ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus Structure (Admission Batch: 2023-24)

School/ Department: School of Mechanical Sciences
Programme: Mechanical Engineering

Abbreviation used:

AC	Audit course	LC	Laboratory Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC/BS/HS	Mandatory/ Common Course	EA	End-Semester Assessment		
ACC	Advanced Competency Course				
*Internal Assessment Mark (40 marks) consists of (i) Mid Semester (20 marks), (ii) Quiz/ Assignment/Attendance (20 marks)					

3rd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	BS	BH2459	Mathematics – III	3	0	0	3	40	60	-	100
2	PC	MS2101	Kinematics and Dynamics of Machines	3	0	0	3	40	60	-	100
3	PC	MS2103	Applied Thermodynamics	3	0	0	3	40	60	-	100
4	PC	MS2105	Introduction to Material Science	3	0	0	3	40	60	-	100
5	ACC	MS2107	Modern Robotics	3	0	0	2	40	60	-	100
6	HS	BH2437	Organizational Behaviour	3	0	0	2	40	60	-	100
7	LC	MS2501	Material Testing Laboratory	0	0	3	1.5	-	-	100	100
8	LC	MS2503	Thermal Engineering Laboratory-1	0	0	3	1.5	-	-	100	100
9	LC	MS2505	Machine Dynamics Laboratory	0	0	3	1.5	-	-	100	100
10	ACC	MS2507	Mechatronics and Robotics Laboratory	0	0	3	1.5	-	-	100	100
			Total	**18**	**0**	**12**	**22**	**240**	**360**	**400**	**1000**

Mathematics – III			
Hours/Week L-T-P :	3-0-0	Credits:	3
Course Type :	Mandatory/ Common Course	Course Code:	BH2459

Course Outcome :

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

CO 1 Demonstrate the use of common numerical methods such as numerical solutions of equations, interpolation, differentiation and integration etc.

CO 2 Recognize mathematical model of heat equations, wave equations and their solution by appropriate method.

CO 3 Understand the different terminology in probability and have clear concept on probability distribution functions both in continuous and discrete case.

CO 4 Select appropriate statistical tools to investigate a research hypothesis, perform data analysis by applying relevant methodology and interpret result in a variety of settings.

UNIT-I*:* Elementary Numerical Methods (7 Hours)

Solution of algebraic and transcendental equations by Newton-Raphson and secant method.
Interpolation: Lagrange's method, divided difference method, Newton's forward and backward method.
Numerical Integration: Trapezoidal and Simpson's Rule.

UNIT- 2*:* Applied PDE's (7 Hours)

Elementary PDE's: separation of variables method to simple problems. One dimensional wave equation: solution by separation of variables and use of Fourier series, D' Alembert's solution of wave equation. Normal forms of PDE's.One dimensional heat equation: solution by Fourier series.

UNIT-3: *Basic* Probability and Probability Distributions (7 Hours)

Probability spaces, conditional probability, independence, Random variables (discrete and continuous), probability mass and density functions, cumulative distribution functions, moments of random variables, mean and variance.
Discrete Probability distributions: Binomial, Poisson and hyper-geometric distributions. Continuous Probability distributions: exponential, uniform and normal distributions.

UNIT-4*:* Applied Statistics (7 Hours)

Random sampling, estimation of parameters, maximum likelihood estimation, confidence intervals, testing of hypotheses for mean and variance.
Regression and correlation analysis: fitting of straight lines (method of lest squares), correlation coefficient with basic properties.

Text Books:

1. Advanced Engineering Mathematics by E. Kreyszig, John Willey & Sons Inc. 10th Edition.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers & Keying Ye, "Probability & Statistics for Engineers & Scientists", Eighth Edition, 2007, Pearson Education Inc., New Delhi.

Reference Books:

1. Ordinary and Partial Differential equations by J. Sinha Roy and S. Padhy, Kalyani Publishers.
2. Higher Engineering Mathematics by B. V. Ramana, McGraw Hill Education.
3. Engineering Mathematics by Pal and S. Bhunia, Oxford Publication.
4. Stochastic Processes, 2nd Edition by Roy D. Yates, Rutgers and David J. Goodman, John Wiley and Sons, INC.

COs and POs Mapping

Course Outcome	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	3	3	3	3	3	3	2	-	2	-	2	3
CO-2	3	3	3	3	3	2	2	-	-	-	2	2
CO-3	3	3	3	3	3	2	3	-	2	-	-	3
CO-4	3	3	3	3	3	2	2	-	2	-	2	3

Kinematics and Dynamics of Machines			
Hours/Week L-T-P :	3-0-0	Credits:	3
Course Type :	Professional Core	Course Code:	MS2101

Prerequisites: Engineering Mechanics, Mechanics of Solid, Engineering Mathematics, Material Science

Course objectives:

1. This course is ideal vehicle for introducing the mechanical engineering students to the process of design. The objectives of the course learning are:
2. The objective of kinematics is to achieve various means of transforming motion to a specific kind needed in various applications.
3. The objective of dynamics is analysis of the behaviour of a given machine or mechanism when subjected to dynamic force.
4. The objectives of Kinematics and dynamics of machines are to use the general concepts which are previously studied with illustrative examples to developing methods and performing analysis of real designs.
5. Hence the KDM involves a great deal of creative details.

Course Outcome:

On successful completion of this course the students should be able to:

CO1: Able to do Basic Kinematic concepts and definitions of Mechanism

CO2: Conversion with Kinematic Analysis and synthesis

CO3: Able to understand the concept of friction in power transmission

CO4: Understanding balancing in machine components

UNIT-1 **9 Hours**

Kinematic fundamental: Introduction to mechanisms and its terminologies - Degree of freedom – Mobility - Kutzbach criterion - Grubler's criterion for planar mechanisms, Grashoff's law, Kinematic Inversions of 4-bar chain - Single slider and double slider crank chains, Quick return mechanism, Limiting positions, Mechanical advantage - Transmission angle and toggle position, Ratchets and escapements, Indexing Mechanisms, Rocking Mechanisms, Straight line generators.

Kinematic Analysis: Graphical analysis of position, velocity and acceleration of simple mechanisms having turning, sliding and rolling pair, Coriolis acceleration using graphical relative motion method, Aronhold-Kennedy Theorem, Instantaneous center method - Four bar and slider crank mechanisms - Analytical method for four bar and slider crank mechanisms.

Mechanism Synthesis: Classification of kinematic synthesis problems - Two position synthesis of slider crank and crank rocker mechanisms, Three position synthesis of double rocker mechanism, Chebychev spacing for precision positions, Freudenstein analytical method.

UNIT-2 9 **Hours**

Cams: Fundamental law of Cam, Cam Terminology, Classification of Cams and followers, Analysis of follower motions (Displacement, velocity, Acceleration and jerk) – Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Generation of Cam Profiles by Graphical Method.

Mechanism Trains: Spur gear terminology and definitions, fundamental law of gearing, Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Force analysis, Interference and Undercutting, Gear trains, Speed ratio, train value, Parallel axis gear trains, Epicyclic Gear Trains

Friction Effects: Single plate and cone clutches, Anti friction bearing, friction circle, friction axis.

Flexible Mechanical Elements: Belt and chain drives, Initial tension, Effect of centrifugal tension on power transmission, Maximum power transmission capacity, Belt creep and slip.

Brakes: Internal expanding shoe brake.

UNIT-3 **9 Hours**

Mechanism for Control (Governors): Governors - Watt, Porter, Proell, Hartnell. Performance parameters: Sensitiveness, Stability, Hunting, Isochronism. Governor Effort and Power, Controlling Force & Controlling Force Curve, Friction & insensitiveness, Comparison between governor and flywheel.

Mechanism for Control (Gyroscope): Introduction to Gyroscopes. Gyroscopic forces and Couple. Effect of Gyroscopic Couple on Aeroplanes, Gyroscopic stabilization of ship, Stability of Two Wheelers and Four Wheelers. Rigid disc at an angle fixed to rotating shaft.

UNIT-4 **9 Hours**

Balancing of rotating components and linkages: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses rotating in same plane and in Different planes. Effect of Inertia Force due to Reciprocating Mass on Engine Frame, Partial balance of single cylinder engines. Balancing of locomotive: variation of tractive force, swaying couple, hammer blow.

Text Books:

1. Kinematics and Dynamics of Machinery by R L Norton, Tata MacGrawHill
2. Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
3. Theory of Machines by S.S.Rattan, Tata MacGrawHill
4. Theory of Machines by Thomas Bevan, CBS Publications

Reference Books:

1. Kinematics and Dynamics of Machinery by Charles E. Wilson and J. Peter Saddler, Pearson Education
2. Mechanism and Machine Theory by J.S. Rao and R.V. Dukipatti, New Age International.
3. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East WestPress.
4. Kinematics and Dynamics of Machines by G.H. Martin, McGraw-Hill.
5. Mechanisms and Dynamics of Machinery by Hamilton H Mabie and Charles F Reinholtz, John- Wiley and Sons.
6. Kinematics, Dynamics, and Design of Machinery by Kenneth J Waldron and Gary L Kinzel, John-Wiley and Sons.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	-	2	-	-	1	-	-	-	1	3	-	1
CO2	3	2	2	-	2	-	-	1	-	-	-	1	3	-	1
CO3	3	2	2	-	2	-	-	1	-	-	-	1	3	-	1
CO4	3	2	2	-	2	-	-	1	-	-	-	1	3	-	1

Applied Thermodynamics			
Hours/Week L-T-P:	3-0-0	Credits:	3
Course Type:	Professional Core	Course Code:	MS2103

Course Objectives:

To familiarize the students to understand the fundamentals of thermodynamics and to perform thermal analysis on their behavior and performance.

(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)

Course Outcomes:

Upon the completion of this course the students will be able to

CO1: Apply the first law of thermodynamics for simple open and closed systems under steady and unsteady conditions.

CO2: Apply second law of thermodynamics to open and closed systems and calculate entropy and availability.

CO3: Apply Rankine cycle to steam power plant and compare few cycles improvement methods

CO4: Derive simple thermodynamic relations of ideal and real gases and calculate the properties of gas mixtures and moist air and its use in psychometric processes

UNIT-1 9 Hours

BASIC CONCEPTS: concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive, total and specific quantities. System and their types. Thermodynamic Equilibrium State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work. P-V diagram. Zeroth law of thermodynamics — concept of temperature and thermal equilibrium– relationship between temperature scales –new temperature scales. First law of thermodynamics –application to closed and open systems — steady and unsteady flow processes. Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries.

UNIT-2 **9 Hours**

ENTROPY, EXERGY: Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. Applications of II Law. High and low grade energy. Available and non-available energy of a source and finite body. Exergy and irreversibility. Expressions for the energy of a closed system and open systems. Energy balance and entropy generation. Irreversibility. I and II law Efficiency.

UNIT-3 9 Hours

PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE: Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles.

UNIT-4 9 Hours

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties. Compressibility factor- Principle of Corresponding states. - Generalized Compressibility Chart and its use-. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations. Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture — Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function.

Text Books:

1. Nag. P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, New Delhi, 2013.
2. R.K. Rajput, "A Text Book Of Engineering Thermodynamics ", Fifth Edition,2017.
3. Yunus a. Cengel & Michael a. Boles, "Thermodynamics", 8th edition 2015.

Reference Books:

1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2. Borgnakke & Sonntag, "Fundamental of Thermodynamics", 8th Edition, 2016.
3. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
4. Michael J. Moran, Howard N. Shapiro, "Fundamentals of Engineering Thermodynamics", 8th Edition.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	-	-	-	-	-	-	1	3	2	2
CO2	3	3	3	2	1	-	-	-	-	-	-	1	3	2	2
CO3	3	3	3	2	1	-	-	-	-	-	-	1	3	2	2
CO4	3	3	3	2	1	-	-	-	-	-	-	1	3	2	2

Introduction to Material Science			
Hours/Week L-T-P :	3-0-0	Credits:	3
Course Type :	Professional Core	Course Code:	MS2105

Course Objectives:

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2. To provide a detailed interpretation of equilibrium phase diagrams

Course Outcomes:

At the end of the course, students will be able to

CO1: Identify crystal structures for various materials and understand the defects in such structures

CO2: Understand how to tailor material properties of ferrous and non-ferrous alloys

CO3: Apply quantify mechanical integrity and failure in materials

CO4: Analyze different phases and heat treatment methods or the properties of Fe-C alloys

UNIT-1 9 Hours

Classification of Engineering Materials, Engineering properties of materials. Characteristic property of metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals, calculation of packing density, voids in common crystal structures and imperfections crystals.

UNIT-2 9 Hours

Concept of plastic deformation of metals, critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, concept of cold working preferred orientation. Annealing; recovery; recrystallization and grain growth; hot working.

Concept of alloy formation, types of alloys, solid solutions, factors governing solids solubility viz. size factor, valency factor, crystal structure factor and chemical affinity factor; order/disorder transformation.

UNIT-3 *9 Hours*

Binary phase diagrams (a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d) Eutectoid system and (e) Peritectoid system. Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors and microstructure of different alloys belonging to those systems, Effect of non-equilibrium cooling, coring and homogenization. Iron cementite and iron graphite phase diagrams, microstructure and properties of different alloys (alloy steels; stainless steel, tool steel, HSS, high strength low alloy steel) types of cast iron, theirmicrostructures and typical uses. Specification of steel. T.T.T. diagram: concept of heat treatment ofsteels i.e. annealing, normalizing, hardening and tempering; microstructural effects brought about bythese processes and their influences on mechanical properties; factor affecting hardenability.

UNIT-4 *9 Hours*

Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres.

Plastic-: Thermosetting and thermoplastics.

Ceramics: Types, structure, Mechanical properties, application

Composite Materials: Agglomerated Materials: Cermets, Reinforced Materials: Reinforced Concrete. Fibre reinforced plastics, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite.

Text Books:

1. Introduction to Physical Metallurgy by Avner, Tata McGrawHill
2. Materials Science and Engineering by W.D. Callister, Wiley and Sons Inc.
3. Physical Metallurgy: Principles and Practice by Ragahvan, PHI

Reference Books:

1. Engineering Physical Metallurgy and Heat Treatment by Y. Lakhtin, Mir Publisher, Moscow.
2. Elements of Material Science and Engineering, L.H.Van Vlack, Addison Wesley
3. Materials Science and Engineering by V. Raghavan, Prentice Hall of India Pvt. Ltd. Pearson
4. Mechanical Metallurgy by Dieter, Tata Mac GrawHill
5. Composite Material science and Engineering by K. K. Chawla, Springer
6. Material Science and Metallurgy, by U. C. Jindal, Pearson

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	1	1	-	-	-	3	1	3	3	3
CO2	3	2	3	2	1	-	2	-	-	-	3	1	3	3	1
CO3	3	3	3	2	1	-	3	-	-	-	3	1	3	3	2
CO4	2	2	3	2	1	-	3	-	-	-	-	1	3	3	3

Modern Robotics			
Hours/Week L-T-P :	3-0-0	Credits:	2
Course Type :	Advanced Competency Course	Course Code:	MS2107

Course Objectives:

1 To introduce definition, history of robotics and robot anatomy.
2 To learn the simulation of robot kinematics
3 To study the grasping and manipulation of robots.
4 To study about mobile robot and manipulation.
5 To study the applications of industrial, service, domestic robots.

Course Outcomes:

At the end of the course the students would be able to

CO1: Discuss the definition, history of robotics and robot anatomy.
CO2: Develop the simulation of robot kinematics
CO3: Describe the grasping and manipulation of robots.
CO4: Explain about mobile robot and manipulation.

UNIT I **10 hours**

Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.

Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation and rotation matrices Dennavit and Hartenberg (D-H) transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system.

UNIT-II **9 Hours**

Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.

UNIT-III **9 Hours**

Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control

UNIT-IV **7 Hours**

Application of robotic: industrial robots, Service robots, domestic and house hold robots, Medical robots, military robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare

TEXT BOOKS:

1. Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch, Frank C. Park,

Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715

2. Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751

REFERENCES:

1. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June

2019)ISBN-10 : 1682856763

2. Advanced Technologies in Modern Robotic Applications, by ChenguangYang , Hongbin Ma Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018), ISBN-10 : 981109263X

3. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451

4. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard

Edition (30 August 2018), ISBN-10 : 1788835441

5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10 : 1639873732

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	1	2	-	-	-	1	-	-	1	1	2	3
CO2	2	1	3	1	2	-	-	-	1	-	-	1	1	2	3
CO3	2	1	3	1	2	-	-	-	1	-	-	1	1	2	3
CO4	2	1	3	1	2	-	-	-	1	-	-	1	1	2	3

Organizational Behaviour			
Hours/Week L-T-P :	3-0-0	Credits:	2
Course Type :	Mandatory/ Common Course	Course Code:	BH2437

Course Objectives:

i) To understand how individual, groups and structure have impacts on the organizational effectiveness.
ii) To learn the basic concepts of Organizational Behaviour and its applications in contemporary organizations.
iii) To appreciate the theories and models of organizations in the workplace to creatively and innovatively engage in solving organizational challenges.
iv) To learn and appreciate different cultures and diversity in the workplace.

Course Outcome:

i) Able to analyse and compare different models used to explain individual behavior related to motivation.
ii) Understanding how individual, groups and structure have impacts on the organizational effectiveness.
iii) Learning the basic concepts of Organizational Behaviour and its applications in contemporary organizations.
iv) Learning and appreciating the different cultures and diversity in the workplace. Understanding the group dynamics and demonstrating skills required to work in teams.

UNIT-I: Individual Level **11 Hours**

The study of Organizational Behaviour: Definition, Meaning, Why study OB; Learning – Principles of learning and learning theories: Classical Conditioning and Operant conditioning, Personality-Meaning, Determinants, Types of Personality, Perception- Perceptual Process, perceptual errors, Attitude (cognitive dissonance), Motives and Motivation-Nature and Process, Theories of Motivation (Herzberg, Maslow, ERG, Vroom's expectancy theory) .

UNIT-II: Group level-I **6 Hours**

Groups in Organizations –Nature, Types, Group formation, Determinants, factors contributing to Group Cohesiveness, Group Decision Making Process: Brainstorming and Nominal group technique

UNIT-III: Group level-II **6 Hours**

Types of Leadership- Effective Leadership, Styles of leadership: Autocratic, Democratic and Lassiez faire, Leadership Theories-Trait Theory and Contingency Theory(SLT, Path-goal theory and Fred Fiedler's model), Conflict- Types of conflict, Conflict Resolution Techniques, Emotional Intelligence, Emotions and Stress in workplace.

UNIT-IV: Structural level **7 Hours**

Organizational Culture: Cultural dimension and organizational effectiveness, Organizational Change: Types of change, Process of change, Reasons to change, Resistance to change and managing resistance to change.

Text Books:

1. Stephens P Robbins, Organisational Behaviour, PHI
2. K. Aswatthappa, Organisational Behaviour, HPH

Reference Books:

1. Kavita Singh, Organisational Behaviour, Pearson
2. D.K.Bhttacharya, Organisational Behaviour, OUP
3. PradeepKhandelwal, Organisational Behaviour, TMH
4. Keith Davis, Organisational Behaviour, McGrawHill
5. Nelson Quick, ORGB, Cengage Learning

Material Testing Laboratory			
Hours/Week L-T-P :	0-0-3	Credits:	1.5
Course Type :	Laboratory Course	Course Code:	MS2501

Course Objectives:

1. Determine the tensile strength/ compressive strength/ bending strength of materials by Universal Testing Machine
2. Identify the Strain measurement using Strain Gauge
3. Apply the concept of estimation of Spring Constant under Tension and Compression
4. Analyze the Brinnel, Rockwell and Vickers Hardness strength of materials

Course Outcomes:
Upon completion of this course, the students will be able to:

CO 1 Determine the tensile strength/ compressive strength/ bending strength of materials by Universal Testing Machine.
CO2 Identify the Strain measurement using Strain Gauge.
CO3 Apply the concept of estimation of Spring Constant under Tension and Compression.
CO4 Analyze the Brinnel, Rockwell and Vickers Hardness strength of materials.

Prerequisites: Mechanics of Material

List of Experiments:(Any Eight)

1. Study of microstructure of steel specimen.
2. Determination of tensile strength/ compressive strength/ bending strength of materials by Universal Testing Machine
3. Double shear test in Universal Testing Machine
4. Determination of Impact strength of material (Charpy and Izod)
5. Determination of Hardness strength of materials (Brinnel, Rockwell andVickers)
6. Determination of Rigidity modulus of material
7. Determination of Fatigue strength of material
8. Estimation of Spring Constant under Tension and Compression.
9. Strain measurement using Strain Gauge.
10. Stress measurement using strain rosette

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	1	1	2	1	1	1	2	3	2	2
CO2	3	2	1	2	-	1	1	2	3	2	1	2	2	2	2
CO3	3	2	2	2	-	2	1	2	2	1	1	2	2	2	1
CO4	2	2	1	2	-	2	1	1	2	2	1	2	2	2	1

Thermal Engineering Laboratory-1			
Hours/Week L-T-P:	0-0-3	Credits:	1.5
Course Type:	Laboratory Course	Course Code:	MS2503

Course Objectives:

- To identify the behavior of analytical models introduced in lecture to the actual behavior of real fluid flows.
- To explain the standard measurement techniques of fluid mechanics and their applications.
- To illustrate the students with the components and working principles of the Hydraulic machines- different types of Turbines, Pumps, and other miscellaneous hydraulics machines.
- To analyze the laboratory measurements and to document the results in an appropriate format.

Course Outcomes:

Students who successfully complete this course will have demonstrated ability to:

CO1: Describe the measurement techniques of fluid mechanics and its appropriate application.
CO2: Interpret the results obtained in the laboratory for various experiments.
CO3: Compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows and draw correct and sustainable conclusions

CO4: Perform test on centrifugal pump, reciprocating pump, turbines.

List of Experiments:

Any 10 experiments from the following

1. Experiments on flow through pipes and application of Bernoulli's principle
2. Determination of metacentric height and application to stability of floating bodies.
3. Determination of C_v and C_d of orifices.
4. Experiments on impact of jets
5. Experiments on performance of centrifugal pump
6. Experiments on performance of reciprocating pump
7. Experiments on Reynold's Apparatus
8. Experiments on performance of gear oil pump
9. Verifications of momentum equation
10. Study on Pelton / Francis / Kaplan Turbine
11. Study of steam power plant.
12. Study of refrigeration system.
13. Study of gas turbine power plant.
14. Measurement of steam quality using calorimeter
15. Verification of Joule-Thomson coefficient.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	1	-	-	1	-	2	3	2	2
CO2	3	2	1	-	-	-	1	-	-	1	-	2	3	2	2
CO3	3	2	1	-	-	-	1	-	-	1	-	2	3	2	2
CO4	2	2	1	2	-	1	-	1	3	2	1	2	2	1	1

Machine Dynamics Laboratory			
Hours/Week L-T-P :	0-0-3	Credits:	1.5
Course Type :	Laboratory Course	Course Code:	MS2505

Course Objectives:

1. Determine the vibration parameters of a vibrating system.
2. Predict the radius of gyration and moment of inertia of vibrating system.
3. Verify the static and dynamic balancing.
4. Study the effect of gyroscopic couple and operations of robotic arm.

Course Outcomes:

CO1: Understand the various practical demonstrations of forces in mechanism.

CO2: Knowledge of various design features of mechanism with practical demonstration.

CO3: Learning the Special purpose mechanism (governor, Gyroscope Cam and followers etc. used in designing of a machine.

CO4: Measure the amplitude of vibration in damped and un damped vibrating system

List of experiments:

1. To perform experiment on watt and Porter Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
2. To perform experiment on Proell Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
3. To perform experiment Hartwell Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
4. To perform the experiment for static balancing on static balancing machine.
5. To perform the experiment for dynamic balancing on dynamic balancing machine.
6. Determine the moment of inertial of connecting rod by compound pendulum method and tri-flair suspension pendulum.
7. To determine gyroscopic couple on Motorized Gyroscope.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	-	1	1	2	1	1	1	2	3	2	2
CO2	1	2	1	2	-	1	1	2	2	1	1	1	2	1	2
CO3	1	1	2	2	-	2	1	2	2	1	1	2	2	2	1
CO4	1	2	1	2	-	2	2	1	2	2	1	2	2	2	1

Mechatronics and Robotics Laboratory			
Hours/Week L-T-P :	0-0-3	Credits:	1.5
Course Type :	Advanced Competency Course- Lab	Course Code:	MS2507

Course Objectives:

To impart knowledge on

1. Fundamentals of fluid power and Mechatronics and primary actuating systems.
2. Programming skills in Programmable logic controllers.
3. Principles of pneumatics and hydraulics and apply them to real life problems.

Course Outcomes:

After completing the course, the student will be able to

CO1 Apply Boolean algebra for logic design of pneumatic circuits.

CO2 Apply Boolean algebra for logic design for hydraulic circuits.

CO3 Build logic circuits for industrial applications.

CO4 Build cascade circuits, automation circuits with PLC for industrial problems, robot movements.

List of experiments: (Any 7)

1. Standard Fluid Power Symbols.
2. Basic Pneumatic Logic Circuits.
3. Pneumatic Circuit for Material Handling System.
4. Electro pneumatic circuit using Relay, Limit Switch and solenoid Valves.
5. Electro-pneumatic circuit for an Automation of Double Acting Cylinder by using proximity Sensors and Cascade System of sequence A+B+ C+ A- B- C
6. Electro –Hydraulic circuit using proximity Sensors.
7. PLC controlled pneumatic Logic circuits
8. PLC controlled pneumatic circuit for Material Handling system
9. Control of Fanuc robot.
10. Robot programming for pick and place application.
11. Assembly and disassembly of PLC controlled based mobile robot.
12. Programming for interfacing of sensors.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	1	1	2	1	1	1	2	3	2	2
CO2	2	1	1	1	-	1	1	2	3	2	1	1	2	2	2
CO3	3	2	2	2	-	2	1	2	2	1	1	1	2	2	1
CO4	2	1	1	2	-	2	1	1	2	2	1	2	2	2	1