VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)
(Revision 2018)

For
Second Year
Of
Four Year Undergraduate Programmes Leading to
Bachelor of Technology (B. Tech) Degree in Mechanical Engineering

Implemented from the batch admitted in First Year, 2018-19

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Bachelor of Technology (B Tech)
In

102 Mechanical Engineering

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

Vision

To establish global leadership in the field of Technology and develop competent human resources for providing service to society

Mission

To provide students with comprehensive knowledge of principles of engineering with a multi-disciplinary approach that is challenging.

To create an intellectually stimulating environment for research, scholarship, creativity, innovation and professional activity.

To foster relationship with other leading institutes of learning and research, alumni and industries in order to contribute to National and International development.

B. Tech. Mechanical Engineering

Program Educational Objectives (PEOs)

1. To attain Analytical, Experimental and Computational expertise in Mathematics, Applied Sciences and Core Engineering subject domain.
2. To discharge responsibilities towards society by achieving high standards of professionalism, leadership and ethical behavior.
3. To comprehend the need for higher studies and lifelong learning so as to remain in competitive and sustainable environment.

Program Outcomes (POs)

PO1: Apply knowledge of mathematics, science and engineering to design, analyze and evaluate mechanical components & complex systems.

PO2: Analyze problems of mechanical engineering including design thermal and manufacturing industrial systems.

PO3: Design, implement, and evaluate mechanical systems and processes considering public health, safety, cultural, societal and environmental issues.

PO4: Design and conduct experiments using domain knowledge and analyze data to arrive at valid conclusions.

PO5: Apply recent techniques, skills, knowledge and computer based methods & tools to solve mechanical problems.

PO6: Analyze the local and global impact of modern technologies on individual organizations, society and culture.

PO7: Apply knowledge of contemporary issues to investigate and solve problems with a concern for sustainability and eco-friendly environment.

PO8: Exhibit responsibility in professional, ethical, legal and social issues.

PO9: Function effectively in teams, in diverse and multidisciplinary areas to accomplish common goal.

PO10: Effective written and verbal communication on complex engineering activities and exhibit leadership qualities.

PO11: Apply management principles to manage projects in multidisciplinary environment.

PO12: Pursue life-long and independent learning as a means to enhance knowledge and skills.

Program Specific Outcomes (PSOs)

Our Graduate should be able to apply principles of Mechanical Engineering to:

1. Specify, manufacture, test, operate and document basic mechanical systems and processes.
2. Analyse, design, develop and implement advanced mechanical systems and processes.
3. Select solutions to the mechanical engineering problems based on ethics, sustainability and long term benefits to society.

SEMESTER- III

	Course Code	Course Name	Hr/Week			Credits	TA	MST	ESE	ESE hours
			L	T	P					
1	R4MA2001S	Mathematics for Mechanical Engineers I	3	1	0	4	20	20	60	3
2	R4ME2001S	Thermodynamics	3	1	0	4	20	20	60	3
3	R4SE2001T	Strength of Materials	3	0	0	3	20	20	60	3
	R4SE2001P	Strength of Materials Laboratory	0	0	2	1	60% CIE + 40% ESE			
4	R4ME2002T	Material Science	3	0	0	3	20	20	60	3
	R4ME2002P	Material Science Laboratory	0	0	2	1	60% CIE + 40% ESE			
5	R4EE2001T	Electrical Machines and Electronic Devices	2	0	0	2	20	20	60	3
	R4EE2001P	Electrical Machines and Electronic Devices Laboratory	0	0	2	1	60% CIE + 40% ESE			
6	R4ME2003L	Machine Drawing Laboratory	1	0	2	2	60% CIE + 40% ESE			
7	R4ME2004A	Economics, Finance and Costing	2	0	0	P/NP	100% CIE			
TOTAL			17	2	8	21				

Abbreviations: L: Lecture, T: Tutorial, P: Practical, TA: Teacher Assessment / Term work Assessment, MST: Mid Semester Tests, ESE: End Semester Written Examination, CIE: Continuous In-semester Evaluation

SEMESTER-IV

	Course Code	Course Name	Hr/Week			Credits	TA	IST	ESE	ESE hours
			L	T	P					
1	R4MA2002S	Mathematics for Mechanical Engineers II	3	1	0	4	20	20	60	3
2	R4ME2005S	Kinematics of Machinery	3	1	0	4	20	20	60	3
3	R4ME2006T	Fluid Mechanics	3	0	0	3	20	20	60	3
	R4ME2006P	Fluid Mechanics Laboratory	0	0	2	1	60% CIE + 40% ESE			
4	R4ME2007T	Manufacturing Processes	3	0	0	3	20	20	60	3
	R4ME2007P	Manufacturing Processes Laboratory	0	0	2	1	60% CIE + 40% ESE			
5	R4ME2008T	Mechanical Measurements	3	0	0	3	20	20	60	3
	R4ME2008P	Mechanical Measurements Laboratory	0	0	2	1	60% CIE + 40% ESE			
6	R4CH2001P	Environmental Studies	1	0	1	P/NP	60% TA+40%ESE			
TOTAL			16	2	7	20				

Abbreviations: L: Lecture, T: Tutorial, P: Practical, TA: Teacher Assessment / Term work Assessment, MST: Mid Semester Tests, ESE: End Semester Written Examination, CIE: Continuous In-semester Evaluation

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4MA2001S**	
Course Title	**Mathematics for Mechanical Engineers – I**	
Prerequisites	**Mathematics for Engineers– I, Mathematics for Engineers – II**	

COURSE OUTCOMES

The student should be able to –

1. Determine, and apply, the important quantities associated with scalar fields and vector fields, such as the gradient vector, directional derivative, the divergence, curl. and to evaluate line, surface, and volume integrals to verify the integral theorems (Green's theorem in the plane, Gauss' divergence theorem and Stokes' theorem).
2. Use basic knowledge of Fourier series and develop Fourier series of periodic functions
3. Demonstrate the ability to evaluate Laplace as well as Inverse Laplace Transform of function and solve the ordinary differential equations and linear time invariant systems.
4. Introduction to partial differential equations (PDEs) and their applications to engineering sciences.
5. Demonstrate knowledge of Matrix calculations as an elegant and powerful mathematical language in connection with Eigen value and Eigen vector, Diagonalization.

Course Contents

Basic Concepts of Vector Calculus

Scalar and vector point function, differential operator, gradient, directional derivative, physical meaning of gradient, divergence, curl and Laplacian with their properties

Line Integrals, Surface Integral, Volume integral

Green's theorem, Gauss' theorem and Stoke's theorem & its application.

Fourier Series

Definition of Fourier series, Orthogonal and orthonormal functions

Fourier series with arbitrary period, in particular periodic function with period 2π

Fourier series of even and odd function

Half range Fourier series.

Laplace Transforms and Applications

Introduction, Definition of the Laplace transform

Useful properties of Laplace transform (without proof): Linearity, Frist shifting theorem, Multiplication and division by t, Transforms of derivatives and integrals, Heaviside unit step function, Dirac's delta function, Second shifting theorem, Laplace transform of Periodic function

Inverse Laplace transform using partial fraction and Convolution theorem (without proof) Application to solve initial and boundary value problem involving ordinary differential equations with one dependent and constant coefficient.

Partial Differential Equation

Second order PDE of mathematical physics (Heat, wave and Laplace equation, one dimensional with standard boundary conditions)

Solution by separation of variable method using Fourier series.

Matrices

Eigen values Eigen vectors of square matrix

Cayley Hamilton's theorem and function of square matrix

Diagonalization of square matrix

Minimal Polynomial and Minimal Equation of a Matrix

Text Books

1. Dass H.K., Advanced Engineering Mathematics, S. Chand & Co. Ltd., Third Edition, 2006
2. Grewal B.S., Higher Engineering Mathematics, Khanna Publications, Forty-third Edition, 2015
3. Kumbhojkar G. V., Applied Mathematics– III, C. Jamnadas & Co., 2011

Recommended Reading

1. Kreyszing E., Advanced Engineering Mathematics, John Wiley & Sons, Singapore, Int. Student Edition, 1995.
2. Wiley C. R., Advanced Engineering Mathematics, McGraw Hill Inc., New York Edition, 1993.
3. O'Neel Peter., Advanced Engg. Mathematics, Thompson, Singapore, Ind. Edition, 2002.
4. Greenbar Michael D., Advanced Engg. Mathematics, Pearson, Singapore, Ind. Edition, 2007.
5. Ramana D. V., Higher Engg. Mathematics, The McGraw-Hill Inc., New Delhi, 2007.
6. Marsden J. E., Tromba A., Weinstein A., Basic multivariable calculus, Springer, 1993.
7. A. R. Vasishtha, A. K. Vasishtha, Matrices, Krishna Prakashan Media, 1991

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	✓	✓	✓										✓	✓	
CO2	✓	✓		✓									✓	✓	
CO3	✓	✓		✓									✓	✓	
CO4	✓	✓	✓	✓									✓	✓	
CO5	✓			✓	✓								✓	✓	

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4ME2001S**	
Course Title	**Thermodynamics**	
Prerequisites	**Applied Physics-II, Mathematics for Engineers – I & II**	

COURSE OUTCOMES

The student should be able to –

1. Apply the Laws of Thermodynamics to different systems.
2. Analyse the thermodynamic performance of Power Cycles.
3. Examine the performance of steam generators
4. Examine the performance of steam nozzles and turbines.

Course Contents

Thermodynamic Concepts & First Law of Thermodynamics

Intensive and Extensive Properties, Path, Process, Cycle.
Thermal Equilibrium and Zeroth Law of Thermodynamics.
First Law of Thermodynamics, Internal energy, Enthalpy.
Throttling, Joule's porous plug experiment, Joule – Thomson coefficient, inversion curve.

Properties of Pure Substances

Introduction to steam as working substance, Dryness fraction, Use of Steam Table and Mollier Chart to find out specific volume, enthalpy, entropy and internal energy for wet, dry-saturated and superheated steam. Pressure-Volume, Temperature-Entropy and Enthalpy-Entropy diagrams.
Control Volume Analysis for steady-state steady-flow reversible processes, Application to many open systems like Compressor, Turbine, Boiler, Condenser, Nozzles, Diffusers etc.
Components of steam power plant.

Second Law of Thermodynamics

Concept of Heat Engine and its thermal efficiency, Concepts of Refrigerator & Heat Pump.
Second Law Statements: Kelvin–Planck Statement, Clausius Statement, their equivalence, Thermodynamic temperature scale, Clausius Equality and Inequality, Concept of Entropy, Principle of increases of entropy.
Introducing the *TdS* Equations, Entropy Change of an Ideal Gas, Entropy Change in Internally Reversible Processes of Closed Systems, Entropy Balance for Closed Systems, Entropy Balance for Control volume, Isentropic Efficiencies of Turbines, Nozzles, Compressors and Pumps,
Maxwell Equations.

Thermodynamic Cycles

Thermodynamic analysis of Carnot, Rankine, Otto, Diesel, Brayton, Joule cycle.

Steam Generators

Classification of Boilers, Ideal requirements of a Boiler, Fire tube and Water tube boiler, Low pressure and high pressure boilers, important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance test, Boiler efficiency.

Steam Turbine

Steam Nozzle: Isentropic flow of Steam through Convergent and Convergent-Divergent Nozzles, Nozzle efficiency, Velocity Coefficient.

Steam Turbine: Basic of steam turbine, Classification, Pressure and Velocity variation along the flow direction, Compounding of turbine,

Impulse turbine – velocity diagram, condition for max efficiency,

Reaction turbine – velocity diagram, degree of reaction, Parson's turbine, Condition for maximum efficiency.

Text Books

1. R. Yadav, Fundamentals of Thermodynamics & Heat Engines–Vol I, Fifth Edition, Central Publishing House, Allahabad, 2012.
2. R. Yadav, Applied Thermodynamics & Heat Engines –Vol II, Fifth Edition, 2012.
3. Domkundwar, Kothandaraman & Domkundwar, A course in Thermal Engineering, Dhanpat Rai & Co., Third Edition, 2016.
4. P. K. Nag, Basic & Applied Thermodynamics, McGraw-Hill Education, Second Edition, 2009.

Recommended Reading

1. Moran & Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons Inc., Ninth Edition, 2018.
2. Yunus A. Cengel and Michael A. Boles, Thermodynamics: An Engineering Approach, McGraw-Hill Higher Edition, Eighth Edition, 2017.
3. Sonntag, Borgnakke & Van Wylen, Fundamentals of Thermodynamics, John Wiley & Sons Inc., Ninth Edition, 2017.
4. Y. V. C. Rao, Theory and Problems in Thermodynamics, Second Edition, 2012.
5. W. Kearton, Steam Turbine, CBS Publication, Third Edition, 2010.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	√	√						√				√	√	√	
CO2	√	√	√									√	√	√	
CO3	√	√	√	√			√					√	√	√	√
CO4	√	√	√	√								√	√	√	

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4SE2001T**	
Course Title	**Strength of Materials**	
Prerequisites	**Engineering Mechanics, Mathematics for Engineers-I & II**	

COURSE OUTCOMES

Upon successful completion of the course, students should be able to -

1. Analyse effect of various types of loading and stresses on structural elements.
2. Interpret shear force and bending moment diagrams.
3. Compute slope and deflection in a beam.
4. Apply column theory to problem solving.

Course contents

Simple Stresses and Strains

Mechanical properties of materials, analysis of internal forces, simple stress and strain, stress-strain curve, Hooke's law, modulus of elasticity, shearing, thermal stress, Hoop stress, Poisson's ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants.

Principle stresses and strains

Uni-axial stress , simple shear, general state of stress for 2Delement, ellipse of stress, principle stresses and principal planes, principal strains, shear strains, strain rosettes, Mohr's circle for stresses and strains.

Strain energy and resilience

Load deflection diagram, strain energy, proof resilience, stresses due to gradual, sudden and impact loadings, shear resilience, strain energy in terms of principal stresses.

Stresses in Beams

Moment of inertia of different sections, bending and shearing stresses in a beam, theory of simple bending, derivation of flexural formula, economic sections, horizontal and vertical shear stress, distribution shear stress for different geometrical sections- rectangular, solid circular, I-section, other sections design for flexure and shear.

Combined Stresses

Combined axial and flexural loads, middle third rule, kernel of a section, load applied off the axes of symmetry.

Shear and Moment in Beams: Shear and moment, interpretation of vertical shear and bending moment, relations among load, shear and moment.

Beam Deflections

Differential equation of deflected beam, slope and deflection at a point, calculations of deflection for determinate beams by double integration and Macaulay's method, Method of superstition

Torsion

Introduction and assumptions, derivation of torsion formula, torsion of circular shafts, stresses and deformation in determinate solid/ homogeneous/composite shafts, torsional strain energy.

Columns and Struts

Concept of short and long Columns, Euler and Rankine's formulae, limitation of Euler's formula, equivalent length, eccentrically loaded short compression members.

Thin Cylindrical and Spherical Shells

Cylinders and Spheres shells subjected to internal pressure.

Text Books

1. S. Ramamrutham, Strength of Materials, Dhanpat Rai & Sons, New Delhi.
2. F.L. Singer and Pytel, Strength of Materials, Harper Collins Publishers, 2002.
3. S. Timoshenko, Strength of Materials: Part-I (Elementary Theory and Problems), CBS Publishers, New Delhi.

Recommended Reading

1. E.P. Popov, Introduction to Mechanics of Solid, prentice- Hall, Second Edition 2005.
2. S.H. Crandall, N.C. Dahl and T.J.Lardner, An introduction to the Mechanics of Solids, Tata McGraw Hill, Third Edition, 2017.
3. S.B. Punmia, Mechanics of Structure, Charotar Publishers, Anand.
4. B.C. Punmia, Ashok Jain, and Arun Jain, Strength of Materials, Laxmi Publications.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	√	√	√										√	√	
CO2	√	√	√	√	√		√					√	√	√	
CO3	√	√	√										√	√	
CO4	√	√	√										√	√	

Programme Name	**Bachelor of Technology in Mechanical Engineering**	**Semester – III**
Course Code	**R4SE2001P**	
Course Title	**Strength of Materials Laboratory**	
Prerequisites	**Engineering Mechanics, Mathematics for Engineers-I & II**	

COURSE OUTCOMES

The student should be able to -

1. Predict material behaviour under the axial, shear and bending action.
2. Select appropriate material for various structural elements.

List of Experiments

1. Tension test on mild steel bar
2. Tension test on tor steel bar
3. Shear test on mild steel bar
4. Tension test on steel plates
5. Flexural test on steel plates
6. Bend and rebend test on mild and tor steel
7. Torsion test on mild and tor steel.
8. Brinnel's Hardness tests on metal specimen
9. Impact test on metal
10. Compression test on wood
11. Tensile test on wood specimen
12. Flexural test on wood

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	√	√	√	√	√								√	√	
CO2	√	√	√	√		√	√	√			√	√	√	√	√

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4ME2002T**	
Course Title	**Material Science**	
Prerequisites	**Applied Physics-I, Engineering Chemistry-I & II**	

COURSE OUTCOMES

The student should be able to –
1. Apply concepts in materials science to solve engineering problems.
2. Interpret Iron-Iron carbide diagram, TTT diagram & their significance
3. Compare various material used for engineering application

Course Contents

Solid Crystalline Structure

Crystallization of liquid into solid state, Nucleation and growth in metals and alloys, Formation of polycrystalline and single crystals, Classification of crystal structure, FCC, BCC and HCP lattice, Lattice structure, unit cell, packing density and co-ordination number, their importance, Crystallographic notations – Methods for planes and directions.

Lattice Imperfections

Definition, classification and significance of imperfections, Point defects, vacancy, interstitially and impurity atom defects, their formation and effects, Dislocations: Edge and screw dislocations Burger's reactor, Motion of dislocations and their significance, Surface defects, Grain boundary, sub-angle grain boundary and stacking faults, their significance Generation of dislocation, Frank Reed source, conditions of multiplications and significance.

Deformation

Definition, elastic and plastic deformation and their significance in design and shaping, Deformation in single crystal and polycrystalline materials, Mechanisms of deformation, Critical stress for deformation. Deformability of FCC, HCP and BCC lattice, slip systems.

Strain Hardening

Definition and importance of strain hardening, Dislocation theory of strain hardening, effects of strain hardening on engineering behavior of materials, Recrystalization Annealing, Theory and stages of recovery, Recrystalization and grain growth, Factors affecting recrystalization, Recrystalization temperature, Hot and cold working theory, Their advantages, limitation and applications.

Constitution of Alloys

Introduction, classification, pure metal, interstitial and intermetallic compounds, Solid solution and its types, phase rule, cooling curves for pure metals and alloys, Phase diagrams: Equilibrium diagram of a binary system in which the components from eutectic In solid state (Lead-Antimony phase diagram).

Equilibrium diagram of a binary system in which there is a complete solubility, In liquid and solid state (copper-nickel phase diagram), Equilibrium diagram of a system in which components have completed Mutual, Solubility in liquid state and limited solubility in solid state and solid solubility, Decrease with the temperature (Lead-tin phase diagram).

Iron-Carbon Equilibrium Diagram:

Allotropy of iron, study of transformation in iron-carbon equilibrium diagram, Definition of structures, study of microstructures, effect of carbon content on Structure and properties of plain carbon steels, critical temperature lines, and effect of Minor constitutes and curves.

Heat Treatment of Steels:

Annealing, normalizing, hardening, and tempering of steels, Surface heat treatments (case hardening), Chemical heat treatments such as carburizing, nit riding, cyaniding, Flame hardening and Induction hardening.

Cast Irons

White, gray, malleable, chilled, S.G. Mechanize Cast iron, alloy cast irons, Effect of Constituents, such as silicon, sulfur, Manganese, phosphorous on cast iron, Mechanical properties and uses of different cast iron.

Alloy Steels

Effect of alloying elements on the structures, properties and applications of steels, such as manganese, nickel, chromium, tungsten, molybdenum and silicon steels.

Effect of alloying elements in steels, Limitations of plain carbon steels, significance of alloying elements. Classification of tool steels and metallurgy of tool steels and special steels. Stainless Steels.

Non-Ferrous Metals and Alloys

Copper and its alloys, Aluminum and its alloys, Nickel and its alloys, Zinc and its alloys and Lead and its alloys.

Fatigue failure

Definition of fatigue and significance of cyclic stress, Mechanism of fatigue and theories of fatigue failure, Fatigue testing, Test data presentation and statistical evaluation, S. N. Curve and its interpretation, Influence of important factors on fatigue, Notch effect surface effect, Effect of pre-stressing, corrosion fatigue and thermal fatigue.

Creep Failure

Effect of temperature on mechanical behavior of materials, Definition and signification of creep, Creep testing and data presentation, Mechanisms and types of creep, Analysis of classical creep curve and Creep Resistant materials.

Powder Metallurgy

Powder making methods, Powder compaction, Sintering, Sintering mechanism, Applications of power metallurgy.

Introduction to New Materials

1. Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications.

2. Nano-Materials: Introduction, Concepts, synthesis of nano-materials, examples, applications and nano-composites.

3. Polymers: Basic concepts, Processing methods, advantages and disadvantages over metallic materials, examples and applications.

Introduction to International Standards/ Codes:

BIS Publications, IS, AISI, ASME section 8, div II, AWS (American Welding Society) Hand Book, ASME section 5 for NDT. Materials specifications commonly used materials for different engineering Components parts.

Text Books

1. Y. Lakhtin, Engineering Physical Metallurgy, Mir publishers, Moscow, First Indian Edition, 2005
2. S.H. Avner, Introduction to Physical Metallurgy, McGraw-Hill Inc., Second Edition
3. V. D. Kodgire, Material Science and Metallurgy, Everest Publication, Pune, Tenth Revised Edition, 2003

Recommended Reading

1. R.A. Higgins, Engineering Metallurgy-Part I, App. Physical Met, ELBS, Revised Sixth Edition, 1993
2. William D. Callister Jr., Materials Science and Engineering-An Introduction, John Wiley & Sons (ASIA) Pvt. Ltd., Singapore, Ninth Edition, 2013
3. Reed Hill, Physical Metallurgy, Cengage Learning, First Edition, 2008
4. W.F.Smith, Foundation of Material Science & Engineering, McGraw Hill, Revised Fifth Edition, 2009

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4ME2002P**	
Course Title	**Material Science Laboratory**	
Prerequisites	**Applied Physics-I, Applied Chemistry-I & II**	

COURSE OUTCOMES

The student should be able to –

1. Identify various defects and failure mechanisms.
2. Compare various material based on their microscopic structure
3. Select appropriate heat treatment process for specific requirements.

List of Experiments [Any TEN]

1. Preparation of specimens for microscopic examination – steels, copper alloys and aluminium alloys; hot mounting and cold mounting and mechanical fixtures.
2. Microstructural study by etching of specimens of steel, copper alloys and aluminium alloys and cast iron.
3. Microstructures of plain carbon steels.
4. Microstructures of cast irons.
5. Observation and drawing of different morphologies of grains – equiaxed dendrites, columnar dendrites, cellular structure, equiaxed grains, polygonal grains, elongated grains.
6. Observation of microstructures using image analyzer, Quantitative Metallography software, models and tools for grain size, shape, phases distribution and porosity.
7. Estimation of phases and drawing of cooling curves for transformation of plain carbon steels with varying carbon contents using Fe-C diagram. Observation and description of microstructures of annealed plain carbon steels.
8. Observations and description of microstructures belonging to various cast irons, brasses, bronzes, wrought and cast aluminium alloys; measurement of their hardness.
9. Annealing, Normalising, Hardening and tempering of medium carbon steel and observation of microstructures.
10. Determination of hardenability of steel using Jominy end Quench Test.
11. Fatigue test – To determine number of cycles to failure of a given material at a given stress.
12. Corrosion rate test
13. Student will bring unknown metallic sample; prepare it for metallographic observation; observe and describe the microstructure with identification of phases present in it.

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4EE2001T**	
Course Title	**Electrical Machines and Electronic Devices**	
Prerequisites	**Basics of Electrical Engineering, Mathematics for Engineers– I & II**	

COURSE OUTCOMES

The student should be able to –

1. Identify various parameters for selection of electrical machines.
2. Analyse the performance of electrical machines.
3. Employ the basics knowledge of electronics for controls.

Course Contents

Single-Phase Induction Motors

Double field revolving theory, analysis of motor equivalent circuit. Split phase, capacitor start and capacitor start run I. M, testing of single phase I. M. Applications of different single phase I.M.

Three-Phase Induction Motors

Construction, principle operation, equivalent circuit, torque equation, torque -slip characteristics, different losses and calculation of efficiency. No load test and blocked rotor test, Load test on 3 phase I. M. Different methods of Speed control of 3 phase I. M., Starter use for 3 phases I. M. Applications of 3 phase I.M.

Synchronous Machines

Alternator: Construction, emf equation, winding factor, armature reaction, synchronous impedance, load characteristics voltage regulation. Use of alternators in power plants. Synchronous Motors: Principle operation, method of starting, V and inverted V curves, applications of Synchronous motors.

Stepper and Servo Motors & Drives

Stepper motor- construction and working principle and applications

Servo motor – types: brushless servo motor, permanent magnet servo motor construction and applications.

Industrial drives- types, group drive, individual drive, multi motor drive,

Stepper motor drive: single stepping and half stepping. Servo drives

Electrical safety: - importance of earthing - electric shock

Variable Frequency Drives

Introduction to Variable Frequency Drives, block diagram of Variable Frequency Drives, principle of operation and working of Variable Frequency Drives.

Introduction to Electronics

Diodes: V-I characteristics, Applications of rectifier diode, Zener diode, LED, photodiode
Operational Amplifiers: Basics-ideal OP-AMP, OP-AMP applications (elementary configurations), CMRR, PSRR, Slew Rate
Introduction to Boolean Algebra, Basic Logic Gates and Truth Tables, digital IC's, registers, timers, counters, multiplexers, de-multiplexers, IC 555 Timer – Block Diagram.
Flip Flops, Counters, Electronic Communication systems

Control systems

Control system design and analysis by Root Locus Method, Control system Design by Frequency response method, stability margin, Nyquist diagram, Bode diagram
P, I and D control actions, P, PI, PD and PID control systems, Transient response:- Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual), Zigler Method

Text Books

1. P.S. Bimbhra, Electrical Machinery, Khanna Publishers, Seventh Edition, 2011
2. B. L. Theraja & A.K. Theraja, Electrical Technology Vol. I & II, S. Chand & Co. Ltd., Twenty-third Edition, 2012
3. M.H. Rashid, Power Electronics, Prentice-Hall of India, Third Edition, First Indian Reprint, 2004
4. Floyd, Electronic Devices, Pearson Education, Ninth Edition, 2012

Recommended Reading

1. M.G. Say, Electrical Machine, A Pitman international text., Fifth Edition, 1984
2. Vukosavic, Slobodan N., Electrical Machine, Springer New York Heidelberg Dordrecht London, Second Edition, 2013
3. P.P. Aearnley, Stepping Motors – A Guide to Motor Theory and Practice, Peter Perengrinus, London, Fourth Edition, 2002
4. K.R. Botkar, Operational Amplifiers, Khanna Publishers, 2008

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4EE2001P**	
Course Title	**Electrical Machines and Drives Laboratory**	
Prerequisites	**Basics of Electrical Engineering, Mathematics for Engineers– I & II**	

COURSE OUTCOMES

The student should be able to –

1. Carry out various tests on electrical machines.
2. Select a particular motor depending on the specified purpose.
3. Employ the principles of electronics for controls.

List of Experiments

1. Load test on 3 phase Induction Motor.
2. O.C. / S.C. test on 3 Phase Induction Motor.
3. Speed control of 3 phase Induction Motor.
4. Performance Test and working of Stepper Motor
5. Performance Test and working of Servo Motor (using Variable Frequency Drive)
6. Implementing study of gates and logic operations like NOT, AND, OR
7. 555 timer as a stable multivibrator
   Operational Amplifier (Adder, Subtracter, Differentiator, Integrator, Inverting and non-Inverting)

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4ME2003L**	
Course Title	**Machine Drawing Laboratory**	
Prerequisites	**Engineering Graphics**	

COURSE OUTCOMES

The student should be able to –

1. Prepare geometrical model of various machine elements.
2. Draw assembly drawing of various machine elements.
3. Draw various machine parts drawing using CAD software.

Course Contents

Introduction to Machine Drawing:

Machine Drawing, Production Drawing, Part Drawing, Assembly Drawing, etc.
Review of dimensioning, notes, Type of section & their use.

Solid Geometry

Intersection of surfaces and solids: - Intersection of prisms, cylinders, cone with prism & cylinder. Both solids in simple position. Primary Auxiliary views, projections of simple machine parts.

Machine Elements Drawings

Preparation of 2-D drawings of standard machine elements (Nuts, Bolts, Keys, Cotter, Screws, Springs, Oil Seals, etc.)

Conventional representation of threaded parts, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components

Types of bearings: Simple, Solid, bushed, I. S. conventional representation of ball and roller bearings.

Pipe Joints: Different types of pipe fittings like sockets, nipples, plugs, bends, Tees, elbows, crosses, etc.

Power transmission elements: Flat belt, V belt, gears, chains, ropes, sprockets

Detailed and Assembly Drawings

Types of Couplings: Muff, Flanged, Protected Flanged, Oldham, Universal.

Types of bearings -: Plummer Block, Foot Step Bearings.

Pipe Joints -: Flanged Joints, Spigot and Socket Joint, Gland and Stuffing Box, Expansion Joint, etc.

Types of Valves: Gate Valve, Stop Valve, Non Return Valve, Needle Valve.

IC Engine parts: Piston, connecting rod, crankshaft etc.

Lathe Tool Post, Machine Vice, Pipe Vice, Screw Jack, etc.

Jigs and Fixtures: Introduction to Jigs and fixtures, Jigs and Fixtures (any two from each)

Introduction to Computer Aided Drafting & Design:

Overview of 2D Drafting: Drawing, Editing, Dimensioning, Layering, Hatching, Array, detailing, detail drawing**,** etc.

3D Geometric Modelling & Assembly: Sketcher – Datum plane – Protrusion – holes – part modelling – extrusion – revolve– sweep –loft – blend – fillet – pattern – chamfer – round – mirror – section – assembly – Drafting - Preparation of Bill of material

Text Books

1. N. D. Bhatt, Machine Drawing, Charotar Publications, Fifty-third Edition, 2014
2. K.I.Narayana, P. Kannaiah, K. Venkata Reddy, Machine Drawing, New Edge publications, Sixth Edition, 2019
3. Sham Tickoo, Customizing AutoCAD 2013, CAD CIM Technologies Publisher, 2013

Recommended Reading

1. Sidheshwar and Kanheya, Machine Drawing, Tata McGraw-Hill Publications, Thirty-seventh Reprint, 2017
2. R.B.Gupta, A Textbook of Machine Drawing, Satya Prakashan Tech. Publication, Sixth Edition, 2012
3. N. D. Bhatt, Engineering Drawing, Charotar Publications, Fifty-third Edition, 2014

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – III*
Course Code	**R4ME2004A**	
Course Title	**Economics, Finance and Costing**	
Prerequisites		

COURSE OUTCOMES

The student should be able to –

1. Understand the basic concepts in economics such as micro and macro-economics, demand and supply and taxation.
2. Apply the economics knowledge to solve problems in taxation and budgeting.
3. Analyse the risk and return of alternative sources of financing.
4. Estimate cash flows from a project, including operating, net working capital, and capital spending
5. Evaluate depreciation and interpret balance statement, profit and loss account.
6. Estimate the product costs by considering direct and indirect costs

Course Contents

Introduction

Introduction to Engineering Economy, Time value of money, Cash flow diagrams, Interest and Interest rate, Discrete compounding and payment.

Economics

Economics and finance basics, Basic concepts; utility, wealth, welfare, price, markets, opportunity cost. Approaches to economics; micro, macro, classical, social; economics of growth. Domestic and international economy. Broad classification of economic functions.

Factors influencing functioning of an economy. Economics of scale, demand and supply effects. Taxation, incentives, budget. Indices of economic trends.

Finance

Finance function in business, goal of finance, profit maximization and others. Sources of finance and their relative importance. Fund allocation, alternative uses of finance. Capital budgeting. Assessment of capital needs. Budgetary control; concept, types of budget. Financial markets. Corporate planning; taxation and other financial incentives, objectives of corporate planning, capital expenditure and financial management, financial statements, fund flow and cash flow analysis.

Interest formulae for discrete compounding and discrete payments- Gradient series factors, Nominal & Effective interest.

Accounting

Financial statements; assets, liabilities, capital, profit, income, expenses. Accounting concepts; Fixed and current assets, short and long term liabilities, reserves and owners funds. Accounting for income and expenses, cash v/s accrual basis, capital and revenue expenditure, capital and operating income, deferred revenue expenditure; depreciation, depletion and

amortization; accounting for fictitious assets and obsolescence, impact of exchange rate variations on corporate financial statements.
Mechanics of accounting; ledger and trial balance based on double entry book keeping. Provision in company law and other legal aspects. Balance sheets, profits and loss statements, annual reports of business enterprises.

Costing

Operating costs. Cost ascertainment; allocation, apportionment, absorption of overheads and non-production cost; overhead analysis, absorption methods, general considerations. Job costing; factory job costing, contract cost.
Unit costing. Marginal costs and breakdown charges. Cost planning and control, standard cost and budgetary control, setting standards, variance analysis. Cost reduction; tools, techniques and productivity.
Comparison of alternatives; selection in present economy, accepting or nor accepting a single alternative of providing equal / unequal services, unequal first cost and unequal lives, evaluation of replacement. Techniques for comparing alternatives; payout periods, rate of return, discounting methods, minimum acceptable rate, net present value, yield, annual capital charge, cash flow, profit incremental discounted cash flow (DCF) returns. Replacement analysis, Economic life of the asset. Depreciation and Depletion.

Text Books

1. Engineering Economics, Tata McGraw Hill, Fourth Edition, 2016.
2. Paul A. Samuelson, Economics, McGraw Hill, Fourteenth Edition, 2008
3. Principles of Economics, PN Chopra, Kalyani Publishers, 2012.
4. Varshneya, Managerial Economics, Sultan Chand and Sons.
5. Prasanna Chandra, Fundamentals of Financial Management, Text and Cases, TMH, 1995.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1						√					√				√
CO2						√					√				√
CO3						√					√				√
CO4						√					√				√
CO5						√					√				√
CO6						√					√				√

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – IV*
Course Code	**R4MA2002S**	
Course Title	**Mathematics for Mechanical Engineers – II**	
Prerequisites	**Mathematics for Engineers – I &II**	

COURSE OUTCOMES

The student should be able to –

1. Use numerical methods to find an approximate solution of algebraic equations using appropriate method and understand the basic concepts of regression and curve fitting.
2. Apply the basic concepts of probability, random variables, probability distribution. Use statistical methodology and tools in the engineering problem solving process.
3. Understand null and research hypothesis, test statistic, level of significance and decision rule.

Course Contents

Numerical Methods

Roots of Algebraic and Transcendental Equations: Bisection, false position, Secant and Newton-Raphson methods, Rate of convergence

Solution of a System of Linear Equations: Gauss elimination, partial pivoting, Gauss-Jacobi and Gauss Seidel methods, Power method for computation of Eigen values

Finite Differences and Interpolation: Finite Differences, Forward, Backward and Central operators, Interpolation by polynomials: Newton's forward, backward interpolation formulae, Gauss & Stirling's central difference formulae, Newton's divided and Lagrange's formulae for unequal Intervals

Numerical Integration: Newton-Cotes formula, Trapezoidal and Simpson's 1/3 and 3/8 formulae, error formulae, Gaussian quadrature formulae for two and three point

Numerical solution of Ordinary Differential Equations: Taylor series method, Euler method, Runge-Kutta method of order three and four for solving first and second order equations, Milne's Predictor-Corrector method

Curve Fitting: Fitting of Linear, Quadratic, Exponential and Logarithmic curves, Least squares method and Engineering Applications

Probability and Statistics

Reorientation: Definition of probability, Exhaustive events, Pair wise independent events, Multiplicative law of probability, Conditional probability, Baye's theorem.

Probability Distributions: Random variable, Mathematical Expectation, Standard Deviation, Binomial, Poisson and Normal distributions, Mean, Median, Mode.

Statistics: Correlation between two variable, application of correlation, evaluation of coefficients of correlation, Rank correlation, Regression, frequency distribution, Binomial, Poisson's distribution and Normal distribution, application to industrial problem.

Data Analysis

Sampling Theory and Estimation: Some basics of sampling, statistical inference, Random samples, sampling distribution, sample mean, variance and other statistics, point estimate and interval estimate confidence of interval, maximum likehood estimate.

Testing of Hypothesis: Test of significance, Chi-square χ^2 test, student's T-test, application of the T-test, Snedecor's variance ratio test or F-test and its application.

Time Series Analysis: Short term fluctuation, trend, Decision theory.

Text Books

1. Sankara Rao K., Numerical Methods for Scientists and Engineers, Prentice Hall of India Private Ltd, New Delhi, Fourth Edition, 2017
2. Kreyszing E., Advanced Engineering Mathematics, John Wiley & Sons, Singapore, Ninth Edition, 2011
3. Devore J. L., Probability and statistics for Engineering and Sciences, Thomson Asia, Singapore, Eighth Edition, 2010.

Recommended Reading

1. Gerald C. F. and Wheatley P.O., Applied Numerical Analysis, Addison-Wesley, Singapore, Seventh Edition, 2007.
2. Conte S. D. and Carl de Boor, Elementary Numerical Analysis-An Algorithmic Approach McGraw-Hill, Third Edition, 1980.
3. Froberg C.E., Introduction to Numerical Analysis, Addison Wesley, Second Edition, 1981.
4. Johnson Richard A., Miller and Freund's, Probability and Statistics, PHI, Eighth Edition
5. Gupta S.C. and Kapoor V. K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons., Eleventh Edition
6. Wiley C. R., Advanced Engineering Mathematics, McGraw Hill Inc., New York Edition
7. Grewal B.S. and Grewal J.S., Numerical methods in Engineering and Science, Khanna Publishers, New Delhi, Eleventh Edition, 2013.
8. Papoulis A., Probability, Random Variables, and Stochastic Processes, Fourth Edition, McGraw-Hill, 2002.

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – IV*
Course Code	**R4ME2005S**	
Course Title	**Kinematics of Machines**	
Prerequisites	**Engineering Mechanics, Mathematics for Engineers – I & II**	

COURSE OUTCOMES

The student should be able to –
1. Identify the mechanisms for various applications.
2. Analyse mechanisms using graphical and analytical methods.
3. Apply the basic kinematic principles for design of machine elements.

Course Contents

Basic Kinematics

Structure, Machine, Link and its types, Kinematics pairs, Kinematic chain and mechanism, Grubbler's criteria, Inversions of kinematic chains, inversions of - four bar chain, single slider crank chain and double slider crank chain.

Inversion of Chain

Study of various mechanisms derived from inversions of following chains with regard to motion of links of mechanism, motion modification, quality of motion transmission(uniform, non uniform, SHM, non – SHM), limiting positions, dead positions, quick return property, applications. Four bar chain (Grashoffian, non-Grashoffian), Single slider crank chain, Double slide crank chain.

Special Mechanisms

Straight line generating mechanisms, Exact straight line generating mechanisms. Mechanism – Peueillier, Hart Approximate straight line generating mechanisms – Watts, Roberts, etc. Offset slider crank mechanism, Pantograph, Hook joint single and double, Steering gear mechanisms – Ackerman, Devis.

Velocity Analysis of Mechanisms

Velocity analysis by instantaneous centre of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical Approach). Analysis is extended to find rubbing velocities at joints, mechanical advantage (graphical approach) (mechanisms upto 6 links)

Acceleration Analysis of Mechanism

Velocity Acceleration analysis by relative method (mechanism upto 6 links) including pairs involving Corioli's acceleration (Graphical approach) Velocity acceleration analysis of mechanisms (upto 4 links) by complex variable method (Analytical approach)

Gear Mechanism

Types of gears, Law of gearing, Involute and cycloid gear tooth profile. Path of contact arc of contact, contact ratio for involute and cycloid tooth profile. Interference in involute gears. Critical Numbers of teeth for interference free motion.
Methods to control interference in involute gears.

Cam Mechanism

Cams and its Classification, Followers and its Classification, Motion analysis and plotting of displacement – time, velocity time, and acceleration time, jerk-time graphs for uniform velocity, UARM, SHM and Cycloid motions (combined motions during one stroke excluded), Cam profile for radial and offset followers. Motion analysis of simple cams – R-R cam, D-R-R and D-R-D-R cam operating radial translating follower, Pressure angle and methods to control pressure angle

Text Books

1. S. S. Ratan, Theory of Machines, McGraw-Hill Education (India) Private Limited, Fourth Revised Edition, 2017
2. P.L. Ballaney, Theory of Machines and Mechanisms, Khanna Publishers, Delhi, Twenty-fifth Edition, 2003
3. Ghosh and A. Malik, Theory of Mechanism and Machines, Affiliated East –West Press Pvt. Ltd. New Delhi, 2008

Recommended Reading

1. John J. Uicker Jr , Gordon R. Pennock , Joseph E. Shigley, Theory of Machines and Mechanisms, Oxford press, Fifth Edition, 2016
2. V. M. Fairs, Kinematics, McGraw Hill, 1988
3. Erdman and G. N. Sander, Mechanism Design: Analysis and Synthesis, Vol. I, Prentice Hall, Fourth Edition, 2001
4. J. Hannah and R.C. Stephens, Mechanics of Machines-Elementary Theory and Examples, Butterworth-Heinemann, Fourth Edition, 1984

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – IV*
Course Code	**R4ME2006T**	
Course Title	**Fluid Mechanics**	
Prerequisites	**Mathematics for Engineers- I & II**	

COURSE OUTCOMES

The student should be able to –

1. Outline the significance of fluid properties
2. Analyse static fluid systems
3. Apply the governing equations of mass, momentum and energy to fluid flows
4. Analyse internal and external fluid flows
5. Develop dimensionless parameters to aid experimentation

Course Contents

Fundamental Concepts

History and Scope of Fluid Mechanics, Definition of a Fluid, Fluid as a Continuum, Methods of Description: Molecular, Lagrangian, and Eulerian; Fluid Properties, Basic Flow Analysis Techniques, Classification of Fluid Motions

Fluid Statics

Force, Stress, and Pressure at a Point, Basic Equation of Fluid Statics, Pressure Variation in a Static Fluid, Pressure Measurement – Manometers, Hydrostatic Forces on Plane and Curved Surfaces, Buoyancy and Stability

Integral Relations for a Control Volume

Basic Physical Laws of Fluid Mechanics, The Reynolds Transport Theorem, Conservation of Mass, The Linear Momentum Equation, Frictionless Flow: The Bernoulli's equation, The Angular Momentum Theorem, The Energy Equation

Differential Relations for Fluid Flow

Motion of a Fluid Particle (Kinematics) –Fluid Translation: Acceleration of a Fluid Particle in a velocity Field, Fluid Rotation, Fluid Deformation, The Differential Equation of Mass conservation, The Differential Equation of Linear Momentum (Navier – Stokes Equations), The Stream Function, Vorticity and Irrotationality, Frictionless Irrotational Flows

Dimensional Analysis and Similarity

The Principal of Dimensional Homogeneity, The Pi Theorem, Significant Dimensionless Groups in Fluid Mechanics, Flow Similarity and Model Studies

Internal Incompressible Viscous Flow

Fully Developed Laminar Flow Between Infinite Parallel Plates (Both Plates Stationary and Upper Plate Moving with Constant Speed), Fully Developed Laminar Flow in a Pipe;

Flow in Pipes and Ducts – Shear Stress Distribution in a Fully Developed Pipe Flow, Turbulent Velocity Profiles in a Fully Developed Pipe Flow, Energy Considerations in a Pipe Flow, Calculation of Head Loss – Major and Minor Losses

Flow Measurement –The Orifice plate, The Flow Nozzle, The Venturimeter, Rotameter, Turbine Meter, Rectangular and Triangular Notches, Electromagnetic Flow Meters, Hot Wire Anemometer, Laser- Doppler Anemometer (LDA), Flow visualization – PIV

External Incompressible Viscous Flow

Boundary Layers: The Boundary Layer Concept, The Boundary Layer thickness, Laminar Flat-Plate Boundary Layer, Momentum Integral Equation, Use of Momentum Integral Equation for Flow with Zero Pressure Gradient – Laminar Flow & Turbulent Flow, Pressure Gradients in Boundary Layer Flows

Fluid Flow about Immersed Bodies: Drag – Flow over Flat Plate Parallel and Normal to the Flow, Friction and Pressure Drag, Flow over Sphere and Cylinder, Streamlining, Lift

Compressible Flow

Introduction: Review of Thermodynamics, The Speed of Sound, Adiabatic and Isentropic Steady Flow, Isentropic Flow with Area changes, The Normal Shock Wave, Operation of Converging and Diverging Nozzles

Text Books

1. S.K. Som, G. Biswas, Suman Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw-Hill Education, Third Revised Edition, 2017
2. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, Fluid Mechanics, Wiley, Eighth Edition, 2018

Recommended Reading

1. Frank M. White, Fluid Mechanics, Tata McGraw-Hill, Eighth Edition, 2015.
2. Victor L. Streeter, E. Benjamin Wylie, Keith W. Bedford, Fluid Mechanics, McGraw-Hill Education (India), Ninth Revised Edition, 2017.
3. Yunus A. Cengel & John M. Cimbala, Fluid Mechanics – Fundamentals & Applications, Tata McGraw-Hill, Third Edition, 2013
4. Edward J. Shaughnessy, Jr. Ira M. Katz, James P. Schaffer, Introduction to Fluid Mechanics, Oxford University Press, 2005

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	√	√	√										√	√	
CO2	√	√	√										√	√	
CO3	√	√	√										√	√	
CO4	√	√	√										√	√	
CO5	√	√	√										√	√	

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – IV*
Course Code	**R4ME2006P**	
Course Title	**Fluid Mechanics Laboratory**	
Prerequisites	**Mathematics for Engineers- I & II**	

COURSE OUTCOMES

The student should be able to –

1. Calibrate instruments used for measurement of pressure, flow rate etc.
2. Verify principles in fluid statics and dynamics.
3. Measure pressure distribution, lift and drag around cylinders and Aerofoils**.**

List of Experiments [Any Ten]:

1. Calibration of Pressure and Vacuum Gauge
2. Hydrostatic Forces on Plane Surfaces
3. Stability of a Floating Body
4. Verification of Bernoulli's Theorem
5. Calibration of Venturimeter
6. Calibration of Orifice Meter
7. Friction Losses in a Pipe
8. Valve Characteristics
9. Friction Losses in Pipe fittings
10. Drag measurement on flat plate parallel and normal to the flow
11. Pressure Distribution around the Cylinder
12. Pressure Distribution around the NACA2412 Aerofoil
13. Drag & Lift Measurement of NACA2412 Aerofoil with variable Flap

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester –IV*
Course Code	**R4ME2007T**	
Course Title	**Manufacturing Processes**	
Prerequisites	**Material Science**	

COURSE OUTCOMES

The student should be able to –

1. Understand the working of conventional machining processes
2. Design a gating system to produce defect free casting
3. Select suitable manufacturing process route to manufacture given component
4. Illustrate suitability of different welding processes for varying requirements
5. Describe non-destructive tests and suggest suitable non-destructive test for specific work

Course Contents

Conventional Machining Processes

Lathes: Types, specifications, construction, working, operations, tools, attachments and accessories. Thread and taper turning methods. Casptan and Turret Lathes: Construction and tool layout. Automats: general construction and tool layout. Drilling and Boring Machines: Types, parts, tools, accessories, construction, working and operations. Milling, Shaping and Planning Machines: Types – Horizontal, Vertical, Universal Tools, Accessories and operations. Simple and Compound Indexing on milling machine. Grinding Machines: Parts, Types, Operations, Grinding wheel – Specifications, selection, truing and dressing.

Metal Casting

Parting line selection. Pattern making, allowances, pattern design, rapid pattern method techniques, core making. Molding and core materials: sand types, sand properties and sand testing. Gating system: design of sprue, runner and ingate. Molding methods. Molten metal preparation: furnaces, ladle metallurgy. Die molding: construction, types of die molding. Die mold design. Defects in casting. Product design considerations.

Welding Technology

Arc welding- Theory, SMAW, GTAW, GMAW, FCAW, Submerged arc welding, Stud welding, Resistance welding- Theory, spot and seam projection welding processes. Gas welding Friction, welding, Ultrasonic welding, Thermit welding, EBW and LASER welding. Welding defects and quality. Soldering, brazing and adhesive bonding.

Hot and Cold Working of Metals

Principles of rolling, forging, drop, press, upset, roll forging, extrusion, drawing, spinning, and effect of hot working. Cold working processes, Cold rolling, swaging, forging, extrusion forward, backward and impact roll forming, tube drawing, wire drawing, spinning, shot penning. Friction and lubrication in metal forming.

Plastics & Composite Material - Forming and Shaping

Engineering plastics – types, properties and uses. Molding processes – Injection, Blow, Transfer, Extrusion, Calendaring and Thermoforming. Processing Elastomer, Processing Polymer Matrix Composite, Processing Metal matrix & Ceramic matrix Composites, Design consideration, Economics of Processing Plastics and Composite Materials

Gear Manufacturing

Gear materials and methods of gear manufacture. Form and generation methods of gear cutting – milling, shaping, planning, Cutting of spur, helical and straight bevel gears. Gear finishing operations – shaving, grinding, lapping and honing.

Destructive and non-destructive tests

Tensile, compressive, toughness, hardness, radiographic, ultrasonic, liquid, dye penetrant and magnetic particle test.

Text Books

1. Chapman W. A., Workshop Technology-Vol. I, II, & III, Edward Arnold Pub. Ltd. London, First Edition, 1972
2. Hajra Chaudhary S.K., Elements of Workshop Technology-Vol. I& II, Media Prom & Pub, Mumbai, Twelfth Edition, 2007
3. Manufacturing Engineering & Technology, S. Kalpakjian and S. R. Schmid, Fourth Edition; Prentice Hall, 2001.
4. Gowri S., Manufacturing Technology, Pearson & Co. Ltd., First Edition, 2008
5. M.P. Groover, Fundamental of Modern Manufacturing: Materials, Processes and Systems. John Wiley and Sons, Fourth Edition, 2010.

Recommended Reading

1. Production Technology – HMT Handbook, Tata McGraw-Hill Education Private Limited, First Revised Edition, Twenty-eighth Reprint, 2017
2. Roy A. & Lindberg, Processes and Materials of Manufacturing, Prentice Hall of India, Delhi, Fourth Edition, 2008
3. Campbell J.S., Principles of Manufacturing Materials and Processes, McGraw-Hill, New York, First Revised, 1984
4. Begeman, Manufacturing Processes, Asia Publishing House, Bombay, Fourth Edition, 2009

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	√												√		
CO2		√	√	√				√					√		
CO3			√		√							√	√		
CO4	√						√						√		
CO5			√			√					√	√	√		

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester –IV*
Course Code	**R4ME2007P**	
Course Title	**Manufacturing Processes Laboratory**	
Prerequisites	**Material Science**	

COURSE OUTCOMES

The student should be able to –

1. Operate various conventional machines
2. Understand the tolerance built up and dimensional inaccuracies
3. Prepare a operation sheet and process pictures

Job:

- Student will be assigned a job which requires usage of Lathe, Drilling, Milling and internal threading operation. Male and female sections of part will be manufactured and assembled by students
- Detailed operation sheet and process picture will be prepared by students.

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester –IV*
Course Code	**R4ME2008T**	
Course Title	**Mechanical Measurements**	
Prerequisites	**Mathematics for Engineers- I & II, Machine Drawing**	

COURSE OUTCOMES

The student should be able to –

1. Estimate errors in measurement
2. Interpret the behavior of the measurement systems
3. Analyze systems for input/output conditions
4. Compute the parameters in measurement.
5. Analyze different measurement technique used in industries

Course Contents

Introduction to Measurements

Significance of mechanical measurement, Basic definitions: Span, Range, Resolution of measuring instruments, Sensitivity, Precision and Accuracy, Hysteresis, Linearity, Threshold, Drift, repeatability, reproducibility. Static calibration. Uncertainty analysis in measurements. Measurement methods, Generalized Measurement system, Static performance characteristics, Statistical analysis of Errors: Systematic errors, random errors.

Strain Gauges

Theory of Strain gauges, Gauge Factor, Temperature compensation, Bridge Circuits, Pressure Cells.

Velocity and Acceleration Measurement

Mechanical, Electrical and Photoelectric Tachometers,
Piezoelectric Accelerometer, Seismic Accelerometer

Temperature measurement:

Temperature Measuring Devices: Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure Thermometers, Pyrometer, Bimetallic strip. Transducers Used for Measurement of Temperature.

Metrology

Vernier calliper, Micrometer, Slip gauges, Optical flat, Limit gauges, Problems on measurements with gauge.

Limits, Fits, Tolerances and Gauging: Interchangeability, Terminology, Types of fit, Basic-Hole System, Basic-Shaft System, Tolerance grades, Metric fits, Design of limit gauges.

Comparators: Mechanical, Pneumatic, optical, electrical and electronic comparators

Gear and Screw Thread Measurements

Surface Roughness Measurement

Geometric Form Measurement: Straightness, Flatness, Roundness,

Introduction to Geometric Dimensioning &Tolerancing (GD&T)

Introduction, Dimensioning with tolerances indicating various types of fits.

Coordinate Measuring Machine (CMM)

Fundamental features of CMM – development of CMMs – role of CMMs – types of CMMs – modes of operation – types of probes – probe calibration – non-contact type probes – direct computer control – software packages – operational modes – metrological features – co-ordinate systems – portable arm CMMs

Text Books

1. Thomas Beckwith, Mechanical Engineering Measurements, Pearson Education, 2013
2. E.O. Doebelin, Measurement Systems (Applications and Design), McGraw Hill, Fifth Edition.
3. C.S. Rangan & G.R. Sarrna, Instrumentation Devices & Systems, Tata McGraw Hill, Second Edition, 2017
4. I.J. Nagrath and M. Gopal, Control System Engineering, New Age International Publishers, Fifth Edition, 2008
5. I.C. Gupta, Engineering Metrology, Dhanpat Rai Publications, Seventh Edition, 2018
6. R. K. Jain, Engineering Metrology, Khanna Publishers, Twentieth Edition, 2009

Recommended Reading

1. A. K. Sawhney, Mechanical Engineering Measurements, Dhanpat Rai & Sons
2. K. Ogata, Modem Control Engineering, Prentice Hall, Fifth Edition, 2015
3. Dhanesh Manik, Control systems, Cengage Learning, First Edition, 2012
4. W. Bolton, Instrumentation and Control System, Elsevier, First Edition, 2004
5. S.P. Venkateshan, Mechanical Measurements, Ane books, India, Second Edition, 2015
6. Norman Nise, Control System Engineering, John Wiley and Sons, Sixth Edition, 2010
7. Richard S. Figliola, Donald E. Beasley, Theory and Design for Mechanical Measurements, Wiley, Fifth Edition, 2012
8. C. Dotson, R. Harlow and R. Thompson, Fundamentals of Dimensional Metrology, Thomson Delmer Learning, Singapore, Sixth Edition, 2015
9. John A Bosch, Giddings and Lewis Dayton, Coordinate Measuring Machines and Systems, Marcel Dekker, Inc., 1999

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	√	√	√	√					√				√	√	
CO2	√	√	√	√				√				√	√	√	
CO3	√	√	√										√	√	
CO4	√	√	√		√								√	√	
CO5	√	√	√			√	√			√	√		√	√	√

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – IV*
Course Code	**R4ME2008P**	
Course Title	**Mechanical Measurements Laboratory**	
Prerequisites	**Mathematics for Engineers- I & II, Machine Drawing**	

COURSE OUTCOMES

The student should be able to –

1. Calibrate various measuring Instruments
2. Estimate errors in measurement

List of Experiments

1. Calibration of Bourdon tube pressure gauge.
   To calibrate a pressure gauge using a dead weight tester and determine following characteristics of the pressure gauge.
   i. Accuracy.
   ii. Linearity by least square method and Terminal Based Lines
   iii. Hysteresis
   iv. Probable error.
2. Calibration of diaphragm type pressure cell.
   To calibrate a pressure cell using dead weight tester and determine its static sensitivity and linearity.
   i. Linearity by straight line fitting, using terminal based line and by least square method.
   ii. Static sensitivity and
   iii. Hysteresis.
3. Calibration of load cell.
   To calibrate a load cell using dead weight and determine its linearity and accuracy.
   i. Linearity by straight line fitting, using terminal based line and by least square method.
   ii. Percentage error and accuracy on the basis of true value and full scale deflection.
4. Calibration of LVDT.
   To calibrate LVDT using slip gauges and to determine its linearity and accuracy.
   i. Linearity by straight line fitting, using terminal based line and by least square method.
   ii. Percentage error and accuracy on the basis of true value and full scale deflection.
5. Calibration of potentiometric angular displacement sensor.
   To determine the static characteristics of potentiometric angular displacement sensor.
6. Determination of time constant of thermometers.
7. Torque measurement using strain gauges.
   To measure torque using strain gauges and to calibrate the setup for torque measurement.
   Programming using Matlab/Scilab.

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

Programme Name	*Bachelor of Technology in Mechanical Engineering*	*Semester – IV*
Course Code	**R4CH2001P**	
Course Title	**Environmental Studies**	
Prerequisites		

COURSE OUTCOMES

The student should be able to –

1. Imply the basic knowledge of environmental protection, sustainable development and improvement.
2. Categorize and scrutinize impact of human development on natural resources. Provide the student with an understanding of radioactive waste.
3. Interpret the impact of environmental problems on socio economic growth and human health.
4. Imply various strategies, technological improvement, and methods for sustainable management of environmental systems and for the remediation of degraded environment.
5. Apply different Science and Technology (S&T) based sustainability solutions and limitations as well as to identify impact of human population on the natural environment and human health.

Course Contents

Significance of Environment Science

Definition, basic principles and scope of environment science. Earth Man and Environment inter-relationship. Need for awareness Industrialization & Urbanization; Modern Human Life, Basic Ecological Concepts Ecosystems, nature of environmental threats Current environmental problems, Importance of clean air.

Ecosystems and Its conservation:

Introduction, definition: genetic, species and ecosystem diversity.

Concept of an ecosystem: Structure and function of an ecosystem, Producers, consumers and decomposers.

Conservation of ecosystem: Natural Resources, Renewable and Non-renewable Resources, Natural resources and associated problems.

Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources.

Role of an individual in conservation of natural resources. Biodiversity and its significance, and conservation. Global, National and effects of biodiversity.

Fundamentals of Environmental Chemistry

Definition, Causes, effects and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards (h) Radioactive Waste (I) E-waste. Importance of Environmental Chemistry to access and manage environmental pollution.

Pollution Monitoring and Control Methods

Methods of controlling air pollution:
Pollution controlling methods, Principle, construction, working and application of Equipment for gaseous pollutants control:
Method to control water pollution: Principle, construction, working.
Concept of Sustainability and Green Chemistry as a tool for sustainable development.

Environmental Assessment, Management and Legislation

Aims And Objectives Of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) And Environmental Management Plan (EMP)
Environmental Ethics: Issues And Possible Solutions:
Environment Audit :Principle, Procedure And Benefits
Case study can be submit by the students.
Projects and activities by students on Current Environmental Issues in India
Global Environmental Issues: Biodiversity loss ,Climate change, Ozone layer depletion, Sea level rise
Global Warming
International efforts for environmental protection and contribution of India for same, National Action Plan on Climate Change

Text Books

1. De., Environmental Chemistry, 6th Edition, New Age International.
2. P.K.Goel, Water Pollution, Causes, Effects and Control, New Age International
3. Erach Bharucha, Text Book of Environmental Studies for Undergraduate Courses, Universities Press, Second Edition
4. Dr. JagdishKrishnaswamy and Dr. R. J. Ranjit Daniels, Environmental Studies, Wiley India Private Limited, New Delhi, First Edition, 2009.

Recommended Readings:

1. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad,
2. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T., Environmental Encyclopedia, Jaico Publ. House, Mumbai, 200
3. Jadhav, H &Bhosale, V.M., Environmental Protection and Laws. Himalaya Pub. House, Delhi, 1995
4. Wanger K.D., Environmental Management. W.B. Saunders Co. Philadelphia, USA, 1998

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	√			√		√	√	√				√			√
CO2	√					√	√	√				√			√
CO3	√					√	√	√				√			√
CO4	√					√	√	√		√		√			√
CO5	√					√	√	√	√			√			√