	B.Tech. (4th Semester) Mechanical Engineering						
ES-204	MATERIALS ENGINEERING						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	0	0	3	75	25	100	3
Purpose:	To understand internal structure- properties relationship of different types of materials and learn about Metallographic analysis and Characterization.						
Course Outcomes							
CO 1	To understand the Crystal structures and deformation mechanism in various materials.						
CO 2	To study various types of phase diagrams, TTT curve and Iron carbon diagram. To learn about different heat treatment processes.						
CO 3	To learn about the failure mechanisms like Creep and Fatigue and designation of materials.						
CO 4	To study Basics of Metallography and Basic Principle involved in the working of various types of Material characterization techniques.						

UNITI

Crystallography: Review of Crystal Structure, Space Lattice, Co-ordination Number ,Number of Atomsper Unit Cell, Atomic Packing Factor; Numerical Problems Related to Crystallography.

Imperfection in Metal Crystals: Crystal Imperfections and their Classifications, Point Defects, Line Defects, Edge & Screw Dislocations, Surface Defects, Volume Defects.

Introduction to Engineering materials and Standard Materials Designation: Introduction to Engineering materials, Steel Terminology, Standard Designation System for Steels, Indian Standard specifications for steels as per BIS: Based on Ultimate Tensile Strength and based on Composition, AISI-SAE standard designation for Steels and Aluminium Alloys

UNIT II

Phase Diagrams: Alloy Systems, Solid solutions, Hume Rothery's Rules, Intermediate phases, Phase Diagrams, Gibbs Phase Rule, Cooling curves, The Lever Rule, binary phase diagrams, Applications of Phase Diagrams, Phase Transformation, Micro constituents of Fe-C system, Allotropic Forms of Iron ,Iron-iron carbide phase diagram, Modified Iron Carbon Phase Diagrams, Isothermal Transformation, TTT Curve,

Heat Treatment: Heat treatment of steels, Annealing, Normalising, Hardening, Tempering, Case Hardening, Ageing, Aus tempering and Mar tempering, Surface Hardening, Mass Effect, Equipments for Heat Treatment, Major Defects in Metals or Alloys due to faulty Heat treatment.

UNIT III

Deformation of Metal: Elastic and Plastic Deformation, Mechanism of Plastic Deformation, Slip; Critical Resolved Shear Stress, Twinning, Conventional and True Stress Strain Curves for Polycrystalline Materials, Yield Point Phenomena, Bauschinger Effect, Work Hardening.

Failure of Materials: Fatigue, Fatigue fracture, fatigue failure, Mechanismof Fatigue Failure, Fatigue Life calculations ,Fatigue Tests, Theories of Fatigue.

Creep: Creep Curve , Types of Creep, Factors affecting Creep, Mechanism of Creep, Creep Resistant Material, Creep Fracture, Cre ep Test, Stress Rupture test.

UNITIV

Introduction to Metallography: Metallography, Phase analysis, Dendritic growth, Cracks and other defects Corrosion analysis, Intergranular attack (IGA), Coating thickness and integrity, Inclusion size, shape and distribution, Weld and heat-affected zones (HAZ), Distribution and orientation of composite fillers, Graphite nodularity, Intergranular fracturing

Materials Characterization Techniques: Characterization techniques suchas X-Ray Diffraction (XRD), Scanning Electron Microscopy, transmission electron microscopy, atomic force microscopy, scanning tunneling microscopy, Atomic absorption spectroscopy.

Text Books:

1. Material Science by S.L.Kakani, New Age Publishers.
2. The Science and Engineering of Materials, Donald R. Askeland , Chapman & Hall.
3. Fundamentals of Material Science and Engineering by W. D. Callister, Wiley.
4. FundamentalofLightMicroscopyandElectronicImagingbyDouglasB.Murphy, Kindle Edition 2001
5. Materials Science and Engineering, V. Raghvan
6. Phase Transformation in Metals and Alloys,D. A.Porter &K.E. Easterling

Reference Books:

7. Material Science by Narula, TMH
8. Metallographic Handbook by Donald C. Zipperian, Pace Technologies, USA.
9. Robert Cahn Concise Encyclopedia of Materials Characterization, SecondEdition:2nd Edition (Advances in Materials Science and Engineering) Elsevier Publication 2005.
10. Smart Materials and Structures by Gandhi and Thompson, Chapman and Hall.

Note: The paper setter will set the paper as per the question paper templates provided.

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	B. Tech. (4th Semester) Mechanical Engineering						
MEC-202A	**APPLIED THERMODYNAMICS**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose:	This course aims to provide a platform to students to understand, model and analyze concept of dynamics involved in thermal energy transformation. To prepare them to carry out experimental investigation and analysis of problems related to applied thermodynamics.						
Course Outcomes							
CO1	Understand the working of boilers, types of boilers, accessories and mountings used on boilers.						
CO 2	Learn about simple and modified Rankine cycles.						
CO 3	Understand the design and analysis of steam flow through steam nozzles. To learn about the working of different types of condensers.						
CO 4	Analyze the working and design of the steam turbine and apply the knowledge in solving the engineering problems of turbines.						

UNITI

Steam Generators: Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox etc.; boiler mountings; stop valve; safety valve; blow off valve; feed check etc.; water level indicator; fusible plug; pressure gauge; boiler accessories; feed pump; feed water heater; preheater; super heater; economizer; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation.

UNIT II

Vapour Power Cycles: Simple and modified Rankine cycle; effect of operating parameters on Rankine cycle performance; effect of superheating; effect of maximum pressure; effect of exhaust pressure; reheating and regenerative Rankine cycle; types of feed water heater; reheat factor; binary vapour cycle. Simple steam engine, compound engine; function of various components.

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UNIT III

Steam Nozzle: Function of steam nozzle; shape of nozzle for subsonic and supersonics flow of stream; variation of velocity; area of specific volume; steady state energy equation; continuity equation; nozzle efficiency; critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. Advantage of steam condensation; component of steam condensing plant; types of condensers; air leakage in condensers; Dalton's law of partial pressure; vacuum efficiency; calculation of cooling water requirement; air expansion pump.

UNIT IV

Steam Turbines: Introduction; classification of steam turbine; impulse turbine; working principle; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse, reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; efficiency of blade height; condition of maximum efficiency; internal losses in steam turbine; governing of steam turbine.

Text Books:

1. Thermal Engineering – P L Ballaney, Khanna Publishers.
2. Thermodynamics and Heat Engines vol II – R Yadav, Central Publishing House
3. Engineering Thermodynamics Work and Heat Transfer - G. F. C Rogers and Y. R. Mayhew, Pearson.
4. Applied Thermodynamics for Engineering Technologists - T. D. Eastop and A. McConkey, Pearson.

Reference Books:

1. Applied Thermodynamics for Engineering Technologists – T D Eastop and A. McConkey, Pearson Education
2. Heat Engineering – V P Vasandani and D S Kumar, Metropolitan Book Co Pvt Ltd.

Note: The paper setter will set the paper as per the question paper templates provided.

	B. Tech. (4th Semester) Mechanical Engineering						
MEC-204A	**FLUID MECHANICS&FLUID MACHINES**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**

Purpose: To build a fundamental understanding of concepts of Fluid Mechanics and their application in rotodynamic machines.

Course Outcomes	
CO1	Upon completion of this course, students will be able to apply mass and momentum conservation laws to mathematically analyze simple flow situations.
CO2	The students will be able to obtain solution for boundary layer flows using exact or approximate methods.
CO3	The students will be able to estimate the major and minor losses through pipes and learn to draw the hydraulic gradient and total energy lines.
CO4	The students will be able to obtain the velocity and pressure variations in various types of simple flows.
CO5	They will be able to analyze the flow and evaluate the performance of pumps and turbines.

Unit I

Fluid Properties: Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, weight density, specific volume, specific gravity, viscosity, compressibility, surface tension and capillarity.

Fluid Kinematics: Types of fluid flows, stream, streak and path lines; flow rate and continuity equation, differential equation of continuity in cartesian and polar coordinates, rotation and vorticity, circulation, stream and potential functions, flow net. Problems.

Fluid Dynamics: Concept of system and control volume, Euler's equation, Navier-Stokes equation, Bernoulli's equation and its practical applications, Impulse momentum equation. Problems.

Unit II

Viscous Flow: Flow regimes and Reynold's number, relationship between shear stress and pressure gradient. Exact flow solutions, Couette and Poisuielle flow, laminar flow through circular conduits. Problems.

Turbulent Flow Through Pipes: Darcy Weisbach equation, friction factor, Moody's diagram, minor losses in pipes, hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes; equivalent pipe, power transmission through pipes. Problems.

Boundary Layer Flow: Concept of boundary layer, measures of boundary layer thickness, Blasius solution, von-Karman momentum integral equation, laminar and turbulent boundary layer flows, separation of boundary layer and its control. Problems.

Unit III

Dimensional Analysis: Need for dimensional analysis – methods of dimension analysis – Dimensionless parameters – application of dimensionless parameters. Problems.

Hydraulic Pumps: Introduction, theory of Rotodynamic machines, Classification, various efficiencies, velocity components at entry and exit of the rotor, velocity triangles; Centrifugal pumps, working principle, work done by the impeller, minimum starting speed, performance curves, Cavitation in pumps, Reciprocating pumps, working principle, Indicator diagram, Effect of friction and acceleration, air vessels, Problems.

Unit IV

Hydraulic Turbines: Introduction, Classification of water turbines, heads and efficiencies, velocity triangles, Axial, radial and mixed flow turbines, Pelton wheel, Francis turbine and Kaplan turbines, working principles, work done, design of turbines, draft tube and types, Specific speed, unit quantities, performance curves for turbines, governing of turbines. Problems.

Text Books:

1. Introduction to Fluid Mechanics – R.W. Fox, Alan T. McDonald, P.J. Pritchard, Wiley Publications.
2. Fluid Mechanics – Frank M. White, McGraw Hill
3. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons
4. Fluid Mechanics – Streeter V L and Wylie E B, Mc Graw Hill
5. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, Tata McGraw Hill.

Reference Books:

1. Mechanics of Fluids – I H Shames, Mc Graw Hill
2. Fluid Mechanics: Fundamentals and Applications - YunusCengel and John Cimbala, McGraw Hill.
3. Fluid Mechanics: Pijush K. Kundu, Ira M. Cohen and David R. Rowling, Academic Press.

Note: The paper setter will set the paper as per the question paper templates provided.

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	B. Tech. (4th Semester) Mechanical Engineering						
MEC-206A	**MECHANICS OF SOLIDS-II**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to show the development of strain energy and stresses in springs, pressure vessel, rings, links, curved bars under different loads. The course will help the students to build the fundamental concepts in order to solve engineering problems						
Course Outcomes							
CO1	Identify the basics concepts of strain energy and various theories of failures and solve the problems						
CO 2	Differentiate different types of stresses induced in thin pressure vessel and solve the problems. Use of Lame's equation to calculate the stresses induced in thick pressure vessel.						
CO 3	Able to compute stresses in ring, disk and cylinder due to rotation. Classify the different types of spring and analyze the stresses produced due to loading						
CO 4	Determine the stresses in crane hook, rings, chain link for different cross section and also the deflection of curved bars and rings. Analyze the stresses due to unsymmetrical bending and determine the position of shear centre of different section.						

Unit I

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's theorem, Numerical.

Theories of Elastic Failures: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading, Numericals.

Unit II

Thin Walled Vessels: Hoop & Longitudinal stresses & strains in cylindrical &spherical vessels & their derivations under internal pressure, wire would cylinders, Numericals.

Thick Cylinders & Spheres: Derivation of Lame's equations, radial & hoop stresses and strains in thick, and compound cylinders and spherical shells subjected to internal fluid pressure only, hub shrunk on solid shaft, Numericals.

Unit III

Rotating Rims & Discs: Stresses in uniform rotating rings & discs, rotating discs of uniform strength, stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders, hollow cylinders & solids cylinders. Numericals.

Springs: Stresses in closed coiled helical springs, Stresses in open coiled helical springs subjected to axial loads and twisting couples, leaf springs, flat spiral springs, concentric springs, Numericals.

Unit IV

Bending of Curved Bars : Stresses in bars of initial large radius of curvature, bars of initial small radius of curvature, stresses in crane hooks, rings of circular & trapezoidal sections, deflection of curved bars & rings, deflection of rings by Castigliano's theorem, stresses in simple chain links, deflection of simple chain links, Problems.

Unsymmetrical Bending: Introduction to unsymmetrical bending, stresses due to unsymmetrical bending, deflection of beam due to unsymmetrical bending, shear center for angle, channel, and I-sections, Numericals.

Text Books:

1. Strength of Materials – R.K. Rajput, Dhanpat Rai & Sons.
2. Strength of Materials – Sadhu Singh, Khanna Publications.
3. Strength of Materials – R.K. Bansal, Laxmi Publications.

Reference Books:

1. Strength of Materials – Popov, PHI, New Delhi.
2. Strength of Materials – Robert I. Mott, Pearson, New Delhi
3. Strength of Material – Shaums Outline Series – McGraw Hill
4. Strength of Material – Rider – ELBS

Note: The paper setter will set the paper as per the question paper templates provided.

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	B. Tech. (4th Semester) Mechanical Engineering						
MEC-208A	**Instrumentation & Control**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time(Hrs)**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Purpose	To understand the basics of the measurement of various quantities using instruments, their accuracy and range and the techniques for controlling devices automatically.						
Course Outcomes							
CO1	Students will have basic knowledge about measurement systems and their components.						
CO2	Students will learn about various sensors used for measurement of mechanical quantities.						
CO3	Students will have basic knowledge of process monitoring and control.						

Unit I

Instrumentation System: introduction, typical applications of instrument systems, functional elements of a measurement system, classification of instruments, standards and calibration, static and dynamic characteristics of measurement systems.

Statistical Error Analysis: statistical analysis of data and measurement of uncertainty: probability, confidence interval or level, mean value and standard deviation calculation, standard normal distribution curve and probability tables, sampling and theory based on samples, goodness of fit, curve fitting of experimental data.

Unit II

Sensors and Transducers: introduction and classification, transducer selection and specifications, primary sensing elements, resistance transducers, variable inductance type transducers, capacitive transducers, piezo-electric transducers, strain gauges.Smart Sensors: Introduction, architecture of smart sensor, bio sensor and physical sensor, Piezo-resistive pressure sensor, microelectronic sensor.

Measurement of force, torque, shaft power, speed and acceleration: force and weight measurement system, measurement of torque, shaft power, speed and velocity: electrical and contactless tachometers, acceleration: vibrometers, seismic and piezo-electric accelerometer.

Unit III

Measurement of pressure, temperature and flow: Basic terms, Pressure: Liquid column manometers, elastic type pressure gauges, electrical types for pressure and vacuum, temperature measuring instruments: RTD sensors, NTC thermistor, thermocouples, and semiconductor based sensors. Flow Measurement: drag force flow meter, turbine flow meter, electronic flow meter, electromagnetic flow meter, hot-wire anemometer.

Instruments for measuring Humidity, Density, and Viscosity: Humidity definitions, Humidity measuring devices, Density and Specific Gravity, Basic terms, Density measuring devices, Density application considerations, Viscosity, Viscosity measuring instruments, basic terms used in pH, pH measuring devices, pH application considerations. Problems.

Unit IV

Basic Control System: Introduction, basic components of control system, classification : closed loop and open loop control system, transfer function, block diagram representation of closed loop system and its reduction techniques, mathematical modelling of various mechanical systems and their analogy with electrical systems, signal flow graph and its representation.

Mechanical Controllers: Basics of actuators: pneumatic controller, hydraulic controller and their comparison.

Text Books:

1.Instrument and control by Patranabis D., PHI Learning.
2.Fundamental of Industrial Instrumentation and Process control by W.C.DUNN, McGrawHill,
3. Thomas G. Beckwith, Roy D. Marangoni, John H. LienhardV , Mechanical Measurements (6th Edition), Pearson Education India, 2007
4. Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York,1999.

Reference Books:

1. Mechanical Measurement and Control by A K Sawhney
2. Modern control Engineering by Katsuhiko Ogata, PHI publication

Note: The paper setter will set the paper as per the question paper templates provided.

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	B. Tech. (4th Semester)Mechanical Engineering							
ES-206LA	**MATERIALS ENGINEERING LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**-**	**40**	**60**	**100**	**3**
Purpose	Tomakethestudentsawareofmaterialstructureandpropertiesofmaterialusing differentexperiments.							
CourseOutcomes								
CO 1	Ability to design and conduct experiments, acquire data, analyze and interpret data							
CO 2	Ability to determine the grain size and microstructure in different Ferrous alloys by means of experiments.							
CO 3	Ability to learn about microstructures of different Non-Ferrous alloys by means of experiments.							
CO 4	To learn about heat treatment processes through experiments.							
CO 5	Ability to Analyze microstructure of Heat-treated specimens and perform Fatigue and creep test on different materials.							

List ofExperiments:

1. To Study various Crystal Structures through Ball Models.
2. To study the components and functions of Metallurgical Microscope.
3. To learn about the process of Specimen Preparation for metallographic examination.
4. To perform Standard test Methods for Estimation of Grain Size.
5. To perform Microstructural Analysis of Carbon Steels and low alloy steels.
6. To perform Microstructural Analysis of Cast Iron.
7. To perform Microstructural Analysis of Non-Ferrous Alloys: Brass & Bronze.
8. To perform Microstructural Analysis of Non-Ferrous Alloys: Aluminium Alloys.
9. To Perform annealing of a steel specimen and to analyze its microstructure.
10. To Perform Hardening of a steel specimen and to analyze its microstructure.
11. To performFatiguetest on fatiguetestingmachine.
12. To perform Creep test oncreep testingmachine.

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Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

	B. Tech. (4th Semester) Mechanical Engineering							
MEC-210LA	**FLUID MECHANICS &FLUID MACHINES LAB**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To familiarize the students with the equipment and instrumentation of Fluid Mechanics and Machines							
Course Outcomes								
CO1	Operate fluid flow equipment and instrumentation.							
CO2	Collect and analyse data using fluid mechanics principles and experimentation methods.							
CO3	Determine the coefficient of discharge for various flow measurement devices.							
CO4	Calculate flow characteristics such as Reynolds number, friction factor from laboratory measurements.							
CO5	Analyze the performance characteristics of hydraulic pumps.							
CO6	Analyze the performance characteristics of hydraulic turbines.							

List of Experiments:

1. To verify the Bernoulli's Theorem.
2. To determine coefficient of discharge of an orifice meter.
3. To determine the coefficient of discharge of Venturimeter.
4. To determine the coefficient of discharge of Notch.
5. To find critical Reynolds number for a pipe flow.
6. To determine the friction factor for the pipes.
7. To determine the meta-centric height of a floating body.
8. Determination of the performance characteristics of a centrifugal pump.
9. Determination of the performance characteristics of a reciprocating pump.
10. Determination of the performance characteristics of a gear pump.
11. Determination of the performance characteristics of Pelton Wheel.
12. Determination of the performance characteristics of a Francis Turbine.
13. Determination of the performance characteristics of a Kaplan Turbine.
14. Determination of the performance characteristics of a Hydraulic Ram.

Note: At least ten experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

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	B. Tech. (4th Semester) Mechanical Engineering						
MC-902A	**Constitution of India**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**-**	**75**	**25**	**100**	**3 Hrs.**
Purpose	To know the basic features of Constitution of India						
	Course Outcomes						
CO1	The students will be able to know about salient features of the Constitution of India.						
CO2	To know about fundamental duties and federal structure of Constitution of India.						
CO3	To know about emergencyprovisions in Constitution of India.						
CO4	To know about fundamental rights under constitution of India.						

UNIT I

Meaning of the constitution law and constitutionalism, Historical perspective of the Constitution of India. Salient features and characteristics of the Constitution of India.

Scheme of the fundamental rights

UNIT II

The scheme of the Fundamental Duties and its legal status. The Directive Principles of State Policy – Its importance and implementation. Federal structure and distribution of legislative and financial powers between the Union and the States.

Parliamentary Form of Government in India – The constitution powers and status of the President of India

UNIT III

Amendment of the Constitutional Powers and Procedure. The historical perspectives of the constitutional amendments in India.

Emergency Provisions: National Emergency, President Rule, Financial Emergency. Local Self Government – Constitutional Scheme in India.

UNIT IV

Scheme of the Fundamental Right to Equality. Scheme of the Fundamental Right to certain Freedom

under Article 19.

Scope of the Right to Life and Personal Liberty under Article 21.

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Text Books

1. Constitution of India. Prof. Narender Kumar (2008) 8th edition. Allahabad Law Agency.

Reference Books:

1. The constitution of India. P.M. Bakshi (2016) 15th edition. Universal law Publishing.