**	**3**	
CO3	**3**	**3**	**3**	**3**	**3**	
CO4	**3**	**3**	**3**	**3**	**3**	**2**
CO5	**3**	**3**	**2**	**3**	**3**	**2**

Semester: I						
Jigs and Fixtures Design						
Course Code	**:**	**1MME105F**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals and principles of jigs and fixtures.
CLO2	Select suitable locating and clamping devices for machining operations.
CLO3	Understand drill bushings, guiding elements, indexing methods and fixture principles.
CLO4	Design different types of jigs, fixtures and their components.
CLO5	Apply jig and fixture design principles to improve machining accuracy and productivity.

Module – 1	**08 Hrs**
Introduction: Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, Steps for design. Location Degree of freedom, 3-2-1 principles, Choice of location, redundant location, Diamond pin calculation, Locating methods and chip control.	
Module – 2	**08 Hrs**
Locating Devices: Surface location, Rest blocks, pins, V-blocks, Equalizers, Profile locators, Vee locaters, Nesting locaters, Diamond Pins, adjustable Locaters. **Clamping Devices**: Basic principles, cutting forces, Rigid clamping, wedge clamping, cam clamping, quick action clamps, strap clamps, screw clamps, swing clamps, Toggle clamps, simultaneously acting clamps.	
Module – 3	**08 Hrs**
Guiding Elements, Drill Bushings: Standard Drill Bushing types, Jig bushes Installation, Standards, Tool Setting gauges. **Indexing Jigs and Fixtures:** Indexing methods, Linear, Rotary, Indexing jigs, Indexing fixtures. Assembly and Welding Fixture – Principles.	
Module – 4	**08 Hrs**
Design of Jigs and Fixture Bodies, other Elements, types of Jigs and Fixtures: Plate Jigs. Box Jigs, Indexing Jigs, Milling Fixtures and Indexing milling Fixtures, Turning Fixtures, Grinding Fixtures, Universal Jigs & Fixtures, Welding fixtures, Broaching fixtures and assembly fixtures, Modular Fixturing.	

Module – 5	**08 Hrs**
Preparation and Presentation of typical designs in the form of drawings for the following 1. Drill Jig 2. Drilling and Reaming Jigs 3. Milling Fixtures 4. Indexing Jigs 5. Indexing Milling Fixtures. 6. Turning Fixtures.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the acquired knowledge on various jigs and fixtures.
CO2	Discuss the designs of clamping methods.
CO3	Apply the knowledge for different indexing methods.
CO4	Illustrate the different applications of fixtures and Jig.
CO5	Demonstrate the different typical jigs and fixtures.

Text Books	
1	Jigs & Fixtures - JOSHI P .H.- New Delhi -Tata McGraw Hill Pub. Co. Ltd., 11th print 1999.
2	Jigs. & Fixtures & Gauges -BOYES E. WILLIAM-Michigan -SME 1st Ed. 1986..
3	Jigs and Fixture Design Manual- by Erik k Henriksen, Industrial Press Inc.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**		**1**	
CO2	**3**	**3**	**2**	**2**	**2**	
CO3	**3**	**3**	**3**	**2**	**2**	
CO4	**3**	**3**	**3**	**3**	**3**	
CO5	**3**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Industrial Internet of Things						
Course Code	**:**	**1MME105G**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NO**
Knowledge on Fundamental Concepts	**NO**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals, architecture, and enabling technologies of IIoT.
CLO2	Explain industrial communication protocols, networking technologies, and edge computing.
CLO3	Apply sensors, data acquisition, and edge-processing techniques in industrial systems
CLO4	Analyze cloud platforms, big-data analytics, machine learning, and cybersecurity aspects of IIoT.
CLO5	Develop IIoT-based solutions for smart manufacturing, predictive maintenance, and Industry 4.0 applications.

Module – 1	**08 Hrs**
Introduction to IIoT: Evolution from IoT to IIoT. IIoT architecture: perception, network, edge, and application layers. Key enabling technologies: sensors, actuators, embedded systems. Industrial applications and case studies.	
Module – 2	**08 Hrs**
Communication and Networking in IIoT: Industrial communication protocols: MQTT, CoAP, OPC-UA, Modbus, Profibus. Wireless technologies: Wi-Fi, Bluetooth, ZigBee, LoRaWAN, 5G. Edge computing and gateways. Interoperability challenges.	
Module – 3	**08 Hrs**
Sensors, Data Acquisition, and Edge Processing: Smart sensors and transducers. Data acquisition systems and signal conditioning. Edge analytics and real-time processing. Integration with PLCs and SCADA systems.	
Module – 4	**08 Hrs**
Cloud Platforms, Big Data, and Cybersecurity: Cloud computing for IIoT: AWS IoT, Azure IoT Hub, Google Cloud IoT. Big data analytics and machine learning in IIoT. Cybersecurity challenges: authentication, encryption, intrusion detection. Standards and frameworks for IIoT security.	
Module – 5	**08 Hrs**

IIoT Applications and Case Studies: Smart manufacturing and Industry 4.0. Predictive maintenance and asset management. Digital twins and simulation. Case studies: automotive, energy, healthcare, and logistics.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the architecture and components of the Industrial Internet of Things.
CO2	Analyze communication protocols and networking technologies used in IIoT.
CO3	Apply sensor integration, data acquisition, and edge computing concepts in industrial systems.
CO4	Evaluate cloud platforms, big data analytics, and cybersecurity in IIoT applications.
CO5	Design IIoT solutions for smart manufacturing, predictive maintenance, and industrial automation

Text Books	
1	Gubbi, J., Buyya, R., Marusic, S., and Palaniswami, M., Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions, Elsevier, 2013, ISBN 9780128053959.
2	Al-Fuqaha, A., Internet of Things: Applications and Protocols, CRC Press, 2019, 1st Edition, ISBN 9780367331580.

Reference Books	
1	Da Xu, L., He, W., and Li, S., Internet of Things in Industries: A Survey, IEEE Transactions on Industrial Informatics, 2014, ISBN 9781119226079.
2	Gilchrist, A., Industry 4.0: The Industrial Internet of Things, Apress, 2016, ISBN 9781484220467.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**	**3**	**2**	**1**	
CO2	**3**	**2**	**3**	**3**	**2**	
CO3	**3**	**3**	**2**	**3**	**3**	
CO4	**3**	**3**	**3**	**3**	**2**	
CO5	**3**	**3**	**3**	**3**	**3**	

Semester: I						
Design For Reliability and Lifecycle Engineering						
Course Code	**:**	**1MME106A**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals of reliability and product lifecycle engineering.
CLO2	Apply reliability models, statistical distributions and reliability analysis techniques.
CLO3	Analyze failures and assess risks using FMEA, FTA and mitigation techniques.
CLO4	Evaluate lifecycle costs, maintainability and sustainable design practices.
CLO5	Apply reliability and lifecycle engineering concepts to industrial systems and case studies.

Module – 1	**08 Hrs**
Fundamentals of Reliability and Lifecycle Engineering: Reliability concepts, definitions, and importance. Lifecycle phases: design, development, operation, maintenance, disposal. Case studies in mechanical engineering.	
Module – 2	**08 Hrs**
Reliability Modeling and Analysis: Reliability functions, hazard rate, MTBF. Reliability block diagrams and Markov models. Statistical distributions in reliability (exponential, Weibull, normal).	
Module – 3	**08 Hrs**
Failure Analysis and Risk Assessment: Failure modes and effects analysis (FMEA). Fault tree analysis (FTA). Risk assessment and mitigation strategies.	
Module – 4	**08 Hrs**
Lifecycle Costing and Maintainability: Lifecycle cost estimation methods. Maintainability analysis and design for serviceability. Sustainable design and circular economy concepts.	
Module – 5	**08 Hrs**
Applications and Case Studies: Reliability in aerospace, automotive, and energy systems. Reliability testing and accelerated life testing. Case studies: product lifecycle management (PLM), reliability-centered maintenance (RCM).	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of reliability engineering and lifecycle concepts.
CO2	Apply reliability modeling and prediction techniques to mechanical systems.
CO3	Analyze lifecycle costs, maintainability, and sustainability in engineering design.
CO4	Evaluate risk assessment and failure modes using FMEA, FTA, and reliability testing.
CO5	Integrate reliability and lifecycle engineering principles in product development and industrial applications.

Text Books	
1	O'Connor, P.D.T. and Kleyner, A., Practical Reliability Engineering, Wiley, 2012, 5th Edition, ISBN 9780470979723.
2	Blanchard, B.S., System Engineering and Analysis of Lifecycle Costing, Pearson, 1991, ISBN 9780138812365.

Reference Books	
1	Modarres, M., Reliability Engineering and Risk Analysis, CRC Press, 2016, 3rd Edition, ISBN 9781439894149.
2	Kececioglu, D., Reliability Engineering Handbook, Prentice Hall, 1991, ISBN 9780137456119.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**		**1**	
CO2	**3**	**3**	**2**	**2**	**2**	
CO3	**3**	**3**	**3**	**3**	**2**	**1**
CO4	**2**	**3**	**3**	**2**	**2**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Lean Manufacturing and Sustainable Production Systems						
Course Code	**:**	**1MME106B**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the principles of lean manufacturing and identify production wastes.
CLO2	Apply lean tools and techniques for process improvement.
CLO3	Understand sustainable manufacturing and optimize energy and resources.
CLO4	Apply lifecycle engineering and circular economy concepts.
CLO5	Analyze lean and sustainable practices through industrial case studies.

Module – 1	**08 Hrs**
Introduction to Lean Manufacturing: Evolution of lean thinking. Principles of lean production. Waste identification and elimination (7 wastes).	
Module – 2	**08 Hrs**
Lean Tools and Techniques: 5S methodology, Kaizen, Kanban, Just-In-Time (JIT). Total Productive Maintenance (TPM). Value stream mapping and process improvement.	
Module – 3	**08 Hrs**
Sustainable Production Systems: Concepts of sustainability in manufacturing. Green manufacturing practices. Energy efficiency and resource optimization.	
Module – 4	**08 Hrs**
Lifecycle Engineering and Assessment: Product lifecycle management (PLM). Lifecycle costing and environmental impact assessment. Circular economy and sustainable supply chains.	
Module – 5	**08 Hrs**
Case Studies and Applications: Lean and sustainable practices in automotive, aerospace, and energy sectors. Industry 4.0 and digital sustainability. Case studies: zero-waste manufacturing, carbon footprint reduction.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the principles of lean manufacturing and sustainable production systems.
CO2	Analyze waste elimination, value stream mapping, and continuous improvement strategies.
CO3	Apply lean tools (5S, Kaizen, Kanban, JIT, TPM) in manufacturing environments.
CO4	Evaluate sustainability metrics, green manufacturing practices, and lifecycle assessment.
CO5	Integrate lean and sustainable practices in modern production systems for efficiency and environmental responsibility.

Text Books	
1	Womack, J.P. and Jones, D.T., Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Free Press, 2003, ISBN 9780743231640.
2	Dalela, S. and Saurabh, S., Sustainable Manufacturing: Principles, Tools, and Practices, CRC Press, 2019, ISBN 9780367331580.

Reference Books	
1	Dennis, P., Lean Production Simplified, CRC Press, 2015, 3rd Edition, ISBN 9781498705301.
2	Jawahir, I.S. and Dillon, O.W., Sustainable Manufacturing Processes, Systems, and Technologies, Springer, 2013, ISBN 9783642298981.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**	**2**	**1**	**2**	
CO2	**3**	**3**	**3**	**2**	**3**	
CO3	**3**	**3**	**3**	**3**	**3**	**2**
CO4	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**2**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Heat Transfer in Multiphase and Micro-Scale Systems						
Course Code	**:**	**1MME106C**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals and governing principles of multiphase heat transfer.
CLO2	Analyze boiling and condensation heat transfer mechanisms.
CLO3	Evaluate two-phase flow regimes, pressure drop, and heat transfer.
CLO4	Understand micro-scale heat transfer, nanofluids, and MEMS applications.
CLO5	Apply multiphase heat transfer concepts to thermal and engineering applications.

Module – 1	**08 Hrs**
Fundamentals of Multiphase Heat Transfer: Review of conduction, convection, and radiation. Introduction to multiphase systems. Governing equations and boundary conditions.	
Module – 2	**08 Hrs**
Boiling and Condensation Heat Transfer: Pool boiling and flow boiling. Nucleate and film boiling regimes. Filmwise and dropwise condensation.	
Module – 3	**08 Hrs**
Two-Phase Flow and Heat Transfer: Flow regimes in two-phase systems. Pressure drop and heat transfer correlations. Applications in power plants and refrigeration.	
Module – 4	**08 Hrs**
Micro-Scale Heat Transfer: Heat transfer in micro-channels and MEMS. Nanofluids and enhanced thermal conductivity. Rarefied gas dynamics and slip flow.	
Module – 5	**08 Hrs**
Applications and Case Studies: Electronics cooling and thermal management. Biomedical applications (micro-scale heat exchangers). Case studies: energy systems, aerospace, and micro-reactors.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of heat transfer in multiphase and micro-scale systems.
CO2	Analyze boiling, condensation, and two-phase flow heat transfer mechanisms.
CO3	Apply micro-scale heat transfer principles in MEMS, micro-channels, and nanofluids.
CO4	Evaluate computational and experimental methods for multiphase heat transfer.
CO5	Integrate advanced heat transfer concepts in energy, electronics cooling, and biomedical applications.

Text Books	
1	Incropera, F.P., DeWitt, D.P., Bergman, T.L., and Lavine, A.S., Fundamentals of Heat and Mass Transfer, Wiley, 2011, 7th Edition, ISBN 9780470501978.
2	Kandlikar, S.G., Garimella, S., Li, D., Colin, S., and King, M.R., Heat Transfer and Fluid Flow in Minichannels and Microchannels, Elsevier, 2006, ISBN 9780080445274.

Reference Books	
1	Carey, V.P., Liquid-Vapor Phase-Change Phenomena, CRC Press, 2008, 2nd Edition, ISBN 9781560324785.
2	Kakac, S., Shah, R.K., and Aung, W., Handbook of Single-Phase Convective Heat Transfer, Wiley, 1987, ISBN 9780471829453.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**	**1**	**1**	
CO2	**3**	**3**	**2**	**2**	**2**	
CO3	**3**	**3**	**3**	**3**	**2**	
CO4	**3**	**3**	**3**	**3**	**3**	
CO5	**3**	**3**	**3**	**3**	**3**	**2**

Semester: I						
High-Temperature Materials and Creep Mechanics						
Course Code	**:**	**1MME106D**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand high-temperature materials and their applications.
CLO2	Explain the fundamentals and mechanisms of creep deformation.
CLO3	Analyze the effects of microstructure, alloying and heat treatment on creep resistance.
CLO4	Understand creep testing, characterization and evaluation techniques.
CLO5	Apply creep concepts to the design of high-temperature engineering components.

Module – 1	**08 Hrs**
Introduction to High-Temperature Materials: Classification: superalloys, ceramics, composites. Thermo-mechanical properties and applications. Challenges in high-temperature environments.	
Module – 2	**08 Hrs**
Fundamentals of Creep Mechanics: Creep stages: primary, secondary, tertiary. Stress-strain-time relationships. Creep rate equations and models.	
Module – 3	**08 Hrs**
Creep Mechanisms and Microstructural Effects: Diffusion creep, dislocation creep, grain boundary sliding. Effect of microstructure on creep resistance. Role of alloying and heat treatment.	
Module – 4	**08 Hrs**
Creep Testing and Characterization: Experimental methods for creep testing. High-temperature tensile and fatigue testing. Non-destructive evaluation techniques.	
Module – 5	**08 Hrs**
Applications and Case Studies: Creep in turbine blades, boilers, and nuclear reactors. Design considerations for high-temperature components. Case studies: aerospace engines, power plants, automotive exhaust systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of high-temperature materials and their mechanical behavior.
CO2	Analyze creep mechanisms and deformation models under elevated temperatures.
CO3	Apply design principles for materials used in aerospace, automotive, and energy systems.
CO4	Evaluate experimental methods for creep testing and high-temperature characterization.
CO5	Integrate creep mechanics and material selection in lifecycle engineering.

Text Books	
1	Courtney, T.H., Mechanical Behavior of Materials, McGraw-Hill, 2000, 2nd Edition, ISBN 9780070132658.
2	Frost, H.J. and Ashby, M.F., Deformation Mechanism Maps: The Plasticity and Creep of Metals and Ceramics, Pergamon Press, 1982, ISBN 9780080293370.

Reference Books	
1	Evans, R.W. and Wilshire, B., Creep of Metals and Alloys, Institute of Metals, 1985, ISBN 9780904357197.
2	Reed, R.C., The Superalloys: Fundamentals and Applications, Cambridge University Press, 2006, ISBN 9780521859042.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**		**2**	
CO2	**3**	**3**	**2**	**2**	**2**	
CO3	**3**	**3**	**3**	**2**	**3**	
CO4	**3**	**3**	**2**	**3**	**3**	
CO5	**3**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Biomechanics and Biomedical Applications						
Course Code	**:**	**1MME106E**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals and mechanical properties of biological tissues.
CLO2	Analyze musculoskeletal mechanics, human motion and joint loading.
CLO3	Understand cardiovascular and respiratory biomechanics and their medical applications.
CLO4	Apply biomechanical principles to prosthetics, implants, orthotics and rehabilitation devices.
CLO5	Apply computational and experimental techniques for biomechanical analysis and evaluation.

Module – 1	**08 Hrs**
Fundamentals of Biomechanics: Introduction to biomechanics and biomedical engineering. Mechanical properties of biological tissues. Stress–strain behavior of bones, muscles, and ligaments.	
Module – 2	**08 Hrs**
Musculoskeletal Mechanics: Kinematics and dynamics of human motion. Joint mechanics and load distribution. Case studies in orthopedic biomechanics.	
Module – 3	**08 Hrs**
Cardiovascular and Respiratory Biomechanics: Hemodynamics: blood flow in arteries and veins. Respiratory mechanics and airflow modeling. Applications in medical devices (stents, ventilators).	
Module – 4	**08 Hrs**
Biomedical Devices and Applications: Prosthetics and orthotics design. Biomechanics of implants and biomaterials. Rehabilitation engineering and assistive devices.	
Module – 5	**08 Hrs**
Computational and Experimental Biomechanics: Finite element modeling in biomechanics. Experimental techniques: motion capture, force plates, imaging. Case studies: sports biomechanics, injury prevention, rehabilitation	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of biomechanics and its relevance to mechanical engineering.
CO2	Analyze the mechanics of biological tissues, joints, and musculoskeletal systems.
CO3	Apply engineering principles to biomedical devices and prosthetics.
CO4	Evaluate computational and experimental methods in biomechanics.
CO5	Integrate biomechanics concepts into healthcare, rehabilitation, and biomedical engineering applications.

Text Books	
1	Fung, Y.C., Biomechanics: Mechanical Properties of Living Tissues, Springer, 1993, 2nd Edition, ISBN 9780387979472.
2	Nigg, B.M. and Herzog, W., Biomechanics of the Musculoskeletal System, Wiley, 2007, 3rd Edition, ISBN 9780470017677.

Reference Books	
1	Ozkaya, N. and Nordin, M., Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, Springer, 2012, 3rd Edition, ISBN 9781441999996.
2	Bronzino, J.D., The Biomedical Engineering Handbook, CRC Press, 2018, 4th Edition, ISBN 9781439825334.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**	**1**	**2**	
CO2	**3**	**3**	**3**	**2**	**2**	
CO3	**3**	**3**	**2**	**3**	**3**	**1**
CO4	**3**	**3**	**3**	**2**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	**1**

Semester: I						
Gauges and Measurements						
Course Code	**:**	**1MME106F**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the principles of metrology and linear and angular measurement.
CLO2	Apply limits, fits and tolerances for achieving interchangeability.
CLO3	Analyze different types of fits and determine tolerance limits.
CLO4	Design gauges using Taylor's principle and gauge design concepts.
CLO5	Apply GD&T principles for functional and accurate component design.

Module – 1	**08 Hrs**
Introduction: Definition and objectives of metrology, Linear measurement: neutral axis significance, imperial standard yard, international standard meter, airy points, Basel points, Line, End & Wave length standards, **Slip Gages. Angular Measurement:** introduction, comparisons with linear measurement, sine bar: principle, types, advantages & limitations, uses, problems on sine bar, practical uses, material, construction, limitations problems on angle blocks (angle gauges).	
Module – 2	**08 Hrs**
Limits, Fits and Tolerance: Definitions, need of tolerance, types of tolerance, tolerance analysis (addition & subtraction of tolerances) interchangeability & selective assembly, representation of holes & shaft as per I.S. class & grade of tolerance, -difference between allowance & tolerance.	
Module – 3	**08 Hrs**
Fits: Definition, types of fits, (clearance, interference & transition), tolerance disposition chart, problems (calculation of fits) hole base system & shaft base system, procedure for solving on finding the hole & shaft tolerance upper & lower limits.	
Module – 4	**08 Hrs**
Design of Gauges: Taylor's principle, MMC & LMC of hole & shaft types of gauges (plain, threaded, limit, single end, double end, progressive, position, etc.,) important points for gauge design, limitations of gauges, - problems on gauge design.	
Module – 5	**08 Hrs**

Geometric Dimensioning & Tolerancing (Gd&T) Introduction, ANSI, ASME & ISO systems of Gd&T, functional dimensioning, feature & feature of size, advantages & limitations, feature control frame, fourteen characteristic symbols, form controls, profile controls, orientation controls, location controls, run-out controls, datum. Design Exercise: Design of Plug Gauge, Ring Gauge, Snap Gauge, Indicator Gauge, Taper plate Gauge, Taper Plug Gauge, Thread Gauge and Position Gauge.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the specification of limits, fits and tolerance.
CO2	Discuss the design knowledge of different gauges and their uses.
CO3	Apply the knowledge on the Interference of fits and their needs in calculations.
CO4	Demonstrate the different types of Geometric dimensioning and tolerance.
CO5	Explain the design knowledge of different gauges in manufacturing.

Text Books	
1	Mechanical Measurements, Beckwith Maragoni and Lienhard, 6th edition, McGraw –Hill Pearson Education,2006
2	Engineering Metrology, R.K. Jain, 2nd edition Khanna Publishers, Delhi, 2009

Reference Books	
1	Engineering Metrology and Measurements Bentle y, Pearson Education, 2000
2	Engineering Metrology and measurements, N.V. Raghavendra and L.Krishnamurthy, Oxford University

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**	**2**	**2**	
CO2	**3**	**3**	**3**	**2**	**2**	
CO3	**3**	**3**	**3**	**2**	**2**	
CO4	**3**	**3**	**3**	**2**	**3**	
CO5	**3**	**3**	**3**	**3**	**3**	

Semester: I						
AI And Robotics Laboratory						
Course Code	**:**	**1MMEL107A**		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	28		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Implement basic robot path-planning algorithms using computational tools.
CLO2	Simulate robot kinematics and develop motion-control solutions.
CLO3	Apply sensors, machine learning and computer vision for robotic applications.
CLO4	Develop AI-based solutions for autonomous and intelligent robotic systems.
CLO5	Design and prototype innovative robotic and IoT-based automation solutions.

PART – A **FIXED SET OF EXPERIMENTS**
1. Implementation of search algorithms (DFS, BFS, A*) for robot path planning. 2. Simulation of robotic arm kinematics using Python/Matlab. 3. Obstacle avoidance using sensor data (ultrasonic/IR). 4. Machine learning-based classification of sensor inputs. 5. Vision-based object detection using Open CV. 6. Control of a mobile robot using reinforcement learning.
PART – B **OPEN ENDED EXPERIMENTS**
Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.
Concept 1: Design and simulate a robot for warehouse automation. Concept 2: Develop an AI-based predictive maintenance system for robots. Concept 3: Implement swarm robotics algorithms for cooperative tasks. Concept 4: Explore human-robot interaction using gesture recognition. Concept 5: Integrate IoT with robotics for smart factory applications. Concept 6: Prototype a vision-guided autonomous vehicle.

Course Outcomes: After completing the course, the students will be able to	
CO1	Implement basic AI algorithms for robotics applications.
CO2	Design and simulate robotic motion planning and control.
CO3	Apply machine learning techniques for sensor data analysis.
CO4	Integrate vision systems for robotic perception.
CO5	Conduct open-ended experiments to explore AI-driven robotics solutions.

Text Books	
1	Russell, S., Norvig, P., Artificial Intelligence: A Modern Approach, Pearson, 2021, 4th Edition, ISBN 9780134610993.
2	Siciliano, B., Khatib, O., Springer Handbook of Robotics, Springer, 2016, 2nd Edition, ISBN 9783319325521.

Reference Books	
1	Goodfellow, I., Bengio, Y., Courville, A., Deep Learning, MIT Press, 2016, ISBN 9780262035613.
2	Bishop, C.M., Pattern Recognition and Machine Learning, Springer, 2006, ISBN 9780387310733.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**	**2**	**2**	**3**	
CO2	**3**	**3**	**3**	**2**	**3**	
CO3	**3**	**3**	**3**	**3**	**3**	
CO4	**3**	**3**	**3**	**3**	**3**	**1**
CO5	**3**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Manufacturing Automation Lab (CNC/CIM)						
Course Code	**:**	**1MMEL107B**		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	28		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand CNC machines, programming concepts, and safety practices.
CLO2	Develop CNC part programs for turning and milling operations.
CLO3	Simulate and optimize CNC tool paths using CAD/CAM software.
CLO4	Integrate CNC machines with robotics, AGVs, and CIM systems.
CLO5	Apply Industry 4.0 concepts and automation techniques to manufacturing problems.

PART – A **FIXED SET OF EXPERIMENTS**
1. Introduction to CNC machine tools and safety practices. 2. Part programming for CNC turning (linear and circular interpolation). 3. Part programming for CNC milling (pocketing, contouring). 4. Toolpath simulation using CAD/CAM software. 5. Machining of a component using CNC lathe/mill. 6. Demonstration of CIM system integration (robotics/AGV/automated storage).
PART – B **OPEN ENDED EXPERIMENTS**
Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.
Concept 1: Optimization of machining parameters for surface finish. Concept 2: Development of complex tool paths using CAD/CAM. Concept 3: Integration of CNC with robotics for part handling. Concept 4: Simulation of flexible manufacturing systems (FMS). Concept 5: Case study on Industry 4.0 applications in CNC/CIM. Concept 6: Prototype project on automated inspection using sensors.

Course Outcomes: After completing the course, the students will be able to	
CO1	Operate CNC machines and understand their control systems.
CO2	Develop part programs for turning, milling, and drilling operations.
CO3	Apply CAD/CAM software for tool path generation and simulation.
CO4	Integrate CNC with CIM systems for automated manufacturing.
CO5	Conduct open-ended experiments to explore automation and optimization in manufacturing.

Text Books	
1	Groover, M.P., Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2018, 4th Edition, ISBN 9789332578329.
2	Kundra, T.K., Rao, P.N., Numerical Control and Computer-Aided Manufacturing, McGraw-Hill, 1998, ISBN 9780074621302.

Reference Books	
1	Mikell P. Groover, Fundamentals of Modern Manufacturing, Wiley, 2020, 7th Edition, ISBN 9781119722014.
2	Rao, P.N., CAD/CAM: Principles and Applications, McGraw-Hill, 2017, 3rd Edition, ISBN 9780070634459.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**1**		**2**	
CO2	**3**	**3**	**3**	**2**	**3**	
CO3	**3**	**3**	**3**	**3**	**3**	
CO4	**3**	**3**	**3**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Product Design Visualization Engineering Lab						
Course Code	**:**	**1MMEL107C**		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	28		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the basic CAD interface and 2D drafting techniques.
CLO2	Develop parametric 3D models of mechanical components.
CLO3	Create assemblies, exploded views and BOMs using CAD tools.
CLO4	Apply rendering, visualization and basic simulation techniques.
CLO5	Design and visualize innovative products through open-ended CAD projects.

PART – A **FIXED SET OF EXPERIMENTS**
1. Introduction to CAD software interface and basic sketching. 2. 2D drafting of mechanical components (orthographic and sectional views). 3. 3D modeling of simple parts using parametric features. 4. Assembly modeling of multiple components. 5. Generation of exploded views and bill of materials (BOM). 6. Rendering and visualization of product models with material and lighting effects.
PART – B **OPEN ENDED EXPERIMENTS**
Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.
Concept 1: Design and visualize a consumer product (e.g., bottle, chair, gadget). Concept 2: Develop a 3D model of an automotive component with realistic rendering. Concept 3: Create a product animation for assembly/disassembly visualization. Concept 4: Explore simulation of product stress/thermal performance. Concept 5: Prototype visualization for biomedical or aerospace applications. Concept 6: Case study project on sustainable product design visualization.

Course Outcomes: After completing the course, the students will be able to	
CO1	Operate CNC machines and understand their control systems.
CO2	Develop part programs for turning, milling, and drilling operations.
CO3	Apply CAD/CAM software for tool path generation and simulation.
CO4	Integrate CNC with CIM systems for automated manufacturing.
CO5	Conduct open-ended experiments to explore automation and optimization in manufacturing.

Text Books	
1	Sham Tickoo, Autodesk Inventor for Engineers and Designers, CADCIM Technologies, latest edition.
2	Zeid, I., Mastering CAD/CAM, McGraw-Hill, 2005, ISBN 9780072868456.

Reference Books	
1	Kalpakjian, S., Schmid, S.R., Manufacturing Engineering and Technology, Pearson, 2014, 7th Edition.
2	P.N. Rao, CAD/CAM: Principles and Applications, McGraw-Hill, 2017, 3rd Edition.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**	**1**	**3**	
CO2	**3**	**3**	**3**	**2**	**3**	
CO3	**3**	**3**	**3**	**2**	**3**	
CO4	**3**	**3**	**3**	**3**	**3**	
CO5	**3**	**3**	**3**	**3**	**3**	**2**

Semester: I						
Engineering Computational Lab						
Course Code	**:**	**1MMEL107D**		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	28		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Apply numerical methods to solve engineering problems.
CLO2	Develop computational models for engineering systems.
CLO3	Analyze and visualize engineering data using computational tools.
CLO4	Apply optimization and simulation techniques to engineering problems.
CLO5	Use AI, machine learning and data analytics for engineering applications.

PART – A **FIXED SET OF EXPERIMENTS**
1.Solving linear algebraic equations using matrix methods (Gauss elimination, LU decomposition). 2. Numerical solution of ordinary differential equations (Euler, Runge-Kutta methods). 3. Curve fitting and regression analysis using computational tools. 4. Root-finding methods (Bisection, Newton-Raphson). 5. Simulation of mechanical/thermal systems using MATLAB/Python. 6. Data visualization and plotting of engineering datasets.
PART – B **OPEN ENDED EXPERIMENTS**
Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.
Concept 1: Optimization of engineering design parameters using computational methods. Concept 2: Simulation of dynamic systems (mechanical/electrical). Concept 3: Development of a computational model for heat transfer problems. Concept 4: Case study on big data analytics in engineering. Concept 5: Application of machine learning algorithms for engineering datasets. Concept 6: Prototype project on computational modeling of sustainable energy systems.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply computational tools (MATLAB, Python, Excel) for solving engineering problems.
CO2	Develop algorithms and programs for numerical methods and simulations.
CO3	Analyze engineering data using statistical and optimization techniques.
CO4	Visualize engineering solutions through graphs, plots, and computational models.
CO5	Conduct open-ended computational experiments integrating creativity and problem-solving.

Text Books	
1	Chapra, S.C., Canale, R.P., Numerical Methods for Engineers, McGraw-Hill, 2015, 7th Edition.
2	Rao, S.S., Engineering Optimization: Theory and Practice, Wiley, 2019, 5th Edition.

Reference Books	
1	Mathews, J.H., Fink, K.D., Numerical Methods Using MATLAB, Pearson, 2004.
2	Hanselman, D., Littlefield, B., Mastering MATLAB, Pearson, 2011.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**	**2**	**2**	**3**	
CO2	**3**	**3**	**3**	**3**	**3**	
CO3	**2**	**3**	**2**	**3**	**3**	
CO4	**3**	**3**	**3**	**3**	**3**	
CO5	**2**	**3**	**3**	**3**	**3**	**1**

Semester: I						
Tool Design Engineering Lab-1						
Course Code	**:**	**1MMEL107E**		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	28		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**Yes**
Knowledge on Fundamental Concepts	**Yes**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Study the Design, Assembly and Drafting of Combination tool, simple drill jig, leaf jig.
CLO2	Study the Design, Assembly, Drafting and Analysis of Milling Fixture.
CLO3	Study the Design, Assembly and Drafting of Stage and Progressive Press Tool.
CLO4	Study the Design, Assembly and Drafting of Compound Tool and Bending Tool.
CLO5	Study the Design, Assembly and Drafting of a Cavity Injection Molding Tool for Simple Component.

EXPERIMENTS
1. Design, Assembly and detail drawings of simple drill jig. 2. Design, Assembly, Drafting and Analysis of a leaf jig.. 3. Design, Assembly, Drafting and Analysis of Milling & Turning Fixture. 4. Design, Assembly, Drafting and Analysis of Simple Stage Tool. 5. Design, Assembly, Drafting and Analysis of Progressive Press Tool. 6. Design, Assembly, Drafting and Analysis of a Compound Tool & Combination Tool. 7. Design, Assembly, Drafting and Analysis of a Single Cavity Injection Molding Tool for a given component. 8. Design, Assembly, Drafting and Analysis of a two cavity Injection molding tool for a given component. 9. Design, Assembly, Drafting and Analysis of a Single Cavity Cold Chamber die casting tool for a simple component. 10. Design, Assembly, Drafting and Analysis of a two cavity hot chamber die casting tool for a given component.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply computational tools (MATLAB, Python, Excel) for solving engineering problems.
CO2	Develop algorithms and programs for numerical methods and simulations.
CO3	Analyze engineering data using statistical and optimization techniques.
CO4	Visualize engineering solutions through graphs, plots, and computational models.
CO5	Conduct open-ended computational experiments integrating creativity and problem-solving.

Text Books	
1	P. H. Joshi**,** *Jigs and Fixtures*, McGraw Hill Education, New Delhi.
2	C. Elanchezhian, T. Sunder Selwyn and B. Vijaya Ramnath**,** *Computer Aided Manufacturing*, Laxmi Publications.

Reference Books	
1	P. C. Sharma – *A Textbook of Production Engineering*, S. Chand & Company.
2	H. M. T. – *Production Technology: Manufacturing Processes, Technology and Automation*, Tata McGraw-Hill.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**		**1**	
CO2	**3**	**3**	**3**	**2**	**3**	
CO3	**3**	**3**	**3**	**2**	**3**	
CO4	**3**	**3**	**3**	**2**	**3**	**1**
CO5	**3**	**3**	**3**	**3**	**3**	



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SJC INSTITUTE OF TECHNOLOGY
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Estd.:1986

Scheme of Teaching and Examinations (2026)

M.Tech.(Machine Design)

Choice-Based Credit System (CBCS) and Outcome-Based Education (OBE)

II SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching and Learning Scheme					Examination				Credits
					Classroom Instruction (Cl) hours per semester		Laboratory Instruction (LI) hours Per semester	Term work s self -learning in hours	Teaching -Learning hours per semester = Cl +LI+TW+SL	Duration in h ours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	TW+SL						
1	PCC/IPCC	1MME201	Advanced Finite Element Methods and Applications		42		28	50	120	03	50	50	100	4
2	PCC	1MME202	Advanced Machine Design		42	0	0	48	90	03	50	50	100	3
3	PCC	1MME203	Mechanics of Composite Materials		42	0	0	48	90	03	50	50	100	3
4	PCC	1MME204	Machine Learning for Mechanical Systems		42	0	0	48	90	03	50	50	100	3
5	PEC	1MME205x	Professional Elective Courses-III		42	0	0	48	90	03	50	50	100	3
6	PEC	1MME206x	Professional Elective Course-IV		42	0	0	48	90	03	50	50	100	3
7	PCCL	1MMEL207	Professional Core Course- Lab (AEC Lab)		--	--	28	2	30	03	50	50	100	1
8	PCC	1MMES208	Minor Project /Ability Skill Development Project*		--				60	03	50	50	100	2
								Total	660	--	400	400	800	22

***** An Ability Enhancement Course Laboratory is a practical, skill-oriented lab course designed to strengthen students' practical abilities, professional competencies that support communication, environmental awareness, computational thinking, interdisciplinary learning, and application skills through hands-on learning experiences. The laboratory may pertain to disciplinary or interdisciplinary involving experiments, design tasks, and mini-projects aligned with current industry practices.

Professional Elective Courses (PECs)				
PEC-III			PEC-IV	
Code	Title of the Course		Code	Title of the Course
1MME205A	Material Selection in Machine Design		1MME206A	Design for Manufacturing and Assembly
1MME205B	Theory of Metal Cutting and forming		1MME206B	Additive Manufacturing Techniques
1MME205C	Fatigue and Fracture Mechanics		1MME206C	Mechanical Behavior of Materials
1MME205D	Sustainability Engineering		1MME206D	Industrial Robots

Semester: II						
ADVANCED FINITE ELEMENT METHODS AND APPLICATIONS						
Course Code	**:**	**1MME201**		**Credits**	**:**	04
Hours/Week(L:T:P)	**:**	3:2:0		**CIE**	**:**	50 Marks
Total Hours	**:**	42 T + 28 P		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**YES**

Course Learning Objectives: This course will enable the students to	
CLO1	Introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
CLO2	Discuss the use of finite element methods in engineering problem-solving drawing from applications in solid mechanics and other engineering Domains.
CLO3	Familiarize students with professional-level finite element software.
CLO4	To define, derive and assemble stiffness matrices for spring element, truss element, beam elements, Plane Stress element.
CLO5	To be familiar with the idea of Isoparametric formulation for various FE Elements
CLO6	FE Formulation of Axisymmetric and Solid Elements.

Module – 1	**10 Hrs**
Mathematical Preliminaries: Principle of Virtual Work, General steps of the Finite Element Method. **Introduction to the Stiffness (Displacement) Method:** Definition of the Stiffness Matrix, Derivation of the Stiffness Matrix for a Spring Element, Example of a Spring Assemblage, Assembling the total Stiffness Matrix by Superposition Method, Boundary Conditions, Potential Energy Approach to Derive Spring Element Equations.	
Module – 2	**10 Hrs**
Development of Truss Equations: Derivation of the Stiffness Matrix for a Bar Element in Local Coordinates, Selecting a Displacement Function, Transformation of vectors in Two Dimensions, Global Stiffness Matrix for Bar Arbitrarily Oriented in the Plane, Computation of Stress for a Bar in the x – y Plane, Solution of a Plane Truss, Transformation Matrix and Stiffness Matrix for a Bar in three-Dimensional space, Inclined Supports, Potential Energy Approach to Derive Bar Element Equations, Galerkin's Residual Method and its Use to Derive the One-Dimensional Bar Element Equations.	
Module – 3	**10 Hrs**
Development of Beam Equations: Beam stiffness, Example of Assemblage of Beam Stiffness Matrices, Examples of Beam analysis Using the Direct stiffness Method, Distributed Loading, Beam Element with Nodal Hinge, Potential Energy Approach to Derive Beam Element Equations, Galerkin's Method for Deriving Beam Element Equations.	
Module – 4	**10 Hrs**

Development of the Plane Stress and Plane Strain Stiffness Equations: Basic Concepts of Plane Stress and Plane Strain, Derivation of the Constant-Strain triangular Element Stiffness Matrix and Equations, Treatment of body and Surface Forces, Explicit Expression for the Constant-Strain Triangle Stiffness Matrix, Finite Element Solution of a Plane Stress Problem, Rectangular Plane Element (bilinear rectangle, Q4). **Development of the Linear Strain Triangle Equations**: Derivation of the Linear-Strain Triangular Element Stiffness Matrix and Equations, Example LST Stiffness Determination, Comparison of Elements.
Module – 5 **10 Hrs**
Isoparametric Formulation: Isoparametric Formulation of the Bar Element Stiffness Matrix, Isoparametric Formulation of the plane Quadrilateral (Q4) Element Stiffness Matrix, Newton-Cotes and Gaussian Quadrature, Evaluation of the Stiffness Matrix and Stress Matrix by Gaussian Quadrature, Higher-Order Shape Functions (including Q6, Q8,Q9, and Q12 Elements without stiffness matrix derivation)

PRACTICAL COMPONENT OF IPCC

Sl No.	Experiments
1	Solve (with MATLAB), the ODE using the weak formulation (FEM/MATLAB): $a\frac{d^2u}{dx^2}+b\frac{du}{dx}+cu=f(x)$, $0<x<L$ with Boundary Conditions: $u(0)=0$ and $u(L)=0$ take a=1, b=-3, c=2 and f(x)=1. Take domain size as 1 (i.e. L=1) and take Five linear elements of equal size.
2	Solve (with MATLAB), the ODE using the weak formulation (FEM/MATLAB): $a\frac{d^2u}{dx^2}+b\frac{du}{dx}+cu=f(x)$, $0<x<L$ with Boundary Conditions: $u(0)=0$ *and* $\frac{du}{dx}(1)=0$ take a=1,b=-3, c=2 and f(x)=1. Take domain size as 1(i.e. L=1) and take Five linear elements of equal size.
3	Solve using MATLAB, the Laplace equation representing two dimensional steady-state problems using both linear triangle elements with the given boundary conditions: $\frac{\partial^2u}{\partial x^2}+\frac{\partial^2u}{\partial y^2}=0$ for $0<x<5$ and $0<y<10$. The boundary conditions are u(x, 0) =0 for 0<x<5, u(0,y)=0 for 0<y<10, u(x,10)=100sin(ϖx/10) for 0<x<5, and $\frac{\partial u(5,y)}{\partial x}$=0 for 0<y<10.
4	Solve the problem 3 using the bilinear rectangular elements with other conditions remaining same
5	Write a MATLAB program to Use Gauss-Legendre quadrature for integration of $f(x,y)=1+4xy-3x^2y^2+x^4y^6$ over the domain -1<x<1 and -1<y<1. Use 3-point quadrature rule along the x-axis and 4-point quadrature rule along y-axis.
6	Determine the natural frequency of a free bar (Fixed at one end and free at other) using the finite element method. The bar has Young's Modulus of 200 GPa, Cross-sectional area of 0.001 m^2, Density of 7860 Kg/m^3 and Length of 4 m.
7	Write a MATLAB program to perform stress analysis of a cantilever beam subjected to end load using two dimensional Isoparametric elements assuming plane stress condition. Model the beam using ten four-node quadrilateral elements.
8	Write a generalized MATLAB Code that can solve any two dimensional truss structure to find member forces.
9	Make a report of available 1D, 2D and 3D Elements in a commercial FE Software.
10	Make a report of the practical aspects to be considered while generating a mesh in commercial software.
Demonstration Experiments (For CIE)	
11	Solve a problem of a Cantilever beam subjected to end point load in a commercial software to find out its displacements and stresses
12	Write a script in commercial software to automate the above problem for various dimensions and material properties.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the Basis of formulation of Finite Element Methods.
CO2	Formulate the complete FE Formulation for 1D, 2D, and 3D Elements.
CO3	Evaluate various boundary conditions in the FE Application.
CO4	Write a small computer program to analyze a simple Truss structure.

Text Books	
1	Daryl L. Logan, "A First Course in the Finite Element Method", 6th Edition, Cengage Learning, 2017.
2	Jacob Fish and Ted Belytschko, "A First Course in Finite Elements", John Wiley & Sons, 2007
3	J. N. Reddy, "An Introduction to the Finite Element Method", 3rd Edition, Mc-Graw Hill, 2006
4	Ferreira, Antonio & Fantuzzi, Nicholas., "MATLAB Codes for Finite Element Analysis: Solids and Structures", Springer, 2009.

Web links and Video Lectures (e-Resources)	
1	NOC: Finite Element Method: Variational Methods to Computer Programming, IIT Guwahati (https://nptel.ac.in/courses/112103295)
2	NOC:Basics of Finite Element Analysis - II, IIT Kanpur (https://nptel.ac.in/courses/112104205)
3	Abaqus FEA Tutorial Videos (https://www.youtube.com/user/AbaqusPython)
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Write MATLAB/ SCILAB programs to Analyze the 1D, 2D, and 3D Finite Elements.
2	Practice the Modelling, Meshing, and Analysis of simple structures in commercial software and compare the results with closed form solutions.
3	Take an open source FE Software, Compile, and generate an executable file.
4	Understand and summaries the format of the input ASCII files generated by commercial meshing software for any well know FE Solver.

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**2**				
CO2	**3**	**3**	**2**	**2**		
CO3	**2**	**3**	**2**	**2**		
CO4	**2**	**2**	**1**	**2**	**3**	

Note: High - 1, Medium – 2, and Low – 3

Semester: II						
ADVANCED MACHINE DESIGN						
Course Code	**:**	**1MME202**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Outline the basic philosophy of machine design
CLO2	Compute the required load under various practical conditions
CLO3	Apply the various static load based theories of failures
CLO4	Apply the various fatigue load based theories of failures

Module – 1	**08 Hrs**
Introduction to Mechanical Engineering Design: Design and Mechanical Engineering Design, Phases and Interactions of the Design Process, Design Tools and Resources, The Design Engineer's Professional Responsibilities, Standards and Codes, Stress and Strength, Design Factor and Factor of Safety, Reliability, Dimensions and Tolerances, Calculations and Significant Figures.	
Module – 2	**08 Hrs**
Load Determination: Loading Classes, FBDs, Load Analysis, 2D Static Loading Case Studies, 3D Static Loading Case Studies, Impact Loading, Beam Loading.	
Module – 3	**08 Hrs**
Stress and Strain: Stress, Strain, Principal Stress, Plane Stress and Plane Strain, Mohr's Circle, Applied Versus Principal Stresses, Axial Tension, Direct Shear Stress, Bearing Stress and Tearout.	
Module – 4	**08 Hrs**
Deflection: Beams and Bending Stresses, Deflection in Beams, Torsion, Combined Stresses, Spring Rates, Stress Concentration, Stresses in Cylinders, Case Studies In Static Stress And Deflection Analysis.	
Module – 5	**08 Hrs**
Static Failure Theories: Failure of Ductile Materials, Failure of Brittle Materials, Case Studies: Bicycle Brake Lever, Crimping Tool, Automobile Scissors- jack, Bicycle Brake Arm.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the core phases of the mechanical design process, standard codes, professional ethics, safety factors, and dimensional tolerance principles.
CO2	Construct Free Body Diagrams (FBDs) and analyze static, impact, and multi-dimensional loading conditions on mechanical components.
CO3	Calculate state of stress, strain, principal stresses, and Mohr's Circle for components subjected to tension, shear, bearing, and tearout loads.

CO4	Evaluate beam deflections, torsional loads, stress concentrations, and combined stresses in pressure vessels and structural elements.
CO5	Select and apply appropriate static failure theories for ductile and brittle materials to evaluate real-world engineering systems

Text Books	
1	Robert L. Norton, Machine design - An Integrated Approach, 4th Edition, Prentice- Hall, 2011.
2	R G Budynas, and J K Nisbett, Shigley's Mechanical Engineering Design, 9th Edition, McGraw Hill,2011

Skill Development Activities Suggested	
1	Write a small C Program to design a shaft for both static and dynamic loading
2	Compute the fatigue life of simple rod subject to constant amplitude load in a commercial software.
3	Learn the usage of MSC Fatigue Module of NASTRAN

Web links and Video Lectures (e – Resources)	
1	https://www.machinedesign.com/
2	https://archive.nptel.ac.in/courses/112/105/112105125/
3	https://archive.nptel.ac.in/courses/112/105/112105124/

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**2**	**1**	**2**		**2**	**1**
CO2	**3**	**3**	**2**		**1**	
CO3	**3**	**3**	**2**	**1**	**1**	
CO4	**3**	**3**	**3**	**2**	**2**	
CO5	**3**	**3**	**3**	**1**	**2**	**2**

Note: High - 1, Medium – 2, and Low – 3

Semester: II						
MECHANICS OF COMPOSITE MATERIALS						
Course Code	**:**	**1MME203**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Comprehend the basics of Composite Materials.
CLO2	Select composite materials.
CLO3	Conduct stress and Stiffness analyses of Lamina and Laminate.
CLO4	Use the theories of failure of composite materials under static loading.

Module – 1	**08 Hrs**
Introduction: Basic Concepts, Design Process, Composites Design Methods, Fracture Mechanics. **Materials:** Fiber Reinforcements, Fiber Types-Glass Fibers, Silica and Quartz Fibers, Carbon Fibers, Carbon Nanotubes, Organic Fibers, Boron Fibers, Ceramic Fibers, Basalt Fibers, Metallic Fibers, Natural Fibers; Fiber-Matrix Compatibility, Fiber Forms, Matrix Materials, Thermoset Matrices, Thermoplastic Matrices, Biodegradable Matrices, Creep, Temperature, and Moisture, Corrosion Resistance, Flammability	
Module – 2	**08 Hrs**
Micromechanics: Basic Concepts Volume and Mass fraction, Heterogeneous Material, Anisotropic Material, Orthotropic Material, Transversely Isotropic Material, Isotropic Material; Stiffness-Longitudinal Modulus, Transverse Modulus, In-Plane Poisson's Ratio, In-Plane Shear Modulus, Intralaminar Shear Modulus, Restrictions on the Elastic Constants, **Strength** - Longitudinal Tensile Strength, Longitudinal Compressive Strength, Transverse Tensile Strength, Mode I Fracture Toughness, In-Plane Shear Strength, Mode II Fracture Toughness, Transverse Compressive Strength, Mohr-Coulomb Failure, Intralaminar Shear Strength.	
Module – 3	**08 Hrs**
Ply Mechanics: Coordinate Systems, Stress and Strain, Stress-Strain Equations, Off-Axis Stiffness, Specially Orthotropic Lamina. **Macromechanics:** Plate Stiffness and Compliance, Computation of Stresses, Common Laminate Types, Laminate Moduli, Universal Carpet Plots.	
Module – 4	**08 Hrs**
Ply Strength: Lamina Failure Criteria-Strength Ratio, Maximum Stress Criterion, Maximum Strain Criterion, Interacting Failure Criterion, First Ply Failure, Last Ply Failure, Laminate Strength.	
Module – 5	**08 Hrs**
Manufacturing Processes: Hand Layup, Prepreg Layup, Bag Molding, Autoclave Processing, Compression Molding, Resin Transfer Molding, Vacuum-Assisted Resin Transfer Molding, Pultrusion, Filament Winding, Textile Manufacturing.	

Course Outcomes: After completing the course, the students will be able to	
CO1	**Understand** the fundamentals of composite materials, including fiber-matrix systems, durability characteristics, and composite design principles.
CO2	**Analyze** micromechanical behavior to estimate effective mechanical properties and strength characteristics of a single lamina.
CO3	**Formulate** stress-strain relations for an off-axis lamina and evaluate macro-mechanical behavior (stiffness and compliance) of composite laminates.
CO4	**Apply** failure criteria to assess lamina strength and predict progressive laminate failure behavior (FPF to LPF).
CO5	**Select** appropriate composite manufacturing techniques based on component geometry, material matrix, and production volume requirements.

Text Books	
1	Ever J. Barbero, "Introduction to Composite Materials Design", 3rd Edition, CRC Press, 2018.
2	Autar K. Kaw," Mechanics of composite materials", CRC, 2nd Edition, Indian Print, 2009

Skill Development Activities Suggested	
1	Write a MATLAB programme to find the stress and strain of an angle lamina
2	Write a MATLAB code to find A,B, D Matrix of a Laminate and to find strains when subjected to applied stresses.
3	Write a MATLAB code to accommodate the theories of failure for composite materials

Web links and Video Lectures (e – Resources)	
1	Introduction to Composites, IIT Kanpur, https://nptel.ac.in/courses/112104168
2	Composite Materials and Structures, IIT Kanpur, https://nptel.ac.in/courses/101104010

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**1**				
CO2	**3**	**3**	**1**	**2**		
CO3	**3**	**3**	**2**	**2**	**1**	
CO4	**3**	**3**	**2**	**3**	**1**	
CO5	**2**	**2**	**3**		**2**	

Note: High - 1, Medium – 2, and Low – 3

Semester: II						
Machine Learning for Mechanical Systems						
Course Code	**:**	**1MME204**		**Credits**	**:**	03
Hours/Week (L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the fundamentals of machine learning, its history, and basic classification algorithms.
CLO2	Analyze different learning models, learning strategies, and theoretical concepts of machine learning.
CLO3	Apply regression, neural networks, support vector machines, and clustering techniques to engineering problems.
CLO4	Apply genetic algorithms and genetic programming for optimization and hypothesis search.
CLO5	Apply machine learning and genetic algorithms to smart machining, process monitoring, and robotic applications.

Module – 1	**08 Hrs**
Introduction to Machine Learning, history of machine learning, artificial intelligence vs machine learning, data science vs machine learning, decision tree, Naive Bayes approach.	
Module – 2	**08 Hrs**
Learning Models, Types of Learning: Supervised, Unsupervised, Reinforcement, Perspectives and Issues, Version Spaces, PAC Learning, VC Dimension	
Module – 3	**08 Hrs**
Regression: Linear Regression, Multiple Linear Regression, Bayesian Regression, Neural Networks: Introduction, Perception, Multilayer Perception, Support Vector Machines: Linear and Non-Linear, Kernel Functions, K nearest Neighbours. Introduction to clustering, K-means clustering, K-Mode Clustering.	
Module – 4	**08 Hrs**
Genetic Algorithms: Hypotheses, Genetic Operator, Fitness Function and Selection, an Illustrative Example, Hypothesis Space Search, Genetic Programming, Parallelizing Genetic Algorithms..	
Module – 5	**08 Hrs**
Smart machining: application of neural networks, genetic algorithm for turning, milling, drilling and robotic applications, sensing, monitoring, data analysis, parameters, interpretation of responses	

Course Outcomes: After completing the course, the students will be able to

CO1	Understand the basics of probability distributions and components of learning.
CO2	Develop the regression models and algorithms for mechanical applications
CO3	Assess the solution using advanced optimisation techniques.
CO4	Predict the responses from neural network and genetic algorithms for smart machining applications.

Text Books	
1	Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India, 3rd Edition 2014, ISBN: 9780262028189.
2	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar" Foundations of Machine Learning", MIT Press, 2012, ISBN: 9780262039406
3	Tom Mitchell, "Machine Learning", McGraw Hill, 3rdEdition, 1997, ISBN 0070428077
4	MACHINE LEARNING - An Algorithmic Perspective, Second Edition, Stephen Marsland, 2015, ISBN:9781466583283

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**2**	**1**			**1**	
CO2	**2**	**3**		**2**	**2**	
CO3	**2**	**3**	**2**	**3**	**3**	
CO4	**2**	**3**	**3**	**2**	**3**	
CO5	**2**	**3**	**3**	**3**	**3**	

ABILITY / SKILL ENHANCEMENT COURSES (OFFLINE)

Semester: II						
NUMERICAL PROGRAMMING FOR MECHANICAL ENGINEERS (Using MATLAB/NumPy)						
Course Code	**:**	**MME208**		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	15		**SEE**	**:**	50 Marks
Course Type	**:**	AEC/SEC		**SEE Duration**	**:**	1 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Note: Instead of MATLAB any equivalent open source and commercial software can be used

Course Learning Objectives: This course will enable the students to	
CLO1	Gain knowledge of basic numerical methods and algorithms used in mechanical engineering.
CLO2	Understand the mathematical foundations and applications of numerical techniques.
CLO3	Learn to use MATLAB and NumPy for numerical problem-solving in mechanical engineering contexts.
CLO4	Familiarize with key concepts in solving linear and nonlinear equations, interpolation, and numerical differentiation.
CLO5	Learn to apply numerical methods for mechanical engineering simulations and error analysis.

Module – 1	**03 Hrs**
Introduction to Numerical Programming **Overview of Numerical Methods:**Basic definitions and examples of numerical methods, Significance of numerical programming in engineering. **Introduction to MATLAB and NumPy:** Syntax, commands, and basic operations, Understanding variables, matrices, and vectors. **Basic Programming Constructs:** Loops, conditional statements, and functions, Debugging techniques in MATLAB/NumPy.	
Module – 2	**03 Hrs**
Solving Linear and Nonlinear Equations: **Linear Systems of Equations:** Gaussian elimination, LU decomposition. **Iterative methods:** Jacobi and Gauss-Seidel. **Nonlinear Equations:** Bisection method, Newton-Raphson method, Fixed-point iteration	
Module – 3	**03 Hrs**
Numerical Differentiation and Integration: **Numerical Differentiation:** Forward and backward difference methods, Central difference approximation. **Numerical Integration:** Trapezoidal rule, Simpson's rule	
Module – 4	**03 Hrs**
Interpolation and Curve Fitting: Polynomial Interpolation: Lagrange and Newton interpolation methods, Application to curve fitting. Least Squares Method: Fitting a linear model to data points	
Module – 5	**03 Hrs**

Numerical Solutions of Ordinary Differential Equations (ODEs) **Introduction to ODEs:** Types of ordinary differential equations in mechanical engineering, Initial value and boundary value problems. Numerical Methods for ODEs: **Euler's method, Runge-Kutta methods (4th order)**

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the appropriate numerical method for a given engineering problem.
CO2	Understand and recognize various methods for solving equations, integration, and interpolation.
CO3	Select suitable algorithms for solving ODEs in mechanical engineering.
CO4	Evaluate the accuracy of numerical methods and identify common sources of error.
CO5	Apply numerical methods to basic mechanical engineering problems using MATLAB/NumPy.

Text Books	
1	"**Numerical Methods for Engineers**" by Steven C. Chapra and Raymond P. Canale
2	"**Applied Numerical Methods with MATLAB for Engineers and Scientists**" by Steven C. Chapra
3	"**Numerical Methods in Engineering with Python 3**" by Jaan Kiusalaas
4	"**MATLAB for Engineers**" by Holly Moore
5	"**Python for Engineers and Scientists**" by E.M. Kranakis

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Collaborative Learning
2	Gamification of Learning
3	Online Code Repositories

Web links and Video Lectures (e – Resources)	
1	**MATLAB Documentation:** https://www.mathworks.com/help/matlab/
2	**NumPy Documentation:** https://numpy.org/doc/stable/
3	**MIT OpenCourseWare - Numerical Methods:** https://ocw.mit.edu/courses/mechanical-engineering/
4	**Coursera - Numerical Methods for Engineers:**https://www.coursera.org/learn/numerical-methods- engineering
5	**SciPy Documentation (for advanced numerical computing):** https://docs.scipy.org/doc/scipy/

Semester: II						
MECHANICAL SIMULATION LABORATORY						
Course Code	**:**	**1MMEL207**		**Credits**	**:**	02
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	28		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Apply Finite Element Analysis (FEA) to solve structural problems and understand stress, strain, and deformation in mechanical components.
CLO2	Analyze multi-body dynamic systems using simulation tools to evaluate kinematics and dynamic behaviours of mechanisms.
CLO3	Implement computational optimization techniques to improve the performance and efficiency of mechanical structures.
CLO4	Model and simulate mechanical systems such as gears, trusses, and linkages using industry-standard software.
CLO5	Utilize machine learning techniques for the classification of material properties based on mechanical characteristics.

**** Software mentioned are representative only, any other equivalent commercial or open source software can be used**

Sl No	Name of Experiment
1	**Static Structural Analysis of a Cantilever Beam** • **Objective:** Analyze a **cantilever beam** subjected to a point load. • **Software:** MSC Nastran / MATLAB • **Outcome:** Understanding **stress, displacement, and boundary conditions**.
2	**Modal Analysis of a Plate Structure** • **Objective:** Compute the **natural frequencies and mode shapes** of a rectangular plate. • **Software:** MSC Nastran / Python • **Outcome:** Learning **eigenvalue analysis** for vibration studies.
3	**Multi-Body Dynamic Simulation of a Four-Bar Mechanism** • **Objective:** Simulate a **four-bar linkage** and analyze motion parameters like velocity and acceleration. • **Software:** MSC Adams • **Outcome:** Understanding **kinematic and dynamic behavior of mechanisms**.
4	**Finite Element Analysis of a 2D Truss Structure** • **Objective:** Solve a **2D truss problem** using the **stiffness matrix method**. • **Software:** MATLAB / MSC Nastran • **Outcome:** Understanding **axial forces, stress distribution, and deformations**.
5	**Optimization of Structural Components using Quadratic Programming** • **Objective:** Optimize a mechanical component **subjected to constraints using quadratic programming**. • **Software:** Python (cvxopt) • **Outcome:** Exposure to **optimization techniques in mechanical design**.
6	**Multi-Body Dynamic Analysis of a Suspension System** • **Objective:** Simulate and analyze a **vehicle suspension system** under a road profile. • **Software:** MSC Adams

	• **Outcome:** Understanding **shock absorption, damping, and ride comfort**.
7	**Computational Analysis of a Simple Gear Train** • **Objective:** Model and simulate a **gear train** to evaluate torque transmission and speed ratios. • **Software:** MSC Adams • **Outcome:** Understanding **gear motion, forces, and efficiency**.
8	**Machine Learning-Based Classification of Material Properties** • **Objective:** Apply **K-Means and Fuzzy C-Means clustering** to classify materials based on mechanical properties. • **Software:** Python (scikit-learn, NumPy) • **Outcome:** Understanding **unsupervised learning applications in material classification**.
	Demonstration Experiments (For CIE) if any
9	**Buckling Analysis of a Slender Column** • **Objective:** Simulate buckling behavior of a **column under axial compression**. • **Software:** MSC Nastran • **Outcome:** Understanding **critical load determination and stability analysis**.
10	**Impact Analysis of a Drop Test on a Mechanical Component** • **Objective:** Simulate an impact test for a **falling object striking a rigid surface**. • **Software:** MSC Nastran / MATLAB • **Outcome:** Understanding **stress wave propagation and impact forces**.
11	**Fatigue Analysis of a Rotating Shaft** • **Objective:** Perform a **fatigue life prediction** for a rotating shaft under cyclic loading. • **Software:** MSC Nastran • **Outcome:** Understanding **failure prediction and fatigue cycles**.
12	**Topology Optimization of a Mechanical Bracket** • **Objective:** Optimize the **shape and material distribution** of a mechanical bracket to minimize weight while maintaining strength. • **Software:** MSC Nastran / MATLAB • **Outcome:** Understanding **design optimization and lightweight structures**.

Course Outcomes: After completing the course, the students will be able to	
CO1	**Perform static and dynamic analysis** of mechanical components using FEA-based software like MSC Nastran and MATLAB.
CO2	**Simulate and evaluate motion characteristics** of multi-body systems such as linkages, suspensions, and gear trains using MSC Adams.
CO3	**Solve optimization problems** in mechanical engineering using Python-based quadratic programming techniques.
CO4	**Analyze real-world mechanical problems** and validate results through computational simulations.
CO5	**Apply AI-based clustering techniques** to classify materials based on their mechanical properties using Python.

Text Books	
1	**Zienkiewicz, O.C., & Taylor, R.L.** (2013). The Finite Element Method: Its Basis and Fundamentals (7th ed.). Elsevier.
2	**Chandrupatla, T.R., & Belegundu, A.D.** (2011). Introduction to Finite Elements in Engineering (4th ed.). Pearson.
3	**Madier, D.** (2018). Practical Finite Element Analysis (1st ed.). Independently Published.
4	**Nakasone, Y., Yoshimoto, S., & Stolarski, T.** (2017). Engineering Analysis with ANSYS Software (2nd ed.). Butterworth-Heinemann.
5	**Gattringer, H., & Gerstmayr, J.** (2013). Multibody System Dynamics, Robotics and Control (1st ed.). Springer.
6	**Shabana, A.A.** (2013). Dynamics of Multibody Systems (4th ed.). Cambridge University Press.
7	**Flores, P., & Lankarani, H.M.** (2015). Introduction to Multibody Dynamics: Solutions and Practical Applications (1st ed.). Springer.
8	**Boyd, S., & Vandenberghe, L.** (2004). Convex Optimization (1st ed.). Cambridge University Press.
9	**Bishop, C.M.** (2006). Pattern Recognition and Machine Learning (1st ed.). Springer.
10	**Nagarajan, R.** (2021). Data Science for Engineers (1st ed.). Cambridge University Press.
11	**Meriam, J.L., & Kraige, L.G.** (2016). Engineering Mechanics: Dynamics (8th ed.). Wiley.
12	**Hibbeler, R.C.** (2021). Mechanics of Materials (10th ed.). Pearson.

Web links and Video Lectures (e – Resources)	
1	**MSC Software Learning Hub** – https://www.mscsoftware.com/
2	**Finite Element Analysis Blog** – https://www.simscale.com/blog/
3	**Introduction to FEA** (MIT Open Course Ware) – https://ocw.mit.edu/courses/mechanical-engineering/
4	**MSC Adams Tutorials** – https://www.mscsoftware.com/products/adams
5	**Multibody Dynamics Simulations** – https://www.comsol.com/multibody-dynamics-module
6	**Python Quadratic Programming (cvxopt)** – https://cvxopt.org/

Professional Elective III

Semester: II						
Material Selection in Machine Design						
Course Code	**:**	**1MME205A**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To develop advanced understanding on the basic concepts and methodology of material selection in mechanical design.
CLO2	To understand how to use diverse engineering materials property data to select appropriate materials for structural applications in a variety of engineering contexts..
CLO3	To use engineering materials property data to justify the selection of materials, processes and component geometry against various design goals.

Module – 1	**08 Hrs**
Introduction: Materials in design, The evolution of engineering materials. Case Study: Vacuum cleaner. **Design Process:** The design process, Types of design, Design tools and materials data, Function, material, shape, and process	
Module – 2	**08 Hrs**
Engineering Materials and their Properties: The families of engineering materials, The definitions of material properties, Exploring material properties and charts **Materials Selection:** The selection strategy, Attribute limits and material indices, Selection procedure, Computer-aided selection. **Case Studies:** Materials for springs, heat exchangers, thermal distortion in precision devices, Radomes in Aircrafts.	
Module – 3	**08 Hrs**
Processes and Process Selection: Classifying processes, The processes: shaping, joining, and finishing, Systematic process selection, Computer-aided process selection **Multiple constraints and objectives:** Selection with multiple constraints, Conflicting objectives, penalty-functions, and exchange constants	
Module – 4	**08 Hrs**

Designing Hybrid Materials: Filling holes in material-property space, The method: A + B +Configuration + Scale. Composites: Hybrids of type 1, Sandwich structures: Hybrids of type 2, Lattices: hybrids of type 3, Segmented structures: Hybrids of type 4 **Case studies: Efficiency of** Natural materials, Designing metal matrix composites, Refrigerator walls, Extreme combinations of thermal and electrical conduction, The mechanical efficiency of natural materials

Module – 5	**08 Hrs**
Materials and the Environment: The material life cycle, Material and energy-consuming systems, The eco-attributes of materials, Eco-selection **Materials and Industrial Design**: The requirements pyramid, Product character, Using materials and processes to create product personality.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Use materials property charts, to apply engineering and science principles, to make initial judgements about the selection of materials for diverse engineering design contexts.
CO2	Apply engineering and science principles to understand a broad range of processes for materials manufacture and their implications for materials and process selection.
CO3	Apply engineering and science principles to analyse the mechanics of a materials design problem so as to select materials and geometry to minimise weight, minimize environmental impact, etc.
CO4	Analyse complex problems in order to establish when a hybrid material might provide a better design solution than a monolithic engineering material.

Text Books	
1	Materials Selection in Mechanical Design, Third Edition by Michael F. Ashby
2	A History of Technology (21 volumes), edited by Singer, C., Holmyard, E.J., Hall, A.R., Williams,T.I., and Hollister-Short, G. Oxford University Press (1954–2001)
3	Cross, N. (2000) Engineering Design Methods, 3rd edition, Wiley, Chichester, UK. ISBN 0-471-87250-4. (A durable text describing the design process, with emphasis on developing and evaluating alternative solutions.)
4	ASM Engineered Materials Handbook (2004) "Testing and characterization of polymeric materials", ASM International, Metals Par

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		**3**				**3**
CO2	**3**			**3**		
CO3			**3**		**3**	
CO4	**2**	**2**	**3**			**3**

Semester: I						
Theory of Metal Cutting and forming						
Course Code	:	**1MME205B**		**Credits**	:	03
Hours/Week(L:T:P)	:	3:0:0		**CIE**	:	50 Marks
Total Hours	:	40		**SEE**	:	50 Marks
Course Type	:	PEC		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To understand basics of metal cutting and metal forming
CLO2	To understand various factors of machining
CLO3	To understand the process of various forming methods.
CLO4	To practically study and practice the machining and forming methods

Module – 1	**08 Hrs**
Introduction to metal cutting: Mechanism of chip formation, Orthogonal & Oblique cutting, types of chips, built-up edge, Determination of shear plane angle, forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, effect of cutting parameters on tool geometry. Characteristics of tool materials, types of tool materials – carbon tool steels, high speed steels, cast alloys, cemented carbides, ceramics, diamonds, SIALON, CBN, UCON.Mechanisms of tool wear, Sudden & gradual wear, crater wear, flank wear, tool failure criteria, tool life equations, effect of process parameters on tool life.	
Module – 2	**08 Hrs**
Force measurements: Reasons for measuring cutting forces, Classification of cutting force dynamometers – mechanical, hydraulic, pneumatic, optical, inductance, piezoelectric, and strain gage type dynamometers. **Temperature measurements**: Heat sources in metal cutting, temperature in chip formation, temperature distribution, and experimental determination of tool temperatures. **Advanced Machining** Techniques: cryo machining and high-speed machining its defects and remedies.	
Module – 3	**08 Hrs**
Introduction to metal forming: Effect of temperature on forming process-hot working, cold working. Effect of Metallurgical structure, Effect of speed of deformation work of Plastic deformation, Friction in forming operation. Concept of true stress and true strain, uniaxial, biaxial, triaxial stresses, Von-mises criteria, tresca criteria, principle stresses concepts of plane stress and plane strain.	

Module – 4	**08 Hrs**
Forging: Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging of slabs, discs with respect to sticking, sliding and mixed friction forging defects. **Rolling**: Classification, forces and geometrical relationships in rolling. Expression for rolling load, roll separating force and rolling defects	
Module – 5	**08 Hrs**
Extrusion: Classification, Extrusion equipment, variables in extrusion, Deformation in extrusion, Extrusion defects, **Drawing**: Principles of Rod and wire drawing, variables in wiredrawing, Residual stresses in rod, wire and tube drawing, Defects in Rod and wire drawing	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the Basics of Metal Cutting and Forming
CO2	Explore Various Machining Forces and Measuring Instruments
CO3	Apply the Practical Aspects of Machining and Forming
CO4	Analyze the various Parameters in Machining and Forming

Web links and Video Lectures (e-Resources)	
1	VTU e-Shikshana Program VTU EDUSAT Program
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1	Seminars
2	Assignments

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		**3**	**3**			**3**
CO2	**2**			**2**	**2**	
CO3			**2**		**2**	
CO4	**2**	**2**	**3**		**3**	**1**

Semester: II						
FATIGUE AND FRACTURE MECHANICS						
Course Code	**:**	**1MME205C**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Introduce basic aspects of Fatigue and Failure
CLO2	Discuss the availability of various fatigue analysis methods that are used by professional.
CLO3	Know the modifications required in case of mean stress and notches
CLO4	To understand various cycle counting methods used in industries and in commercial software.
CLO5	To understand the basic Fracture Mechanics

Module – 1	**08 Hrs**
Fatigue Damage Theories: Fatigue damage mechanism, Cumulative damage models, and Linear damage models, Double linear damage rule by Manson and Halford.	
Module – 2	**08 Hrs**
Stress-Based Fatigue Analysis and Design: Introduction,The stress-life (S-N) and fatigue limit testing, Estimated SN curve of a component based on ultimate tensile strength, Notch effect, Mean stress effect, Combined proportional loads.	
Module – 3	**08 Hrs**
Strain-Based Fatigue Analysis and Design: Introduction, Experimental test program, Analysis of monotonic and cyclic stress–strain behaviour of materials, Mean stress correction methods, Estimation of cyclic and fatigue properties, Notch analysis.	
Module – 4	**08 Hrs**
Cycle Counting Techniques: One-parameter cycle counting methods, Two-parameter cycle counting methods, Four-Point Cycle Counting Method, Reconstruction of a load-time history.	
Module – 5	**08 Hrs**
Introduction to Fracture Mechanics: assumptions of LEFM, brittle vs. ductile fracture, stress intensity factor (SIF) for Mode I, Mode II, and Mode III, crack tip stress fields, Griffith's energy criterion, Irwin's modification for plastic zone, fracture toughness (KIC) and its measurement, crack tip plasticity models (Irwin and Dugdale), R-curve and stable crack growth, failure prediction, applications in aerospace, automotive, and structural components.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Correctly predict Fatigue life of metal components using Stress and Strain life Methods
CO2	Analyze the situation to apply appropriate fatigue failure method
CO3	Identify and describe the basic fatigue mechanisms.
CO4	Use appropriate Rain counting Method for variable amplitude loading

Text Books	
1	Yung-Li Lee, Jwo Pan, Richard Hathaway, Mark Barkey." Fatigue Testing and Analysis: Theory and Practice“, Elsevier, 2005.
2	Julie A. Bannantine, Jess J. Comer, James L. Handrock,”Fundamentals of Metal Fatigue Analysis”, Prentice Hall, 1990.
3	Ralph I. Stephens, Ali Fatemi, Robert R. Stephens, Henry O. Fuchs,”Metal Fatigue in Engineering”, John Wiley & Sons, 2000.
4	Anderson T L, “Fracture Mechanics: Fundamentals and Applications”, 4th Edition, CRC Press, 2017.
5	ASTM Standard E399, “Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness KIc of Metallic Materials,” ASTM International.
6	MSC Fatigue 2021.4 (Theory Guide): (https://www.mscsoftware.com)
7	Broek, D. Elementary Engineering Fracture Mechanics, Springer, 1982.

Web links and Video Lectures (e – Resources)	
1	Practical Fatigue Theory (Online) (https://www.ncode.com/services/training-courses/practical- fatigue-theory-ncode-training-online)
2	Constant Amplitude Stress-Life Analysis,(https://www.efatigue.com/constantamplitude/stresslife/#a)
3	Fatigue & Fracture Mechanics in FEA (https://www.nafems.org/training/e-learning/fatigue- fracture-fea/)
4	What is Fatigue Analysis? | MSC Nastran (https://simulatemore.mscsoftware.com/what-is-fatigue- analysis-msc-nastran/)
5	NPTEL Fracture Mechanics Course: https://nptel.ac.in/courses/105/106/105106052/
6	MIT Open Course Ware - Fracture Mechanics: https://ocw.mit.edu/courses/mechanical-engineering/

Skill Development Activities Suggested	
1	Write MATLAB/ SCILAB programs to implement the rain flow counting
2	Run a MSC NASTRAN Fatigue Analysis
3	Try A sample Problem of Spot Welding in MSC Fatigue
4	Explore various Fatigue and Fracture software such as NASGRO, FRANC3D, NISA Endure etc.

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**1**	**3**	**1**	**3**	**1**
CO2	**3**	**-**	**1**	**3**	**1**
CO3	**3**	**-**	**1**	**2**	**1**
CO4	**3**	**3**	**1**	**3**	**3**

Note: High - 1, Medium – 2, and Low – 3

Semester: II						
SUSTAINABILITY ENGINEERING						
Course Code	**:**	**1MME205D**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To have an increased awareness among students on issues in areas of sustainability
CLO2	To understand the role of engineering and technology with sustainable development.
CLO3	To know the methods, tools and incentives for sustainable products service system development.
CLO4	To establish clear understanding of the role and impact t of various aspects of engineering decisions on environmental, societal and economic problems.

Module – 1	**08 Hrs**
Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development.	
Module – 2	**08 Hrs**
Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, legal provisions for environmental protection.	
Module – 3	**08 Hrs**
Environmental Management Standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA).	
Module – 4	**08 Hrs**
Resources and its Utilization: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels.	
Module – 5	**08 Hrs**
Sustainability Practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanization, Sustainable cities, Sustainable transport.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the relevance and the concept of sustainability and the global initiatives in this direction.
CO2	Explain the different types of environmental pollution problems.
CO3	Discuss the environmental regulations and standards.

CO4	Outline the concepts related to conventional and non-conventional energy.
CO5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles.

Text Books	
1	Allen, D .T. and Shonnard, D .R. Sustainability Engineering: Concepts, Design and case studies, Prentice Hall.
2	Bradley, A.S; Adebayo, A.O; Maria, P, Engineering applications in sustainable design and development, Cengage learning.
3	Environmental Impact assessment guidelines, Notification of Govt. of India, 2006.
4	Mackenthun, K M; Basic concepts in Environmental management, Lewis publication, London 1998.
5	Ni bin Chang, Systems analysis for sustainable Engg. Theory and applications, Mcgraw Hill professional.

Web links and Video Lectures (e – Resources)	
1	VTU e-Shikshana Program
2	VTU EDUSAT Program

Skill Development Activities Suggested	
1	Case study
2	Quizzes
3	Assignments
4	Seminars

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**1**	**2**	**3**	**3**	**2**
CO2	**3**	**2**	**1**	**3**	**1**
CO3	**1**	**2**	**1**	**3**	**2**
CO4	**3**	**3**	**1**	**3**	**1**
CO5	**1**	**3**	**1**	**2**	**1**

Note: High - 1, Medium – 2, and Low – 3

Semester: II						
DESIGN FOR MANUFACTURING AND ASSEMBLY						
Course Code	**:**	**1MME206A**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Understanding the basic rules for design for manufacturing and material selection.
CLO2	Applying the guidelines for ease of design, manufacturing and assembly.
CLO3	Analyze factors for selection of material and process, relationship to manufacturing processes.
CLO4	Apply the concepts of design for manufacturing and assembly for product manufacturing.
CLO5	Compare various manufacturing processes and assembly techniques required for product development to optimize the process.

Module – 1	**08 Hrs**
Material and process selection – Introduction, Advantages of applying DFMA, General requirements of early materials and process selection, Selection of Manufacturing processes, Selection of materials. Engineering Design features. – Dimensioning, Tolerances, General Tolerance, Geometric Tolerances.	
Module – 2	**08 Hrs**
Assembly limits, Datum features. Component design – Machining Considerations – Drills, Milling cutters, Drilling, Keyways, Dowels, Screws, Reduction in machining areas, Simplification by separation and amalgamation, work piece holding, surface grinding, Examples.	
Module – 3	**08 Hrs**
Component design – Casting Considerations – Pattern, Mould, parting line, cast holes, machined holes, identifying parting line, special sand cores, designing to obviate sand cores. Examples	
Module – 4	**08 Hrs**
Design for Injection: Molding and Sheet metal working – Injection molding materials, Molding cycle, Systems, molds, machine size, cycle time, Cost estimation, Insert molding, Design guidelines, Introduction to sheet metalworking.	
Module – 5	**08 Hrs**
Selective Assembly: Interchangeable part manufacture and selective assembly, deciding the number of groups Group tolerance of Mating parts equal, Model total and group tolerances of shaft equal. Control of axial play- Introducing secondary machining operations, laminated shims, examples.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the principles of manufacturability and design for manufacture.
CO2	Design casting for economic production.
CO3	Understand the concept of easy assembly, based on rules of DFMA to reduce the time of assembly.
CO4	Redesign the parts for easy manufacturing based on rules of DFMA to reduce the time of manufacturing and enhance cost effectiveness.
CO5	Design guidelines and background for powder metallurgy parts and reviewing of formed parts.

Text Books	
1	Product Design for Manufacture and Assembly – Geoffrey Boothroyd - Peter Dewhurst - Winston Knight
2	Designing for Manufacturing – Harry Peck - Pitman Publications – 1983
3	Dimensioning and Tolerancing for Quantity Production – Merhyle F Spotts –Inc. Englewood Cliffs - New Jersey - Prentice Hall, 5thedition.

Web links and Video Lectures (e – Resources)	
1	VTU e-Shikshana Program
2	VTU EDUSAT Program

Skill Development Activities Suggested	
1	Quizzes.
2	Seminar
3	Assignment

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**			**1**
CO2	**1**	**2**			**1**
CO3	**3**	**2**			**1**
CO4	**3**	**2**			**1**
CO5	**3**	**2**			**1**

Note: High - 1, Medium – 2, and Low – 3

Semester: II						
Additive Manufacturing Techniques						
Course Code	**:**	1MME206B		**Credits**	**:**	04
Hours/Week (L:T:P)	**:**	3:2:0		**CIE**	**:**	50 Marks
Total Hours	**:**	50		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Develop a comprehensive understanding of fundamental additive manufacturing–alternatively, "three-dimensional (3D) printing" – approaches, including extrusion- based deposition, stereo lithography, powdered – based melting, and inkjet based deposition.
CLO2	Cultivate a "design -for- additive manufacturing" skill set for combining computer-aided design (CAD) and computer-aided manufacturing (CAM) methodologies to produce successful 3D prints.
CLO3	Fabricate 3D mechanical objects using a variety of 3D printing technologies on campus.
CLO4	Execute a design project that demonstrates how additive manufacturing technologies can overcome critical limitation soft traditional manufacturing processes.

Module – 1	**10 Hrs**
Introduction and Basic Principles: The Generic AM Process and its Benefits. Distinction between AM and CNC Machining. Example of AM Parts and other Related Technologies. **Development of Additive Manufacturing Technology**: Computer-Aided Design Technology and Other Associated Technologies. The Use of Layers. Metal Systems and Hybrid Systems	
Module – 2	**10 Hrs**
Generalized Additive Manufacturing Process Chain: Introduction. Steps in Additive Manufacture, Variations from One AM Machine to Another. Maintenance of Equipment and Materials Handling Issues. **Vat Photo polymerization Processes:** Introduction, Reaction Rates, Laser Scan Vat Photo-polymerization, Photo polymerization Process Modelling, Vector Scan VP Machines, Scan Patterns. Vector Scan Micro-Vat Photo polymerization. Process Benefits and Drawbacks	
Module – 3	**10 Hrs**
Extrusion-Based Systems: Introduction, Basic Principles, Material Loading Liquefaction, Extrusion, Solidification, Positional Control, Bonding, Support Generation Plotting and Path Control. FDM Machine. Types, Materials, Limitations of FDM. Bio-Extrusion and Other Systems **Material Jetting:** Materials for Material Jetting, Materials for Material Jetting, MJ Process Modelling, Material Jetting Machines, Process Benefits and Drawbacks	

Module – 4	10 Hrs
Design for Additive Manufacturing: Motivation, Design for Manufacturing and Assembly, AM Unique Capabilities. Shape Complexity. Hierarchical Complexity. Functional Complexity Material Complexity Core DFAM Concepts and Objectives Complex Geometry Integrated Assemblies Customized Geometry Multifunctional Designs Elimination of Conventional DFM Constraints Contents Exploring Design Freedoms Part Consolidation and Redesign Hierarchical Structures Industrial Design Applications. **Rapid Tooling:** Introduction Direct AM Production of Injection Moulding Inserts EDM Electrodes Investment Casting Other Systems Vacuum Forming Tools Paper Pulp Moulding Tools Formwork for Composite Manufacture Assembly Tools And Metrology Registration Rigs	

Module – 5	10 Hrs
Applications for Additive: Manufacture Introduction Historical Developments Value of Physical Models Functional Testing Rapid Tooling The Use of AM to Support Medical Applications Surgical and Diagnostic Aids Prosthetics Development Manufacturing Tissue Engineering and Organ Printing Software Support for Medical Applications **Limitations of AM**: Limitations of AM for Medical Applications Speed Accuracy Materials Ease of Use Further Development of Medical AM Applications Approvals Insurance Engineering Training Location of the Technology Service Bureaus Aerospace Applications Characteristics Favouring AM Production Manufacture Automotive Applications	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the importance and growth of Rapid Prototyping Techniques.
CO2	Differentiate and describe the operation, applications and advantages of Stereo lithography, selective Laser sintering and fused deposition modelling.
CO3	Analyze solid ground curing and laminated object manufacturing processes and their working.
CO4	Evaluate different Concept Model less and recommend different tooling requirements for Rapid Prototype

Text Books	
1	Pham D.T.& DimovS.S"RapidManufacturing"SpringerLondon2011.2.
2	C.P.Paul&A.N.Jinoop,“AdditiveManufacturing:Principles,TechnologiesandApplications”, McGrawHill2021.
3	TerryWohlers"Wohler'sReport2000"Wohler'sAssociation2000
4	PaulF.Jacobs:"StereolithographyandotherRP&MTechnologies",SME,NY1996,Springer

Web links and Video Lectures(e-Resources):	
1	https://youtu.be/t7yv4gSnNkE?list=PLwdnzlV3ogoWI8QEu4hsT-n_r8UbWbquy
2	https://youtu.be/Bwog2XYCmN8

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	2	2
CO2	3	2	1	2	2	1
CO3	3	2	1	2	2	1
CO4	3	2	1	2	1	1

Semester: II						
MECHANICAL BEHAVIOUR OF MATERIALS						
Course Code	**:**	**1MME206C**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**YES**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To familiarize the concept of deformation mechanisms in single crystal and polycrystalline materials.
CLO2	To study strengthening mechanisms and mechanics of fracture in ductile and brittle materials.
CLO3	To study the fatigue and creep properties of materials under various conditions.
CLO4	To familiarize the various characterization techniques used to probe mechanical properties.

Module – 1	**08 Hrs**
Plastic Deformation: Concepts of crystals, Plastic deformation by slip and twinning, Slip systems in FCC, BCC and HCP lattices, Critical resolved shear stress for slip, Theoretical shear strength of solids, Stacking faults and deformation bands.	
Module – 2	**08 Hrs**
Dislocation Theory : Observation of dislocations, Climb and cross slip, Dislocations in FCC and HCP lattice, Partial dislocations, Stress fields and energies of dislocations, Forces between dislocations, Interaction of dislocations, Dislocation sources and their multiplications.	
Module – 3	**08 Hrs**
Strengthening Mechanisms: Strengthening from grain boundaries, Grain size measurements, Yield point phenomenon, Strain aging, Solid solution strengthening, Strengthening from fine particles, Fiber strengthening, Cold working and strain hardening, Annealing of cold worked metal.	
Module – 4	**08 Hrs**
Creep and Stress Rupture: Creep curve, Stress rupture test, Mechanism of creep deformation, Activation energy for steady state creep, Super plasticity, Fracture at elevated temperature, Creep resistant alloys, Creep under combined stresses.	
Module – 5	**08 Hrs**
The Tension Test: Stress-strain curves, Instability in tension, Ductility measurement, Effect of strain rate, temperature and testing machine on flow properties, Stress relaxation testing, Notch tensile test, Anisotropy of tensile properties. **The Hardness Test:** Brinnel, Rockwell and Vickers hardness, flow of metal under the indenter, relationship between hardness and flow curve, micro hardness testing, Hardness at elevated temperatures.	

Course Outcomes: After completing the course, the students will be able to	
CO1	**Understand** the fundamental crystallographic principles of plastic deformation, slip systems, and stacking faults in FCC, BCC, and HCP structures
CO2	**Analyze** dislocation interactions, stress fields, forces between dislocations, and dislocation multiplication mechanisms.
CO3	**Evaluate** various strengthening mechanisms including Hall-Petch grain refinement, strain aging, solid solution, dispersion, and strain hardening
CO4	**Explain** high-temperature creep behavior, stress rupture mechanisms, and design criteria for creep-resistant alloys under multi-axial stress states.
CO5	**Assess** mechanical response under tensile and indentation loading to determine flow properties, hardness values, and mechanical anisotropy.

Text Books	
1	Dieter M. George, Mechanical Metallurgy, McGraw- Hill Inc., 2001.
2	Richard W Hertzberg Deformation and fracture mechanics, John Wiley & Sons.
3	Reed Hill and Robert E, Physical Metallurgy Principles, East West Press.
4	Hyden W. M. Structure and properties of Materials, Vol. 3, McGraw Hill.

Web links and Video Lectures (e – Resources)	
1	Mechanical Behavior of Materials https://onlinecourses.nptel.ac.in/noc21_mm27/preview
2	Mechanical Behavior of Materials https://onlinecourses.nptel.ac.in/noc22_mm04/preview

Skill Development Activities Suggested	
1	Use a strain gage setup to estimate the strains at a surface point of a plate subjected to tensile loading.
2	Identify and list the values of SN curves for various alloys of Steel and Aluminium.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**			
CO2	**3**	**3**	**2**	**2**	
CO3	**3**	**3**	**3**	**2**	
CO4	**3**	**3**	**3**	**2**	
CO5	**3**	**2**	**2**	**3**	**1**

Note: High - 1, Medium – 2, and Low – 3

Semester: II						
Industrial Robotics						
Course Code	**:**	**1MME206D**		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	The goal of the course is to familiarize the students with the concepts and techniques in robotic engineering, manipulator kinematics, dynamics and control, chose, and incorporate robotic technology in engineering systems.
CLO2	Make the students acquainted with the theoretical aspects of Robotics
CLO3	Enable the students to acquire practical experience in the field of Robotics through design projects and case studies.
CLO4	Make the students to understand the importance of robots in various fields of engineering.

Module – 1	**08 Hrs**
Introduction: Automation and Robotics – An over view of Robotics – present and future applications. Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.	
Module – 2	**08 Hrs**
Motion Analysis: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.	
Module – 3	**08 Hrs**
Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton –Euler formations – Problems. Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion straight line motion.	
Module – 4	**08 Hrs**
Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools	
Module – 5	**08 Hrs**

Robot Application in Manufacturing: Material Transfer – Material handling, loading and unloading- Processing – spot and continuous arc welding & spray painting – Assembly and Inspection. Robotic Programming Methods – Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.

Course Outcomes: After completing the course, the students will be able to	
CO1	To understand the basic components of robots.
CO2	Differentiate types of robots and robot grippers.
CO3	Model forward and inverse kinematics of robot manipulators.
CO4	Analyze forces in links and joints of a robot.
CO5	Programme a robot to perform tasks in industrial applications.

Text Books	
1	Industrial Robotics / Groover M P /Mc Graw Hill
2	Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson
Web links and Video Lectures (e-Resources):	
1	VTU e-Shikshana Program
2	VTU EDUSAT Program

CO – PO MAPPING

	PO1	PO2	PO 3	PO 4	PO 5	PO6
CO1	**2**	**2**	**3**	**3**	**3**	**2**
CO2	**2**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**2**	**2**	**2**	**2**
CO5	**2**	**2**	**2**	**3**	**3**	**3**

Institute Vision

Preparing Competent Engineering and Management Professionals to Serve the Society

Institute Mission

- **Providing Students with a Sound Knowledge in Fundamentals of their branch of Study.**
- **Promoting Excellence in Teaching, Training, Research and Consultancy.**
- **Exposing Students to Emerging Frontiers in various domains enabling Continuous Learning.**
- **Developing Entrepreneurial acumen to venture into Innovative areas.**
- **Imparting Value based Professional Education with a sense of Social Responsibility.**

Department Vision

Building Technically Competent Engineers to Serve the Society

Department Mission

- **Imparting strong fundamental knowledge in Mechanical Engineering and allied fields.**
- **Fostering a culture of collaboration and propagating Industry institute interactions to enhance advances in latest technologies.**
- **Creating State-of-Art facilities benefitting students and faculty to carryout Research, Innovation and Consultancy.**
- **Providing conducive environment for both students and faculty to engage in lifelong learning activities.**
- **Inculcating Professional ethics, Leadership qualities and Entrepreneurial skills among students.**

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

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