SREEPATHY INSTITUTE OF MANAGEMENT AND TECHNOLOGY

COURSE HANDBOOK

DEPARTMENT OF MECHANICAL ENGINEERING

SEMESTER III (2019 Scheme)

SREEPATHY INSTITUTE OF MANAGEMENT AND TECHNOLOGY

VISION

"Strive for excellence in generation and dissemination of knowledge."

MISSION

- To mould engineers of tomorrow, who are capable of addressing the problems of the nation and the world, by imparting technical education at par with international standards.
- To instil a desire in students for research, innovation, invention and entrepreneurship.
- To strive for creative partnership between the industry and the Institute.
- To impart the values of environment awareness, professional ethics, societal commitment, life skills and a desire for lifelong learning.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To act as quality knowledge center for creating technologically competent Mechanical Engineering professionals who will cater to the needs of emerging and interdisciplinary industry and research fields.

MISSION

- To provide theoretical and conceptual knowledge in Mechanical engineering stream and enhance lifelong learning.
- To work in close association with stakeholders in industry by enhancing industry-institute interaction, to take up need based research and industry specific programs.
- To infuse professional, social and economic responsibilities along with ethical values to graduates.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

The graduates from Mechanical Engineering program are expected to achieve the following Program Educational Objective within a few years of graduation

PEO1: Have an overall knowledge in Mechanical Engineering and also in the fields of Mathematics, Science, Communication and Computing skills.

PEO2: Design machines, analyze thermo-fluid problems and optimize the quality of products and services.

PEO3: Implement ideas of Mechanical Engineering for the challenging task in the interdisciplinary areas like Electrical, Electronics, Computer Science, Civil, Bio-Technology and allied branches.

PROGRAM OUTCOMES (POs)

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex Problems:** Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions
11. **Project management and finance**: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO)

The **Mechanical Engineering** Graduates will be able to

PSO1: Solve real-time problems in Design, Fluids, Thermal, Manufacturing and allied Engineering sectors of Mechanical Engineering.

PSO2: Recognize the importance of self-learning and engage in continuous independent learning to become experts in either as entrepreneurs or employees in the field.

BL BLOOM'S LEVEL

L1	Level -1	Remembering	Recalling from memory of previously learned material
L2	Level -2	Understanding	Explaining Ideas or Concepts
L3	Level -3	Applying	Using information in another familiar situation
L4	Level -4	Analyzing	Breaking information into part to explore understandings and relationships
L5	Level -5	Evaluating	Justify a decision or course of action
L6	Level -6	Creating	Generating new ideas, products or new ways of viewing things

MAT 201 PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS

COURSE INFORMATION SHEET:

Program: **Mechanical Engineering**	Degree :**B-Tech**
Course**: Partial Differential Equations and Complex Analysis**	Course code**: MAT 201**
L-T-P**:3-1-0**	Credit**:4**

SYLLABUS:

MODULE	CONTENT	HOURS	UNIVERSITY % MARKS
I	Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order Lagrange's linear equation, Non-linear equations of the first order - Charpit's method, Solution of equation by method of separation of variables.	8	20
II	One dimensional wave equation- vibrations of a stretched string, derivation, solution of the wave equation using method of separation of variables, D'Alembert's solution of the wave equation, One dimensional heat equation, derivation, solution of the heat equation	10	20
III	Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugate, Conformal mappings- mappings $w = z^2$, $w = e^z$,. Linear fractional transformation w =1/z, fixed points, Transformation $w = sinz$	9	20
IV	Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method-indefinite integration and substitution of limit, second evaluation method-use of a representation of a path, Contour integrals, Cauchy integral theorem (without proof) on simply connected domain, Cauchy integral theorem (without proof) on multiply connected domain Cauchy Integral formula (without proof), Cauchy Integral formula for derivatives of an analytic function, Taylor's series and Maclaurin series.,	9	20
V	Laurent's series(without proof), zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem, Residue integration of real integrals –	9	20

	Integrals of rational functions of $cos\theta$ and $sin\theta$, integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x)dx$ with no poles on the real axis.		

TEXT BOOKS:

1	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.
2	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

REFERENCES:

1	Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012

PREREQUISITE: A basic course in partial differentiation and complex numbers

COURSE OBJECTIVES:

1	This course introduces the basic idea of partial differential equations which are widely used in modelling and analysis of wide range of physical phenomena and has got applications in all branches of engineering. To understand the basic theory of functions of a complex variable, residue integration and conformal transformation.

COURSE OUTCOMES:

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

CO's	DESCRIPTION
1	Understand the concept and the solution of partial differential equation.
2	Analyse and solve one dimensional wave equation and heat equation
3	Understand complex functions, its continuity differentiability with the use of Cauchy-Riemann equations
4	Evaluate complex integrals using Cauchy's integral theorem and Cauchy's integral formula; understand the series expansion of analytic function
5	Understand the series expansion of complex function about a singularity and Apply residue theorem to compute several kinds of real integrals.

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	3	3	2	1						2			
CO2	3	3	3	3	2	1						2			
CO3	3	3	3	3	2	1						2			
CO4	3	3	3	3	2	1						2			
CO5	3	3	3	3	2	1						2			

CO-PO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PO1	3	Using of P.D.E to solve various equations
	PO2	3	Using of PDE to solve problems
	PO3	3	The solutions for various engineering problems requires mathematical modelling
	PO4	3	Use of PDE can help to solve complex problems
	PO5	2	Using of P.D.E for modelling
	PO6	1	DE can model various daily life problems
	PO12	2	DE is a mathematical field which needs lot of research
CO2	PO1	3	Using PDE for solving boundary-value problems related to the diffusion of heat, waves etc.
	PO2	3	Use of wave and heat equations to solve problems
	PO3	3	PDE is used to mathematically formulate and thus aid the solution of physical and other problems involving functions of several variables such as propagation of heat or sound
	PO4	3	PDE can design various experiments
	PO5	2	In the field of acoustic, electromagnetic and fluid dynamics wave equations are used.
	PO6	1	For society we can use the P.D.E to solve problems
	PO12	2	DE is a mathematical field which needs lot of research

CO3	PO1	**3**	Fundamental knowledge in complex analysis will help to analyse engineering problems easily
	PO2	**3**	Basic knowledge in conformal mapping will help to model various problems in engineering fields
	PO3	**3**	Complex analysis helps in design and development of solution to complex problems
	PO4	**3**	Utilize the knowledge of mathematics to identify analytic functions and harmonic functions
	PO5	**2**	Design system components by Identifying conformal mappings and find regions that are mapped under certain transformation for engineering problems.
	PO6	**1**	Complex analysis may address various society related problems
	PO12	**2**	Complex analysis is a long field with great research opportunities
CO4	PO1	**3**	Complex integration will help to simplify problems with high complexity in Engineering
	PO2	**3**	The integral techniques are useful for many problems arising solid and fluid mechanics.
	PO3	**3**	Identify, formulate and analyze complex engineering and real life problems and provide eco-friendly and economical solutions by identifying different types of functions.
	PO4	**3**	Complex integration will help to design solutions to various complex engineering problems
	PO5	**2**	Complex integration helps in solving problems of various branches of engineering
	PO6	**1**	Complex analysis may address various society related problems
	PO12	**2**	Complex analysis is a long field with great research opportunities
CO5	PO1	**3**	Singularities and Series expansions will help to enrich the analysis of Engineering problems
	PO2	**3**	Utilize the knowledge of mathematics to evaluate real definite integrals as applications of residue theorem
	PO3	**3**	Singularities and Series expansions will help to design solutions to various complex engineering problems

	PO4	**3**	Use of residue theorem and series expansions to evaluate various complex problems
	PO5	**2**	Digital filters are designed by looking the locations of zeros and poles in the complex plane
	PO6	**1**	Complex analysis may address various society related problems
	PO12	**2**	Complex analysis is a long field with great research opportunities

MET 201 MECHANICS OF SOLIDS

COURSE INFORMATION SHEET:

Program: **Mechanical Engineering**	Degree : **B-Tech**
Course**: Mechanics of Solids**	Course code**: MET 201**
L-T-P**: 3-1-0**	Credit**: 4**

SYLLABUS:

MODULE	CONTENT	HOURS	UNIVERSITY % MARKS
I	Deformation behaviour of elastic solids in equilibrium under the action of a system of forces, method of sections. Stress vectors on Cartesian coordinate planes passing through a point, stress at a point in the form of a matrix. Equality of cross shear, Cauchy's equation. Displacement, gradient of displacement, Cartesian strain matrix, strain- displacement relations (small-strain only), Simple problems to find strain matrix. Stress tensor and strain tensor for plane stress and plane strain conditions. Principal planes and principal stress, meaning of stress invariants, maximum shear stress. Mohr's circle for 2D case.	9	20
II	Stress-strain diagram, Stress–Strain curves of Ductile and Brittle Materials, Poisson's ratio. Constitutive equations-generalized Hooke's law, equations for linear elastic isotropic solids in terms of Young's Modulus and Poisson's ratio, Hooke's law for Plane stress and plane strain conditions Relations between elastic constants E, G, ν and K(derivation not required). Calculation of stress, strain and change in length in axially loaded members with single and composite materials, Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.	9	20
III	Torsional deformation of circular shafts, assumptions for shafts subjected to torsion within elastic deformation range, derivation of torsion formula Torsional rigidity, Polar moment of inertia, basic design of transmission shafts. Simple problems to estimate the stress in solid and hollow shafts. Shear force and bending moment diagrams for cantilever and simply supported beams. Differential equations between load, shear force and bending moment. Normal and shear stress in beams: Derivation of flexural formula, section modulus, flexural rigidity, numerical problems to evaluate bending stress, economic sections. Shear stress formula for beams: (Derivation not required), shear stress distribution for a rectangular section.	9	20
IV	Deflection of beams using Macauley's method Elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads. Expressions for strain energy in terms of load, geometry and material properties of the body for axial,	8	20

	shearing, bending and torsional loads. Castigliano's second theorem, reciprocal relation (Proof not required for Castigliano's second theorem, reciprocal relation). Simple problems to find the deflections using Castigliano's theorem.		
V	Fundamentals of bucking and stability, critical load, equilibrium diagram for buckling of an idealized structure. Buckling of columns with pinned ends, Euler's buckling theory for long columns. Critical stress, slenderness ratio, Rankine's formula for short columns. Introduction to Theories of Failure, Rankine's theory for maximum normal stress, Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain, Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy	8	20

TEXT BOOKS:

1	Mechanics of materials in S.I. Units, R .C. Hibbeler, Pearson Higher Education 2018
2	Advanced Mechanics of Solids, L. S. Srinath, McGraw Hill Education
3	Design of Machine Elements, V. B Bhandari, McGraw Hill Education

REFERENCES:

1	Engineering Mechanics of Solids, Popov E., PHI 2002
2	Mechanics of Materials S. I. units, Beer, Johnston, Dewolf, McGraw Hills 2017
3	Mechanics of Materials, Pytel A. and Kiusalaas J. Cengage Learning India Private Limited, 2ndEdition, 2015
4	Strength of Materials, Rattan, McGraw Hills 2011
5	Strength of Materials, Surendra Singh, S. K. Kataria& Sons

PREREQUISITE: EST100 ENGINEERING MECHANICS

COURSE OBJECTIVES:

1	To acquaint with the basic concepts of stress and deformation in solids.
2	To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

COURSE OUTCOMES:

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

CO's	DESCRIPTION
1	Determine the stresses, strains and displacements of structures by tensorial and graphical (Mohr's circle) approaches
2	Analyse the strength of materials using stress-strain relationships for structural and thermal loading
3	Perform basic design of shafts subjected to torsional loading and analyse beams subjected to bending moments
4	Determine the deformation of structures subjected to various loading conditions using strain energy methods
5	Estimate the strength of thin cylinders, spherical vessels and columns, and appreciate the theories of failures and its relevance in mechanical design

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	3	2									1		3	1
CO2	3	3	2									1		3	1
CO3	3	3	1									2		3	2
CO4	3	3	1									1		3	1
CO5	3	3	1									1		3	1

CO-PO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PO1	3	Basic concepts and relations of stress and strain enable the students to apply the equations for solving problems in solid mechanics
	PO2	3	Equations of stress transformation enable the students to identify, formulate and analyze problems in the Design of components
	PO3	2	Equations of stress transformation enable the students to do safe and sound design of structures.
	PO12	1	Stress and strain tensor matrix knowledge recognize the need to engage in independent and life-long learning in the broadest context of technological change.
CO2	PO1	3	Knowledge of elastic constants relation will enable the students to apply these equations for solving problems.
	PO2	3	Stress strain calculations enable the students to analyze complex problems in shaft design

	PO3	**2**	Thermal stress analysis enable the students to do safe and sound design of structures.
	PO12	**1**	Thermal study recognize the need to engage in independent and life-long learning in the broadest context of technological change.
CO3	PO1	**3**	Knowledge of shear forceand bending moment in beams will enable the students to solve complex problems in beam bending
	PO2	**3**	Understanding of shear force and bending moment diagram enable the students to identify, formulate and analyze engineering problems
	PO3	**1**	Torsion analysis will enable the students to design safe and sound design of structures.
	PO12	**2**	Shear force and bending moment study recognize the need to engage in independent and life-long learning in the broadest context of technological change.
CO4	PO1	**3**	Knowledge to compute the deflection in beams will enable the students to apply these equations for solve problems in Structural design of beams.
	PO2	**3**	Understanding of strain energy methods enable the students to analyze problems in the structural and component design
	PO3	**1**	Strain energy method study enable the students to do safe and sound design of components and structures
	PO12	**1**	Deflection study recognize the need to engage in independent and life-long learning in the broadest context of technological change.
CO5	PO1	**3**	Buckling and stability study in columns will enable the students to apply these equations for solve problems in Structural design of columns.
	PO2	**3**	Bending theories enable the students to analyze the stresses in different structures
	PO3	**1**	Theories of failure enable the students to design safe and sound design of components and structures
	PO12	**1**	Circumferential and longitudinal stresses recognize the need to engage in independent and life-long learning in the broadest context of technological change.

CO-PSO MAPPING JUSTIFICATION:

CO's	PSO's	LEVEL	JUSTIFICATION
CO1	PSO1	**3**	Student's ability to solve problems in solid Mechanics will be enhanced by studying fundamentals of stress and strain tensors
	PSO2	**1**	Determine the stresses and strains of structures by tensorial and graphical approaches recognize the need to adopt technological change.
CO2	PSO1	**3**	Knowledge in elastic constants and thermal stresses will enhance Student's capability to solve engineering problems
	PSO2	**1**	Analyse the strength of materials using stress-strain relationships for structural and thermal loading recognize the need of self-learning to adopt technological change.
CO3	PSO1	**3**	Knowldege of shear force and bending moment helps in solving basic problems in beams, machine components and structures
	PSO2	**2**	Design of shafts and beam analysis recognize the need to engage in independent and life-long learning in the broadest context of technological change.
CO4	PSO1	**3**	Clear understanding of bending stresses and strain energy methods will enhance student's capability to solve engineering problems.
	PSO2	**1**	Determine the deformation using strain energy methods recognize the need to adopt technological change.
CO5	PSO1	**3**	Application of failure and column theories enable student to solve real time problems in structures, beams and mechanical components
	PSO2	**1**	Estimating the strength of thin cylinders and columns recognize the need to engage in independent and life-long learning in the broadest context of technological change.

MET 203 MECHANICS OF FLUIDS

COURSE INFORMATION SHEET:

Program: **Mechanical Engineering**	Degree : **B-Tech**
Course**: Mechanics Of Fluids**	Course code**: MET 203**
L-T-P**: 3-1-0**	Credit**: 4**

SYLLABUS:

MODULE	CONTENT	HOURS	UNIVERSITY % MARKS
I	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.	9	20
II	Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines, flow nets, uses and limitations.	8	20
III	Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in cartesian co-ordinates. Dynamics of Fluid flow: Bernoulli's equation, Energies in flowing fluid, head, pressure, dynamic, static and total head, Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot-static tube.	8	20
IV	Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen Poiseuille equation. Turbulent flow: DarcyWeisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.	12	20
V	Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer,	10	20

	velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control. Dimensional Analysis: Dimensional analysis, Buckingham's theorem, important non dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynolds, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only		

TEXT BOOKS:

1	John. M. Cimbala and Yunus A. Cengel, Fluid Mechanics: Fundamentals and Applications (4th edition, SIE), 2019
2	Robert W. Fox, Alan T. McDonald, Philip J. Pritchard and John W. Mitchell, Fluid Mechanics, Wiley India, 2018

REFERENCES:

1	White, F. M., Fluid Mechanics, McGraw Hill Education India Private Limited, 8th Edition, 2017
2	Rathakrishnan, E. Fluid Mechanics: An Introduction, Prentice Hall India, 3rd Edition 2012

PREREQUISITE: NIL

COURSE OBJECTIVES:

1	This course provides an introduction to the properties and behaviour of fluids.
2	It enables to apply the concepts in engineering, pipe networks.
3	It introduces the concepts of boundary layers, dimensional analysis and model testing

COURSE OUTCOMES:

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

CO's	DESCRIPTION
1	Define Properties of Fluids and Solve hydrostatic problems
2	Explain fluid kinematics and Classify fluid flows
3	Interpret Euler and Navier-Stokes equations and Solve problems using Bernoulli's equation
4	Evaluate energy losses in pipes and sketch energy gradient lines
5	Explain the concept of boundary layer and its applications
6	Use dimensional Analysis for model studies

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	2												3	
CO2	3	2	1											3	
CO3	3	2	1											3	
CO4	3	3	2											3	
CO5	3	2	1											3	
CO6	3	2	1											3	

CO-PO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PO1	3	Fundamental knowledge of science is required for understanding the properties of fluids. The knowledge of mathematics is required for derivation of the formula relating pressure variation to height
	PO2	2	The student should be able to analyze and interpret the given problem to determine the hydrostatic force and stability of floating and completely immersed bodies in a fluid.
CO2	PO1	3	Fundamental knowledge of science and mathematics is required for analysing Kinematics of fluid flow
	PO2	2	The student should be able to analyze the given data and apply equations to find the velocity and acceleration of fluids.
	PO3	1	Fluid flow properties and behaviour help the students to analyse and interpret real life problems in a systematic way.
CO3	PO1	3	Fundamental knowledge of science and mathematics is required for analysing Dynamics of fluid flow
	PO2	2	The students should be able to understand the various energies involved in a fluid flow problem and find the total energy by applying Bernoulli's equation.
	PO3	2	Various fluid flow approaches help the students to achieve solutions to real life problems in a systematic way.
CO4	PO1	3	Fundamental knowledge of science and mathematics is required for analysing fluid flow through pipes
	PO2	3	The students should be able to interpret and analyze the given flow problem and select the required instrument used for flow measurement

	PO3	**2**	With the knowledge of fluid flow characteristics, students can achieve solutions to real life problems in a systematic way.
CO5	PO1	**3**	Fundamental knowledge of science and mathematics is required for analysing the concept of boundary layer
	PO2	**2**	By interpreting the details of the flow of a real fluid students should be able to calculate the energy loss.
	PO3	**1**	With the knowledge of boundary layer characteristics, students can achieve solutions to real life problems in a systematic way.
C06	PO1	**3**	Fundamental knowledge of science and mathematics is required for dimensional analysis
	PO2	**2**	By analyzing the data the students should be able to find out the relation between fluid variables through dimensional analysis technique.
	PO3	**1**	With the knowledge of dimensional analysis, students can achieve solutions to real life problems in a systematic way.

CO-PSO MAPPING JUSTIFICATION:

CO's	PSO's	LEVEL	JUSTIFICATION
CO1	PSO1	**3**	With the knowledge of fluid flow behaviour, fluid kinematics and dynamics students should be able to solve real-time problems in Fluid power engineering and allied sectors of Mechanical Engineering
CO2	PSO1	**3**	
CO3	PSO1	**3**	
CO4	PSO1	**3**	
CO5	PSO1	**3**	
CO6	PSO1	**3**	

MET 205 METALLURGY & MATERIAL SCIENCE

COURSE INFORMATION SHEET:

Program: **Mechanical Engineering**	Degree : **B-Tech**
Course**: Metallurgy & Material Science**	Course code**: MET 205**
L-T-P**: 3-1-0**	Credit**: 4**

SYLLABUS:

MODULE	CONTENT	HOURS	UNIVERSITY % MARKS
I	Earlier and present development of atomic structure - Primary bonds: - characteristics of covalent, ionic and metallic bond - properties based on atomic bonding: - Secondary bonds: - classification, application. (Brief review only). Crystallography: - SC, BCC, FCC, HCP structures, APF - theoretical density simple problems – Miller Indices: - crystal plane and direction - Modes of plastic deformation: - Slip and twinning -Schmid's law - Crystallization: Effects of grain size, Hall - Petch theory, simple problems.	9	20
II	Classification of crystal imperfections - forest of dislocation, role of surface defects on crack initiation- Burgers vector – Frank Read source - Correlation of dislocation density with strength and nano concept - high and low angle grain boundaries– driving force for grain growth and applications - Polishing and etching - X – ray diffraction, simple problems –SEM and TEM - Diffusion in solids, fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.	8	20
III	Phase diagrams: - need of alloying - classification of alloys - Hume Rothery`s rule – equilibrium diagram of common types of binary systems: five types - Coring - lever rule and Gibb`s phase rule - Reactions- Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties -Heat treatment: - TTT, CCT diagram, applications - Tempering- Hardenability, Jominy end quench test, applications- Surface hardening methods.	9	20
IV	Strengthening mechanisms - cold and hot working - alloy steels: how alloying elements affecting properties of steel - nickel steels - chromium steels - high speed steels -cast irons - principal non ferrous alloys.	9	20
V	Fatigue: - creep -DBTT - super plasticity - need, properties and applications of composites, super alloy, intermetallics, maraging steel, Titanium - Ceramics:- structures, applications.	10	20

TEXT BOOKS:

1	Callister William. D., Material Science and Engineering, John Wiley, 2014
2	Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998

REFERENCES:

1	Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009
2	Anderson J.C. et.al., Material Science for Engineers, Chapman and Hall,1990
3	Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964
4	Dieter George E, Mechanical Metallurgy, Tata McGraw Hill, 1976
5	Raghavan V, Material Science and Engineering, Prentice Hall,2004
6	Reed Hill E. Robert, Physical metallurgy principles, 4th edition, Cengage Learning,2009
7	Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008
8	Van Vlack -Elements of Material Science - Addison Wesley,1989
9	https://nptel.ac.in/courses/113/106/113106032

PREREQUISITE: PHT 110 Engineering Physics and CYT 100 Engineering Chemistry

COURSE OBJECTIVES:

1	Understanding of the correlation between the chemical bonds and crystal structure of metallic materials to their mechanical properties.
2	Recognize the importance of crystal imperfections including dislocations in plastic deformation.
3	Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.
4	Examine the mechanisms of materials failure through fatigue and creep.
5	To determine properties of unknown materials and develop an awareness to apply this knowledge in material design

COURSE OUTCOMES:

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

CO's	DESCRIPTION
1	Understand the basic chemical bonds, crystal structures (BCC, FCC, and HCP), and their relationship with the properties.
2	Analyze the microstructure of metallic materials using phase diagrams and modify the microstructure and properties using different heat treatments.
3	How to quantify mechanical integrity and failure in materials.
4	Apply the basic principles of ferrous and non-ferrous metallurgy for selecting materials for specific applications.
5	Define and differentiate engineering materials on the basis of structure and properties for engineering applications.

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3														
CO2		3													
CO3				2											
CO4					3										
CO5												2		3	

CO-PO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PO1	3	As they could apply their knowledge of engineering fundamentals to the solution of complex engineering problems.
CO2	PO2	3	As they could analyze phase diagrams to arrive at substantiated conclusions.
CO3	PO4	2	As they could analyze failure of engineering materials and arrive at substantiated conclusions.
CO4	PO5	3	Students will be able to identify and arrive at conclusions regarding the type of material to be used for a particular application.
CO5	PO12	2	As they could engage in independent and life-long learning about the different engineering materials and their application in the broadest context of technological change

CO-PSO MAPPING JUSTIFICATION:

CO's	PSO's	LEVEL	JUSTIFICATION
CO5	PSO1	3	Students will be able to select materials depending upon the application for designing components.

MCN 201 SUSTAINABLE ENGINEERING

COURSE INFORMATION SHEET:

Program: **Mechanical Engineering**	Degree : **B-Tech**
Course**: Sustainable Engineering**	Course code**: MCN 201**
L-T-P**: 2-0-0**	Credit**: NIL**

SYLLABUS:

MODULE	CONTENT	HOURS	UNIVERSITY % MARKS
I	Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).	5	20
II	Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.	6	20
III	Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.	6	20
IV	Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.	4	20
V	Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.	4	20

REFERENCES:

1	Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall
2	Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3	Environment Impact Assessment Guidelines, Notification of Government of India, 2006

4	Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
5	ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
6	Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
7	Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
8	Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

PREREQUISITE: NIL

COURSE OBJECTIVES:

1	Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability.
2	The student should realize the potential of technology in bringing in sustainable practices.

COURSE OUTCOMES:

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

CO's	DESCRIPTION
1	Understand the relevance and the concept of sustainability and the global initiatives in this direction
2	Explain the different types of environmental pollution problems and their sustainable Solutions
3	Discuss the environmental regulations and standards
4	Outline the concepts related to conventional and non-conventional energy
5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1						2	3					2			
CO2						2	3					2			
CO3						2	3					2			
CO4						2	3					2			
CO5						2	3					2			

CO-PO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PO6	**2**	Fundamental awareness about the concept and importance of sustainability is essential for the existence in future world
	PO7	**3**	The basic knowledge in sustainability helps to identify and analyze the impact caused to the environment by human activities
	PO12	**2**	Awareness about concept and importance of sustainability and the impact caused to the environment by human activities develops a strong desire in students for lifelong learning in the broadest context of technological change.
CO2	PO6	**2**	The study of zero waste and 3R waste concepts helps to assess societal, health, safety, legal and cultural issues
	PO7	**3**	Learning the basic concepts about types, causes and effects of pollution in sustainability helps to identify and analyze the environmental issues and derive solutions for the same
	PO12	**2**	Study of environmental pollution problems and its effect on environment develops keenness in students for lifelong learning in the broadest context of technological change.
CO3	PO6	**2**	Fundamental knowledge about Environmental Impact Assessment creates an awareness about various engineering applications in environmental management
	PO7	**3**	LCA and EIA study helps the students to understand impact of the engineering solutions in minimizing the environmental pollution to a greater extent
	PO12	**2**	Study of importance of ISO standards in environment management develops a thirst in students for lifelong learning in the broadest context of technological change.
CO4	PO6	**2**	Idea about conventional and nonconventional energy sources helps to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
	PO7	**3**	Basic knowledge of various types of conventional and nonconventional energy sources helps to understand the impact of the professional engineering solutions in societal and environmental contexts.
	PO12	**2**	Understanding importance of nonconventional energy sources develops a desire in students for lifelong learning in the broadest context of technological change.

CO5	PO6	**2**	Basic sustainability principles help in understanding the importance of role that sustainability plays in the future existence of society
	PO7	**3**	Study of sustainable buildings, cities and transportion helps to Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
	PO12	**2**	Study of importance of sustainable habitat develops a desire in students for lifelong learning in the broadest context of technological change.

EST 200 DESIGN AND ENGINEERING

COURSE INFORMATION SHEET:

Program: **Mechanical Engineering**	Degree :**B-Tech**
Course**: Design And Engineering**	Course code**: EST200**
L-T-P**:2-0-0**	Credit**:2**

SYLLABUS:

MODULE	CONTENT	HOURS	UNIVERSITY % MARKS
I	Design Process:- Introduction to Design and Engineering Design, Defining a Design Process-:Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.	5	20
II	Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.	5	20
III	Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.	5	20
IV	Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Biomimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.	5	20
V	Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design	5	20

TEXT BOOKS:

1	YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285
2	Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

REFERENCES:

1	Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420
2	Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5
3	Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361
4	Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

PREREQUISITE: NIL

COURSE OBJECTIVES:

1	Introduce the undergraduate engineering students the fundamental principles of design engineering,
2	Make them understand the steps involved in the design process
3	Familiarize them with the basic tools used and approaches in design.

COURSE OUTCOMES:

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

CO's	DESCRIPTION
1	Explain the different concepts and principles involved in design engineering.
2	Apply design thinking while learning and practicing engineering
3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	2	1					1			1						
CO2		2				1		1				2				
CO3			2			1	1		2	2		1				

CO-PO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PO1	**2**	Students could use the knowledge to develop solutions for problems
	PO2	**1**	Understanding the concepts of design leads to Identify, formulate, research literature, and analyze engineering problems.
	PO7	**1**	Understanding of user centered design will be in the interest of sustainable development of society
	PO10	**1**	Appreciating the different concepts and principles involved in design engineering help to communicate effectively with the engineering community and with society at large.
CO2	PO2	**2**	Design thinking help to Identify, formulate, research literature, and analyze engineering problems to reach at relevant solutions
	PO6	**1**	Students will analyse design based on society, safety
	PO8	**1**	Students will understand ethical principles and commit to professional ethics and responsibilities of the engineering practice.
	PO12	**2**	Analyze and improvise the designs around them on their own and keep up the process to full extent
CO3	PO3	**2**	Students will be able to come up with different design solutions for complex engineering problems
	PO6	**1**	Students will analyse design based on society, safety
	PO7	**1**	Uunderstanding of user centered design will be in the interest of sustainable development of society
	PO9	**2**	Studens will appreciate the teamwork including the multidisciplinary settings.
	PO10	**2**	Students will be able to communicate effectively with the engineering community, able to comprehend and write effective reports, make effective presentations, and give and receive clear instructions.
	PO12	**1**	Study the designs around them on their own and keep up the process to full extent

MEL 201 COMPUTER AIDED MACHINE DRAWING

COURSE INFORMATION SHEET:

Program: **Mechanical Engineering**	Degree : **B-Tech**
Course**: Computer Aided Machine Drawing**	Course code**: MEL 201**
L-T-P**: 0-0-3**	Credit**: 2**

SYLLABUS

Introduction to machine drawing, drawing standards, fits, tolerances, surface roughness, assembly and part drawings of simple assemblies and subassemblies of machine parts viz., couplings, clutches, bearings, I.C. engine components, valves, machine tools, etc.; introduction to CAD etc.

LIST OF EXERCISES:

NO.	LIST OF EXERCISES	HOURS
PART –A (Manual drawing)		
1	Temporary Joint: Principles of drawing, free hand sketching, Importance of machine Drawing. BIScode of practice for Engineering Drawing, lines, types of lines, dimensioning, scales of drawing, sectional views, Riveted joints.	3
2	Fasteners: Sketching of conventional representation of welded joints,Bolts and Nuts or Keys and Foundation Bolts	3
3	Fits and Tolerances: Limits, Fits – Tolerances of individual dimensions – Specification of Fits – basic principles of geometric & dimensional tolerances. Surface Roughness: Preparation of production drawings and reading of part and assembly drawings, surface roughness, indication of surface roughness, etc.	3
4	Detailed drawing of Cotter joints, Knuckle joint and Pipe joints	3
5	Assembly drawings(2D): Stuffing box and Screw jack	3
PART –B (CAD drawing)		
6	Introduction to drafting software like Auto CAD, basic commands, keyboard shortcuts. Coordinate and unit setting, Drawing, Editing, Measuring, Dimensioning, Plotting Commands, Layering Concepts, Matching, Detailing, Detailed drawings.	3
7	Drawing of Shaft couplings and Oldham's coupling	3
8	Assembly drawings(2D)with Bill of materials: Lathe Tailstock and Universal joint	3
9	Assembly drawings(2D)with Bill of materials: Connecting rod and Plummer block	3
10	Assembly drawings(2D)with Bill of materials: Rams Bottom Safety Valve OR steam stop valve	3

PREREQUISITE: EST 110 - Engineering Graphics

COURSE OBJECTIVES:

1	To introduce students to the basics and standards of engineering drawing related to machines and components.
2	To make students familiarize with different types of riveted and welded joints, surface roughness, symbols; limits, fits and tolerances.
3	To convey the principles and requirements of machine and production drawings.
4	To introduce the preparation of drawings of assembled and disassembled view of important valves and machine components used in mechanical engineering applications
5	To introduce standard CAD packages for drafting and modeling of engineering components

COURSE OUTCOMES:

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

CO's	DESCRIPTION
1	Apply the knowledge of engineering drawings and standards to prepare standard dimensioned drawings of machine parts and other engineering components.
2	Prepare standard assembly drawings of machine components and valves using part drawings and bill of materials.
3	Apply limits and tolerances to components and choose appropriate fits for given assemblies
4	Interpret the symbols of welded, machining and surface roughness on the component drawings.
5	Prepare part and assembly drawings and Bill of Materials of machine components and valves using CAD software.

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3									3				2	
CO2	2		2							3				3	
CO3	3	2												2	
CO4	3														
CO5	3				3					3		1			3

CO-PO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PO1	**3**	Standard way of representing parts is possible while designing and sketching Engineering drawings.
	P010	**3**	Able to give clear instructions regarding the standards to be used for preparing drawings of machine parts
CO2	PO1	**3**	Selection and assembly of mechanical components and valves requires fundamental knowledge in machine components
	PO3	**2**	Able to design and prepare standard assembly drawings of mechanical components and valves
	PO10	**3**	Give clear instructions on how to prepare standard assembly drawings of mechanical components and valves from part drawings and bill of materials
CO3	PO1	**3**	Basic knowledge in engineering is helpful in providing the tolerances and fits while preparing the production drawings
	PO2	**2**	Knowledge in geometric and dimensional tolerance is necessary for proper design and assembly of mechanical components.
CO4	PO3	**2**	Basic knowledge in engineering is helpful to interpret the symbols of welded, machining and surface roughness on the component drawings.
CO5	PO1	**3**	Designs of mechanical parts can be easily prepared and communicated effectively with others using CAD packages
	PO5	**3**	Able to use modern drafting tool for easy preparation of production drawings.
	PO10	**3**	Capable of explaining symbols used in apart drawing effectively to others
	PO12	**1**	Lifelong learning is required for becoming an expert in the usage of CAD tools for designing machine component.

CO-PSO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PSO1	**2**	Use of standards in design and manufacturing improves the quality of products
CO2	PS01	**3**	Assembly Drawing of mechanical parts can be prepared by following the drawing standards
CO3 CO4	PSO1	**2**	Use of fits, tolerances and surface roughness in part modelling helps in standardizing the manufacturing industry
CO5	PSO2	**3**	Continuous independent learning helps in becoming an expert in the usage of CAD tools for designing machine component

MEL 203 MATERIALS TESTING LABORATORY

COURSE INFORMATION SHEET:

Program: **Mechanical Engineering**	Degree : **B-Tech**
Course**: Materials Testing Laboratory**	Course code**: MEL 203**
L-T-P**: 0-0-3**	Credit**: 2**

SYLLABUS

List of experiments:

1. To conduct tension test on ductile material (mild steel/ tor-steel/ high strength steel) using Universal tension testing machine and Extensometer.
2. To conduct compression test on ductile material (mild steel/ tor-steel/ high strength steel) using Universal tension testing machine and Extensometer.
3. To conduct tension test on Brittle material (cast iron) using Universal tension testing machine and Extensometer.
4. To conduct shear test on mild steel rod.
5. To conduct microstructure features of mild steel/copper/ brass/aluminum using optical microscope, double disc polishing machine, emery papers and etchant.
6. To conduct fractography study of ductile or brittle material using optical microscope.
7. To conduct Hardness test of a given material. (Brinell, Vickers and Rockwell)
8. To determine torsional rigidity of mild steel/copper/brass rod.
9. To determine flexural rigidity of mild steel/ copper/brass material using universal testing machine.
10. To determine fracture toughness of the given material using Universal tension testing machine.
11. To study the procedure for plotting S-N curve using Fatigue testing machine.
12. To conduct a Toughness test of the given material using Izod and Charpy Machine.
13. To determine spring stiffness of close coiled/open coiled/series/parallel arrangements.
14. To conduct bending test on wooden beam.
15. To conduct stress measurements using Photo elastic methods.
16. To conduct strain measurements using strain gauges.
17. To determine moment of inertia of rotating bodies.
18. To conduct an experiment to Verify Clerk Maxwell’s law of reciprocal deflection and determine young's Modulus of steel.
19. To determine the surface roughness of a polished specimen using surface profilometer.

PREREQUISITE: A course on Engineering Mechanics is required

COURSE OBJECTIVES:

1	To give a broad understanding of common materials related to mechanical engineering with an emphasis on the fundamentals of structure-property -application and its relationships

COURSE OUTCOMES:

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

CO's	DESCRIPTION
1	To understand the basic concepts of analysis of circular shafts subjected to torsion
2	To understand the behaviour of engineering component subjected to cyclic loading and failure concepts
3	Evaluate the strength of ductile and brittle materials subjected to compressive, Tensile shear and bending forces
4	Evaluate the microstructural morphology of ductile or brittle materials and its fracture modes (ductile /brittle fracture) during tension test
5	To specify suitable material for applications in the field of design and manufacturing.

CO-PO-PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3				3									3	
CO2	3	3	1		3				3	2	2	1		3	1
CO3	3	3	3	1	3				3	2	3	2		3	2
CO4	3	3	3	3	3	2	2	1	3	2	3	2		3	2
CO5	3	3	3	1	3	2	2	1	3	2	3	2		3	2

CO-PO MAPPING JUSTIFICATION:

CO's	PO's	LEVEL	JUSTIFICATION
CO1	PO1	**3**	Students apply fundamental knowledge to analyse circular shafts subjected to torsion
	PO5	**3**	Students will be able to use modern engineering tools to analysis of circular shafts subjected to torsion.
CO2	PO1	**3**	Students apply fundamental knowledge to analyse the behaviour of engineering component subjected to cyclic loading

	PO2	**3**	Students identify the behaviour of engineering component subjected to cyclic loading and analyse it.
	PO3	**1**	Students will be able to design engineering component subjected to cyclic loading and failure concepts
	PO5	**3**	Students will be able to use modern engineering tools to analyse the behaviour of engineering component subjected to cyclic loading
	PO9	**3**	Students are encouraged to work in a team while conducting experiments and to analyse the data individually.
	PO10	**2**	Students are encouraged to communicate effectively in a team and present reports.
	PO11	**2**	Students are encouraged to work as a team and manage their roles well in conducting the experiments.
	PO12	**1**	Knowledge of the behaviour of engineering component subjected to cyclic loading and failure concepts will enable the students for lifelong learning of design for various applications
CO3	PO1	**3**	Students apply fundamental knowledge to evaluate the strength of ductile and brittle materials subjected to compressive, Tensile shear and bending forces
	PO2	**3**	Students analyse the strength of ductile and brittle materials subjected to compressive, Tensile shear and bending forces
	PO3	**3**	Students will be able to design ductile and brittle materials subjected to compressive, Tensile shear and bending forces
	PO4	**1**	Students conduct experiments of ductile and brittle materials subjected to compressive, Tensile shear and bending forces and analyse and interpret the data.
	PO5	**3**	Students will be able to use modern engineering tools to evaluate the strength of ductile and brittle materials subjected to compressive, Tensile shear and bending forces
	PO9	**3**	Students are encouraged to work in a team while conducting experiments and to analyse the data individually.
	PO10	**2**	Students are encouraged to communicate effectively in a team and present reports.
	PO11	**3**	Students are encouraged to work as a team and manage their roles well in conducting the experiments.

	PO12	**2**	Knowledge of ductile and brittle materials subjected to compressive, Tensile shear and bending forces will enable the students for lifelong learning of design for various applications
CO4	PO1	**3**	Students apply fundamental knowledge to evaluate the microstructural morphology of ductile or brittle materials and its fracture modes during tension test
	PO2	**3**	Students identify and analyse the microstructural morphology of ductile or brittle materials and its fracture modes during tension test
	PO3	**3**	Students will be able to select materials for design based on the fracture modes.
	PO4	**3**	Students will be able to analyse and interpret the microstructural morphology of ductile or brittle materials and its fracture modes
	PO5	**3**	Students will be able to use modern engineering tools to evaluate the microstructural morphology of ductile or brittle materials and its fracture modes during tension test
	PO6	**2**	Students will be able to check and ensure safety for design based on the fracture modes.
	PO7	**2**	Students will be able to analyse and design differents mechanical systems which will be ecofriendly and minimize the wastages.
	PO8	**1**	Students will be encouraged to follow ethical practices in selection or design for various applications
	PO9	**3**	Students are encouraged to work in a team while conducting experiments and to analyse the data individually.
	PO10	**2**	Students are encouraged to communicate effectively in a team and present reports.
	PO11	**3**	Students are encouraged to work as a team and manage their roles well in conducting the experiments.
	PO12	**2**	Knowledge of different fracture modes will enable the students for lifelong learning of design for various applications
CO5	PO1	**3**	Students apply fundamental knowledge to specify suitable material for applications in the field of design and manufacturing.
	PO2	**3**	Students identify and analyse suitable material for applications in the field of design and manufacturing.

	PO3	**3**	Students will be able to specify suitable material for applications in the field of design and manufacturing.
	PO4	**1**	Students use their knowledge to specify suitable material for different designs and applications
	PO5	**3**	Students will be able to use modern engineering tools to specify suitable material for applications in the field of design and manufacturing.
	PO6	**2**	Students will be able to specify suitable material for a safe design.
	PO7	**2**	Students will be able to select suitable material for different designs and applications which will be ecofriendly and minimize the wastages.
	PO8	**1**	Students will be encouraged to follow ethical practices in selection or design for various applications
	PO9	**3**	Students are encouraged to work in a team while conducting experiments and to analyse the data individually.
	PO10	**2**	Students are encouraged to communicate effectively in a team and present reports.
	PO11	**3**	Students are encouraged to work as a team and manage their roles well in conducting the experiments.
	PO12	**2**	Students will be able to specify suitable material for applications which will enable the students for lifelong learning in the field of design and manufacturing.

CO-PSO MAPPING JUSTIFICATION:

CO's	PSO's	LEVEL	JUSTIFICATION
CO1	PSO 1	**3**	Students will be able to solve problems related to circular shafts subjected to torsion.
CO2	PSO 1	**3**	Students will be able to solve problems on component subjected to cyclic loading.
	PSO 2	**1**	Knowledge of the behaviour of engineering component subjected to cyclic loading and failure concepts will enable the students for continuous learning of design for various applications
CO3	PSO 1	**3**	Students will be able to evaluate the strength of ductile and brittle materials subjected to compressive, Tensile, shear and bending forces

	PSO 2	**2**	Knowledge of ductile and brittle materials subjected to compressive, Tensile shear and bending forces will enable the students for continuous learning of design for various applications
CO4	PSO 1	**3**	Students will be able to evaluate the microstructural morphology of ductile or brittle materials and its fracture modes
	PSO 2	**2**	Knowledge of different fracture modes will enable the students for continuous learning of design for various applications
CO5	PSO 1	**3**	Students will be able to select suitable material for applications in the field of design and manufacturing.
	PSO 2	**2**	Students will be able to specify suitable material for applications which will enable the students for continuous learning in the field of design and manufacturing.