Hindi Seva Mandal's,
Shri Sant Gadge Baba
College of Engineering & Technology,
Near Z.T.C., Bhusawal. Dist. - Jalgaon (Maharashtra) Pin - 425203.

An Autonomous Institute with Accreditation by NAAC with A+ Grade

(Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere.)

www.ssgbcoet.com

Master of Technology (M Tech)
In
Design (Mechanical Engineering)
Programme Curriculum

With Effect from the Academic Year 2025-2026

2-year, 4 Semester Full time Programme Choice Based Credit System (CBCS) and Grading System Outcome Based Education Pattern Aligned with National Education Policy (NEP) 2020

Program Specific Outcomes

PSO1: SPECIFY, DESIGN and **EVALUATE** mechanical components and systems using modelling and analysis software.

PSO2: APPLY knowledge of machines, tools, automation, properties of advanced materials and modern management methods for manufacturing of mechanical components and systems.

PSO3: **APPLY** core aspects of thermal and fluid engineering to determine the performance of mechanical systems including power absorbing and power generating systems.

Program Educational Objectives

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing a graduate to achieve.

PEO1: The graduate will have a successful career in mechanical engineering with strong technical, research & professional skills.

PEO2: The graduate will possess an ability to work in diversified fields along with team work and leadership qualities.

PEO3: The graduate will continue to learn and to adapt in a society of constantly evolving technological environment

Programme Outcomes (POs)

Program Outcomes (POs) are statements that articulate what students are expected to know, understand, and be able to do by the time they graduate from the program. These outcomes are aligned with the overall educational objectives of the program and reflect the skills, knowledge, attitudes, and behaviors acquired by students throughout their academic journey. On successful completion, students will be able to:

PO No.	Title	Program Outcome Description
PO1	Engineering Knowledge	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop the solution of complex engineering problems.
PO2	Problem Analysis	Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for public health and safety, whole-life cost, net zero carbon, culture, society and environment. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling, recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference

		to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Team Work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for: (i) independent and life-long learning, (ii) adaptability to new and emerging technologies, and (iii) critical thinking in the broadest context of technological change. (WK8)

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Knowledge and Attitude Profile (WK)

WK1	Natural Sciences and Social Sciences	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Mathematics and Data Analysis	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	Engineering Fundamentals	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering Specialist Knowledge	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Engineering Design and Environmental Considerations	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Engineering Practice (Technology)	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Role of Engineering in Society	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Research and Critical Thinking	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics and Inclusive Behavior	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability, etc., with mutual respect.

Abbreviations

PEO:	Program Educational Objectives
PO:	Program Outcomes
CO:	Course Outcomes
L:	No. of Lecture hours (per week)
T:	No. of Tutorial hours (per week)
P:	No. of Practical hours (per week)
C:	Total number of credits
PCC:	Professional Core Course
OEC:	Open Elective Course
PEC:	Programme Elective Course
IKS:	Indian Knowledge Society
MDM:	Multidisciplinary Minor

Shri Sant Gadge Baba College of Engineering and Technology, Bhusawal

Department of Mechanical Engineering

First Year Structure 25-26 as per NEP 2020

Semester I											
Course Category	**Category under NEP**	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**No. of Credits**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC	Programme Core	251MTMEPC101	Advanced Methods in Engineering Design	03			20	20	60	100	3
PCC	Programme Core	251MTMEPC102	Analysis and Synthesis of Mechanisms	03			20	20	60	100	3
PEC	Programme Elective-I	251MTMEPE103A-D	Programme Elective-I	03			20	20	60	100	3
PEC	Programme Elective-II	251MTMEPE104A-D	Programme Elective-II	03			20	20	60	100	3
PCC	Programme Core	251MTMEPC105L	PG Lab-I			04	50			50	2
ELC	Experiential Learning	251MTMEEL106	Seminar I			04	50			50	2
IKS	IKS	251MTMEIK107	IKS Bucket	03			20	20	60	100	3
Audit	Ability Enhancement course	251MTMEAE108	YOGA for Stress Management			02	50			50	1
			Total	12	04	10	180	80	240	500	**20**

Programme Elective-I		**Programme Elective-II**	
251MTMEPE103A	Composite Materials and Mechanics	251MTMEPE104A	Theory of Elasticity and Plasticity
251MTMEPE103B	Advance Engineering Materials	251MTMEPE104B	Mechatronics
251MTMEPE103C	Advanced Machine Design	251MTMEPE104C	Failure Analysis and Design
251MTMEPE103D	Advanced Mechanical Vibrations	251MTMEPE104D	Machine Tool Design

IKS :- https://iksindia.org/courses-offered-by-iks-centers.php

Semester -II

Course Category	Category under NEP	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
				L	T	P	CA	MSE	ESE	Total	
PCC	Programme Core	251MTMEPC201	Finite Element Analysis & Simulation	03			20	20	60	100	3
PCC	Programme Core	251MTMEPC202	Design Optimization	03			20	20	60	100	3
PEC	Programme Elective-III	251MTMEPE203A-D	Programme Elective-III	03			20	20	60	100	3
PCC	Programme Core	251MTMEPC204	Process Equipment Design	03			20	20	60	100	3
OEC	Open Elective-I	251MTMEOE205A-D	Open Elective-I	03			20	20	60	3	3
PCC	Programme Core	251MTMEPC206L	PG Lab-II			04	50			50	2
ELC	Experiential Learning	251MTMEEL207	Mini Project			04	50			50	2
Audit	Ability Enhancement course	251MTMEAE208	Disaster Management			02	50			50	1
			Total	15		10	200	100	300	600	20

Programme Elective-III		**Open Elective-I**	
251MTMEPE203A	Vehicle Dynamics	251MTMEOE205A	Instrumentation and Automatic Control
251MTMEPE203B	Tribology in Design	251MTMEOE205B	Design For Manufacture and Assembly
251MTMEPE203C	Reverse Engineering	251MTMEOE205C	Experimental Stress Analysis
251MTMEPE203D	Integrated Product Development	251MTMEOE205D	Advance Manufacturing

Second Year Structure 25-26 as per NEP 2020

Semester -III

Course Category	Category under NEP	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
				L	T	P	CA	MSE	ESE	Total	
OE	Open Elective-II	252MTMEOE301A-D	**Open Elective-II**	03			20	20	60	100	3
MDM	Multidisciplinary Minor	252MTMEMM302	Research Methodology	03			20	20	60	100	3
ELC	Experiential Learning	252MTMEEL303	Seminar II			04	50		50	100	2
ELC	Experiential Learning	252MTMEEL304	Project-I				100		100	200	12
			Total	06		04	190	40	270	500	20

Open Elective-II	
252MTMEOE301A	Advance CAD
252MTMEOE301B	Intellectual Property Rights
252MTMEOE301C	Supply Chain Management
252MTMEOE301D	Design for Piping System

Semester- IV

Course Category	Category under NEP	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				No. of Credits
				L	T	P	CA	MSE	ESE	Total	
ELC	Experiential Learning	252MTMEEL401	Project-II				100		100	200	20
			Total				100		100	200	20

Credit Distribution				
SEM I	**SEM II**	**SEM III**	**SEM IV**	**Total**
20	**20**	**20**	**20**	**80**

Advanced Methods in Engineering Design

251MTMEPC101	Advanced Methods in Engineering Design	PCC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course objective:

- To introduce various design philosophies and models for creative problem solving.
- To train students in product design strategy development and concept evaluation.
- To develop understanding of materials and processes in design for manufacturing.
- To analyze mechanical failure theories and durability design.
- To incorporate economic and ergonomic principles for sustainable product development.

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

CO1	Understand and apply various design philosophies and models to analyse problems, generate creative solutions, and ensure design safety and reliability.
CO2	Develop skills in product design strategies, including concept generation, selection, testing, and planning based on value and user needs.
CO3	Gain expertise in design for manufacturing, focusing on materials, processes, and the design of components made from metals and non-metals like plastics, rubber, ceramics, wood, and glass.
CO4	Analyse failure mechanisms, such as fatigue, creep, and surface wear, and apply static and dynamic failure theories to ensure product durability and optimal performance.
CO5	Incorporate economic and ergonomic considerations in design, including value engineering, cost analysis, and human-centred design for effective and sustainable product development.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	2	2	1	2	1	2	2
CO2	2	3	3	2	2	2	1	2	2	3	2
CO3	3	2	3	2	2	2	1	1	1	2	2
CO4	3	3	2	3	2	1	1	1	1	1	2
CO5	2	2	3	1	1	3	2	1	1	3	2

Course Contents:

Unit 1

Design Philosophy:

Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations - standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability.

Unit 2

Product Design:

Product strategies, value, planning and specification, concept generation, concept selection, concept testing.

Unit 3

Design for Manufacturing:

Forging design, casting design, Design process for non- metallic parts, Plastics, Rubber, Ceramic, Wood and Glass parts. Material selection in machine design.

Unit 4

Failure Theories:

Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory, Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles, Fatigue failure theories, cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation.

Unit 5

Surface Failures:

Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive' wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.

Texts/References:

1. Smith Seely, "Advanced Mechanics of Materials", John Willey & Sons Publications.
2. Timoshenko, "Strength of Materials"
3. Kocanda, "Fatigue Failure of Metal", Sijthoff and Noordhoff International Publications.
4. Frost N. E., "Metals Fatigue", Oxford University Press, London.
5. Benhan & Crawford, "Mechanics of Engineering Materials", John Willey & Sons Pub.
6. Spotts M. F., "Mechanical Design Analysis", PHI Publications, New Delhi.

Analysis and Synthesis of Mechanisms

251MTMEPC102	Analysis and Synthesis of Mechanisms	PCC	3-0-0	3 Credits

Continuous Assessment 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- To understand the fundamental principles of kinematics and mechanisms.
- To apply graphical and analytical methods for velocity and acceleration analysis.
- To develop synthesis techniques for planar and spatial mechanisms.
- To design mechanisms for specific motion tasks using curvature and synthesis theories.

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

CO1	Understand fundamental concepts of kinematics, including types of mechanisms, kinematic pairs, degrees of freedom, and perform velocity and acceleration analysis using graphical and analytical methods.
CO2	Apply curvature theory and geometric principles such as centrodes, inflection circles, and Euler-Savary equation to analyze and design mechanisms with precise motion characteristics.
CO3	Develop graphical synthesis skills for planar mechanisms to achieve accurate motion generation and rigid body guidance using pole and circle point methods.
CO4	Perform analytical synthesis of mechanisms like four-bar and slider-crank systems using equations such as Freudenstein's, incorporating compatibility conditions and complex number techniques.
CO5	Analyze coupler curves and spatial mechanisms, using the Robert-Chebychev theorem and Denavit-Hartenberg parameters for understanding advanced motion paths and 3D kinematic systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	3	1	1	1	1	1	2
CO2	3	3	3	2	3	1	1	1	1	1	2
CO3	3	2	3	2	3	1	1	2	2	1	2
CO4	3	3	3	2	3	1	1	1	1	1	2
CO5	3	3	2	3	3	1	1	1	1	1	2

Course Contents:

Unit 1

Basic Concepts

Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods.

Unit 2

Curvature Theory:

Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell mechanisms.

Unit 3

Kinematic Synthesis of Planar Mechanisms-Graphical:

Accuracy (precision) points, Chebesychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, centre and circle point curves

Unit 4

Kinematic Synthesis of Planar Mechanisms – Analytical:

Analytical synthesis of four-bar and slider-crank mechanisms, Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers, three accuracy point synthesis using complex numbers.

Unit 5

Coupler Curves:

Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry.

Texts/Reference:

1. R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw- Hill,New York, 1980.
2. Robert L. Nortan ,"Design of Machinery', Tata McGraw Hill Edition
3. Hamilton H. Mabie, "Mechanisms and Dynamics of Machinery", John Wiley and sonsNew York
4. S. B. Tuttle, "Mechanisms for Engineering Design" John Wiley and sons New York
5. A. Ghosh and A.K. Mallik, "Theory of Machines and Mechanisms", Affiliated East-West Press, New Delhi, 1988.
6. A.G. Erdman and G.N. Sandor, "Mechanism Design – Analysis and Synthesis", (Vol. 1and 2), Prentice Hall India, 1988.
7. A.S. Hall, "Kinematics and Linkage Design", Prentice Hall of India.
8. J.E. Shigley and J.J. Uicker, "Theory of Machines and Mechanisms", 2nd Edition,McGraw-Hill, 1995.

Composite Materials and Mechanics

251MTMEPE103A	Composite Materials and Mechanics	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of composite materials and mechanics.
- Explore theoretical and practical aspects of composite materials and mechanics for real-world applications.
- Develop analytical skills to evaluate and solve problems related to composite materials and mechanics.
- Apply appropriate tools, methods, and techniques in the domain of composite materials and mechanics.
- Gain foundational knowledge for advanced study or research in the area of composite materials and mechanics.

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

CO1	Understand the fundamentals and classifications of composite materials, including their characteristics, advantages, limitations, and applications compared to conventional materials.
CO2	Analyze the elastic behavior of unidirectional lamina, using stress-strain relationships, transformation techniques, and material property evaluations.
CO3	Evaluate the strength and failure mechanisms of composite lamina, applying micromechanics and macro-mechanical failure theories to predict material behavior under loading.
CO4	Study the elastic behavior of laminates, including stress-strain analysis, load-deformation relations, and design considerations for various laminate configurations.
CO5	Examine the effects of hygrothermal conditions and stress analysis, including residual stresses, warpage, and progressive failure mechanisms to ensure safe and reliable design of composite structures.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	1	2	1	1	1	1	2
CO2	3	3	2	2	3	1	1	1	1	1	2
CO3	3	3	2	3	2	1	1	1	1	1	2
CO4	3	3	3	2	2	1	1	1	1	1	2
CO5	3	3	3	3	2	2	1	1	1	1	2

Course Contents:

Unit 1

Introduction, Basic Concepts and Characteristics:

Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus, Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials.

Unit 2

Elastic Behaviour of Unidirectional Lamina:

Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters.

Unit 3

Strength of Unidirectional Lamina:

Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macro-mechanical failure theories, Applicability of various failure theories.

Unit 4

Elastic Behavior of Laminate:

Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, general load– deformation relations, Analysis of different types of laminates.

Unit 5

Hygrothermal Effects:

Hygro-thermal effects on mechanical behavior, Hygro- thermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage.

Texts/References:

1. Isaac M. Daniels, OriIshai, “Engineering Mechaincs of Composite Materials”, Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, “Analysis and Performance of fiber composites”, John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., “Composite Materials: Engineering and Science”, CRC Press, Boca Raton, 2003.
4. Madhujit Mukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press, 2004.
5. Mazumdar S. K., “Composaite Manufacturing – Materials, Product and Processing Engineering”, CRC Press, Boca Raton, 2002.

Advance Engineering Materials

251MTMEPE103B	Advance Engineering Materials	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of advance engineering materials.
- Explore theoretical and practical aspects of advance engineering materials for real-world applications.
- Develop analytical skills to evaluate and solve problems related to advance engineering materials.
- Apply appropriate tools, methods, and techniques in the domain of advance engineering materials.
- Gain foundational knowledge for advanced study or research in the area of advance engineering materials.

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

CO1	Understand the metallurgical aspects, composition, and applications of special steels.
CO2	Study the significance and properties of alloy cast irons, including heat-resistant and high-performance types for specialized industrial uses.
CO3	Gain knowledge of light metals and their alloys, particularly aluminum, magnesium, and titanium.
CO4	Explore the characteristics of superalloys and their strengthening mechanisms.
CO5	Examine modern materials including nanomaterials, smart materials, and biomaterials.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	1	1	1	1	1	1	2
CO2	3	2	2	1	1	2	1	1	1	1	2
CO3	3	2	2	1	1	2	1	1	1	1	2
CO4	3	2	2	1	1	2	1	1	1	1	2
CO5	3	2	3	2	1	3	1	1	1	1	3

Course Contents:

Unit 1

Special Steels:

Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels etc.

Unit 2

Alloy Cast Iron:

Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant cast iron: Composition, Properties and their applications.

Unit 3

Light Metals and Their Alloys:

Aluminium, magnesium and titanium alloys: Metallurgical aspects, Properties and applications

Unit 4

Super Alloys:

Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications.

Unit 5

Nano Materials:

Definition, Types, Properties and applications, Carbon nano tubes, Methods of production.

Smart Materials:

Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto- rheological fluids.

Texts/References:

1. The Science and Engineering of Materials by D. R. Askeland and P. P. Phule,Thomson Publication
2. Advances in Material Science by R. K. Dogra and A. K. Sharma
3. Material science by Van Black.
4. Engineering Materials and Applications by R. A. Flinn and P. K. Trojan
5. Materials, their Nature, Properties and Fabrication by R. A. Lindberg and S. D.Sehgal, S Chand & Co.
6. Light Alloys: Metallurgy of Light Metals by I. J. Polmear
7. Engineering Materials: Properties and applications of Metals and alloys by CPSharma, PHI
8. Engineering Materials: Polymers, ceramics and composites by AK Bhargava, PHI
9. Nano Technology by AK Bandyopadhyay, New age international publishers

Advanced Machine Design

251MTMEPE103C	Advanced Machine Design	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of advance engineering materials.
- Explore theoretical and practical aspects of advance engineering materials for real-world applications.
- Develop analytical skills to evaluate and solve problems related to advance engineering materials.
- Apply appropriate tools, methods, and techniques in the domain of advance engineering materials.
- Gain foundational knowledge for advanced study or research in the area of advance engineering materials.

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

CO1	Understand the statistical basis of design for safety, including the selection of safety factors based on load variations, tolerances, and failure risk assessments.
CO2	Apply principles of optimum design to mechanical elements such as shafts, beams, and bars under various loading conditions, using design equations and optimization strategies.
CO3	Design specialized mechanical components, including various types of springs, considering their geometry, material behavior, dynamic performance, and stress conditions.
CO4	Analyze and design flat plates under different loading and support conditions, using stress-strain relationships, plate theory, and strain energy methods.
CO5	Explore modern design methodologies and innovation strategies, including creative problem-solving, TRIZ, Quality Function Deployment, morphological analysis, and the evaluation of design alternatives for effective product development.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	1	1	1	1	1	1	2
CO2	3	2	2	1	1	2	1	1	1	1	2
CO3	3	2	2	1	1	2	1	1	1	1	2
CO4	3	2	2	1	1	2	1	1	1	1	2
CO5	3	2	3	2	1	3	1	1	1	1	3

Course Contents:

Unit 1

Introduction:

Statistical Considerations in Design for factor of safety, relationship between actual load and load capability, selection of factor of safety based on percentage estimates for tolerances on actual load and load capability and where the occurrence of the failure phenomenon would be disastrous

Unit 2

Optimum Design:

Optimum design for mechanical elements by considering adequate design, optimum design, P.D.E., S.D.E., limit equations, principles of optimum design with normal specifications, redundant specifications, incompatible specifications, optimum design of tensile bar, torsion shaft, beams, step shafts and with combined loading.

Unit 3

Mechanical Springs:

Design of square or rectangular bar helical springs, Belleville springs, ring springs, torsion bar springs, theory of square or rectangular bar helical springs under axial loading, cone or flat disc spring theory.

Unit 4

Flat Plate:

Stress resultants in a flat plate, kinematics strain- displacement, relations for plates, equilibrium equation for small displacement, theory of plates, stress-strain temperature relations for isotropic elastic plates, strain energy of a plate, boundary conditions for plates, Circular plates with hole and without hole with different types of support and loading.

Unit 5

Advances in Machine Design:

Defining design, creativity, invention and innovation, design methodology, patterns of evaluation, design patents, functional approach, performance specifications, Quality Function Deployment, improvement of ideality, design strategy, problem definition, objective, top down and bottom up approaches, system, problem formulation, substance field analysis, morphological analysis, creative problem solving, inventive principle, evaluation of ideas or concepts, product design specifications, selection of best design,

Texts/References:

1. Robert L. Norton, Machine Design: An Integrated Approach, Prentice-Hall New Jersey, USA.
2. George E Dieter, Engineering Design, McGraw Hill, 2008.
3. J.E. Shigley and L.D. Mitchell, Mechanical Engineering Design, McGraw Hill International Book Company, New Delhi.
4. Hamrock, Schmid and Jacobian, Fundamentals of machine elements, 2nd edition,McGraw-Hill International edition.
5. Karl T. Ulrich and Steven D. Eppinger, Product design and development, 3rd edition,Tata McGraw Hill.
6. A.K. Chitale and R.C. Gupta, Product Design and Manufacturing, Prentice Hall
7. T.K. Varadan and K. Bhaskar, "Analysis of Plates - Theory and Problems", NarosaPublishing House
8. Stephen P. Timoshenko and S. Woinowsky-Krieger, "Theory of Plates and Shells",Tata McGraw Hill
9. Spring Design and Manufacture, Tubal Cain
10. Mechanical Springs, A D Brown
11. Fundamentals of Machine Design, R C Juvinall and K M Marshek, Wiley India.

Advanced Mechanical Vibrations

251MTMEPE103D	Advanced Mechanical Vibration	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of advanced mechanical vibrations.
- Explore theoretical and practical aspects of advanced mechanical vibrations for real-world applications.
- Develop analytical skills to evaluate and solve problems related to advanced mechanical vibrations.
- Apply appropriate tools, methods, and techniques in the domain of advanced mechanical vibrations.
- Gain foundational knowledge for advanced study or research in the area of advanced mechanical vibrations.

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

CO1	Understand and analyze multi-degree of freedom systems using advanced thematical techniques such as matrix methods, Lagrangian and Hamiltonian formulations, and eigenvalue analysis.
CO2	Gain proficiency in vibration measurement techniques, including the use of accelerometers, signal processing, digital analyzers, and ISO standards for evaluating vibration severity.
CO3	Apply modal analysis for structural vibration studies, including both analytical and experimental approaches, and understand its role in detecting structural damage.
CO4	Explore methods of vibration control, including passive techniques like mass and damping adjustments, and an introduction to active and semi-active control systems.
CO5	Analyze non-linear vibrations and diagnose machinery malfunctions using phase-plane methods, frequency and time-domain analysis, and root cause identification techniques such as signature and orbit analysis.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	3	1	1	1	1	1	2
CO2	3	2	2	3	3	1	1	1	1	1	2
CO3	3	3	2	3	3	2	1	1	1	1	2
CO4	3	3	3	2	3	2	1	1	1	1	2
CO5	3	3	2	3	3	2	1	1	1	2	2

Course Contents:

Unit 1

Multi-Degree of Freedom System:

Free Vibration Equation of motion, Influence Coefficients (Stiffness and Flexibility), Generalized Coordinates, and Coordinate Coupling. Lagrangian and Hamilton Equations, Matrix Method, Eigen value and Eigen Vector Method

Unit 2

Vibration Measurement:

Basic signal attributes, Vibration measuring sensors (Displacement, Velocity, and Acceleration), Piezoelectric Accelerometers, Method for Calibrating Accelerometer, Basic Process of Digital Frequency Analyzer, Digital Analyzer operating principles, Measurement of phase, Phase fundamentals, Comparing two waveforms using reference, Cross Channel phase analysis, Electronic Filters, Time and orbital domain, Time and frequency domains, Evaluation of vibration severity, ISO standards: ISO 10816 and ISO 7919

Unit 3

Modal Analysis:

Introduction, Free vibration response using modal analysis, Force vibration response using modal analysis, Experimental modal analysis: Necessary equipment, signal processing, Measurement of mode shapes, Introduction to damage detection in structures using changes in modal frequency and mode shapes

Unit 4

Vibration Control:

Conventional Methods: By Mass/Inertia, Stiffness, Damping (Vibration Isolation Principles). Dynamic vibration absorbers. Introduction to Semi-Active and Active Vibration Control

Unit 5

Non-Linear Vibrations:

Basics of non-linear vibration, Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase- plane techniques, Duffing‟s equation, Jump phenomenon, Limit cycle, Perturbation method.

Texts/References:

1. Leonard Meirovitch – Elements of Vibration Analysis, McGraw Hill
2. Thomson W.T , Theory of Vibration with Applications., Prentice Hall India.
3. Rao V and J Srinivas, Mechanical Vibrations, PHI Learning Pvt. Ltd.
4. S.S Rao, Mechanical Vibrations, Pearson Education India

Theory of Elasticity and Plasticity

251MTMEPE104A	Theory of Elasticity and Plasticity	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of theory of elasticity and plasticity.
- Explore theoretical and practical aspects of theory of elasticity and plasticity for real-world applications.
- Develop analytical skills to evaluate and solve problems related to theory of elasticity and plasticity.
- Apply appropriate tools, methods, and techniques in the domain of theory of elasticity and plasticity.
- Gain foundational knowledge for advanced study or research in the area of theory of elasticity and plasticity.

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

CO1	To understand stress and strain transformations in 2D and 3D elastic bodies.
CO2	To analyze two-dimensional problems in elasticity under various loading and boundary conditions.
CO3	To develop competence in solving three-dimensional elasticity problems.
CO4	To apply elasticity theory to analyze bending and shear behavior in prismatic bars.
CO5	To utilize energy methods in solving elasticity problems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	3	1	1	1	1	1	2
CO2	3	3	2	2	3	1	1	1	1	1	2
CO3	3	3	2	2	3	1	1	1	1	1	2
CO4	3	3	3	2	3	1	1	1	1	1	2
CO5	3	3	2	3	3	1	1	1	1	1	2

Course Contents:

Unit 1

Introduction:

Stress transformation and Strain transformation at a point in an elastic body, 3D Problems, Rigid body translation and rotation of an element in space. Generalized, Hook law, Elastic Strains and rigid body displacement for a general displacement field u, v, w. Principal Stress and Strains.

Unit 2

Two Dimensional Problems in Elasticity:

Plane Stress and Plane Strain Problems. Differential equations of equilibrium and compatibility equations. Boundary Conditions & Stress Functions. Problems in Rectangular coordinates, Polynomial solutions, Cantilever loaded at the end, simply supported load beam under uniformly distributed load, linear loading, Two dimensional problems in polar coordinated, stress distribution symmetrical about an axis, pure bending of curved bar, Displacement for symmetric loaded cases, Bending of curved bar by forces at end. Effect of circular hole in plate under in plane loading. Concentrated load at point of Straight boundary. Stresses in circular disk. Forces acting on end of wedge.

Unit 3

Three Dimensional Problems in Elasticity:

Differential equation of equilibrium in 3D, Condition of Compatibility, Determination of Displacement, Principal of superposition, Uniqueness theorem, Problems of Rods under axial stress, Bar under its own weight, Pure bending of Prismatic roads, Torsion of Prismatic bars of Elliptical, rectangular, triangular and other sections, Membrane Analogy-Torsion of narrow rectangular bars. Torsion of hollow shaft and thin tubes.

Unit 4

Bending of Prismatic Bars as A Problem Of Elasticity in 3D:

Bending of a cantilever, Stress function, Circular and rectangular sections, Non-symmetrical cross section. Shear Centre for different cross sections of bars, Calculation of deflections.

Unit 5

Energy Theorems:

Applications of complimentary energy theorems to the problems of elasticity.

Texts/References:

1. Wang, “Applied Elasticity”, McGraw hill book Co.
2. Timoshenko, “Theory of Elasticity”, McGraw hill book Co.
3. J. Chakrabarti, “Theory of Plasticity”, McGraw hill book Co.

Mechatronics

251MTMEPE104B	Mechatronics	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of process equipment design.
- Explore theoretical and practical aspects of process equipment design for real-world applications.
- Develop analytical skills to evaluate and solve problems related to process equipment design.
- Apply appropriate tools, methods, and techniques in the domain of process equipment design.
- Gain foundational knowledge for advanced study or research in the area of process equipment design.

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

CO1	Define sensor, transducer and understand the applications of different sensors and transducers
CO2	Explain the signal conditioning and data representation techniques
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Write a PLC program using Ladder logic for a given application
CO5	Understand applications of microprocessor and micro controller and analyze PI, PD and PID controllers for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	3	2	1	1	1	1	2
CO2	3	2	2	2	3	1	1	1	2	1	2
CO3	3	2	3	2	3	2	1	1	1	1	2
CO4	3	2	3	2	3	2	1	1	1	1	2
CO5	3	2	3	2	3	2	1	1	1	1	2

Course Content:

Unit 1

Introduction to Mechatronic systems,

elements, advantages and practical examples of Mechatronic systems. Sensors and Transducers: Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

Unit 2

Signal Conditioning and Data Representation

Types of electronic signals, need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters,

Interfacing devices, Electro-magnetic Relays, Data representation systems, Displays, seven segment displays, LCD displays, Printers, Data loggers, Data Acquisition Cards/Systems

Unit 3

Electrical Drives:

Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc. Pneumatics and Hydraulics Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electro-pneumatic valves, Electro- pneumatic circuits using single and double solenoid methods. Hydraulic cylinders, design of cylinder.

Unit 4

Microprocessor and Microcontroller

8085 microprocessor, architecture, various types of registers and their functions in 8085µP, Instruction sets, interfacing, applications.8081 microcontroller, architecture, Instruction sets, various pins and their functions interfacing, applications.

Unit 5

Control Systems Open and closed loop system;

block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using spring, Dashpot and Masse equivalence. Stability of Systems On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers,

Texts/References:

1. HMT Limited, Mechatronics, Tata McGraw-Hill, 1998.
2.Bolton, W., Mechatronics; Electronic Control System in Mechanical Engineering, PearsonEducationAsia,1999.
3. Raven, Automatic Control Engineering, McGraw Hill, NewYork,1986

Failure Analysis and Design

251MTMEPE104C	Failure Analysis and Design	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of failure analysis and design.
- Explore theoretical and practical aspects of failure analysis and design for real-world applications.
- Develop analytical skills to evaluate and solve problems related to failure analysis and design.
- Apply appropriate tools, methods, and techniques in the domain of failure analysis and design.
- Gain foundational knowledge for advanced study or research in the area of failure analysis and design.

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

CO1	To understand and apply various theories of failure in mechanical design**.**
CO2	To analyze different fracture mechanisms in materials under static and dynamic loading**.**
CO3	To understand the principles of fracture mechanics and fatigue failure**.**
CO4	To investigate time-dependent failure modes such as creep and brittle fracture at elevated conditions**.**
CO5	To assess and differentiate between various types of material failures through observation and analysis**.**

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	2	2	2	1	1	1	2
CO2	3	3	2	3	2	2	1	1	1	1	2
CO3	3	3	2	3	2	2	1	1	1	1	2
CO4	3	3	2	3	2	2	1	1	1	1	2
CO5	3	3	2	3	3	1	1	1	2	1	2

Course content:

Unit 1

Theories of Failure:

Maximum shear stress theory, Maximum normal stress theory, Maximum distortion energy theory, Maximum strain theory, Applicability of theories of failure.

Unit 2

Fracture:

Type of fracture, Theoretical cohesive strength of metals, Griffith theory of brittle fracture, fracture single crystals, Metallographic aspects of fracture, Dislocation theories of brittle fracture, Ductile fracture, Notch effects, Fracture under combined stresses.

Unit 3

Elements of Fracture Mechanics:

Strain- energy release rate, Stress intensity factor, Fracture toughness, Plane - strain toughness testing, Crack-opening displacement, J- Integral to solve energy of crack formation, R-curves, Toughness of material.

FATIGUE FAILURE: Stress cycle, S-N curve, Description of fatigue fractured parts, Phases of fatigue fracture, Fatigue crack propagation, Effects of metallurgical variables, Temperature, Stress concentration, Size and surface factors, Fatigue under combined stresses.

Unit 4

Creep Failure:

Creep curve, Structural changes and mechanisms during creep, Activation energy for steady-state creep, Fracture at elevated temperature.

BRITTLE FRACTURE: Transition temperature curves, Fracture analysis diagrams, Various types of embitterment, Fracture under very rapid loading.

Unit 5

Ductile Fracture:

Condition for necking, Dislocation and void formation activities, Types of fractured parts.

Assessment of Types Of Fractures By Observation: Comparison between different fractured parts undergoing various type of fracture.

Texts/ References:

1. Madoyag, F., Metal Fatigue Design and Theory.
2. Sors, L., Fatigue Design of Machine Components, Pergamon Press.
3. Rolfe, S.T. and Barson, J.M., Fracture and Fatigue Control Structures, Prentice Hall.
4. Broek, D., Elementary Engineering Fracture Mechanics, Noordnoff.
5. Dieter, G.E., Mechanical Metallurgy, McGraw Hill Book Co., New Delhi.

Machine Tool Design

251MTMEPE104D	Machine Tool Design	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of machine tool design.
- Explore theoretical and practical aspects of machine tool design for real-world applications.
- Develop analytical skills to evaluate and solve problems related to machine tool design.
- Apply appropriate tools, methods, and techniques in the domain of machine tool design.
- Gain foundational knowledge for advanced study or research in the area of machine tool design.

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

CO1	To introduce the fundamentals of metal cutting machine tools and their operational criteria.
CO2	To impart knowledge on basic design principles and power estimation in machine tools.
CO3	To train students in the design of critical components in machine tools.
CO4	To analyze structural and functional elements of machine tools.
CO5	To introduce advanced concepts like micro-feeding mechanisms, modular design, and ergonomics.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	1	1	1	1	1	1	2
CO2	3	2	3	2	2	1	1	1	1	1	2
CO3	3	2	3	2	2	1	1	1	1	1	2
CO4	3	2	3	2	2	2	1	1	1	1	2
CO5	3	2	3	2	3	2	1	1	1	1	2

Course Contents:

Unit 1

Introduction to metal cutting machine tools- criteria for the selection of operating capacity and design parameters, kinematics of machine tools.

Unit 2

Basic principles of machine tool design, estimation of drive power, machine tool drives, electrical, mechanical and fluid drives, stepped and step less speed arrangements and systems.

Unit 3

Design of machine tool spindles and bearings, design of power screws, design of slide ways, selective and pre-selective mechanisms.

Unit 4

Machine tool structures-beds, columns, tables and supports, stock feed mechanism, Measurement and control of machine tools, protective and safety devices, design of precision machine tools.

Unit 5

Micro-feeding mechanisms, concept of modular design and integration of SPM`s, and Concepts of aesthetic and ergonomics applied to machine tools.

Texts/References:

1. N. K.Mehta , Machine tool design, Tata Mcgraw-hill, New Delhi, 1989.
2. N.Acherkan, Machine tool design, Vol. 3 and 4, Mir publisher, Moscow, 1968.
3. A.Koenigsburger, Design principles of metal cutting machine tools, Pergamon press,1964.
4. C.M.T.I. Machine tool design course notes, C.M.T.I. Bangalore.
5. G.Sen andA.Bhattacharya , Principles of machine tools, Vol. 2, NCB, Calcutta, 1973.

PG Lab- I

251MTMEPC105L	PG Lab- I	PCC Lab	0-0-4	2 Credits

Continuous Assessment 50 Marks	Total 50 Marks

Course Objectives:

- Understand the core principles and significance experiments listed.
- Explore theoretical and practical aspects of each experiment for real-world applications.
- Develop analytical skills to evaluate and solve problems related to practical aspects of each experiment.
- Apply appropriate tools, methods, and techniques in the domain of practical aspects of each experiment.
- Gain foundational knowledge for advanced study or research in the area of practical aspects of each experiment.

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

CO1	To perform and analyze experiments on damped and torsional vibrations in mechanical systems.
CO2	To investigate failure modes in mechanical components through experimental analysis.
CO3	To design and develop mechatronic systems for real-world mechanical applications.
CO4	To demonstrate and understand PID-based process control in parameters like temperature, level, and flow.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	3	2	1	1	2	2	2	2
CO2	3	2	2	3	2	2	1	2	2	2	2
CO3	3	2	3	2	2	2	1	2	2	2	2
CO4	3	2	3	2	2	2	1	2	2	2	2

Course Contents

1. Experiment on damped vibration
2. Torsional vibration analysis
3. Experiment based on failure analysis of mechanical component.
4. Study of a mechatronic system for mechanical application
5. Design of a mechatronic components.
5. Demonstration of process control such as temp, level, flow, etc control using PLD controller.
6. Optimization techniques using MATLAB

Note: Any 5 experiments to be performed.

Seminar-I

251MTMEEL106	Seminar - I	ELC	0-0-4	2 Credits

Continuous Assessment 50 Marks	Total 50 Marks

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

CO1	Identify and compare technical and practical issues related to the area of course specialization.
CO2	Outline annotated bibliography of research demonstrating scholarly skills.
CO3	Prepare a well-organized report employing elements of technical writing and critical thinking.
CO4	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	1	2	1	1	1	2	3	2	2
CO2	1	2	1	2	1	1	1	2	2	1	2
CO3	2	2	1	1	1	1	1	2	3	2	2
CO4	2	2	1	2	1	1	1	2	3	2	2

Objective:

To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self- confidence and courage that are essential for an engineer.

Concepts and Applications in Engineering

251MTMEIK107A	Concepts and Applications in Engineering	IKS	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of concepts and applications in engineering.
- Explore theoretical and practical aspects of concepts and applications in engineering for real-world applications.
- Develop analytical skills to evaluate and solve problems related to concepts and applications in engineering.
- Apply appropriate tools, methods, and techniques in the domain of concepts and applications in engineering.
- Gain foundational knowledge for advanced study or research in the area of concepts and applications in engineering.

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

CO1	To introduce the concept, history, and structure of the Indian Knowledge System and its Vedic foundations.
CO2	To explore the unique contributions of Indian mathematics and astronomy, including ancient number systems and calendar science.
CO3	To understand traditional Indian engineering, metallurgy, and technology practices and their historical significance.
CO4	To study ancient Indian town planning, architecture, and the philosophical framework underlying knowledge classification.
CO5	To examine the fundamentals of Indian linguistics, Sanskrit grammar, and their applications in computational linguistics.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	1	1	2	2	1	1	1	1
CO2	2	1	1	1	1	2	2	1	1	1	1
CO3	2	1	1	1	1	2	2	1	1	1	1
CO4	2	1	1	1	1	2	2	1	1	1	1
CO5	2	1	1	1	1	2	2	1	1	1	1

Course Contents

Unit-1

Indian Knowledge System – An Introduction:

1. What is IKS? 2. Why do we need IKS? 3. Organization of IKS 4. Historicity of IKS 5. Some salient aspects of IKS

The Vedic Corpus:
1. Introduction to Vedas 2. A synopsis of the four Vedas 3. Sub- classification of Vedas 4. Messages in Vedas 5. Introduction to Vedāṅgas 6. Prologue on Śikṣā and Vyākaraṇa 7. Basics of Nirukta and Chandas 8. Introduction to Kalpa and Jyotiṣa 9. Vedic Life: A Distinctive Features

Unit-2

Number Systems and Units of Measurement:
1. Number systems in India – Historical evidence 2. Salient aspects of Indian Mathematics 3. Bhūta-Saṃkhyā system 4. Kaṭapayādi system 5. Measurements for time, distance, and weight 6. Piṅgala and the Binary system

Mathematics: 1. Introduction to Indian Mathematics 2. Unique aspects of Indian Mathematics 3. Indian Mathematicians and their Contributions 4. Algebra 5. Geometry 6. Trigonometry 7. Binary mathematics and combinatorial problems in Chandaḥ Śāstra 8. Magic squares in India

Astronomy: 1. Introduction to Indian astronomy 2. Indian contributions in astronomy 3. The celestial coordinate system 4. Elements of the Indian calendar 5. Notion of years and months 6. Pañcāṅga – The Indian calendar system 7. Astronomical Instruments (Yantras) 8. Jantar Mantar of Rājā Jai Singh Sawai.

Unit-3

Engineering and Technology: Metals and Metalworking:
1. Wootz Steel: The rise and fall of a great Indian technology 2. The Indian S & T heritage 3. Mining and ore extraction 4. Metals and metalworking technology 5. Iron and steel in India 6. Lost wax casting of idols and artefacts 7. Apparatuses used for extraction of metallic components

Engineering and Technology: Other applications: 1. Irrigation systems and practices in South India 2. Literary sources for science and technology 3. Physical structures in India 4. Irrigation and water management 5. Dyes and painting technology 6. The art of making perfumes 7. Surgical techniques 8. Shipbuilding 9. Sixty-four art forms (64 Kalās) 10. Status of Indigenous S & T.

Unit-4

Town Planning and Architecture:
1. Perspective of Arthaśāstra on town planning 2. Vāstu- śāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: marvelous stone architecture for eternity 6. Temple architecture in India 7. Iconography**.**

Knowledge Framework and classifications: 1. Indian scheme of knowledge 2. The knowledge triangle 3. Prameya – A vaiśeṣikan approach to physical reality 4. Dravyas – the constituents of the physical reality 5. Attributes – the properties of substances and Action – the driver of conjunction and disjunction 6. Sāmānya, viśēṣa, samavāya 7. Pramāṇa – the means of valid knowledge 8. Saṃśaya – ambiguities in existing knowledge 9. Framework for establishing valid knowledge 10. Deductive or inductive logic framework 11. Potential fallacies in the reasoning process 12. Siddhānta: established tenets in a field of study

Unit-5

Linguistics
1. Introduction to Linguistics 2. Aṣṭādhyāyī 3. Phonetics 4. Word generation 5. Computational aspects 6. Mnemonics 7. Recursive operations 8. Rule based operations 9. Sentence formation 10. Verbs and prefixes 11. Role of Sanskrit in natural language processing.

TEXTBOOKS /REFERENCES:

1. **Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022),** "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

For additional reading:

2. Pride of India: A Glimpse into India‟s Scientific Heritage, Samskrita Bharati, New Delhi.
3. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
4. Bag, A.K. (1979). Mathematics in Ancient and Medieval India, Chaukhamba Orientalia, New Delhi.
5. Datta, B. and Singh, A.N. (1962). History of Hindu Mathematics: Parts I and II, Asia Publishing House, Mumbai.
6. Kak, S.C. (1987). "On Astronomy in Ancient India", Indian Journal of History of Science, 22(3), pp. 205–221.
7. Subbarayappa, B.V. and Sarma, K.V. (1985). Indian Astronomy: A Source Book, Nehru Centre, Mumbai.
8. Bag, A.K. (1997). History of Technology in India, Vol. I, Indian National Science Academy, New Delhi.
9. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
10. Banerjea, P. (1916). Public Administration in Ancient India, Macmillan, London.
11. Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.

Humanities and Social Sciences

251MTMEIK107B	Humanities and Social Sciences	IKS	2-0-0	2 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of humanities and social sciences.
- Explore theoretical and practical aspects of humanities and social sciences for real-world applications.
- Develop analytical skills to evaluate and solve problems related to humanities and social sciences.
- Apply appropriate tools, methods, and techniques in the domain of humanities and social sciences.
- Gain foundational knowledge for advanced study or research in the area of humanities and social sciences.

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

CO1	To introduce the foundations and historical significance of the Indian Knowledge System and the Vedic corpus.
CO2	To explore major Indian philosophical systems and their contributions to wisdom and cultural heritage.
CO3	To understand the Indian framework of knowledge, logic, linguistics, and the role of Sanskrit in knowledge dissemination.
CO4	To study traditional Indian mathematics, measurement systems, and holistic approaches to health and psychology.
CO5	To examine ancient Indian town planning, architecture, governance, and public administration principles.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	1	1	2	3	1	1	1	1
CO2	2	1	1	1	1	2	3	1	1	1	1
CO3	2	1	1	1	1	2	3	1	1	1	1
CO4	2	1	1	1	1	2	3	1	1	1	1
CO5	2	1	1	1	1	2	3	1	1	1	1

Course Contents

Unit-1

Indian Knowledge System – An Introduction:

1. What is IKS? 2. Why do we need IKS? 3. Organization of IKS 4. Historicity of IKS 5. Some salient aspects of IKS

The Vedic Corpus: 1. Introduction to Vedas 2. A synopsis of the four Vedas 3. Sub- classification of Vedas 4. Messages in Vedas 5. Introduction to Vedāṅgas 6. Prologue on Śikṣā and Vyākaraṇa 7. Basics of Nirukta and Chandas 8. Introduction to Kalpa and Jyotiṣa 9. Vedic Life: A Distinctive Features

Unit-2

Philosophical Systems:

1. An introduction to philosophical systems 2. Development of philosophy 3. Unique features of philosophy 4. Sāṅkhya approach of philosophy 5. Introduction to Yoga 6. Tenet of Nyāya philosophy 7. Principles of Vaiśeṣika 8. Doctrine of Pūrva-Mīmāṃsā Darśana 9. Thesis of Vedānta and synopsis of Advaita 10. Philosophy of Viśiṣṭādvaita 11. Ideology of Dvaita 12. Tenets of Jaina 13. Doctrine of Buddhism 14. Notions of Cārvāka

Wisdom through the Ages: 1. Gateways of ancestral wisdoms 2. Introduction to Purāṇa 3. The Purāṇic repository 4. Issues of interest in Purāṇas 5. Introduction to Itihāsas 6. Key messages in Itihāsas 7. Wisdom through Nīti-śāstras 8. Wisdom through Subhāṣita

Unit-3

Knowledge Framework and classifications:

1. Indian scheme of knowledge 2. The knowledge triangle 3. Prameya – A vaiśeṣikan approach to physical reality 4. Dravyas – the constituents of the physical reality 5. Attributes – the properties of substances and Action – the driver of conjunction and disjunction 6. Sāmānya, viśēṣa, samavāya 7. Pramāṇa – the means of valid knowledge 8. Saṃśaya – ambiguities in existing knowledge 9. Framework for establishing valid knowledge 10. Deductive or inductive logic framework 11. Potential fallacies in the reasoning process 12. Siddhānta: established tenets in a field of study

Linguistics: 1. Introduction to Linguistics 2. Aṣṭādhyāyī 3. Phonetics 4. Word generation 5. Computational aspects 6. Mnemonics 7. Recursive operations 8. Rule based operations 9. Sentence formation 10. Verbs and prefixes 11. Role of Sanskrit in natural language processing

Unit-4

Number Systems and Units of Measurement:

Number systems in India – Historical evidence 2. Salient aspects of Indian Mathematics 3. Bhūta-Saṃkhyā system 4. Kaṭapayādi system 5. Measurements for time, distance, and weight 6. Piṅgala and the Binary system

Health Wellness and Psychology: 1. Introduction to health 2. Āyurveda: approach to health 3. Sapta-dhātavaḥ: seven-tissues 4. Role of agni in health 5. Tri-doṣas 6. Āyurveda: definition of health 7. Psychological aspects of health 8. Disease management elements 9. Dinacaryā: daily regimen for health & wellness 10. Importance of sleep 11. Food intake methods and drugs 12. Approach to lead a healthy life 13. Indian approach to psychology 14. The tri guṇa system & holistic picture of the individual 15. The Nature of Consciousness 16. Consciousness studies and issues

Unit-5

Town Planning and Architecture:

Perspective of Arthaśāstra on town planning 2. Vāstu-śāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: marvelous stone architecture for eternity 6. Temple architecture in India 7. Iconography

Governance and Public Administration: 1. Introduction to raja dharma 2. Arthaśāstra: a historical perspective 3. Elements of a kauṭilyan state 4. The king & the amātya 5. Janapada & durga 6. Treasury and the State Economy (Kośa) 7. Danda 8. Mitra 9. The Administrative Setup 10. Relevance of Arthaśāstra 11. Public Administration in Epics

TEXTBOOKS /REFERENCES:

1. **Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022),** "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

Additional Readings:

1. Pride of India: A Glimpse into India‟s Scientific Heritage, Samskrita Bharati, New Delhi.
2. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
3. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
4. Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.
5. Dasgupta,S. (1975). A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi.
6. PLofker, K. (1963). Mathematics in India, Princeton University Press, New Jeresy, USA"

YOGA for Stress Management

251MTMEAE108	YOGA for Stress Management	Audit	0-0-2	1 Credits

Continuous Assessment 50 Marks

Course Objectives:

1. Understand the physiological and psychological aspects of stress and its impact on overall well-being.
2. Learn and practice specific yoga postures, breathing exercises, and relaxation techniques to alleviate stress.
3. Explore the connection between mindfulness, meditation, and stress reduction, fostering mental clarity.
4. Discover holistic practices that promote better sleep, nutrition, and overall lifestyle habits for stress management.
5. Develop practical skills to manage stress in daily life, enhancing resilience and promoting emotional balance.

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

CO1	Understand the concept of stress from both Western and Eastern perspectives and the relevance of Yoga in stress management.
CO2	Explain the physiological and psychological impacts of stress and apply yogic practices to mitigate stress-related symptoms.
CO3	Analyze traditional yogic texts such as Patanjali Yoga Sutra and Bhagavad Gita to understand their insights into stress and its management.
CO4	Assess stress using modern tools and explain research-based evidence supporting the role of Yoga in managing stress-related disorders.
CO5	Perform various Yoga techniques, including asanas, pranayama, loosening, breathing, and relaxation practices for holistic stress management.
CO6	Integrate knowledge and practices from yogic traditions to design personalized stress management programs promoting lifelong wellness.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	1	1	2	3	2	2	1	3
CO2	2	1	1	1	1	2	3	2	2	1	3
CO3	2	1	1	1	1	2	3	2	2	1	3
CO4	2	2	1	2	2	2	3	2	2	1	3
CO5	2	2	1	2	2	2	3	2	2	1	3
CO6	3	2	2	2	2	3	3	2	2	1	3

Course Contents:

UNIT I

Introduction to Yoga for Stress Management –

Introduction to Yoga for Stress Management - 2 Stress according to Western perspective Stress Eastern Perspective Developmental process: Western and Eastern Perspective Stress Hazards and Yoga

UNIT II

Meeting the challenges of Stress –

Meeting the challenges of Stress - 2 Introduction to Stress Physiology Stress, Appetite and Dietary management- Modern and Yogic perspective Sleep and Stress: understanding the relationship for effective management of stress

UNIT III

Stress Assessment methods-

A valuable tool toward stress management Role of Yoga in prevention and management of stress related disorders – a summary of research evidence Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 1 Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 2 Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 3

UNIT IV

Concept of stress and its management –

perspectives from Bhagavad Gita - Part 1 Concept of stress and its management - perspectives from Bhagavad Gita - Part 2 Concept of stress and its management - perspectives from Bhagavad Gita - Part 3

UNIT V

Bio-Psycho-Socio-Spiritual model of stress management

Yoga practices for Stress Management Breathing practices – 1

Hands in and out breathing, Hands stretch breathing, Ankle stretch breathing Breathing practices – 2

Dog Breathing, Rabbit breathing, Tiger breathing, Sashankasana breathing Breathing practices – 3

Bhujangasana breathing, Ardha Shalabhasana breathing (alternate legs), Straight leg raising (alternate legs), Straight leg raising (both legs), Sethubandhasana lumbar stretch, Instant Relaxation Technique (IRT)

Loosening Practices – 1

Shoulder Rotation, Side bending, standing twist, Hip rotation, Thigh strengthening Loosening practices – 2 Chakki chalan, Bhunamasana Chalana, Alternative toe touching Loosening practices – 3

Side leg raising, Pavana muktasana kriya: Wind releasing pose movements, Quick Relaxation Technique (QRT)

UNIT VI

Asana practices – 1

Tadasana, Ardhakati Chakrasana, Ardha Chakrasana, Trikonasana, Vrikshasana Asana practices – 2, Vakarasana, Janu Sirshasana, Ushtrasana, Sashankasana, Asana practices – 3

Ardhamatseyndrasana, Paschimottanasana, Poorvottanasana, Gomukhasana Asana practices – 4

Makarasana, Bhujangasana, Salambha Shalabahasana, Dhanurasana Asana practices – 5

Setubandhasana, Sarvangasana, Mastyasana, Deep Relaxation Technique (DRT)

Soorya Namaskar Pranayama – 1 Kapalbhati kriya and Sectional Breathing Pranayama – 2

Nadishuddhi Pranayama Pranayama – 3 Bhramari, Sheetali, Sitkari and Ujjayi Om Meditation Cyclic Meditation Integrated Yoga Module I Integrated Yoga Module II Integrated Yoga Module III

Textbooks / References:

1. H R Nagendra and R Nagarathna. Yoga for Promotion of Positive Health. Swami Vivekananda Yoga Prakashana. 2011.
2. Contrada, R., & Baum, A. (Eds.). The handbook of stress science: Biology, psychology, and health. Springer Publishing Company. 2010
3. Al'Absi, M. (Ed.). Stress and addiction: Biological and psychological mechanisms. Elsevier. 2011.
4. Van den Bergh, O. Principles, and practice of stress management. Guilford Publications. 2021.
5. Swami Muktibodhananda, Hatha Yoga Pradipika, Bihar Scool of Yoga, 1998
6. Swami Satyananda Saraswati, Four Chapters on Freedom, Bihar Scool of Yoga, 1975
7. Swami Tapasyananda, Srimad Bhagavat Gita, Sri Ramakrishna Math, 2012

Semester II

Finite Element Analysis and Simulation

251MTMEPC201	Finite Element Analysis and Simulation	PCC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the foundational principles of linear elastic mechanics and variational methods such as virtual displacement and Rayleigh-Ritz techniques for 1D structural problems.
- Develop the ability to model and analyze 2D structural problems under plane stress and plane strain conditions using various finite element shapes including triangles and quadrilaterals.
- Apply isoparametric formulation and numerical integration techniques to accurately model complex geometries and assess element performance through convergence tests.
- Analyze axisymmetric and 3D solid structures, including flat plate bending problems, using appropriate finite element formulations and boundary conditions.
- Explore the application of finite element methods in dynamic analysis, mass matrix formation, plate bending, shell structures, and introduction to elastic stability concepts.

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

CO1	To understand the fundamentals of 1-D finite element analysis using linear elasticity and energy principles.
CO2	To formulate and solve 2-D problems under plane stress and strain conditions using triangular and quadrilateral elements and ISO parametric formulation with numerical integration techniques using Lagrange and Serendipity shape functions.
CO3	To analyze axisymmetric 3-D problems and plate bending using mixed formulations and Kirchhoff's theory.
CO4	To study discrete Kirchhoff elements, thick plate modeling, and shell analysis using finite element methods.
CO5	To study the simulation techniques and its benefits.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	3	2	1	1	2	2	2
CO2	3	3	3	2	3	2	1	1	2	2	2
CO3	3	3	3	2	3	2	1	1	2	2	2
CO4	3	3	3	2	3	2	1	1	2	2	2
CO5	2	2	2	2	3	2	1	1	2	2	2

Course Contents:

Unit 1

1-D Problems:

Principles of linear elastic mechanics, principles of virtual displacements and minimum potential energy, Rayleigh Ritz method, exact v/s approximate solution, beam elements.

Unit 2

2-D Problems:

Plane stress and plane strain conditions, triangular elements, constant straintriangle, linear strain triangle, Boundary conditions, body forces and stress recovery, quadrilateral elements. Lagrange and Serendipity shape functions, isoparametric formulation, numerical integration, modeling with isoparametric elements, requirements for convergence, patch test, nonconforming elements, reduced integration.

Unit 3

3-D Problems:

Axisymmetric solids, governing equations, axisymmetric elements and their applications, mixed formulations, bending of flat plates (Kirchhoff Theory), continuity requirements and boundary conditions.

Unit 4

3-D Problems:

Discrete Kirchhoff‟s elements, thick plate elements, plate bending applications, shells as assemblage of flat plates, finite element formulation for dynamic problems, mass properties, introduction to elastic stability for frames and plate.

Unit 5

System models and studies: -

concepts of a system, system environment, stochastic activities, continuous and discrete systems, system modeling, types of models, principles used in modeling, types of system studies.

System simulation: - The techniques of simulation, Monte Carlo method, comparison of simulation and analytical methods, simulators, continuous system simulation languages, system dynamics, growth models, logistic curves, multi segments models.

Texts / References:

1. R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley and Sons, second edition, 1981.
2. C.S. Krishnamurti, Finite element method, Tata Mc-Graw Hill Publication.
3. K.J. Bathe, Finite Element Method and Procedures, Prentice hall, 1996.
4. Tirupathi, R., and Chandrupatla,Finite Elements in Engineering, PHI Publication, NewDelhi.
5. Bruce Irons and SoharabAhmed,Techniques of Finite Elements, John Wiley and Sons,New York.
6. K.J. Bathe, Finite Element Method, Prentice Hall, 1987.
7. O.P., Gupta, Finite and Boundary Element Methods in Engineering, Oxford and IBH.

Design Optimization

251MTMEPC202	Design Optimization	PEC-III	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of design optimization.
- Explore theoretical and practical aspects of design optimization for real-world applications.
- Develop analytical skills to evaluate and solve problems related to design optimization.
- Apply appropriate tools, methods, and techniques in the domain of design optimization.
- Gain foundational knowledge for advanced study or research in the area of design optimization.

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

CO1	To introduce the fundamentals of engineering optimization and problem formulation techniques.
CO2	To study various single and multivariable optimization algorithms and their applications.
CO3	To analyze and apply constrained optimization methods including Kuhn-Tucker conditions and gradient-based approaches.
CO4	To explore special optimization algorithms like genetic algorithms, simulated annealing, and global optimization techniques.
CO5	To apply optimization methods to operations research problems including linear programming and sensitivity analysis.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	3	2	1	1	2	2	2
CO2	3	3	2	2	3	2	1	1	2	2	2
CO3	3	3	3	2	3	2	1	1	2	2	2
CO4	3	3	3	2	3	2	1	1	2	2	2
CO5	3	3	3	2	3	2	1	1	2	2	2

Course Contents:

Unit 1

Introduction:

Optimal problem formulation, engineering optimization problems, optimization algorithms. Single Variable Optimization Algorithms: Optimality criteria, bracketing methods, region elimination methods, point estimation methods, gradient based methods, root finding using optimization techniques.

Unit 2

Multivariable Optimization Algorithms:

Optimality criteria, unidirectional search, direct search methods, gradient based methods, Computer programs on above methods.

Unit 3

Constrained Optimization Algorithms:

Kuhn-Tucker conditions, transformation methods, sensitivity analysis, direct search for constrained minimization, linearized search techniques, feasible direction method, generalized reduced gradient method, gradient projection method, Computer programs on above methods.

Unit 4

Special Optimization Algorithms:

Integer programming, Geometric programming, Genetic Algorithms, Simulated annealing, global optimization, Computer programs on above methods.

Optimization in Operations Research:

Linear programming problem, simplex method, artificial variable techniques, dual phase method, sensitivity analysis.

Unit 5

Stochastic Programming:

Basic concepts of probability theory, random variables Distributions – mean, variance, Correlation, co variance, joint probability distribution stochastic linear, dynamic programming.

Texts/References:

1. Deb Kalyanmoy, "Optimization in Engineering Design", PHI, New Delhi
2. Rao S. S. "Engineering Optimization", John Wiley, New Delhi.
3. Deb Kalyanmoy, "Multi-objective Algorithms using Evolutionary Algorithms", JohnWiley, New Delhi.
4. Paplambros P. Y. and Wilde D. J., "Principles of Optimum Design: Modeling and Computation", Cambridge University Press, UK
5. Chandrupatla, "Optimization in Design", PHI, New Delhi.

Vehicle Dynamics

251MTMEPE203A	Vehicle Dynamics	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of vehicle dynamics.
- Explore theoretical and practical aspects of vehicle dynamics for real-world applications.
- Develop analytical skills to evaluate and solve problems related to vehicle dynamics.
- Apply appropriate tools, methods, and techniques in the domain of vehicle dynamics.
- Gain foundational knowledge for advanced study or research in the area of vehicle dynamics.

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

CO1	To introduce the fundamental concepts and scope of vehicle dynamics.
CO2	To analyze longitudinal dynamics including load distribution, acceleration, braking, and dynamics of tractor-semi trailers.
CO3	To understand tire mechanics, including slip, grip, rolling resistance, and tire force generation.
CO4	To apply simplified tire models for evaluating lateral force generation and combined slip conditions.
CO5	To examine lateral dynamics using bicycle models, understeer gradient, and state-space analysis for vehicle handling.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	2	2	1	1	2	1	2
CO2	3	3	3	2	2	2	1	1	2	1	2
CO3	3	3	3	2	2	2	1	1	2	1	2
CO4	3	3	3	2	2	2	1	1	2	1	2
CO5	3	3	3	2	2	2	1	1	2	1	2

Course Contents:

Unit 1

Introduction to Vehicle Dynamics

Understanding different modeling approaches like lumped mass, coordinate systems (vehicle and earth-fixed). Analyzing forces acting on a vehicle, Understanding how to represent vehicle motion using appropriate coordinate systems.

Unit 2

Longitudinal Dynamics:

Vehicle Load Distribution – Acceleration and Braking - Brake Force Distribution, Braking Efficiency and Braking Distance - Longitudinal dynamics of a Tractor-Semi Trailer

Unit 3

Tire Mechanics – An Introduction:

Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance – Tire Construction and Force Development- Contact Patch and Contact Pressure Distribution

Unit 4

A Simple Tire Model:

Lateral Force Generation - Ply Steer and Conicity - Tire Models – Magic Formula Classification of Tire Models and Combined Slip

Unit 5

Lateral Dynamics:

Bicycle Model - Stability and Steering Conditions - Understeer Gradient and State Space Approach – Handling Response of a Vehicle - Mimuro Plot for Lateral Transient Response - Parameters affecting vehicle handling characteristics

Vertical Dynamics: Rollover Prevention - Half Car Model - Quarter Car Model

Texts/References:

1. Pacejka, Hans. Tire and vehicle dynamics. Elsevier, 2005.
2. Wong, Jo Yung. Theory of ground vehicles. John Wiley & Sons, 2001.
3. Moore, Desmond F. "The friction of pneumatic tyres." (1975).
4. Jazar, Reza N. Vehicle dynamics: theory and application. Springer, 2008
5. Gillespie, Thomas D. Fundamentals of vehicle dynamics, 1992

Tribology in Design

251MTMEPE203B	Tribology in Design	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of tribology in design.
- Explore theoretical and practical aspects of tribology in design for real-world applications.
- Develop analytical skills to evaluate and solve problems related to tribology in design.
- Apply appropriate tools, methods, and techniques in the domain of tribology in design.
- Gain foundational knowledge for advanced study or research in the area of tribology in design.

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

CO1	Understand the fundamentals of surface interactions, friction, and wear phenomena.
CO2	Develop foundational knowledge of lubrication theory and regimes, and to explore alternative lubrication methods and their applications.
CO3	Design and analyze fluid film bearings under various loading conditions.
CO4	Study the design, performance, and failure analysis of rolling element bearings.
CO5	Apply tribo-instrumentation and measurement techniques for evaluating bearing systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	2	2	1	1	2	2	2
CO2	3	2	2	2	2	2	1	1	2	2	2
CO3	3	2	3	2	3	2	1	1	2	2	2
CO4	3	2	3	2	3	2	1	1	2	2	2
CO5	3	2	3	2	3	2	1	1	2	2	2

Course Contents:

Unit 1

Surfaces, Friction And Wear:

Topography of Surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non -metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistance materials, Surface treatment, Surface modifications, Surface coatings.

Unit 2

Types of Lubrication: Electro-hydrodynamic (EHD), Magneto hydrodynamic lubrication, Hydro static lubrication, Gas lubrication, Solid lubrication.

Lubrication Theory: Lubricants and their physical properties lubricants standards, Lubrication Regimes in Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects.

Unit 3

Design of Fluid Film Bearings: Design and performance analysis of thrust and journal bearings, Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings, Hydrostatic Bearing design.

Unit 4

Rolling Element Bearings: Geometry and kinematics, Materials and manufacturing processes, contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, bearing life capacity and variable loads, ISO standards, Oil films and their effects, Rolling Bearings Failures.

Unit 5

Tribo Measurement and Instrumentation:

Surface Topography measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, bearing vibration measurement

Texts/References:

1. Cameron A., "Basic Lubrication Theory", Ellis Horwood Ltd., UK, 1981
2. Halling J. (Editor) – "Principles of Tribology ", Macmillian, 1984.
3. Williams J.A., "Engineering Tribology", Oxford Univ. Press, 1994.
4. Neale, M.J., "Tribology Hand Book", Butterworth Heinemann, 1995.
5. StolarskiT.a., "Tribology in Machine Design", Industrial Press Inc., 1990.

Reverse Engineering

251MTMEPE203C	Reverse Engineering	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of reverse engineering.
- Explore theoretical and practical aspects of reverse engineering for real-world applications.
- Develop analytical skills to evaluate and solve problems related to reverse engineering.
- Apply appropriate tools, methods, and techniques in the domain of reverse engineering.
- Gain foundational knowledge for advanced study or research in the area of reverse engineering

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

CO1	To introduce the fundamentals, phases, and applications of reverse engineering
CO2	To analyze material characteristics affecting part performance and durability
CO3	To identify materials and verify manufacturing processes used in component design
CO4	To develop skills in data processing, statistical analysis, and system performance evaluation
CO5	To evaluate the legal aspects and ethical considerations of reverse engineering

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	2	2	2	1	2	2	2
CO2	3	2	2	2	2	2	2	1	2	2	2
CO3	3	2	2	2	2	2	2	1	2	2	2
CO4	3	2	2	2	2	2	2	1	2	2	2
CO5	3	2	2	2	2	2	3	1	2	2	2

Course contents:

Unit 1

Introduction to Reverse Engineering & Geometric Form

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

Unit 2

Material Characteristics, Part Durability and Life Limitation

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

Unit 3

Material Identification and Process Verification

Material Specification - Composition Determination - Microstructure Analysis – Manufacturing Process Verification.

Unit 4

Data Processing, Part Performance and System Compatibility

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis — Data Conformity and Acceptance — Data Report — Performance Criteria — Methodology of Performance Evaluation – System Compatibility.

Unit 5

Acceptance, Legality and Industrial Applications of RE

Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Material. Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.

REFERENCES

1. Co-ordinate Measurement and reverse engineering, Donald R. Honsa, ISBN 1555897,American Gear Manufacturers Association
2. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996
3. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
4. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996
6. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994

Integrated Product Development

251MTMEPE203D	Integrated Product Development	PEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of integrated product development.
- Explore theoretical and practical aspects of integrated product development for real-world applications.
- Develop analytical skills to evaluate and solve problems related to integrated product development.
- Apply appropriate tools, methods, and techniques in the domain of integrated product development.
- Gain foundational knowledge for advanced study or research in the area of integrated product development.

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

CO1	To understand the fundamentals of product design, development processes, and customer need identification.
CO2	To learn methods for setting product specifications and generating, selecting, and testing innovative concepts.
CO3	To explore product architecture, delayed differentiation, and the role and management of industrial design.
CO4	To apply principles of Design for Manufacture (DFM), prototyping techniques, and robust design methodology.
CO5	To evaluate the economic aspects of product development and techniques for effective project planning and execution.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	2	2	1	1	2	2	2
CO2	3	2	3	2	2	2	1	1	2	2	2
CO3	3	2	3	2	2	2	1	1	2	2	2
CO4	3	2	3	2	2	2	1	1	2	2	2
CO5	3	2	3	2	2	2	1	1	2	2	2

Course Contents:

Unit 1:

Introduction to Product Design

Characteristics of Successful Product development –Duration and Cost of Product Development — Challenges of Product Development - Product Development Processes and Organizations – Product Planning Process - Process of Identifying Customer Needs

Unit– 2

Product Specifications, Concept Generation, Selection and Testing

Establish Target and Final product specifications — Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies.

Unit–3

Product Architecture and Industrial Design

Product Architecture — Implications and establishing the architecture — Delayed Differentiation — Platform Planning — Related system level design issues - Need and impact of industrial design - Industrial design process - management of the industrial design process - assessing the quality of industrial design

Unit– 4

Design For Manufacture, Prototyping and Robust Design

DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping — Prototyping technologies - Planning for prototypes - Robust design – Robust Design Process

Unit– 5

Product Development Economics and Managing Projects

Economic Analysis — Elements of Economic Analysis - Understanding and representing tasks- Baseline Project Planning - Accelerating the project - Project execution — Postmortem project evaluation.

REFERENCES:

1. Karl T.Ulrich, Steven D.Eppinger, Anita Goyal, "Product Design and Development", McGraw – Hill Education (India) Pvt. Ltd, 4th Edition, 2012.
2. Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
3. Kevin N Otto, Kristin L Wood, “Product Design – Techniques in Reverse Engineering and
4. New Product Development”, Pearson Education, Inc, 2016
5. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin Homewood, 1992
6. Stuart Pugh, "Total Design — Integrated Methods for successful Product Engineering", Addison Wesley Publishing, New York, NY, 1991.

Process Equipment Design

251MTMEPC204	Process Equipment Design	PEC-II	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of process equipment design.
- Explore theoretical and practical aspects of process equipment design for real-world applications.
- Develop analytical skills to evaluate and solve problems related to process equipment design.
- Apply appropriate tools, methods, and techniques in the domain of process equipment design.
- Gain foundational knowledge for advanced study or research in the area of process equipment design.

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

CO1	To introduce the fundamentals of pressure vessel design and fabrication practices
CO2	To provide knowledge of storage vessel design under different operating conditions
CO3	To design pressure vessels subjected to internal and external pressure, including closures and joint.
CO4	To understand the design of high-pressure and tall vessels using advanced construction techniques.
CO5	To design agitators and mixing systems for pressure vessels used in process applications.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	2	2	1	1	1	2	2
CO2	3	2	2	2	2	2	1	1	1	2	2
CO3	3	2	3	2	3	2	1	1	1	2	2
CO4	3	2	3	2	3	2	1	1	1	2	2
CO5	3	2	3	2	3	2	1	1	1	2	2

Course Content:

Unit 1

Design Considerations for Pressure Vessel:

Introduction; Selection of type of vessel, Methods of fabrication, Effect of fabrication methods, Various criteria in vessel design, Economic considerations, Types of process equipment, Constructional requirement and applications., Fabrication and testing, Inspection and non-destructive testing of equipment.

Unit 2

Storage Vessel:

Design methods of atmospheric storage vessel: storage of fluids, storage of non-volatile liquids, storage of volatile liquids, storage of gases, Optimum tank proportion, Bottom design, Shell design, Wind girder for open top tank, Rub curb angle, Self supported roof, Design of rectangular tank.

Unit 3

Pressure Vessel:

Unfired process vessel with internal and external pressure, Operating condition, Selection of material, Design condition, Stresses, Design criteria, Design of shell Subjected to internal and external pressure, Cylindrical vessel under combined loading, Design of heads and closures: flat head and formed heads for vessel. Design consideration for rectors and chemical process vessels. Flange facings, Gaskets, Design of flanged joint, Flange thickness, and Blind flanges.

Unit 4

High Pressure Vessel:

Design of thick walled high-pressure vessel, Constructional features, Materials for high-pressure vessels, Multilayer vessel with shrink fit construction, Thermal expansion for shrink fitting, stress in multishell or shrink fit construction, autofrettage, Pre-stressing. Tall vessels and their design, Stress in shell, Determinations of longitudinal stresses, Longitudinal bending stresses due to eccentric loads, Determination of resultant longitudinal stresses.

Unit 5

Agitated Vessel:

Type of agitators, Baffling, Power requirement for agitation, Design based on torque and bending moment, Design based on critical speed, Blade design, Hub and key design, Stuffing box and gland design, Turbine agitator design,

Texts/References:

1. Process Equipment Design by V.V .Mahajani and S. B. Umarji. Macmillan PublisherIndia Ltd.
2. Process equipment design by L.E.Brownell and E.H.Young, John Wiley and Sons.
3. Introduction to process Equipment Design by B.C. Bhattacharya
4. Pressure Vessel Design Manual by Dennis Moss, Elsevier.
5. Theory and Design of Pressure Vessels by John F. Harvey, P. E., CBS Publication.

Instrumentation and Automatic Control

251MTMEOE205A	Instrumentation and Automatic Control	OEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of instrumentation and automatic control.
- Explore theoretical and practical aspects of instrumentation and automatic control for real-world applications.
- Develop analytical skills to evaluate and solve problems related to instrumentation and automatic control.
- Apply appropriate tools, methods, and techniques in the domain of instrumentation and automatic control.
- Gain foundational knowledge for advanced study or research in the area of instrumentation and automatic control.

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

CO1	Understand the fundamentals and objectives of measurement systems used in scientific and engineering applications, including the classification of methods for measuring physical quantities.
CO2	Apply principles of measurement and statistical techniques such as parameter estimation, regression, correlation, error analysis, and effective data presentation.
CO3	Gain practical knowledge in measuring various field quantities like temperature, pressure, velocity, flow, force, humidity, and vibration using both contact and non-intrusive techniques.
CO4	Learn methods to measure derived quantities such as torque, power, thermo-physical and radiative properties, with an emphasis on engineering relevance and accuracy.
CO5	Explore analytical instrumentation and control systems, including pollution monitoring tools and the basics of P, PI, PID controllers with applications in industrial systems like furnaces and machine tools.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	3	2	1	1	2	2	2
CO2	3	3	2	2	3	2	1	1	2	2	2
CO3	3	3	2	2	3	2	1	1	2	2	2
CO4	3	3	2	2	3	2	1	1	2	2	2
CO5	3	3	2	2	3	2	1	1	2	2	2

Course Contents:

Unit 1

Introduction to measurements for scientific and engineering application needs and goals. Broad category of methods for measuring field and derived quantities

Unit 2

Principles of measurement, parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data

Unit 3

Measurement of field quantities, thermometry, heat flux measurement, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration, measurement of the above by probe and non-instructive techniques

Unit 4

Measurement of derived quantities, torque, power, thermo physical properties, radiation and surface properties

Unit 5

Analytical methods and pollution monitoring, mass spectrometry, chromatography, spectroscopy Basics of P, PI, PID controllers, pneumatic and hydraulic controllers, electronic controllers, applications to machine tools, furnaces, material handling etc

Texts/References

1. Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.
1. Beckwith TG. N. Lewis Buck and Marangoni R.D: Mechanical Measurements,Narosa Publishing House, New Delhi
2. Liptak B.G. Instrument Engineers‟ Handbook
3. Bolton W, Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg.
4. Modern Electronic Instrumentation and Measurement Technique by A.D. Helfrick and W.D. Cooper Johnson C.D., Process Control Instrumentation
5. J. P. Holman: Experimental Methods for Engineers, McGraw Hill International Edition, Seventh Edition.

Design for Manufacture & Assembly

251MTMEOE205B	Design for Manufacture & Assembly	OEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of design for manufacture & assembly.
- Explore theoretical and practical aspects of design for manufacture & assembly for real-world applications.
- Develop analytical skills to evaluate and solve problems related to design for manufacture & assembly.
- Apply appropriate tools, methods, and techniques in the domain of design for manufacture & assembly.
- Gain foundational knowledge for advanced study or research in the area of design for manufacture & assembly.

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

CO1	To understand and apply the principles of Design for Manufacturing (DFM) to reduce production costs and process constraints.
CO2	To learn the design considerations involved in metal casting including gating, molding, and solidification.
CO3	To explore design guidelines for welding, forging, sheet metal, and powder metallurgy processes.
CO4	To develop the ability to select appropriate materials and manufacturing processes based on design requirements.
CO5	To analyze and rank various manufacturing methods for effective material-process integration in product design.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	3	2	1	1	2	2	2
CO2	3	2	3	2	3	2	1	1	2	2	2
CO3	3	2	3	2	3	2	1	1	2	2	2
CO4	3	2	3	2	3	2	1	1	2	2	2
CO5	3	2	3	2	3	2	1	1	2	2	2

Course Contents:

Unit1

Design for Manufacturing:

reduce the cost of manufacturing process, understanding the process and constraints, standard components and process, consider the impact of DFM decisions and other factors.

Unit2
Design Consideration in Metal Casting:
Mold and Gating System Design, Directional Solidification, and Troubleshooting.

Unit 3
Design for Welding:
selection of materials for joining, welding defects, minimize the residual stresses etc. Design for forging and sheet metal and powder metal process.

Unit 4
Selection of Materials:
choice of materials, organizing material and processes.

Unit 5
Application of Design
for manufacture and assembly with selection of materials and ranking of processes like casting, injection moulding, sheet metal working, die casting, powder metal process, investment casting and hot forging, Design for assembly and automation

Texts/References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
2. Harry Peck, "Design for Manufacture", Pittman Publication 1983.
3. Robert Matousek, "Engineering Design – A systematic approach", Blackie & sons Ltd., 1963.
4. James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw HillCo., 1986.
4. Swift K. G. "Knowledge based design for manufacture", Kogan Page Ltd., 1987.

Experimental Stress Analysis

251MTMEOE205C	Experimental Stress Analysis	OEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of experimental stress analysis.
- Explore theoretical and practical aspects of experimental stress analysis for real-world applications.
- Develop analytical skills to evaluate and solve problems related to experimental stress analysis.
- Apply appropriate tools, methods, and techniques in the domain of experimental stress analysis.
- Gain foundational knowledge for advanced study or research in the area of experimental stress analysis.

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

CO1	Understand the need, advantages, and limitations of experimental stress analysis techniques.
CO2	Apply basic principles of elasticity to analyze 2D stress and strain conditions.
CO3	Identify and describe various strain measurement methods including mechanical, optical, electrical, acoustical, and semiconductor techniques.
CO4	Use electrical strain gauges and Wheatstone bridge circuits for precise strain measurement under varying environmental conditions.
CO5	Interpret stress patterns using optical methods such as photoelasticity, polariscopes, isochromatic and isoclinic fringe analysis, and moiré fringe techniques.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	3	2	1	1	2	2	2
CO2	3	3	2	2	3	2	1	1	2	2	2
CO3	3	3	2	2	3	2	1	1	2	2	2
CO4	3	3	2	2	3	2	1	1	2	2	2
CO5	3	3	2	2	3	2	1	1	2	2	2

Course Contents:

Unit 1

Introduction:

Need of stress analysis; Why experimental methods? Merits and demerits of experimental methods. Stress at a point; stress equations of equilibrium; 2-D state of stress; Strains and displacements; Stress strain relationship for 2-D state of stress; Plane stress and plane strain approach.

Unit 2

Measurement of Strain:

Strain gauges: Mechanical, optical, electrical, acoustical and semiconductor; Grid method of strain analysis.

Unit 3

Electrical Strain Gauges:

Gauge construction; Strain gauge adhesives and mounting techniques; Gauge sensitivity and gauge factor; Strain gauge linearity, hysteresis and zero shift; Temperature compensation; Environmental effects: moisture, humidity and hydrostatic pressure, high and cryogenic temperatures; The Wheatstone bridge; Calibration of strain gauge circuit; Strain analysis method: 3-element rectangular rosette, torque gauge.

Unit 4

Basics of Optics:

Nature of light; Wave theory of light; Optical instruments; Plane and circular polariscopes

Unit 5

Theory of Photo elasticity:

Stress optics law; Effects of a stressed model in a plane polariscope; Effects of principal stress directions; Effects of principal stress difference; Effects of a stressed model in circular polariscope in dark and light field arrangements; 2-D Photoelasticity; Isochromatic and isoclinic fringe patterns; Materials for 2-D Photoelasticity; Introduction to more fringe technique and coating methods.

Texts/References:

1. Doyle, J.F.: Modern Experimental Stress Analysis. J. Wiley, 2004.
2. Dove Adams, Experimental Stress Analysis, McGraw Hill, 1992.
3. CC Perry and HR Lissner, “The Strain Gage Primer”, McGraw-Hill, 2000.
4. Abdul Mubeen, “Experimental Stress Analysis”, DhanpatRai and Sons, 2001.
5. PS Theocaris, “Moire Fringes in Strain Analysis”, Pergammon Press, 2002.

Advanced Manufacturing

251MTMEOE205D	Advanced Manufacturing	OEC	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of advanced manufacturing.
- Explore theoretical and practical aspects of advanced manufacturing for real-world applications.
- Develop analytical skills to evaluate and solve problems related to advanced manufacturing.
- Apply appropriate tools, methods, and techniques in the domain of advanced manufacturing.
- Gain foundational knowledge for advanced study or research in the area of advanced manufacturing.

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

CO1	To understand the fundamentals and working principles of different Advanced Machining Processes.
CO2	To analyse and evaluate the performance of Advanced Machining Processes for machining of different Advanced Engineering Materials.
CO3	To identify Advanced Machining Processes for creating desired features in different Advanced Engineering Materials.
CO4	To illustrate the machining performance characteristics and analysis for optimization of process performance.
CO5	To understand the hybrid machining with non-conventional finishing and machining process

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	3	2	1	1	2	2	2
CO2	3	2	2	2	3	2	1	1	2	2	2
CO3	3	2	2	2	3	2	1	1	2	2	2
CO4	3	2	2	2	3	2	1	1	2	2	2
CO5	3	2	2	2	3	2	1	1	2	2	2

COURSE CONTENTS:

Unit- 1.

Mechanical Energy based Machining Processes:

Need and Classification of Advanced Machining Processes; Process Principle, Applications, Equipment, Process Analysis and Tool Design of Ultra-Sonic Machining (USM); Jet Machining Processes: Process Principle, Applications, Equipment, Process Analysis of Abrasive Water Jet Machining (AWJM), Abrasive Jet Machining (AJM), and Water Jet Machining (WJM).

Unit- 2.

Chemical Energy based Machining Processes:

Process Principle, Applications, Equipment, Process Analysis and Tool Design of Electro-Chemical Machining (ECM); Chemical Machining Processes: Process Principle, Applications, Equipment, Process Parameters of Chemical Milling (CHM), Chemical Engraving (CHE), Chemical Blanking (CHB), and Photochemical Machining (PCM).

Unit- 3.

Thermal Energy based Machining Processes:

Process Principle, Applications, Equipment, Process Analysis and Tool Design of Electro-Discharge Machining (EDM); Beam Machining Processes: Process Principle, Applications and Equipment for Laser Beam Machining (LBM), Electron Beam Machining (EBM), Ion Beam Machining (IBM), and Plasma Beam Machining (PBM).

Unit- 4.

Hybrid Machining Processes:

Introduction, need, and classification of Hybrid Machining Processes; Process Principle, Applications and Equipment for Combined Machining Processes (Electrochemical Grinding (ECG), Electrochemical Deburring (ECD), Electrochemical Honing (ECH), Electrochemical Superfinishing, Electrical Discharge Diamond Grinding (EDDG), Electrolytic Magnetic Abrasive Machining (EMAM), and Electro-Chemical Discharge Machining (ECDM)) and Assisted Machining Processes (Ultrasonic Assisted EDM and ECM as well as Laser Assisted EDM and ECM).

Unit- 5.

Non-Conventional Finishing and Micromachining

Need and Classification; Process Principle, Applications and Equipment for Abrasive Flow Finishing (AFF), Magnetic Abrasive Finishing (MAF), Magneto-Rheological Finishing (MRF); Micromachining: Process Principle and Applications of Non-Conventional Micromachining and Combined Micromachining.

Textbooks Recommended:

1. V. K. Jain, Advanced Machining Processes, Allied, New Delhi, 2004.
2. P. K. Mishra, Nonconventional Machining, Narosa Publishing House, New Delhi, 2014.
3. A. Ghosh and A. K. Mallik, Manufacturing Science, 2nd Ed., East-West Press Private Limited, 2010.
4. P. C. Pandey and H. S. Shan, Modern Machining Processes, TMH Publishing Limited, New Delhi, 2008.

Reference Books Recommended:

1. Hassan Abdel-Gawad El-Hofy, Advanced Machining Processes, McGraw-Hill Companies, USA, 2005.
2. V. K. Jain, Introduction to Micromachining, 2nd Ed., Narosa Publishers, New Delhi, 2009.
3. M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems; 3rd Ed., Wiley India Pvt. Ltd., New Delhi, 2012.

PG LAB -II

251MTMEPC206L	PG LAB -II	PCC	0-0-4	2 Credit

Continuous Assessment 50 MARKS	Total 50 MARKS

Course Objectives:

1. Understand the core principles and significance of experiments.
2. Explore theoretical and practical aspects of experiments for real-world applications.
3. Develop analytical skills to evaluate and solve problems related to experiments.
4. Apply appropriate tools, methods, and techniques in the domain of experiments.
5. Gain foundational knowledge for advanced study or research in the area of experiments**.**

Course Outcomes:

CO1	To understand the static analysis using the 3D software.
CO2	To understand the dynamic analysis using the 3D software.
CO3	To understand the modal analysis using the 3D software.
CO4	To understand the thermal analysis using the 3D software.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	3	3	2	1	2	2	2	2
CO2	3	2	2	3	3	2	1	2	2	2	2
CO3	3	2	3	3	3	2	1	2	2	2	2
CO4	3	2	2	3	3	2	1	2	2	2	2

Course Contents:

1. 2D element problem linear static analysis
2. 3D element problem linear static analysis
3. Static analysis of any mechanical component
4. Dynamic analysis of any mechanical component
5. Modal analysis of cantilever beam
6. Thermal analysis of mechanical component
7. Design and modeling of mechanical component using commercial software

Note: Any 5 experiments to be performed.

Mini Project

251MTMEEL207	Mini Project	ELC	0-0-4	2 Credit

Continuous Assessment 50 MARKS	Total 50 MARKS

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

CO1	Equip students to identify and analyze real-world engineering and managerial problems effectively.
CO2	Develop problem-solving skills by proposing practical and innovative solutions.
CO3	Enhance teamwork and collaboration through group activities and industrial exposure.
CO4	Strengthen technical writing and reporting skills by documenting project work comprehensively.
CO5	Build confidence in presenting and defending project outcomes before expert committees.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2	2	1	3	3	2	2
CO2	3	3	2	2	2	2	1	3	3	2	2
CO3	2	2	1	1	1	1	1	3	3	2	2
CO4	2	2	2	1	1	1	1	3	3	2	2
CO5	3	3	2	1	1	1	1	3	3	2	2

Objectives:

To train students in identification, analysis, finding solutions and execution of live engineering and managerial problems. It is also aimed to enhance the capabilities of the students for group activities. Individual students are required to choose a topic of their interest. The course content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from manufacturing organisations as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50. Internal marks will be awarded by respective guides as per the stipulations given below. Attendance, regularity of student (20 marks)

Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, beforethe committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

Report = 25 marks

Concept/knowledge in the topic = 15 marks, Presentation = 10 marks,

Total marks = 50 marks

Disaster Management

251MTMEAE208	Disaster Management	Audit	0-0-2	Audit

Course Objectives:

- Understand the basic concepts of hazards, disasters, vulnerabilities, and risks.
- Gain knowledge of natural and man-made disasters with a focus on their causes, impacts, and management.
- Study major disaster events and analyze their environmental, social, and economic consequences with case studies.
- Understand disaster mitigation strategies, policies, and the role of national and state bodies.
- Gain practical exposure through training, awareness programs, GIS/RS applications, and mini-projects related to disaster preparedness and risk assessment.

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

CO1	Define and classify various natural and man-made disasters and understand the associated risks and vulnerabilities
CO2	Analyze significant disasters in India with a focus on causes, types, impacts, and management strategies, especially for Sikkim and its surroundings
CO3	Demonstrate understanding of disaster mitigation techniques, disaster management policy, and the role of government bodies
CO4	Apply knowledge of disaster-resilient design and retrofitting of infrastructure in seismic zones.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2				2					
CO2	2	3				3					
CO3	2	2				3	2				
CO4	3		2		2	2					

Course Contents:

Unit: I

Definition and types of disaster

Hazards and Disasters, Risk and Vulnerability in Disasters, Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes, tsunami, avalanches, global climate extremes. Man-made disasters: Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.

Unit: II

Study of Important disasters

Earthquakes and its types, magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, landside and its managements case studies of disasters in Sikkim (e.g) Earthquakes, Landside). Social Economics and Environmental impact of disasters.

Unit: III

Mitigation and Management techniques of Disaster

Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management, Early Warming Systems, Building design and construction in highly seismic zones, retrofitting of buildings.

Unit IV

Training, awareness program

Project on disaster management Training and drills for disaster preparedness, Awareness generation program, Usages of GIS and Remote sensing techniques in disaster management, Mini project on disaster risk assessment and preparedness for disasters with reference to disasters in Sikkim and its surrounding areas.

Text Books:

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.
5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD

Semester III

Advanced CAD

252MTMEOE301A	Advanced CAD	OE	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of advanced cad.
- Explore theoretical and practical aspects of advanced cad for real-world applications.
- Develop analytical skills to evaluate and solve problems related to advanced cad.
- Apply appropriate tools, methods, and techniques in the domain of advanced cad.
- Gain foundational knowledge for advanced study or research in the area of advanced cad.

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

CO1	To introduce the principles of Computer-Aided Engineering and the role of CAD in the mechanical design process.
CO2	To understand and implement 2D and 3D geometric transformations using homogeneous coordinates and computer coding.
CO3	To design and analyze various types of curves such as Bezier, B-spline, and NURBS using mathematical models and algorithms.
CO4	To explore surface design techniques including parametric surface modelling, curvature analysis, and B-spline surface generation.
CO5	To study solid modelling approaches like B-rep, CSG, and Boolean operations for 3D object representation.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	3	1	1	1	2	1	2
CO2	3	2	3	2	3	1	1	1	2	1	2
CO3	3	2	3	2	3	1	1	1	2	1	2
CO4	3	2	3	2	3	1	1	1	2	1	2
CO5	3	2	3	2	3	1	1	1	2	1	2

Course Contents:

Unit 1

I**ntroduction**:

Introduction to CAE, CAD. Role of CAD in Mechanical Engineering, Design process, software tools for CAD, Geometric modelling.

Unit 2

Transformations in Geometric Modelling:

Introduction, Translation, Scaling, Reflection, Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Implementation of the transformations using computer codes.

Unit 3

Design of Curves:

Analytic Curves, PC curve, Ferguson, Composite Ferguson, curve Trimming and Blending, Bezier segments, de Casteljau's algorithm, Bernstein polynomials, Bezier subdivision, Degree elevation, Composite Bezier, Splines, Polynomial Splines, B-spline basis functions, Properties of basic functions, Knot Vector generation, NURBS, Developing algorithms/computer codes for Design of Curves.

Unit 4

Design of Surfaces:

Differential geometry, Parametric representation, Curves on surface, Classification of points, Curvatures, Developable surfaces, Surfaces of revolution, Intersection of surfaces, Surface modelling, 16-point form, Coons patch, B-spline surfaces, Developing algorithms/computer codes for Design of Surfaces.

Unit 5

Design of Solids:

Solid entities, Boolean operations, B-rep of Solid Modelling, CSG approach of solid modelling, advanced modelling methods, Applications of CAD Applications: Data exchange formats, Finite element analysis, mesh generation for finite element analysis, reverse engineering, modelling with point cloud data, working with .STL files, Additive Manufacturing.

TEXTS/REFERENCES:

1. Mathematical Elements for Computer Graphics, David F. Rogers, J. A. Adams, TMH, 2008.
2. Geometric Modeling", Michael E. Mortenson, Wiley, NY, 1997.
3. Product Design", Kevin N. Otto, Kristin L. Wood, Pearson Education, 2004.
4. CAD/CAM Theory and Practice, Ibrahim Zeid and Sivasubramanian, R., Tata McGraw Hill Publications, New Delhi, 2009.
5. Computer Aided Engineering Design", Anupam Saxena, BirendraSahay, Springer, 2005.

Intellectual Property Rights

252MTMEOE301B	Intellectual Property Rights	OE	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of intellectual property rights.
- Explore theoretical and practical aspects of intellectual property rights for real-world applications.
- Develop analytical skills to evaluate and solve problems related to intellectual property rights.
- Apply appropriate tools, methods, and techniques in the domain of intellectual property rights.
- Gain foundational knowledge for advanced study or research in the area of intellectual property rights.

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

CO1	Enumerate and demonstrate fundamental terms such as copy-rights ,Patents ,Trademarks etc.,
CO2	Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration
CO3	Processes to register own project research.
CO4	exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.
CO5	Develop awareness at all levels (research and innovation) of society to develop patentable

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	1	1	1	3	1	2	1	1
CO2	2	1	1	1	1	1	3	1	2	1	1
CO3	2	1	1	1	1	1	3	1	2	1	1
CO4	2	1	1	1	1	1	3	1	2	1	1
CO5	2	1	1	1	1	1	3	1	2	1	1

Course Contents:

Unit-1

Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents ;their definition; granting; infringement ;searching & filing; Utility Models an introduction;

Unit-2

- **Copyrights** ; their definition; granting; infringement ;searching & filing, distinction between related and copy rights; role in commerce ,importance , protection, registration; domain names;

Unit-3

- **Industrial Designs** ; Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications , international protection; Plant varieties; breeder's rights, protection; biotechnology& research and rights managements; licensing, commercialization; ; legal issues, enforcement ;Case studies in IPR.

Unit-4

Trade Marks: Introduction and overview of trademark, Evolution of trade mark law, Object and scope of trade mark protection, Features of good trade mark, Different forms of trade mark, Trade mark registry and register of trademarks, Assignment franchising and transmission, Infringement of trade mark and remedies, Offences and penalties.

Unit-5-

Geographical Indication of Goods History of geographical indication of goods protection, meaning of geographical indication of goods, Nature and scope of protection, salient features of The Geographical Indications of Goods (Registration and Protection) Act, 1999 - procedure for obtaining geographical indication protection, registration, right to use the geographical indication tag, infringement and remedies, role and functions of Registrar of geographical indications, conflict between Trademark and geographical indications.

TEXT BOOKS/REFERENCES:

1. Prabuddha Ganguli, IPR: Unleashing the Knowledge Economy, published by Tata McGraw Hill 2001.
2. Bouchoux, D. (2012). Intellectual property right, Cengage learning.
3. Ganguli, Prabuddha. (2017). Intellectual property right - Unleashing the knowledge economy, Tata McGraw Hill Publishing Company Ltd.
4. Johnson, M.(2021).Intellectual Property Law: Basics and Beyond. Coursera.
5. Sreenivasulu, N.S. (2013). Law Relating to Intellectual Property. Partridge Publishing India
6. Vaidhyanathan, Siva. (2017)."Intellectual Property: A Very Short Introduction". Oxford University Press.
7. World Intellectual Property Organization (WIPO): www.wipo.int
8. World Intellectual Property Organization. (2022). Introduction to Intellectual Property. https://www.wipo.int/edocs/pubdocs/en/wipo-pub-944-2022-en-world-intellectual-propertyreport-2022-the-direction-of-innovation.pdf

Supply Chain Management

252MTMEOE301C	Supply Chain Management	OE	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of supply chain management.
- Explore theoretical and practical aspects of supply chain management for real-world applications.
- Develop analytical skills to evaluate and solve problems related to supply chain management.
- Apply appropriate tools, methods, and techniques in the domain of supply chain management.
- Gain foundational knowledge for advanced study or research in the area of supply chain management.

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

CO1	To understand the fundamental concepts, types, and strategic decisions involved in managing a supply chain.
CO2	To analyze inventory management techniques and transportation strategies for optimizing logistics performance.
CO3	To explore the role of Information Technology and ERP systems in streamlining supply chain operations.
CO4	To examine the structure, types, and challenges of reverse supply chains with a focus on sustainability.
CO5	To evaluate collaboration strategies and integrative approaches for enhancing supply chain responsiveness.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	2	1	2	2	1	2	3	2	1
CO2	2	3	2	1	2	2	1	2	3	2	1
CO3	2	3	2	1	2	2	1	2	3	2	1
CO4	2	3	2	1	2	2	1	2	3	2	1
CO5	2	3	2	1	2	2	1	2	3	2	1

Course Contents:

Unit1

Introduction

Introduction, Generic Types of supply chain, Various Definitions and Implications, Major Drivers of Supply chain. Strategic Decisions- in Supply Chain Management Introduction, Business Strategy, Core Competencies in Supply Chain, Strategic SC Decisions, Customer Reletationship Management Strategy, Supplier Relationship Management Strategy Source of Management in Supply Chain Introduction, Elements of Strategic Sourcing, A Collaborative Perspective, Development of Partnership.

Unit 2

Inventory Management in Supply Chain

Introduction, Types of Inventory, Supply/ Demand Uncertainties, Inventory costs, Selective Inventory Control, Vendor Manage Inventory system, Inventory Performance Measure Logistics In Supply Chain Management Introduction, Strategy, Transportation Selection, Trade-off, Models for Transportation and Distribution, Third Party Logistics,, Overview of Indian Infrastructure for Transportation

Unit 3

Information Technology in Supply Chain

Introduction, Types of IT Solutions like Electronic Data Inter change (EDI), Intranet/ Extranet, Data Mining/ Data Warehousing and Data Marts, E-Commerce, E- Procurement, Bar Coding Technology. Information System in Supply Chain Introduction, Computer Based Information Systems, Computer Models and Perceptions about ERP, ERP & SCM. Application of Mathematical Modeling in Supply Chain Introduction, Modeling, Consideration in Modeling SCM System, Structuring the Logistic chain, Concept of Modeling.

Unit 4

Reverse Supply Chain

Introduction, Reverse Supply Chain v/s Forward Supply Chain, Types of Reverse Flows, Issues in Management of Reverse Supply Chain, Reverse Supply Chain for Food items, Reverse Logistic and Environment Impact. Integration & Collaborative Supply Chain Introduction, Evolution of collaborative SCM, Efficient Customer response, Collaboration at various levels, Imperatives for Successful Integrative Supply Chains.

Unit 5

Agile Supply Chain

Introduction, Source of Variability, Characteristics of Agile Supply Chain, Achieving Agility in Supply Chain. Cases of Supply Chain Cases of Supply Chain like, News Paper Supply Chain, Book Publishing, Mumbai Dabbawala, 9 management, Organic Food, Fast Food.

TEXTS / REFERENCES:

1. Supply Chain Management Theories & Practices, R. P. Mohanty, S. G. Deshmukh, Dreamtech Press, 19-A, Anari Road, Daryaganj, New Delhi
2. Supply Chain Management Strategy, Planning & Operation by Sunil Chopra, Peter Meindl
3. Total Supply Chain Management by Ron Basu, J. Nevan Wright
4. Supply Chain Management, Chopra, Pearson
5. Logistics Engineering and Management, Blanchard, pearson

Design for Piping System

252MTMEOE301D	Design for Piping System	OE	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam – 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of design for piping system.
- Explore theoretical and practical aspects of design for piping system for real-world applications.
- Develop analytical skills to evaluate and solve problems related to design for piping system.
- Apply appropriate tools, methods, and techniques in the domain of design for piping system.
- Gain foundational knowledge for advanced study or research in the area of design for piping system.

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

CO1	To understand the fundamentals of process piping, relevant codes and standards, material selection, and component design.
CO2	To learn piping system layout and design principles for various industrial applications including steam and oil pipelines.
CO3	To develop skills in pipe installation planning, size selection, steam regulation, and flexibility analysis for efficient operation.
CO4	To study process auxiliaries such as pressure relief systems, fabrication methods, and scale model layout techniques.
CO5	To analyze mechanical piping design including stress analysis, insulation, support systems, and underground piping design.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	3	2	1	1	2	2	2
CO2	3	2	3	2	3	2	1	1	2	2	2
CO3	3	2	3	2	3	2	1	1	2	2	2
CO4	3	2	3	2	3	2	1	1	2	2	2
CO5	3	2	3	2	3	2	1	1	2	2	2

Course Contents:

Unit 1

Process Piping: Scope of Piping; Code and Standards; Mechanical Design Fundamentals; Mechanical design of piping system; Wall thickness; Piping size selection; Steel and cast iron pipe; Steel and wrought iron pipe; Light wall pipe; Tubing; Pipe connection and fittings; Rail fittings; Piping elements and specialties; Pipe representation; Welded and flanged fittings; Valves.

Unit 2

Piping System Layout And Design: Piping layout; Equipment Layout; Process Piping Layout; Utility Piping Layout; Pipe flow sheets; Tube fastening and attachment; Non- ferrous tube fittings; Ducts and elbows; Pipe and tube design data; Design of steam piping; Design of oil piping; Design of cast iron pipe; Miscellaneous design and applications: Pipeline; Flexibility expansive forces in pipelines; Expansion stresses and reaction pipelines.

Unit 3

Pipe Installation: Selection of materials; Piping design; Basic principle; Piping sketches; Steam reducing and regulating valves; Selection of pipe size; Pipe hydraulics and sizing; Flow of water in pipes; Economical pipe selection; Selection of steam pipe size; Determination of steam pipe size; Development of plot plan; Flexibility analysis.

Unit 4

Process Auxiliaries: Piping; Explanation of code; Methods of fabrication; Nominal pipe size; Non-metallic piping and tubing; Pipe sizing by internal diameter; Choosing the final pipe size; Process steam piping; Pressure relief system; Pressure relief devices; Design of pressure relief system; Layout by scale model method.

Unit 5

Mechanical Piping Design: Piping drawings; Piping stress design; Internal or external fluid pressure stresses; Design of overhead piping; Design of underground piping; Erection of piping and support; Insulation; Drainage piping design; Design of natural gas pipeline.

Texts/ References:

1. J. M. Coulson, R. K. Sinnott and J. F. Richerdson,„Chemical Engineering‟ vol.6,Maxwell McMillan International Edition.
2. Sabin Crocker, „Piping Handbook‟ Fifth Edition, McGraw Hill Publication.
3. Sahu G. K. handbook of Piping Design, New Age International**,** 1998

Research Methodology

252MTMEMM302	Research Methodology	MDM	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam - 60 Marks	Total 100 Marks

Course Objectives:

- Understand the core principles and significance of research methodology.
- Explore theoretical and practical aspects of research methodology for real-world applications.
- Develop analytical skills to evaluate and solve problems related to research methodology.
- Apply appropriate tools, methods, and techniques in the domain of research methodology.
- Gain foundational knowledge for advanced study or research in the area of research methodology.

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

CO1	To understand the fundamental concepts, objectives, and types of research in various domains.
CO2	To learn the structured research process, including literature review and formulation of research tasks.
CO3	To develop skills for proposing and selecting research problems based on critical analysis and field studies.
CO4	To explore mathematical modelling and simulation techniques for representing and analyzing real-world systems.
CO5	To interpret research findings effectively and apply appropriate techniques for accurate data analysis.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2	2	1	1	2	2	3
CO2	3	3	2	2	2	2	1	1	2	2	3
CO3	3	3	2	2	2	2	1	1	2	2	3
CO4	3	3	2	2	2	2	1	1	2	2	3
CO5	3	3	2	2	2	2	1	1	2	2	3

Course content

Unit 1

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

Unit 2

Research process – Criteria for good research – Problems encountered by Indian researchers. Formulation of Research Task – Literature Review – Importance & Methods – Sources –

Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

Unit 3

Hypothetical proposals for future development and testing, selection of Research task.

Unit 4

Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

Unit 5

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

Texts/References

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata McGraw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Seminar II

252MTMEEL303	Seminar II	ELC	0-0-4	2 Credit

Continuous Assessment 50 Marks	End Sem Evaluation 50 Marks	Total 100 Marks

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

CO1	Develop the ability to research and select relevant technical topics beyond the core syllabus.
CO2	Enhance skills in preparing and delivering a structured technical seminar effectively.
CO3	Build confidence and courage to present ideas clearly before an audience.
CO4	Foster critical thinking through case study analysis and practical manufacturing scenarios.
CO5	Improve written communication skills by preparing a quality seminar report.
CO6	Cultivate self-esteem and professionalism essential for engineering leadership and teamwork.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	1	2	1	1	1	2	3	2	2
CO2	1	2	1	2	1	1	1	2	2	1	2
CO3	2	2	1	1	1	1	1	2	3	2	2
CO4	2	2	1	2	1	1	1	2	3	2	2
CO5	2	2	1	2	1	1	1	2	3	2	2
CO6	2	2	1	2	1	1	1	2	3	2	2

Objective:

To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self- confidence and courage that are essential for an engineer.

Individual students are required to choose a topic of their interest from Manufacturing Systems Management related topics preferably from outside the M.Tech syllabus or an extension of syllabus and give a seminar on that topic for about 30 minutes. The Seminar can also be a case study from a manufacturing organization. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Project -1

252MTMEEL304	Project – I	ELC	0-0-0	12 Credits

Continuous Assessment 100 Marks	End Sem Evaluation 100 Marks	Total 200 Marks

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

CO1	Apply theoretical and practical knowledge to solve real-world industrial or research problems.
CO2	Demonstrate research aptitude through design, experimentation, simulation, or empirical study.
CO3	Formulate project objectives, methodology, and expected outcomes effectively.
CO4	Analyze data or design outputs critically to evaluate project progress and feasibility.
CO5	Present project findings clearly in reviews and preliminary reports for expert evaluation.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	2	2	1	3	3	3	2
CO2	3	3	2	3	2	2	1	3	3	3	2
CO3	3	3	2	3	2	2	1	3	3	3	2
CO4	3	3	2	3	2	2	1	3	3	3	2
CO5	3	3	2	3	2	2	1	3	3	3	2

Objective:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project, experimental project, computer simulation project or an empirical study involving data collection and analysis from manufacturing organisations. The topic should be on Manufacturing Systems Management orany of the topics related with Manufacturing stream. The project work is allotted individually on different topics.The students shall be encouraged to do their project work in the parent institute. If found essential they may be permitted to continue their project outside the parent institute subject to the conditions of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members. The student is required to undertake the masters research project phase-I during the third semester and the same is continued in the 4^{th} semester (Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester

Semester IV
Project – II

252MTMEEL401	Project – II	ELC	0-0-0	20 Credits

Continuous Assessment 100 Marks	End Sem Evaluation 100 Marks	Total 200 Marks

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

CO1	Enhance professional competency and research aptitude by applying theoretical and practical techniques to real-world problems.
CO2	Continue and complete Masters Research Project Phase-II with structured progress reviews for quality assurance.
CO3	Develop skills in critical assessment, thesis preparation, and authentic research documentation.
CO4	Promote academic communication through preparation and submission of a technical paper for publication.
CO5	Prepare students for external evaluation by ensuring comprehensive project completion and presentation.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	3	2	1	3	3	3	3
CO2	3	3	3	3	3	2	1	3	3	3	3
CO3	3	3	3	3	3	2	1	3	3	3	3
CO4	3	3	3	3	3	2	1	3	3	3	3
CO5	3	3	3	3	3	2	1	3	3	3	3

Objectives:
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.