Bachelor of Technology (Mechanical Engineering)
Kurukshetra University, Kurukshetra
MODIFIED SCHEME OF EXAMINATIONS w.e.f: 2024-25
(Semester - III)

S. No.	Course No./ Code	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of exam (Hours)
						End Semester Exam	Internal Assessment	Practical Exam	Total	
1	B23-BSC-201	Oscillations, Waves and Optics	3:1:0	4	4	70	30	--	100	3
2	B23-BSC-203	Mathematics-III	3:1:0	4	4	70	30	--	100	3
3	B23-MEC-201	Theory of Machines	3:1:0	4	4	70	30	--	100	3
4	B23-MEC-203	Mechanics of Solids-I	3:1:0	4	4	70	30	--	100	3
5	B23-ESC -201	Engineering Thermodynamics	3:1:0	4	4	70	30	--	100	3
6	B23-ESC -203	Measurement and Control	3:0:0	3	3	70	30	--	100	3
7	B23-MEC-205	Theory of Machines Lab	0:0:2	2	1	--	40	60	100	3
8	B23-MEC-207	Mechanics of Solids Lab	0:0:2	2	1	--	40	60	100	3
9	B23-MAC-201	Environmental Studies	3:0:0	3	1	70	30	--	100	3
Total				**30**	**26**	**490**	**290**	**120**	**900**	

- **NCC/NSS/Sports/Yoga/Technical or cultural club/society activities may also be joined by students in second year and will be evaluated in 7th semester by the institute based upon continuous evaluation model as per guidelines**

Bachelor of Technology (Mechanical Engineering)
Kurukshetra University, Kurukshetra
MODIFIED SCHEME OF EXAMINATIONS w.e.f: 2024-25
(Semester - IV)

S. No	Course No./ Code	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of exam (Hours)
						End Semester Exam	Internal Assessment	Practical Exam	Total	
1	B23-ESC -202	Materials Engineering	3:0:0	3	3	70	30	--	100	3
2	B23-MEC-202	Fluid Mechanics and Machines	4:1:0	5	5	70	30	--	100	3
3	B23-MEC-204	Mechanical Vibrations and Tribology	3:1:0	4	4	70	30	--	100	3
4	B23-MEC-206	Mechanics of Solids-II	3:1:0	4	4	70	30	--	100	3
5	B23-MEC-208	Manufacturing Technology	3:0:0	3	3	70	30	--	100	3
6	B23-HSM-202	Innovation, Start-up and Entrepreneurship	3:0:0	3	3	70	30	--	100	3
7	B23-ESC-204	Materials Engineering Lab	0:0:2	2	1	--	40	60	100	3
8	B23-MEC-210	Fluid Mechanics and Machines Lab	0:0:2	2	1	--	40	60	100	3
9	B23-MEC-212	Mechanical Vibrations and Tribology Lab	0:0:2	2	1	--	40	60	100	3
10	B23-MAC-202	Essence of Indian Traditional Knowledge	2:0:0	2	1	--	100	--	100	3
Total				**30**	**26**	**420**	**400**	**180**	**1000**	

Note: All students have to undertake the industrial training for 4 to 6 weeks after 4th semester which will be evaluated in 5th semester.

	B. Tech (3rd Semester) Mechanical Engineering						
B23-BSC-201	**OSCILLATIONS, WAVES AND OPTICS**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**1**	**-**	**4**	**70**	**30**	**100**	**3h**
Purpose	To introduce the students with fundamentals of SHM, waves and optics for the application in Engineering fields						
CO1	Introduce the basic concepts of oscillation						
CO2	Familiarize with basic phenomenon related to propagation of waves.						
CO3	Introduce the basic concepts of interference, diffraction and their applications						
CO4	To make the students aware to the Laser technology						

UNIT- I

Simple harmonic motion: Equation of simple harmonic motion and its solution, characteristics of SHM, Energy of harmonic oscillator; Damped harmonic oscillator: Equation of damped oscillator and its solution, Energy of weakly damped harmonic oscillator, Quality factor or Q-Value of damped oscillator; Forced oscillations and resonance: Forced damped harmonic oscillator, Power supplied to the forced oscillator, Band width of resonance and Quality factor.

Unit- II

Waves: Travelling waves, Characteristics of waves, Mathematical representation of travelling waves, General wave equation, Phase velocity, Light source emit wave packets, Wave packet and bandwidth, Group velocity and real waves.

Propagation of Light Waves: Maxwell's equations, Electromagnetic waves and constitutive relations, Wave equation for free space, Uniform plane waves, Wave polarization, Energy density, Pointing vector and intensity, Radiation pressure and momentum, Light waves at boundaries, Wave incident normally on boundary, Wave incident obliquely on boundary: Law of reflection, Snell's law.

Unit- III

Interference: Huygens' principle, superposition of waves, conditions of sustained interference, Young's double slit experiment, Division of wave front: Fresnel's Biprism and its application; Division of Amplitude: Interference due to reflected and transmitted light, wedge shaped thin film, Newton's rings and its applications, Michelson interferometer and its application.

Diffraction: Types of diffraction, Fraunhofer diffraction due to single slit, Plane transmission grating: Theory, secondary maxima and minima, width of principal maxima, absent spectra, overlapping of spectral lines, determination of wavelength; Rayleigh criterion for limit of resolution, Dispersive and resolving power of diffraction grating.

Unit- IV

Lasers: Elementary idea of laser production: Stimulated absorption, Spontaneous and Stimulated emission; Einstein's theory of matter radiation interaction and A and B coefficients, amplification of light by population inversion, pumping schemes, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers (ruby, Neodymium), semiconductor lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, applications of lasers.

Text/Reference books

1. P.K. Diwan, Applied Physics for Engineers, *Wiley India Pvt. Ltd., India*
2. S.P. Taneja, Modern Physics for Engineers, *R. Chand & Company Ltd., India*
3. N. Subrahmanyam, B.Lal, M.n. Avadhanulu, A Textbook of Optics, S. Chand &Company Ltd., India
4. A. Ghatak, Optics, *McGraw Hill Education (India) Pvt. Ltd., India.*
5. E. Hecht, A.R. Ganesan, Optics, *Pearson India Education Services Pvt. Ltd., India*.

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

	B. Tech (3rd Semester) Mechanical Engineering						
B23-BSC-203	**MATHEMATICS-III [For Mechanical, Electrical & Comp. Sc. Engg. students only]**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**1**	**-**	**4**	**70**	**30**	**100**	**3 h**
Purpose	To familiarize the prospective students with Laplace Transform to solve the differential equations and how to apply the principles of probabilty & statistics to model and analyze various phenomena in fields like finance, economics, and engineering, aiding in making informed decisions and predicting outcomes.						
Course Outcomes							
CO1	Introduction about the concept of Laplace transform and how it is useful in solvingthe definite integrals and initial value problems.						
CO 2	To introduce the fundamental concepts of probability to analyze and predict outcomes in real-life situations.						
CO 3	Probability theory provides models of probability distributions(theoretical models of the observable reality involving chance effects) to be tested by statistical methods which has various engineering applications..						
CO4	To make the students familiar about basic statistics including measures of central tendency, measures of dispersion, correlation, and regression.						

UNIT-I (08 Hrs)

Laplace Transform: Introduction, Laplace Transform of Elementary Functions, Basic properties of Laplace Transform, Laplace transform of periodic functions, finding inverse Laplace transform by different methods, Convolution theorem, solving ordinary differential equations by Laplace Transform method.

UNIT-II (10 Hrs)

Basic Probability: Introduction, additive law of probability, Conditional Probability, Independent Events, Bayes' Theorem.

Random Variables: Discrete random variables, probability distribution, Probability mass function and distribution function, Expectation, Moments, Variance and standard deviation of discrete random variables.

UNIT-III (10 hrs)

Continuous Probability distribution:

Continuous random variables, probability distribution, Probability density function and distribution function, Expectation, Moments, Variance and standard deviation of Continuous random variables. Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions.

UNIT-IV (12 hrs)

Basic Statistics:

Measures of Central tendency: Mean, median, quartiles, mode, Geometric mean, Harmonic mean, Measures of dispersion: Range, Quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, Skewness and Kurtosis, Correlation, Coefficient of correlation, methods of calculations, Lines of regression.

Suggested Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003
3. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
4. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed.,Wiley, 1968.
5. N.P. Bali and Manish Goyal, A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
8.Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.

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	B. Tech (3rd Semester) Mechanical Engineering						
B23-MEC-201	**THEORY OF MACHINES**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**70**	**30**	**100**	**3**
Purpose:	Students will be able to design, differentiate and analyze various types of linkage mechanisms for obtaining specific motion and their applicability for optimal functioning in governors, gears and gear trains.						
Course Outcomes							
CO 1	Students will be able to understand the concept of various types of kinematic links, pairs and joints used in a mechanism and be able to solve the problems on degree of freedom of mechanisms. Students will also be able to explain the basic concepts of four- bar chain, single slider and double slider-crank chain mechanism.						
CO 2	Students will be able to determine and calculate the velocity & acceleration of various mechanisms and to construct an instantaneous centre for various link-mechanisms.						
CO 3	Students will be able to determine and calculate the values of various forces on engine parts and will be able to understand the concepts of flywheel and Governors.						
CO 4	Students will be able to construct cam profiles for various types of follower motions and will also be able to explain the basic concepts of gears and gear trains.						

UNIT-I

Simple Mechanisms: Introduction to mechanism and machine, types of constrained motion, rigid and resistant body, Kinematic links and pairs, types of joint, degree of freedom, classification of kinematic pairs, kinematic chain, linkage.

Mechanism and structure: Mobility of mechanisms, equivalent mechanism, Four bar chain mechanism, inversion of four bar chain, single slider-crank chain mechanism, inversion of single slider-crank chain mechanism, double slider-crank chain mechanism, inversion of double slider-crank chain mechanism.

UNIT-II

Velocity Analysis: Absolute and relative motions, vectors, addition and subtraction of vectors, motion of a link, velocity images, angular velocity of links, velocity of four-link mechanism, velocity of rubbing, velocity of slider-crank mechanism, velocity of crank and slotted-lever mechanism, kennedy's theorem, instantaneous centre, locating I-centres, centroid, Problems.

Acceleration Analysis: Acceleration of four-link mechanism, acceleration of intermediate and offset points, acceleration of slider-crank mechanism, coriolis acceleration component, acceleration of crank and slotted-lever mechanism, Problems.

UNIT-III

Dynamic Force Analysis: Dynamic analysis of four-link, dynamic analysis of slider-crank mechanisms, velocity and acceleration of piston, angular velocity and angular acceleration of

connecting rod, turning moment on crank-shaft, turning moment diagrams, fluctuation of energy, flywheels, Problems.

Governors: Introduction, types of governors, centrifugal governors, terms used in governors, watt governor, porter governor, proell governor, hartnell governor, hartung governor, wilson-hartnell governor, pickering governor, sensitiveness of governors, stability of governors, isochronous governor, hunting, effort and power of a governor.

UNIT-IV

Cams and Followers: Classification & terminology, Cam profile by graphical methods with knife edge and radial roller follower for uniform velocity, simple harmonic, constant acceleration and deceleration and cycloidal motion of followers, Problems.

Gears and Gear Trains: Classification of gears, gear terminology, law of gearing, velocity of sliding of teeth, forms of teeth, cycloidal profile teeth, involute teeth, interchangeable gear, non-standard gears, length of path of contact, length of arc of contact, contact ratio, types of gear trains, Simple gear train, compound gear train, reverted gear train, epicyclic gear train, velocity ratio of epicyclic gear train, compound epicyclic gear train (Sun and Planet Wheel).

Text Books:

1. Theory and Machines: S.S. Rattan, Tata McGraw Hill
2. Theory and Machines: R.S. Khurmi and J.K. Gupta, S.Chand publication.
3. Kinematics of Machines-Dr. Sadhu Singh, Pearson Education
4. Mechanism and Machine Theory: J.S. Rao and R.V. Dukkipati Second Edition New age International.

Reference Books:

1. Theory of Mechanisms and Machines: Amitabha Ghosh and Ashok Kumar Mallik, Third Edition Affiliated East-West Press.
2. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
3. Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2005. 3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
4. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Second Edition, MGH, New York.

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

	B. Tech. (3rd Semester) Mechanical Engineering						
B23-MEC-203	**MECHANICS OF SOLIDS-I**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**70**	**30**	**100**	**3**
Purpose	The objective of this course is to make the students aware of Stress, Strain and deformation of solids with the applications to beams, shafts and column and struts. The course will help the students to build the fundamental concepts in order to solve engineering problems.						
Course Outcomes							
CO1	Apply fundamental principles of mechanics & principles of equilibrium to simple and practical problems of engineering, determine centroid and moment of inertia of different geometrical shapes and be able to understand its importance. Explain the basic concepts of stress and strain and solve the problems.						
CO 2	Determine and calculate the values of principal stresses on 2-D inclined planes. Understand the concepts of shear force and bending moment of beams. Able to construct shear force and bending moment diagrams for beams under different loading conditions						
CO 3	Understand the concept of torsion of circular shaft and be able to solve the problems on torsion of circular shaft. Illustrate and solve the problems on bending and shear stresses on beams.						
CO 4	Understand the concept of column and strut and be able to solve the problems. Derive the concept of slope and deflection and solve the problems on slope and deflection using different methods.						

Unit-I

Introduction: Force, types of forces, Characteristics of a force, System of forces, Composition and resolution of forces, forces in equilibrium, principle and laws of equilibrium, Free body diagrams, Lami's Theorem, conditions for equilibrium, Concept of center of gravity and centroid,

centroid of various shapes: Triangle, circle, semicircle and trapezium, theorem of parallel and perpendicular axes, moment of inertia of simple geometrical figures, polar moment of inertia. Numerical Problems.

Simple Stresses & Strains: Different types of stresses and strains, Poisson's ratio, stresses and strain in simple and compound bars under axial loading, stress strain diagrams, Hook's law, elastic constants & their relationships, temperature stress & strain in simple & compound bars under axial loading, Numerical problems.

Unit-II

Principle Stresses: Two dimensional stress systems, stress at a point on an inclined plane, principal stresses and principal planes, Mohr's circle of stresses, Numerical Problems.

Shear Force & Bending Moments: Definitions, SF & BM diagrams for cantilevers, simply supported beams with or without over-hang and calculation of maximum BM & SF and the point of contraflexture under (i) concentrated loads, (ii) uniformly distributed loads over whole span or a part of it, (iii) combination of concentrated loads and uniformly distributed loads, (iv) uniformly varying loads and (v) application of moments, relation between the rate of loading, the shear force and the bending moments, Numerical Problems.

. **Unit-III**

Torsion of Circular Members: Derivation of equation of torsion, Solid and hollow circular shafts, tapered shaft, stepped shaft & composite circular shafts, Numerical problems.

Flexural and Shear Stresses – Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus of rectangular & circular (solid & hollow), I,T, Angle, channel sections, composite beams, shear stresses in beams with derivation, shear stress distribution across various beam sections like rectangular, circular, triangular, I, T, angle sections. Combined bending and torsion, equivalent torque, Numerical problems.

Unit-IV

Columns & Struts: Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formula for crippling load for columns with different end conditions, concept of equivalent length, eccentric loading, Rankine formulae and other empirical relations, Numerical problems.

Slope & Deflection : Relationship between bending moment, slope & deflection, double integration method, Macaulay's method, calculations for slope and deflection of (i) cantilevers and (ii) simply supported beams with or without overhang under concentrated load, Uniformly distributed loads or combination of concentrated and uniformly distributed loads, Numerical problems.

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.
4. Strength of Materials – D.S. Bedi, Khanna Publications.

Reference Books:

1. Strength of Materials – Popov, PHI, New Delhi.
2. Strength of Materials – Robert l. Mott, Pearson, New Delhi
3. Strength of Material – Schaum's Outline Series – McGraw Hill

4. Strength of Material – Rider – ELBS

	B. Tech. (3rd Semester) Mechanical Engineering						
B23-ESC - 201	**ENGINEERING THERMODYNAMICS**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**70**	**30**	**100**	**3**
Purpose	The objective of this course is to make the students aware of Energy, Entropy, and Equilibrium, various laws of thermodynamics, concepts and principles. The course will help the students to build the fundamental concepts to apply in various applications like IC engines and Air conditioning systems						
Course Outcomes							
CO1	Analyze the work and heat interactions associated with a prescribed process path and to perform an analysis of a flow system.						
CO 2	Define the fundamentals of the first and second laws of thermodynamics and explain their application to a wide range of systems.						
CO 3	Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.						
CO 4	Understand the design and analysis of flow through steam nozzles. Solve the problems related to vapour power cycle and steam nozzle						

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

Unit-I

Basic Concepts: Thermodynamics: Macroscopic and Microscopic Approach, Thermodynamic Systems, Surrounding and Boundary, Thermodynamic Property – Intensive and Extensive, Thermodynamic Equilibrium, State, Path, Process and Cycle, Quasi-static, Reversible and Irreversible Processes, Working Substance. Concept of Thermodynamic Work and Heat, Zeroth Law of Thermodynamics and its utility.

First Law of Thermodynamics: Energy and its Forms, Energy and 1st law of Thermodynamics, Internal Energy and Enthalpy, 1st Law Applied to Non-Flow Process, Steady Flow Process and Transient Flow Process, Throttling Process and Free Expansion Process.

Unit-II

Second Law of Thermodynamics: Limitations of First Law, Thermal Reservoir Heat Source and Heat Sink, Heat Engine, Refrigerator and Heat Pump, Kelvin- Planck and Clausius Statements and Their Equivalence, Perpetual Motion Machine of Second Kind. Carnot Cycle, Carnot Heat Engine and Carnot Heat Pump, Carnot's Theorem and its Corollaries, Thermodynamic Temperature Scale, Numericals.

Entropy: Clausius Inequality and Entropy, Principle of Entropy Increase, Temperature-Entropy Plot, Entropy Change in Different Processes, Introduction to Third Law of thermodynamics.

Unit -III

Availability, Irreversibility and Equilibrium: High and Low Grade Energy, Available Energy and Unavailable Energy, Loss of Available Energy Due to Heat Transfer Through a Finite Temperature Difference, Availability of a Non-Flow or Closed System, Availability of a Steady Flow System, Helmholtz and Gibb's Functions, Effectiveness and Irreversibility, Thermodynamic Relations.

Pure Substance: Pure Substance and its Properties, Phase and Phase Transformation, Vaporization, Evaporation and Boiling , Saturated and Superheated Steam, Solid – Liquid – Vapour Equilibrium, T-V, P-V and P-T Plots During Steam Formation, Properties of Dry, Wet and Superheated Steam, Property Changes During Steam Processes, Temperature – Entropy (T-S) and Enthalpy – Entropy (H-S) Diagrams, Throttling and Measurement of Dryness Fraction of Steam.

Unit-IV

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.

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.

Text Books:

1. Engineering Thermodynamics – C P Arora, Tata McGraw Hill
2. Engineering Thermodynamics – P K Nag, Tata McGraw Hill
3. Thermal Engineering- R. K. Rajput, Laxmi Publications

Reference Books:

1. Thermal Science and Engineering – D S Kumar, S K Kataria and Sons
2. Engineering Thermodynamics -Work and Heat transfer – G F C Rogers and Maghew Y R Longman.
3. Thermodynamics – An Engineering Approach; Y. A. Cengel, M. A. Boles; Tata McGraw Hill

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

	B. Tech. (3rd Semester) Mechanical Engineering						
B23-ESC -203	**MEASUREMENT AND CONTROL**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	To understand the fundamentals of mechanical instruments and enable the students for solving the problems related transfer function of control systems						
Course Outcomes							
CO1	Students will understand the fundamentals of measurement systems and understand the static performance characteristics of measurement systems.						
CO2	Student will be able to explain various instruments for the motion, force, torque measurement, length, angle and area measurement.						
CO3	Student will be able to explain various related to pressure and temperature measurements.						
CO4	Students will be able to understand the various concepts related to control systems and different types of controller.						

UNIT-I

Fundamentals of Measurements: Definition, application of measurement instrumentation, functional elements of a generalized measuring system, measuring standards, types of measurement, types of input to measuring instruments and instrument system, classification of measuring instruments, merits and demerits of mechanical measuring systems, comparison of mechanical measuring system with electrical measuring systems, calibration.

Generalized Measurement System: Introduction, types of error, types of uncertainties, propagation of uncertainties in compound quantity, Static performance parameters: accuracy, precision, resolution, static sensitivity, linearity, hysteresis, dead band, backlash, and drift, sources of error, selection of measuring instruments, mechanical and electrical loading.

UNIT-II

Motion, Force and Torque Measurement: Introduction, relative motion, measuring devices, electro-mechanical, optical, photo electric, Moore-Fringe, pneumatic, absolute motion devices, seismic devices, spring mass & force balance type, calibration, hydraulic load cell, pneumatic load cell, elastic force devices, separation of force components, electro-mechanical methods, torque transducer, torque meter.

Metrology: Length, Angle and Area Measurement

Introduction, vernier caliper, micrometer, vernier height gauge, surface plate, dial gauge, surface plate, Angular measurement, Area measurement.

UNIT-III

Pressure Measurement: Terminology, manometers, elastic transducer, high pressure transducer, low pressure measurement, calibration and testing.

Temperature Measurement: Introduction, measurement of temperature, non-electrical methods – solid rod thermometer, bimetallic thermometer, liquid in- glass thermometer, pressure thermometer, electrical methods – electrical resistance thermometers, semiconductor resistance sensors (thermistors), thermo-electric sensors, thermocouple materials, radiation methods (pyrometry), total radiation pyrometer, selective radiation pyrometer.

UNIT-IV

Control Analysis: Introduction, classification of control systems, control system terminology, servomechanism, process control and regulators, manual and automatic control systems, physical systems and mathematical models, linear control systems, transfer function, block diagram, signal flow graphs.

Mechanical Controllers: Basics of actuators: pneumatic controller, hydraulic controller and their comparison, Comparators, form and finish measurement.

Reference and Text Books:

1. Mechanical measurements & control- By D.S. Kumar, Metropolitan book
2. Instrumentation and Mechanical measurements- By A.K. Tayal, Galgotia Publ.
3. Measurements systems application and design-By Ernest Doebelin, McGraw-Hill
4. Automatic Control Systems- By S. Hasan Saeed

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

	B. Tech (3rd Semester) Mechanical Engineering						
B23-MEC-205	**THEORY OF MACHINES LAB**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Internal Assessment**	**Practical Exam**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**40**	**60**	**100**	**3**
Purpose :	Students will be able to analyze and explain various kinds of mechanisms and machines.						
	Course Outcomes						
CO 1	Students will be able to explain various types of kinematic mechanisms and their applications in different machines.						
CO 2	Students will be able to sketch a plot between displacement, velocity and acceleration and crank rotation for single slider crank mechanism and cam follower system.						
CO 3	Students will be able to analyze the flywheel, belt drives, governor and gyroscopic couple of a motorized gyroscope.						
CO 4	Students will be able to analyze various gear and gear trains.						
CO5	Students will be able to describe various steering systems, brakes and dynamometers.						

List of experiments

1. To study inversions of four bar mechanisms, single and double slider crank mechanisms.
2. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism.
3. To find out experimentally the Coriolis component of acceleration and compare with theoretical value.
4. To determine the moment of inertia of a flywheel.
5. To plot follower displacement v/s cam rotation for various cam follower systems.
6. To find gyroscopic couple on motorized gyroscope and compare with applied couple.
7. To calculate the torque on planet carrier and torque on internal gear using epicycle gear train and holding torque apparatus.

8. To determine the coefficient of friction between belt and pulley and plot a graph between $\log_{10} T_1/T_2$ v/s θ
9. To study different types of centrifugal and interia governors and also determine the sleeve position relationship with motor speed.
10. To study different types of brakes and dynamometers with demonstration.
11. To study various types of steering mechanisms.

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. (3rd semester) Mechanical Engineering						
B23-MEC-207	**MECHANICS OF SOLIDS LAB**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Internal Assessment**	**Practical Exam**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**40**	**60**	**100**	**3**
Purpose	To make the students aware of different properties of materials using different experimental set-up.						
Course Outcomes							
CO1	Ability to design and conduct experiments, acquire data, analyze and interpret data						
CO 2	Ability to determine the behavior of ferrous metals subjected to normal and shear stresses by means of experiments.						
CO 3	Ability to determine the behavior of structural elements, such as bars subjected to tension, compression, shear, bending, and torsion by means of experiments.						
CO 4	Physical insight into the behavior materials and structural elements, including distribution of stresses and strains, deformations and failure modes.						
CO5	Write individual and group reports: present objectives, describe test procedures and results, synthesize and discuss the test results.						

List of Experiments:

1. To study the Brinell hardness testing machine & perform the Brinell hardness test on given specimen.
2. To study the Rockwell hardness testing machine & perform the Rockwell hardness test on a given specimen.
3. To study the Vickers hardness testing machine & perform the Vickers hardness test on a given specimen.
4. To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test on a given specimen.
5. To study the Impact testing machine and perform the Impact tests (Izod & Charpy) on a given specimen.

6. To study the Universal testing machine and perform the tensile, compression & bending tests on a given specimen.
7. To perform the shear test on UTM on a given specimen.
8. To study the torsion testing machine and perform the torsion test on a given specimen.
9. To draw shear Force, Bending Moment Diagrams for a simply Supported Beam under point and distributed Loads.
10. To prepare the composite specimen using a hot compression molding machine and test for different mechanical properties.

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. (3rd Semester) Mechanical Engineering						
B23-MAC-201	**ENVIRONMENTAL STUDIES**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**1**	**70**	**30**	**100**	**3**
Course Outcomes							
CO 1	Students will be able to understand the importance of natural resources.						
CO 2	Students will understand the concept of an ecosystem, its structure, and its functions.						
CO 3	The students will be able to understand the causes and impacts of various environmental pollution.						
CO-4	Students will be able to understand the relationship between human population and the environment.						

Unit-1

Introduction to Environmental studies: The Multidisciplinary nature of environmental studies Definition; Scope and importance, Need for public awareness.

Natural Resources: Forest resources: Use and Over-exploitation, deforestation. Timber extraction, mining, dams, and their effects, Water resources: Use and over-utilization of surface and groundwater, conflicts over water, dams benefits and problems, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Food resources: changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, Energy resources: renewable and non-renewable energy sources, Land resources: land degradation, soil erosion, and desertification.

Unit-II

Ecosystems: Concept of an ecosystem, Structure, and function of an ecosystem, Energy flow in the ecosystem, Ecological succession, Food chains, food webs, and ecological pyramids. Major

types of ecosystem-Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystem.

Biodiversity and its Conservation: Introduction-Definition: genetic, species, and ecosystem diversity. Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit-III

Environmental pollution: Causes, effects, and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Nuclear hazards, and Solid waste Management: Causes, effects, and control measures of urban and industrial wastes, Disaster management: floods, earthquake, cyclone and landslides.

Social Issues and the Environment: Sustainable development, Water conservation, rainwater harvesting, Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, and wasteland reclamation. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act., and Forest Conservation Act.

Unit-IV

Human population and the Environment: Population growth, Population Explosion-Family welfare Programme, Environment and human health. Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Drugs and their effects; Useful and harmful drugs; Use and abuse of drugs; Stimulant and depressant drugs. Concept of drug de-addiction. Legal position on drugs and laws related to drugs.

Field Work (Practical)-

- Visit to a local area to document environmental assets -river/forest/grassland/ hill/mountain.
- Visit to a local polluted site- Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, and birds.
- Study of simple ecosystems- pond, river, hill slopes, etc.

Suggested readings:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Kaushik, Anubha and Kaushik, C.P. (2004 Perspectives in Environmental Studies, New age International Publishers.
3. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad - 380013, India, Email: mapin@icenet. net (R).
4. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.
5. Clerk B.S., Marine Pollution, Clanderson Pross Oxford (TB).
6. Cunningham, W.P.Cooper, T.H. Gorhani, E & Hepworth, M.T.2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p.
7. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
8. Down to Earth, Centre for Science and Environment (R).

	B. Tech. (4th Semester) Mechanical Engineering						
B23-ESC-202	**MATERIALS ENGINEERING**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose:	To develop capacity to identify crystal structure, designate various steels, create phase diagrams, analyse material failure mechanisms, perform heat treatment, study green energy materials and basic functioning of sophisticated material characterization techniques. with overall objective of developing the understanding of microstructure-property relations.						
Course Outcomes							
CO 1	Students will be able to identify and differentiate various types of the crystal structures and deformation mechanisms in various materials.						
CO 2	Students will be able to designate various types of steels as per BIS and AISI-SAE standard specifications of steels						
CO 3	Students will be able to draw various types of phase diagrams, Fe-C diagram and TTT curve.						
CO-4	Students will be able to classify heat treatment processes and will be able to select suitable heat treatment process for any industrial application.						
CO 4	Students will be able to explain various mechanisms of deformation and failure mechanisms like Creep and Fatigue.						
CO 5	Students will be able to study various materials used for green energy production.						
CO 6	Students will be able to explain the basic principles involved in the working of various types of material characterization techniques and will develop the capability to select a particular material characterization process for any given application.						

UNIT I

Crystallography: Review of Crystal Structure, Space Lattice, Co-ordination Number, Number of Atoms per 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, 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: Basic concepts and terms, Alloy Systems, Solid solutions, Hume- Rothery's Rules, Phase Diagrams, Gibbs Phase Rule, Cooling curves, Binary phase diagrams, The Lever Rule, Applications of Phase Diagrams, Phase Transformation, Allotropic Forms of Iron, Micro-

constituents of Fe-C system, Iron-iron carbide phase diagram, Modified Iron Carbon Phase Diagrams, Isothermal Transformation, TTT Curve, CCT curve.

Heat Treatment: Heat treatment of steels, Annealing, Normalising, Hardening, Tempering, Ageing, Austempering and Martempering, Surface hardening and Case hardening processes, 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 Phenomenon, Bauschinger Effect, Work Hardening.

Fatigue Failure of Materials: Fatigue, fatigue-failure models, Fatigue loads, Mechanism of Fatigue Failure, Theories of Fatigue, Factors affecting fatigue, SN diagram, Fatigue Life calculations, Fatigue Tests.

Creep: Creep Curve, Types of Creep, Factors affecting Creep, Mechanism of Creep, Creep Resistant Material, Creep Tests, Improving creep resistance.

UNIT IV

Materials for green energy: Biodiesel, Bioethanol**,** Production methods of Biofuels**;** Overview of key fuel cell technologies- various types of fuel cells, materials for electrodes, electrolytes and other components, working mechanisms, hydrogen generation and storage; limitations, recent progress in fuel cells.

Materials Characterization Techniques: Characterization techniques such as X-Ray Diffraction (XRD), Scanning Electron Microscopy(SEM), Energy dispersive X-ray spectroscopy (SEM-EDX), Transmission Electron Microscopy(TEM), Atomic force microscopy(AFM), Scanning tunneling microscopy(STM).

Text Books:

1. Fundamentals of Material Science and Engineering by W. D. Callister, Wiley.
2. Material science and metallurgy by O.P Khanna, Dhanpat Rai Publication.
3. Material Science by S.L. Kakani, New Age Publishers.
4. The Science and Engineering of Materials by Donald R. Askeland , Chapman & Hall.
5. Material Science by Narula, TMH.
6. Machine Design by Robert Norton, Pearson.
7. Phase Transformation in Metals and Alloys by D. A. Porter & K. E. Easterling
8. Fuel Cell Systems Explained by Larminie and A. Dicks, , 2nd Edition, Wiley.
9. Principles of Fuel Cells by Xianguo Li, Taylor and Francis.
10. Fuel Cells: From Fundamentals to Applications by S. Srinivasan, Springer.
11. Fundamental of Light Microscopy and Electronic Imaging by Douglas B. Murphy, Kindle Edition 2001.
12. Concise Encyclopedia of Materials Characterization by Robert Cahn, 2nd Edition (Advances in Materials Science and Engineering) Elsevier Publication 2005.

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

	B. Tech. (4th Semester) Mechanical Engineering						
B23-MEC-202	**FLUID MECHANICS AND MACHINES**						
Lecture	**Tutorial**	**Practical**	**Credit**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
4	**1**	**-**	**5**	**70**	**30**	**100**	**3**
Purpose	To build a fundamental understanding of concepts of Fluid Mechanics and their application in rotodynamic machines.						
Course Outcomes							
CO 1	The students will be able to understand the basic concepts of fluid statics, kinematics and dynamics; and apply mass and momentum conservation laws to mathematically analyze simple flow situations.						
CO 2	The students will be able to understand laminar, turbulent and boundary layer flows and solve problems for the same.						
CO 3	The students will be able to apply dimensional analysis to simple flow problems and understand the basics of hydraulic machines.						
CO 4	The students will be able to design and evaluate the performance of hydraulic turbines and pumps.						

UNIT-I

Fluid Statics: Properties of fluids, Newton's law of viscosity, hydrostatic law, hydrostatic forces on submerged plane and curved surfaces, buoyancy, stability of floating and submerged bodies, Problems.

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 dimensional 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, 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. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons
2. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, Tata McGraw Hill.
3. Fluid Mechanics and Fluid Machines - S.S. Rattan, Khanna Publishing House.
4. Fluid Mechanics and Hydraulic Machines – R. K. Rajput, S. Chand & Company

Reference 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 – Streeter V L and Wylie E B, Mc Graw Hill
4. Mechanics of Fluids – I H Shames, Mc Graw Hill
5. Fluid Mechanics: Fundamentals and Applications - Yunus Cengel and John Cimbala, McGraw Hill.
6. 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.

	B. Tech. (4th Semester) Mechanical Engineering						
B23-MEC-204	**MECHANICAL VIBRATIONS AND TRIBOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**1**	**0**	**4**	**70**	**30**	**100**	**3**
Purpose:	To understand, analyze, derive and calculate various parameters of mechanical vibration systems with different degrees of freedom in different modes and conditions and to understand the basics of tribology.						
Course Outcomes							
CO1	Students will be able to understand the vibration fundamentals for a single degree of freedom system under free and damped vibrations, various spring/ shaft combinations and will also be able to solve mathematical problems based on the same.						
CO2	Students will be able to analyze different types of single degree of freedom forced vibration systems and damped, undamped, free and forced systems with two D.O.F. and will also be able to solve mathematical problems based on the same.						
CO3	Students will be able to evaluate frequencies and principal modes of vibrations for various spring-mass combinations and rotor-shaft systems and will be able to derive frequency expressions for continuous systems viz. transverse, longitudinal and torsional vibration for beams, bars and shafts respectively and will also be able to solve mathematical problems based on the same.						
CO4	Students will be able to understand the fundamentals of tribology, lubrication, friction and wear.						

UNIT-I

Fundamentals: Introduction, elements of a vibratory system, periodic and S.H.M., degrees of freedom (DOF), types of vibrations, work done by a harmonic force, beats, Problems.

Free vibration systems with single degree of freedom undamped systems: Introduction, differential equations, torsional vibrations, spring and shaft combinations: series & parallel, linear and torsional systems, compound pendulum, bifilar and trifilar suspensions, problems.

Free vibration systems with single degree of freedom damped systems: Introduction, types of damping, differential equations of damped free vibrations, initial conditions, logarithmic decrement, vibrational energy, Problems.

UNIT-II

Forced vibration systems with single degree of freedom damped systems: Introduction, excitation and sources, equations of motion, rotating and reciprocating unbalanced system, support motion, vibration isolation, force and motion transmissibility, forced vibration system with different types of damping, vibration measuring instruments, resonance, bandwidth, quality factor and half power points, critical speed of shaft with and without damping with single and multiple discs, problems.

Two degrees of freedom system: Introduction, torsional vibrations, principal modes of vibrations for two D.O.F., damped and undamped forced and free vibrations, semi-definite systems, coordinate coupling, spring and mass type vibration absorber, problems.

UNIT-III

Multi-degree of freedom systems: Introduction, principal modes of vibrations for three or more DOF, influence coefficients, orthogonality principle, matrix method, matrix iteration method, Dunkerley's equation, Holzer's Method, Rayleigh Method, Stodola method, problems.

Continuous systems: Introduction, lateral vibrations of strings, longitudinal vibrations of bars, transverse vibration of beams, torsional vibration of uniform shafts, problems.

UNIT-IV

Tribology: Introduction, tribology in design, tribology in industry, economic aspects.

Lubrication: Introduction, basic modes of lubrication, lubricants, properties of lubricants: physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion.

Friction and wear: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Introduction to wear, types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.

Text Books:

1. Mechanical Vibrations by G. K. Grover, Nem Chand and Bros., Roorkee.
2. Elements of Mechanical Vibrations by Meirovitch, McGraw Hill.
3. Introductory course on theory and practice of Mechanical Vibration by J.S. Rao and K.Gupta, New Age International.
4. Friction and wear of Materials by E. Robinowicz, Johan Wiley
5. Tribology an Introduction by Sushil Kumar Srivastava
6. Introduction to Tribology and Bearings by B. C. Majumdar, S. Chand and Company Ltd. New Delhi.

Reference Books:

1. Mechanical Vibrations by S.S. Rao, Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd. New Delhi.
2. Mechanical Vibrations by V.P. Singh, Dhanpat Rai & Co. Pvt. Ltd., Delhi.
3. Engineering Tribology by Prashant Sahoo, PHI publications.
4. Principles of Tribology by J. Hailing, McMillan Press Ltd.

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

	B. Tech. (4th Semester) Mechanical Engineering						
B23-MEC-206	**MECHANICS OF SOLIDS-II**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**4**	**70**	**30**	**100**	**3**
Purpose	The objective of this course is to show the concept of strain energy and different stresses in springs, pressure vessels, rotating rims/discs, 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	Understand the concepts of strain energy and various theories of failures and solve the problems.						
CO 2	Differentiate different types of stresses induced in thin and thick pressure vessels and solve the problems. Use of Lame's equation to calculate the stresses induced in thick pressure vessels.						
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 sections and also the deflection of curved bars and rings. Analyze the stresses due to unsymmetrical bending and determine the position of shear centre for different sections.						

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 their limitations, comparisons and applications to problems of 2- dimensional stress system, Numerical.

Unit II

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

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 a solid shaft, Numerical.

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 & solid cylinders. Numerical.

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, Numerical.

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, 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, Numerical.

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.
4. Strength of Materials – D.S. Bedi, Khanna Publications.

Reference Books:

1. Strength of Materials – Popov, PHI, New Delhi.
2. Strength of Materials – Robert l. Mott, Pearson, New Delhi
3. Strength of Material – Schaum's 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

	B. Tech. (4th Semester) Mechanical Engineering						
B23-MEC-208	**MANUFACTURING TECHNOLOGY**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose:	To build a foundation in different manufacturing processes related to castings, metal forming, joining, powder metallurgy and plastic material shaping processes.						
Course Outcomes							
CO 1	After completing the course, students will be able to understand the casting fundamentals, and different casting processes.						
CO 2	The students will be able to understand and analyse the different metal forming processes.						
CO 3	The students will understand different welding processes with their applications.						
CO 4	The student will have the basic understanding of powder metallurgy processes and different plastic shaping processes.						

UNIT-I

Fundamentals of castings: Introduction to casting; basic requirements of casting processes, casting terminology, solidification process: cooling curves, prediction of solidification time, fluidity and pouring temperature, role of gating system, solidification shrinkage, casting defects.

Expandable-mould casting processes: Sand casting, cores and core making, other expendable-mould processes with multiple use patterns, shakeout, cleaning and finishing.

Multiple-use-mould casting processes: Permanent mould casting, die casting, squeeze casting and semisolid metal casting, centrifugal casting, cleaning, finishing and heat treating of castings, automation in foundry operations.

UNIT-II

Metal forming processes: Classifications of metal forming processes, bulk deformation processes, material behaviour in metal forming, temperature in metal forming, rolling: flat rolling, shape rolling, rolling mills, forging: open-die forging, impression-die forging, flashless forging, extrusion: types of extrusion, extrusion dies and presses, defects in extruded products, wire and bar drawing, tube drawing.

Sheet metal working: Cutting operations: shearing, blanking, and punching, engineering analysis of sheet-metal cutting, other sheet-metal-cutting operations, bending operations: v-bending and edge bending, springback effect, drawing: mechanics of drawing, defects in drawing.

UNIT-III

Joining processes: Principles of fusion welding processes, arc welding processes, consumable electrodes: shielded metal arc welding, gas metal arc welding, flux-cored arc welding, submerged arc welding, Arc welding processes-non-consumable electrodes: gas tungsten arc welding, plasma

arc welding, resistance welding processes, electron-beam welding, laser beam welding, thermit welding.

Principles of solid-state welding processes: friction welding, explosive welding, ultrasonic welding processes. **Brazing, soldering, and adhesive bonding:** Principles of adhesive, brazing and soldering processes, origins of welding defects.

UNIT-IV

Powder metallurgy: Characterization of engineering powders: geometric features, other features production of metallic powders: atomization: other production methods, conventional pressing and sintering: blending and mixing of the powders, compaction, sintering, heat treatment and finishing, design considerations in powder metallurgy.

Shaping processes for plastics: Properties of polymer melts, extrusion, production of sheet and film, fiber and filament production (spinning), coating processes, injection moulding, compression and transfer moulding, blow moulding and rotational moulding, thermoforming.

Text Books:

1. Fundamentals of modern manufacturing: materials processing and systems by Mikell P. Grover,
   John Wiley and Sons.
2. Materials and processes in manufacturing by J.T. Black and R.A. Kohser, John Wiley and Sons.
3. Principles of Manufacturing Materials & Processes by Campbell J. S., Publisher – Mc Graw Hill.
4. Production Technology by R. K. Jain, Khanna Publishers
5. Manufacturing Technology-Foundry, Forming and Welding by P.N. Rao, Tata McGraw Hill
6. Advanced Manufacturing Process by Hofy, H.E., B and H Publication.
7. Manufacturing Science by Ghosh, A. and Mullik, A, East –West private Limited.

Reference Books:

1. Welding and Welding Technology by Richard L. Little Tata McGraw Hill Ltd.
2. Manufacturing Processes and Systems by Ostwald Phillip F., Munoz Jairo, John Wiley & Sons
3. Elements of Manufacturing Processes by B.S. Nagendra Parasher, RK Mittal, PHI N. Delhi

4. Manufacturing Engineering and Technology by Serope Kalpakjian and Steven R. Schmid, Pearson publications.

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

		B. Tech. (4th Semester) Mechanical Engineering					
B23-HSM-202		**INNOVATION, START-UP AND ENTREPRENEURSHIP**					
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**-**	**-**	**3**	**70**	**30**	**100**	**3**
Purpose	The objective of this Course is to inspire students and help them imbibe entrepreneurial mindset.						
CO 1	Understanding the essence of innovation and features of innovative processes; models and methods of innovative entrepreneurship, the role of innovation as a major factor in creating the value of companies						
CO 2	Understanding, the dynamic role of entrepreneurship and small businesses, types of business structure, organizing and managing a Small Business.						
CO 3	Understanding concept of start-ups, Control Strategic Marketing Planning, concept of incubation and proto type, new Product Development, Business Plan Creation.						
CO 4	Understanding risk analysis in business, financing methods, role of government in supporting entrepreneurship						

Unit -I

Introduction to Innovation and Entrepreneurial Idea Generation and Identifying Business Opportunities, Management Skills for Entrepreneurs, Innovations and their forms, Innovation - features and characteristics, Factors initiating innovations, Innovation process and its stages, Statistical measurement of innovation, Model of innovation, Source of innovation, Technological transfer, Information technology to support innovation, difference between technological and non-technological innovation

Unit-II

Introduction to Entrepreneurship and Start – Ups - Definitions, Traits of an entrepreneur, Intrapreneurship, Entrepreneurial Motivation ,Functions of Entrepreneur, Concept, Growth of Entrepreneurship in India, Types of Business Structures, Similarities /differences between entrepreneurs and managers, Business Ideas and their implementation, Discovering ideas and visualizing the business, Activity map, Types of startups, role of entrepreneurs in economic development, future of entrepreneurs, entrepreneurial process

Unit -III

Start ups - Initial idea generation and planning stages, and incubation referring to the development process of identifying and developing new ideas for products, services, or processes, and creating a working model or prototype to test the feasibility of the concept.

Market Analysis – Identifying the target market, Competition evaluation and Strategy Development, Five Cs of Opportunity Identification, Market Opportunity Identification in emerging technology companies, Process of creating and growing a new business venture, Business plan of the innovation project.

Unit -IV

Risk Analysis: Risk management in venture projects, Financing and Protection of Ideas- Financing methods available for start-ups in India, Communication of Ideas to potential investors – Investor Pitch, Patenting and Licenses, Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy, venture capital, angel investment, and crowdfunding.

Government support- programs and initiatives aimed at supporting the development of new ideas, innovations, and startups, funding and mentorship, IPR - legal protection of a person's or organization's rights to their invention, brand, or creative work

Suggested Readings:

1. Shrutin N Shetty, (2018), Design the Future: Simplifying Design Thinking to Help You, Notion Press
2. "Entrepreneurship development small business enterprises", Pearson, Poornima M Charantimath,2013.
3. Roy Rajiv, "Entrepreneurship", Oxford University Press, 2011.
4. "Innovation and Entrepreneurship",Harper business- Drucker.F, Peter, 2006.
5. "Entrepreneurship", Tata Mc-graw Hill Publishing Co.ltd new Delhi- Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, 8th Edition, 2012
6. The Three-Box Solution: A Strategy for Leading Innovation By Vijay Govindarajan
7. Boutellier, Roman; Gassmann, Oliver; von Zedtwitz, Maximilian (2000). Managing Global Innovation. Berlin: Springer.. ISBN 3-540-66832-2.
8. Brown K. and Stephen P. Osborne (2005) Managing change and innovation in public service organisation. New York: Routledge
9. Cappellin R. and Wink R. (2009) International Knowledge and Innovation Networks Knowledge Creation and Innovation in Medium-technology Clusters. UK: Edward Elgar Publishing Limited.
10. Eveleens, C. (2010). Innovation management; a literature review of innovation process models and their implications. Working Paper HAN University of Applied Sciences.
11. Enterpreneurship Development- S.Chand & Co.,Delhi- S.S.Khanka 1999
12. Small-Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi – Vasant Desai 2003.
13. Entrepreneurship Management -Cynthia, Kaulgud, Aruna, Vikas Publishing House, Delhi, 2003.
14. Entrepreneurship Ideas in Action- L. Greene, Thomson Asia Pvt. Ltd., Singapore, 2007

	B. Tech. (4th Semester) Mechanical Engineering						
B23-ESC-204	**MATERIALS ENGINEERING LAB**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Internal Assessment**	**Practical Exam**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**40**	**60**	**100**	**3**
Purpose	To make the students prudent in metallographical sample preparation, microstructure analysis, basic heat treatment operations and production of Biofuels.						
Course Outcomes							
CO 1	Students will have the ability to design and conduct experiments, acquire data, analyze and interpret data						
CO 2	Students will have the ability to determine the grain size and microstructure in different Ferrous alloys by means of experiments.						
CO 3	Students will have the ability to identify and differentiate microstructures of different Non-Ferrous alloys.						
CO 4	Students will be able to perform various heat treatment processes using muffle furnace in the lab.						
CO 5	Students will have the ability to analyse microstructure of Heat-treated specimens and perform Fatigue and creep test on different materials.						
CO6	Students will be able to perform lab scale production of Biofuel.						

List of Experiments:

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 perform Jominy End-Quench Hardenability Test.
12. To perform Fatigue test on fatigue testing machine.
13. To perform Creep test on creep testing machine.
14. To produce a sample of Biodiesel.
15. To study the functioning of fuel cells.

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						
B23-MEC-210	**FLUID MECHANICS AND MACHINES LAB**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal Assessment**	**Practical Exam**	**Total**	**Time**
-	**-**	**2**	**1**	**40**	**60**	**100**	**3**
Purpose	**To familiarize the students with the equipment and instrumentation of Fluid Mechanics and Machines**						
Course Outcomes							
CO1	**Collect, analyse and interpret data using fluid mechanics principles and experimentation methods.**						
CO2	**Determine the coefficient of discharge for various flow measurement devices.**						
CO3	**Calculate flow characteristics such as Reynolds number, friction factor from laboratory measurements.**						
CO4	**Analyze the performance characteristics of hydraulic pumps and turbines.**						
CO5	**Write individual and group reports, present objectives, describe test procedures and results, synthesize and discuss the test results.**						

List of Experiments:

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

Note: Any 8 experiments from the above list are required to be performed by students in the laboratory.

	B. Tech. (4th Semester) Mechanical Engineering						
B23-MEC-212	**MECHANICAL VIBRATIONS AND TRIBOLOGY LAB**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Internal Assessment**	**Practical Exam**	**Total**	**Time (Hrs.)**
0	**0**	**2**	**1**	**40**	**60**	**100**	**3**
Purpose	To provide practical knowledge of free and forced vibration system fundamentals and the mechanisms of friction, wear and lubrication.						
Course Outcomes							
CO1	The students will be able to know practically the concepts of free and forced vibrations for a spring mass system and will determine the natural frequency.						
CO2	The students will be able to diagnose the machinery faults, their causes and sources using Machinery Fault Simulator (MFS).						
CO3	The students will understand the concept of sliding wear and abrasive wear using wear and friction monitoring apparatus and dry abrasion tester respectively.						
CO4	The students will be capable of measuring the extreme pressure properties of different lubricants using four ball tester.						

LIST OF EXPERIMENTS:

1. To study undamped free vibrations and determine the natural frequency of:
   - 1.1 Spring mass system
   - 1.2 Simple Pendulum
   - 1.3 Torsional spring type double pendulum and compare them with theoretical values.
2. To study the torsional vibration of a single rotor shaft system and determine the natural frequency.
3. To study the free vibration of system for different damper settings. Draw decay curve and determine the log decrement and damping factor. Find also the natural frequency.
4. To verify the Dunkerley's rule.
5. To determine the radius of gyration for:
   - 5.1 Bifilar suspension.
   - 5.2 Compound pendulum.
   - 5.3 Trifilar suspension.
6. To study the forced vibration system with damping, Load magnification factor vs. Frequency and phase angle vs frequency curves. Also determine the damping factor.
7. To find out and locate machinery faults viz. vibrations and unbalancing using Machinery Fault Simulator (MFS) in:
   - 7.1 Direct Driven reciprocating pump;
   - 7.2 Direct Driven centrifugal pump;
   - 7.3 Defective straight tooth gearbox pinions.
8. To determine the wear rate, friction force and coefficient of friction of a metallic pin/ball by using wear and friction monitor apparatus.
9. To determine abrasion index of a material with the help of dry abrasion test rig.
10. To evaluate the wear and extreme pressure properties of a lubricating oil by using four ball tester.
11. To determine the roughness of a specimen using surface roughness tester.

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						
B23-MAC-202	**Essence of Indian Traditional Knowledge**						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
2	**-**	**-**	**1**	**-**	**100**	**100**	**3**
Purpose	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system, analyse and apply to their day to day life.						
	Course Outcomes						
CO 1	The students will be able to understand , connect up and explain basics of Indian traditional knowledge in modern scientific perspective						
CO2	The students will be able to understand Holistic Health using Indian Knowledge System						
CO3	The students will be able to Manage thoughts and Emotions , will learn positivity, self-regulation and control						
CO4	The students will be able to Achieve Consciousness through Indian Knowledge System						

Unit-I

Introduction to Indian Traditional knowledge: Define traditional knowledge, importance, kinds of traditional knowledge. Philosophical systems, Basics of Rajyoga and Karamyoga, Benefits of Rajyoga and Karamyoga.

Unit-II

Holistic Health using Indian Knowledge System: Basic principles of natural life style, Benefits through five elements. Healing through food, Chakras and Mudras. Physical, Mental, Emotional and Spiritual health using traditional knowledge.

Unit-III

Positivity: Traditional approaches. Happiness: objective and subjective measures of wellbeing, life satisfaction. Resilience, Self-regulation and self-control, optimism, self-esteem. Managing thoughts and Emotions with the help of Rajyoga. Achieving Powers for Self Mastery.

Unit-IV

Achieving Consciousness through Indian Knowledge System: Emotional intelligence, Indian approach to Psychology. Consciousness; levels, body-mind relationship, self motivation, Self and Identity in modern Psychology and Indian thought., Spirituality and well being.

Refrence and Text Books:

- Mahadevan, M., Bhat, V.R. & Pavana N. (2022). Introduction to Indian Knowledge System: Concepts and Applications. PHI Learning
- Baumgardner, SR & Crothers, MK (2009). Positive Psychology. Prentice Hall/Pearson Education.
- Cornelissen, R.M., Misra G. & Varma S. (2014). Foundations & Applications of Indian Psychology. Pearson Education.
- Rajyoga Education and Consciousness Improvement Programme for Educators, Rajyoga Education and Research Foundation. Rajyoga Meditation Course, Thoughkart, Jaipur(Rajasthan), India.
- Prakartik Swasthya Shastra, Publisher Natural Lifestyle