With Effect from the Academic Year 2023 – 2024

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

R22 SCHEME & SYLLABUS

B.E. (MECHANICAL ENGINEERING)

SEMESTER – III to SEMESTER – IV

With Effect from the Academic Year 2023 – 2024

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

Scheme of Instruction as per R22 Curriculum

B.E. (MECHANICAL ENGINEERING)

SEMESTER – III

S. No.	Course Code	Title of the Course	Scheme of instruction			Scheme of examination			Credits
			Hours per week			Duration in Hrs	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC10	Partial differential Equations and Statistics	3	1	--	3	40	60	4
2	22CSC35	Data Structures using Python	2	--	--	3	40	60	2
3	22MEC02	Material Science and Metallurgy	3	--	--	3	40	60	3
4	22MEC03	Strength of Materials	3	1	--	3	40	60	4
5	22MEC04	Thermodynamics	3	--	--	3	40	60	3
6	22MEC05	Heat Transfer	2	--	--	3	40	60	2
7	22EEM01	Universal Human Values II: Understanding Harmony	--	1	--	--	50	--	1
8	22CEM01	Environmental Science	2	--	--	2	--	50	Non Credit
PRACTICALS									
9	22MEC06	Material Science and Metallurgy Lab	--	--	2	3	50	50	1
10	22MEC07	Strength of Materials Lab	--	--	2	3	50	50	1
11	22CSC36	Data Structures using Python Lab	--	--	2	3	50	50	1
12	22MEC08	Heat Transfer lab	--	--	2	3	50	50	1
MOOCs/Training/Internship			2-3 weeks/90 hours						2
TOTAL			**18**	**03**	**08**	--	**490**	**610**	**23+2**

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**
CIE - Continuous Internal Evaluation **SEE – Semester End Examination**

22MTC10

PARTIAL DIFFERENTIAL EQUATIONS AND STATISTICS

(For CIVIL/MECH/CHEM)

Instruction	3 L+1T Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives:

1. To explain the expansion of functions in sine and cosine series.
2. To form PDE and to find its solution.
3. To know the model of wave and heat equations.
4. Able to analyze random phenomenon using basic probability.
5. To learn fitting of distribution and predicting the future values.

Course Outcomes: On successful completion of this course the students shall be able to

1. Calculate the Euler's coefficients for Fourier series expansion of a function.
2. Solve Linear and Non-Linear PDE's.
3. Solve One-Dimension Wave and Heat equations and Two Dimension Laplace equation.
4. Use the basic probability for fitting the Random phenomenon.
5. Analyze the random fluctuations of probability distribution and Principles of Least Squares approximationsfor the given data.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	1	-	1	1	-	-	1	3	-	-
CO2	2	2	-	-	-	1	-	1	1	-	-	1	3	-	-
CO3	2	2	-	-	-	1	-	1	1	-	-	1	3	-	-
CO4	2	2	-	-	-	1	-	1	1	-	-	1	2	-	-
CO5	2	2	-	-	-	1	-	1	1	-	-	1	2	-	-

UNIT-I:

Fourier series

Periodic functions, Euler's formulae, Conditions for a Fourier series expansion, Fourier series of Functions having points of discontinuity, Change of interval, even and odd functions, Half range Sine & Cosine Series.

UNIT-II:

Partial Differential Equations

Formation of Partial Differential Equations, Linear Equations of First Order (Lagrange's Linear Equations), Solutionof First Order Non-linear Partial Differential Equation (Standard forms) and Charpits Method.

UNIT-III:

Applications of Partial Diffrential Equations

Solution by Method of Separation of Variables, Solution of One dimensional Wave equation, Solution of One dimensional Heat equation, Solution of Two dimensional Laplace equation and its related problems.

UNIT-IV:

Basic probability

Basic probability, Conditional probability, Baye's theorem. Random variable, Discrete probability distribution and Continuous probability distribution. Expectation, Addition and Multiplication theorem of expectation, properties of variance, Moments (Moments about the mean and moments about a point)

UNIT-V:

Probability Distributions and Curve Fitting

Poisson distribution ,MGF and Cumulants of the Poisson distribution, Normal distribution, Characteristics of Normal distribution, MGF and CGF of Normal distribution, Areas under normal curve. Correlation, Coefficient of Correlation and Lines of Regression. Curve fitting by the Method of Least Squares, Fitting of Straight lines, Second degree parabola and exponential curves.

Text Books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2017.
2. S.C.Gupta, V.K.Kappoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 2014.

Suggested Reading:

1. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
2. S. J. Farlow, "Partial Differential Equations for Scientists and Engineers", Dover Publications, 1993.
3. Sheldon Ross, "A First Course in Probability", 9th Edition, Pearson publications, 2014.

22CSC35

DATA STRUCTURES USING PYTHON

(Common to BioTech, Chemical, Civil and Mechanical Engineering)

Instruction	2L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Course Objectives:

This course aims to:

1. Introduce object-orientation concepts in python.
2. Familiarize students with asymptomatic analysis of various functions and implement different sorting techniques.
3. Examine various linear and non-liner data structures.
4. Explore various string functions and hash functions.

Course Outcomes:

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

1. Understand classes, objects, linear data structures, nonlinear data structures, time complexity.
2. Use python packages to work with datasets.
3. Implement sorting, searching algorithms and analyse their performance.
4. Build solutions for problems using linear, nonlinear data structures and hashing.
5. Apply pattern matching algorithms for real time problems

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PS O4
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT-I

Overview of Python, Concept of Class, and objects; NumPy: The Basics of NumPy Arrays, Aggregations; Pandas: Pandas Objects, Data Indexing and Selection; **Visualisation:** Simple Line Plots, Simple Scatter Plots, Histograms, Binnings, and Density.

UNIT - II

Introduction: Data Structures, Abstract Data Types, Algorithm, Analysis of Algorithms, Running Time Analysis, Commonly Used Rates of Growth, Big O Notation, Omega Notation, Theta Notation, Guidelines for Asymptotic Analysis.

Sorting: Introduction, Classification of Sorting Algorithms, Selection Sort, Merge Sort, Quick Sort, Radix sort, Comparison of Sorting Algorithms.

UNIT-III

Linked Lists: Linked List ADT, Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists; **Stacks:** Stack ADT **Queues:** Queue ADT.

UNIT-IV

Trees: Introduction, Binary Trees, Types of Binary Trees, Properties of Binary Trees, Binary Tree Traversals, Binary Search Trees (BSTs); **Graph:** Introduction, Applications of Graphs, Graph Representation, Graph Traversals

UNIT-V

String Algorithms and Hashing: Introduction, String Matching Algorithms:Brute Force Method, Rabin-Karp. Hash Table ADT, Components of Hashing, Hash Table, Hash Function, Load Factor, Collisions, Collision Resolution Techniques.

Text Books:

1. Narasimha Karumanchi,"Data Structures and Algorithmic Thinking With Python", Career Monk Publications, 2016
2. Tony Gaddis, “Starting out with Python”, 4th Edition, Global Edition, Pearson Education Limited, 2019
3. Jake Vander Plas, “Python Data Science Handbook”, OReilly, 2017

Suggested Reading:

1. Wes McKinney, “Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython”, 2nd Ed, OReilly, 2018
2. Michael T.Goodrich, Roberto Tamassia, Michael H. Goldwasser, “Data Structure and Algorithms in Python”, Wiley, 2013.
3. Kenneth A. Lambert, "Fundamentals of Python: Data Structures",CengageLearning,2018.

Online Resources:

1. https://visualgo.net/en
2. https://jakevdp.github.io/PythonDataScienceHandbook/
3. https://www.coursera.org/specializations/data-structures-algorithms3.
4. https://nptel.ac.in/courses/106/106/106106182/
5. https://www.cs.usfca.edu/~galles/visualization/Algorithms
6. https://www.edx.org/course/algorithms-and-data-structures

22MEC02

MATERIAL SCIENCE AND METALLURGY

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: Student will understand

1. Structure property relations, analyze the failures of metals and their prevention.
2. Fatigue, creep and diffusion mechanisms.
3. Classification of steels and their application.
4. Working principle of various heat treatment operations
5. Principles of extractive metallurgy.

Course Outcomes: At the end of the course a student will be able to

1. Understand the crystal structure and various imperfections of crystals.
2. Related material failure by fatigue and creep.
3. Interpret phase diagrams and TTT diagrams.
4. Understand the methods of improvement of mechanical properties by various heat treatment operations.
5. Differentiate the properties and applications of ceramics, polymers and composites**.**

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	1	1	-	-	-	-	-	1	1	3	2
CO2	2	2	3	1	2	2	1	1	-	1	1	3	3	2	3
CO3	3	2	2	2	2	2	2	1	-	-	-	3	2	3	3
CO4	2	3	3	3	3	3	2	1	-	1	1	3	3	3	3
CO5	3	2	1	2	2	1	2	1	-	1	1	1	3	3	2

UNIT-I:

Plastic Deformation: Introduction to engineering materials, Imperfections in crystals, Dislocation in crystals, Types of dislocations, Effect of slip and twinning on plastic deformation, Strain hardening, Cold and hot working, Bauschinger effect, Recovery, Recrystallization, Grain growth and its effect on mechanical properties of metals.

Fracture: Types of fracture in metals, Ductile and brittle fracture, Griffith theory of brittle fracture, Crack propagation and ductile to brittle transition temperature

UNIT - II

Diffusion: Fick's laws of diffusion, Application of diffusion theory in mechanical engineering.**Fatigue**: S–N curve, Fatigue crack propagation, Effect of metallurgical variables on fatigue of metal, Low and high cycle fatigue, Experimental determination of fatigue strength (RR–Moore Test).

Creep: Creep strength, Creep curve, Creep deformation mechanisms, Creep test.

UNIT- III

Structure of Alloys: Study of Eutectic, Eutectoid, Peritectic and Peritectoid reactions

Iron–Iron Carbide Equilibrium Diagram: Construction and interpretation, Types of plain carbon steels, Cast irons and their properties and characteristics.

Alloy Steels: Effects of alloying elements like Nickel, Chromium, Manganese, Silicon, Tungsten and Titanium, Types of stainless steel, HSLA, TRIP, HSS, Brass, Bronze, Their composition and properties.

UNIT - IV

Heat Treatment: Purpose of heat treatment, Annealing, Normalizing, Hardening, Tempering, Construction and interpretation of T–T–T diagram, Austempering and Martempering, Case hardening, Carburizing, Nitriding, Carbo–nitriding, Flame hardening, Induction hardening, Laser and Electron beam hardening.

Introduction to Non-Destructive Testing: Importance of Non-Destructive Testing, Types: Liquid Penetrant Testing, Ultrasonic Testing, Radiography Testing, Applications of Non- Destructive Testing.

UNIT - V

Introduction to Extractive Metallurgy: Method of production of pig iron by blast furnace, Cast iron by cupola furnace and method of production of steel by electric arc process.

Polymers and Ceramics: Polymerization, Thermoplastics and thermosetting plastics,Elastomers, Resins, Types, properties and applications of ceramics

Composites: Concept of composites, Matrix and reinforcement, Classification and Applications of composites.

Text Books:

1. V. Raghavan, Materials Science and Engineering, 4th edition, Prentice Hall of India Ltd.,New Delhi, 2005.
2. S.H. Avner, Introduction to Physical Metallurgy, 2nd edition, Tata McGraw Hill Publishers, New Delhi, 2005.

Suggested Reading:

1. S.P. Nayak, Engineering Metallurgy and Material Science, 6th edition, Charotar PublishingHouse, Gujarat, 2005.
2. G. E. Dieter, Mechanical Metallurgy, 3rd edition, Tata McGraw Hill, New Delhi, 2005.
3. W.D. Callister (Adapted by R. Balasubramaniam), Materials Science and Engineering, 2nd edition, Wiley India, New Delhi, 2014.

22MEC03

STRENGTH OF MATERIALS

Instruction	3 L+1T Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives:

1. Student is exposed to the concept of different types of loads, stresses, strains and analysis of members for axial loads.
2. Student will acquire knowledge in drawing bending and shear force diagrams of beams of various loads and configurations.
3. Student becomes familiar with methods of evaluation of deflection of beams of various configurations and stresses that arise due to simple bending.
4. Student is exposed to the concept of shear stresses in beams, principal stresses, strains and phenomenon of torsion.
5. Student will acquire knowledge in estimating stresses for thin, thick cylindrical shells and buckling of columns**.**

Course Outcomes: At the end of the course, a student will be able to

1. Determine stresses and strains in members subjected to axial loads and temperature changes.
2. Draw shear force, bending moment diagrams for different types of beams and calculate stresses and strains due to simple bending.
3. Determine slope and deflection for various configurations of beams using different methods, analyze stress, strain and deflection due to torsion in circular members.
4. Analyze shear stress distribution in different sections of beams and find out principal stresses and strains.
5. Find out stresses and strains in thin, thick cylindrical shells and able to calculate critical buckling loads in columns and struts**.**

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	3	-	-	1	-	-	-	-	3	2	1	1
CO2	3	3	1	-	-	-	1	-	-	-	-	3	2	1	1
CO3	3	3	1	-	-	-	1	-	-	-	-	3	2	1	1
CO4	3	3	1	-	-	-	1	-	-	-	-	3	2	1	1
CO5	3	3	1	-	-	-	1	-	-	-	-	3	2	1	1

UNIT -I

Stresses and Strains: Definitions, Types of stresses and strains, Elasticity and plasticity, Hooke's law, Stress-strain diagrams for engineering materials, Modulus of elasticity, Poisson'sratio, Relationship between elastic constants, Linear and volumetric strains, Bars of uniform strength, Temperature stresses, Compound bars, Strain energy for axial and torsional loads.

UNIT – II

Beams: Definition of shear force and bending moment, Relation between intensity of loading,Shear force and bending moment, shear force and bending moment diagrams for cantilever, simply supported and overhanging beams, Theory of simple bending, Moment of resistance andcomparison of various cross-sections.

UNIT – III

Slopes and Deflections: Slope and deflection calculations of cantilever, simply supported beams

subjected to point loads and uniformly distributed loads with Macaulay's and doubleintegration methods.
Torsion of Circular Cross-sections: Theory of pure torsion, Power transmission in solid andhollow circular shafts, combined bending and torsion.

UNIT – IV

Shear Stresses in Beams: Distribution of shear stresses in rectangular, I-section, T-section, Solid and hollow circular sections.
Principal Stresses and Strains: Analysis of biaxial state of stress with and without shear,Mohr's Circle.

UNIT – V

Cylinders: Stresses in thin and thick cylinders with internal and external pressures.
Columns and Struts: Euler's and Rankine's formulae for axial load applications. Secant and Perry formulae for eccentrically loaded columns.

Textbooks:

1. S.S. Rattan., Strength of Materials, 3rd edition, Tata Mc-Graw Hill, 2017.
2. Ferdinand P. Beer, E. Russell Johnston, John T. Dewolf and David F. Mazurek., Mechanics of Materials, 8th edition, McGraw-Hill, New York, 2020.

Suggested Reading:

1. James M Gere, Mechanics of materials, 8th edition, Cengage Learning, 2013.
2. R.C. Hibbeler, Mechanics of Materials, 9th edition, Pearson, 2018.
3. S. Ramamrutham., Strength of Materials, 16th edition, Dhanpatrai and Sons, 2011.

22MEC04

THERMODYNAMICS

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: Student will understand

1. Basic definitions of thermodynamics and significance of Zeroth law of thermodynamics.
2. The importance and application of first law of thermodynamics.
3. The principles associated with second law of thermodynamics.
4. Properties of pure substances, use of Mollier diagram and vapour power cycles.
5. Concepts of air standard cycles and properties of mixture of gases

Course Outcomes: At the end of the course a student will be able to

1. Understand the concepts of system, thermodynamic properties, thermodynamic equilibrium and various methods of pressure and temperature measurements.
2. Apply the first law of thermodynamics to various thermodynamic processes along with the applications of steady flow energy equation.
3. Apply the Second law of thermodynamics to analyze heat pumps, refrigerators, heat engines and to evaluate entropy changes.
4. Evaluate the properties of pure substances and analyze the performance of steam power cycles.
5. Evaluate performance of air standard cycles and analyze the properties of gas mixtures**.**

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	2	1
CO2	2	2	-	-	-	-	-	-	-	3	-	3	2	2	1
CO3	2	2	-	-	-	2	1	-	-	-	-	3	3	2	1
CO4	2	2	-	-	-	-	-	-	-	-	-	3	3	2	1
CO5	2	2	-	-	-	2	1	-	-	3	-	3	3	2	1

UNIT - I

Introduction: Thermodynamics, Macroscopic and Microscopic approaches, Thermodynamic systems, Properties, Processes and cycles, Thermodynamic equilibrium, Quasi – static process, Measurement of pressure, Zeroth law of thermodynamics and its significance, Measurement of temperature, Reference points, Ideal gas equation.

UNIT - II

Energy Interactions and First Law of Thermodynamics: Concept of heat and work, First law of thermodynamics for closed system, Energy a property of the system, Application of first law to various thermodynamic processes like isobaric, Isochoric, Isothermal, Adiabatic and polytropic, Definition of enthalpy, PMM1, First law applied to flow processes, Application of SFEE to Nozzle, Diffuser, Throttling device, Turbine, Compressor and heat exchanger.

UNIT- III

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Kelvin– Planck and Clausius statements of second law of thermodynamics, PMM2, Equivalence of Kelvin-Planck and Clausius

statement, Reversible and irreversible processes, Carnot theorem, Clausius inequality, Calculation of entropy change during various thermodynamic processes, Principle of entropy increase, T–s diagrams, Application of entropy principle for mixing of two fluids, Introduction to available and unavailable energy, Third law of thermodynamics, Helmholtz and Gibb's functions.

UNIT - IV

Pure Substances: Properties of pure substances, P–V diagram, P–T diagram, P-V-T surface, T–s diagram, h–s diagram, Dryness fraction, Use of steam tables, Maxwell relations, Clapeyron equation.

Vapour Power Cycles: Vapour power cycles - Carnot cycle, Simple Rankine cycle, Representation on p-v, T-s and h-s diagrams, Evaluation of performance parameters, Efficiency, Work ratio, Specific steam consumption and heat rate.

UNIT - V

Air Standard Cycles: Air standard cycles, Otto, Diesel, Dual combustion cycles, Working principle, Derivation of expression for air standard efficiency, Comparison of Otto, Diesel anddual cycles for the same compression ratio, For the same maximum pressure and temperature.

Non-reactive Ideal Gas Mixtures: Mole fraction, Mass fraction, Partial pressure, Dalton's law of partial pressures, Amagat-Leduc law of partial volumes, Relation between partial pressures, Mole fraction and volume fraction, Gas constant, Molecular mass, Specific heatsof gas mixtures, Relation between volumetric and gravimetric analysis. Determination of theoretical air fuel ratio and equivalence ratio for various fuels.

Text Books:

1. P.K. Nag., Engineering Thermodynamics, 6th edition, Tata McGraw Hill Publishing,2017
2. Yunus Cengel and Michael Boles., Thermodynamics: An Engineering Approach,8th edition, McGraw Hill Education, 2017.

Suggested Reading:

1. R.K. Rajput., Engineering Thermodynamics, 4th Edition, Laxmi Publications, 2016.
2. Mahesh M Rathore., Thermal Engineering, Tata McGraw Hill Publishers, 2013.
3. D.S. Kumar., Engineering Thermodynamics, S.K. Kataria and Sons, 2014.

22MEC05

HEAT TRANSFER

Instruction	2 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Course Objectives: Student will understand

1. The concepts of 1-D steady state heat conduction.
2. The concepts of heat transfer through fins and unsteady state conduction.
3. The relationship between various dimensionless numbers for free convection and forced convection.
4. The principles of radiation heat transfer.
5. The basic concepts of heat exchangers and phase change heat transfer

Course Outcomes: At the end of the course a student will be able to

1. Estimate heat transfer through composite slabs and cylinders with and without heat generation.
2. Estimate the heat transfer through rectangular straight and pin fins; and temperature distribution in unsteady state conduction.
3. Estimate the heat transfer in case flow over plates, cylinders and flow through tubes.
4. Estimate radiation heat exchange between surfaces in different situations and the effect of radiation shield.
5. Estimate the effectiveness of heat exchanger by LMTD, NTU methods and acquire knowledge of boiling and condensation phenomenon**.**

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	-	-	-	-	-	-	1	1	-	-
CO2	3	2	2	1	1	-	-	-	-	-	-	1	1	-	1
CO3	2	3	2	1	1	-	-	-	-	-	-	1	1	-	1
CO4	2	3	2	1	1	-	-	-	-	-	-	1	1	-	2
CO5	3	2	2	1	1	-	-	-	-	-	-	1	1	-	2

UNIT-I

Modes of heat transfer, Laws of heat transfer - Fourier, Newton, Stefan-Boltzmann General conduction equation in cartesian and cylindrical coordinates, One dimensional steady state conduction through slabs, hollow cylinders with and without heat generation, steady state heat transfer through composite slabs and cylinders, critical radius of insulation.

UNIT-II

Fins: Heat transfer analysis of fins with heat dissipation environment - rectangular straight and pin fins, unsteady state conduction, Lumped parameter analysis of a body with negligible internal temperature gradients, Use of Heisler charts for solving problems of infinite slabs and cylinders.

UNIT-III

Convection: Dimensional analysis and its use in free and forced convection, Buckingham pi theorem, Physical significance of different dimensionless numbers, Concepts of velocity and thermal boundary layers, Reynold's analogy for flow over plane surfaces, Calculation of heat transfer coefficient for flow over plates, cylinders and for flow through tubes in free and forced convection using empirical formulae.

UNIT-IV

Radiation: Definition of absorptivity, reflectivity and transmissivity, Concept of black-body and emissivity. Kirchoff's law, Planck's law , Wien's and Steffan Boltzmann law, Monochromatic and total emissive power, radiant heat exchange between two gray surfaces, Shape factor, Thermal circuit for radiant heat exchange between infinite parallel plates and between concentric cylinders, Radiation shields

UNIT-V

Heat Exchangers: Classification, analysis of parallel flow and counter flow heat exchangers using LMTD and NTU methods, effectiveness, simple problems.

Boiling: Boiling curve and critical heat flux for nucleate pool boiling.

Condensation: Types of condensation, convective heat transfer coefficient for Laminar Film Condensation on a Vertical Plate.

Text Books:

1. Sachdeva,R.C., "Fundamentals of Engineering Heat and Mass Transfer", New Age International (P) Ltd Publishers, New Delhi, 2010
2. Yunus A Cengel, "Heat Transfer A Practical Approach", Second Edition, Mc.Graw-Hill, 2002.

Suggested Reading:

1. Rajput, R.K., "Heat and Mass Transfer", S. Chand & Company Ltd, New Delhi, 2004.
2. Holman, J.P., "Heat Transfer", Tenth Edition, McGraw Hill Publication, New Delhi, 2010
3. Sukhatme,S.P., "A Text Book on Heat Transfer,", University Press, 2005.

Data Book:

1. C.P. Kothandaraman, Heat Transfer Data Book, TMH

22EEM01

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY

(**B.E/B. Tech** - Common to all Branches)

Instruction	1T Hours per week
Duration of Semester End Examination	--
SEE	--
CIE	50 Marks
Credits	1

Introduction

This course discusses the role of human values in one's family, in society and in nature. During the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

Course Objectives: is to

1. Understand the concept of universal human values
2. Cultivate empathy and respect for diversity
3. Inspire the social responsibility and global citizenship

Course Outcomes:

By the end of the course, STUDENT will be able to

1. Become familiar about themselves, and their surroundings (family, society, nature).
2. Develop empathy and respect for diversity by gaining an appreciation for different cultures, perspectives, and identities
3. Exhibit responsible and ethical behavior by adhering to principles of integrity, honesty, compassion, and justice.
4. Recognize their role as global citizens.
5. Exhibit a sense of social responsibility.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	1	-	-	1	-	-	1	-	-	1	0	0	1
CO2	-	-	1	-	-	1	1	-	1	-	1	1	0	0	1
CO3	-	-	-	-	-	1	-	-	-	1	-	-	0	0	1
CO4	-	-	-	-	-	1	1	1	-	-	-	-	0	0	1
CO5	-	-	-	-	-	1	1	1	-	-	-	-	0	0	1

Module -1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and
- Experiential Validation- as the process for self-exploration.
- Natural acceptance of human values.
- Definitiveness of Ethical Human Conduct.
- Continuous Happiness and Prosperity- A look at basic Human Aspirations.
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario.
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module- 2: Understanding Harmony in the Human Being - Harmony in Myself

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module-3: Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
- Understanding the meaning of Trust; Difference between intention and competence.
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.
- Understanding the harmony in society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals.
- Strategy for transition from the present state to Universal Human Order:

a. At the level of individual: as socially and ecologically responsible engineers, technologists, and managers.
b. At the level of society: as mutually enriching institutions and organizations.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss scenarios. Elicit examples from students' lives.

Module -4: Understanding Harmony in Nature and Existence - Whole existence as Coexistence.

- Understanding the harmony in Nature.
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature.
- Understanding Existence as Co-existence of mutually interacting units in all - pervasive space.
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
- Holistic perception of harmony at all levels of existence.
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

Mode of Conduct (L-T-P-C 0-1-0-0)

- While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection, and self- exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentors, in a group sitting.
- **Tutorials (experiments or practical) are important for this course**. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to the development of commitment, namely behaving and working based on basic human values.
- **It is advised to share the experience of the Faculty to the class in a capsule form.**
- **Involve more in evaluating the student by different activities with proper RUBRCCS**

Assessment:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.

Example:

Module-1:	10 M
Module -2:	10 M
Module- 3:	10 M
Module-4:	10 M
Attendance & Attitude:	10 M

The overall pass percentage is 50%. In case the student fails, he/she must repeat the course.

Textbooks

1. "A Foundation Course in Human Values and Professional Ethics" by R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2022.
2. "Teacher's Manual for A Foundation Course in Human Values and Professional Ethics" by R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2022.

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth – by Mohandas Karamchand Gandhi

22CEM01

ENVIRONMENTAL SCIENCE (MANDATORY COURSE)

Instruction	2 L Hours per week
Duration of Semester End Examination	2 Hours
SEE	50 Marks
CIE	--
Credits	--

Course Objectives: The objectives of the course is to make the student

1. To equip the students with inputs on the environment, natural resources and their conservation.
2. To study the interrelationship between the living organisms and the natural environment and also to enable the students to understand the structure and functioning of the ecosystems. To understand the importance of biodiversity and create awareness on its threats and conservation strategies.
3. To enable the students become aware of pollution of various environmental segments including their causes, effects, and control measures. To create awareness about environmental legislations in the context of national conventions

Course Outcomes: At the end of the course a student will be able to

1. Identify the natural resources and realise the importance of water, food, forest, mineral, energy, land resources and effects of over utilisation.
2. Understand the concept of ecosystems and realise the importance of interlinking of food chains.
3. Contribute for the conservation of bio-diversity.
4. Suggest suitable remedial measure for the problems of environmental pollution and contribute for the framing of legislation for protection of environment.
5. Follow the environmental ethics and contribute to the mitigation and management of environmental disasters**.**

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	-	-	-	-	3	-	-	-	-	1	-	-	1
CO2	1	-	-	-	-	-	2	1	-	-	-	1	-	-	1
CO3	1	-	-	-	-	-	2	1	-	-	-	1	-	-	1
CO4	1	-	-	-	-	1	2	1	-	-	-	1	-	-	1
CO5	1	-	-	-	-	1	2	1	-	-	-	1	-	-	1

UNIT- I:

Environmental Studies: Definition, Scope and importance, need for public awareness.

Natural resources: Use and over utilization of Natural Resources - Water resources, Food resources, Forest resources, Mineral resources, Energy resources, Land resources.

UNIT – II:

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, role of producers, consumers and decomposers, energy flow in an ecosystem, food chains, food webs, ecological pyramids, Nutrient cycling, Bio-geo chemical cycles, Terrestrial and Aquatic ecosystems.

UNIT – III:

Biodiversity: Genetic, species and ecosystem biodiversity, Bio-geographical classification of India, India as a Mega diversity nation. Values of biodiversity, hot-spots of biodiversity, threats to biodiversity, endangered and endemic species of India, methods of conservation of biodiversity.

UNIT – IV:

Environmental Pollution: Cause, effects and control measures of air pollution, water pollution, marine pollution, soil pollution, noise pollution and Solid waste management, nuclear hazards

Environmental Legislations: Environment protection Act, Air, Water, Forest & Wild life Acts, issues involved in enforcement of environmental legislation, responsibilities of state and central pollution control boards

UNIT – V:

Social issues and the environment: Water conservation methods: Rain water harvesting and watershed management, Environmental ethics, Sustainable development and Climate change: Global warming, Ozone layer depletion, forest fires, and Contemporary issues.

Text Books:

1. Y. Anjaneyulu, “Introduction to Environmental Science”, B S Publications, 2004.
2. Suresh K. Dhameja, “Environmental Studies”, S. K. Kataria& Sons, 2009.

Suggested Reading:

1. C. S. Rao,” Environmental Pollution Control Engineering”, Wiley, 1991.
2. S. S. Dara, “A Text Book of Environmental Chemistry &Pollution Control”, S. Chand Limited, 2006

22MEC06

MATERIAL SCIENCE AND METALLURGY LAB

Instruction	2 P Hours per week
Duration of Semester End Examination	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives: Student will

1. Acquire basic knowledge by understanding iron-carbide diagram and its application in engineering.
2. Expose to Metallographic study and analysis of various metals.
3. Acquire knowledge in determining the hardness of metals before and after various Heat treatment operations.
4. Understand differences between different heat treatment methods.
5. Understand the relation between micro structure and properties

Course Outcomes: At the end of the course a student will be able to

1. Identify crystal structure of various metals.
2. Measure hardness and can correlate with microstructure.
3. Perform a suitable heat treatment operation based on desired properties.
4. Underlines the importance of grain size in evaluating the desired mechanical properties.
5. Correlate the heat treatment methods and the mechanical properties obtained.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	-	-	-	-	-	-	2	1	2	1
CO2	1	1	1	-	1	1	1	1	-	1	-	2	2	2	3
CO3	2	2	2	2	2	1	1	1	1	-	-	-	1	1	1
CO4	2	2	2	2	2	-	-	1	-	1	-	-	2	2	2
CO5	2	2	2	2	2	1	1	1	1	1	-	-	3	3	3

List of the experiments

1. Study of metallurgical microscope.
2. Observing the microstructure of low carbon steel, medium carbon steel and high carbon steel specimens.
3. Observing the microstructure of austenitic stainless steel, high speed steel and case carburized steel specimens.
4. Observing the microstructure of grey cast iron, white cast iron and spheroidal castiron specimens.
5. Observing the microstructure of Al-Si alloy, and malleable cast iron specimens.
6. Preparation of α-β brass and normalized steel specimens for micro structuralobservation
7. Preparation of medium carbon steel and mild steel specimens for micro structural observation.
8. Preparation of nodular cast iron and grey cast iron specimens for micro structural observation.
9. Determination of grain size using image analyzer.
10. Annealing and preparation of the given Steel specimen for microstructural observation.
11. Normalizing and preparation of the given Steel specimen for microstructural observation.
12. Hardening and preparation of the given Steel specimen for microstructural observation.
13. Comparative study on the influence of heat treatments (annealing, normalizing and hardening) on the microstructure and hardness of the given Steel specimen.

Note: A minimum of 12 experiments need to be conducted

Suggested Reading:

1. V. Raghavan, Materials Science and Engineering, 4th edition, Prentice Hall of India Ltd., New Delhi, 2005.
2. S. H. Avner, Introduction to Physical Metallurgy, 2nd edition, Tata McGraw Hill Publishers, New Delhi, 2005.
3. Virtual labs – Physical Metallurgy Lab, NITK SURATHKAL

22MEC07

STRENGTH OF MATERIALS LAB

Instruction	2 P Hours per week
Duration of Semester End Examination	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives: Student will

1. Demonstrate an understanding of tension, and the relationship between stress, strain and application of Hooke's law.
2. Demonstrate an understanding of types of beams, deflections and measurement of material property through deflections.
3. Demonstrate an understanding of torsion and deformations resulting from torsion.
4. Demonstrate the understanding of hardness and its measurement using different scales like Brinnel and Rockwell.
5. Demonstrate an understanding of measurement of shear modulus and young's modulus for machine members like helical and leaf springs through loading respectively.

Course Outcomes: On successful completion of the course, students will be able to

1. Draw stress-strain curve for an isotropic material and understand the salient features of it.
2. Determine the Young's modulus of various beam materials and leaf spring by conducting load-deflection test.
3. Rigidity modulus of a given shaft specimen by torsion test and shear modulus of closely coiled helical spring.
4. Evaluate hardness of different materials using different scales
5. Find the compressive and crushing strengths of concrete cubes and bricks**.**

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	-	-	-	-	-	2	-	3	2	1	1
CO2	3	3	2	1	-	-	-	-	-	2	-	3	2	1	1
CO3	3	3	2	1	-	-	-	-	-	2	-	3	2	1	1
CO4	3	3	2	1	-	-	-	-	-	2	-	3	2	1	1
CO5	3	3	2	1	-	-	-	-	-	2	-	3	2	1	1

List of the experiments:

1. Tension test on mild steel.
2. Compression test on mild steel.
3. Tension test on cast iron.
4. Compression test on cast iron.
5. Brinell's and Rockwell's hardness tests.
6. Izod Impact test.
7. Load-deflection test on a leaf spring to find out the Young's modulus of leafmaterial.
8. Deflection test on a helical spring to determine the rigidity modulus.
9. Torsion of shaft to determine the rigidity modulus of shaft material.
10. Defection test on a cantilever beam to determine the Young's modulus.

11. Deflection test on a simply supported beam to determine the Young'smodulus.
12. Deflection test on propped cantilever to determine the Young's modulus.
13. Deflection test on continuous beam to determine the Young's modulus.
14. Crushing and compression test on bricks and concrete cubes.
15. Look at each component (arm, leg, seat, back, etc.) of a chair in a classroom and decide what type of familiar structure it is and what type of loads act on it during normal use. List each component, state where and how the load acts and select the theory which you would have to consider when analyzing the stresses in the chair

Note: A minimum of 12 experiments need to be conducted.

Suggested Reading:

1. S.S. Rattan., Strength of Materials, 3rd edition, Tata Mc-Graw Hill, 2017.
2. R. C. Hibbler, Mechanics of Mechanics of Materials, 9th Pearson, 2018.
3. Virtual labs – Strength of Materials Lab, NITK Surathkal

22CSC36

DATA STRUCTURES USING PYTHON LAB

Instruction	2 P Hours per week
Duration of Semester End Examination	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives:

This course aims to:

1. Introduce data structures in python.
2. Familiarize with visualization techniques and tools in python.
3. Implement ADT for linear and non linear structures.
4. Analyze the performance of sorting and searching techniques.
5. Gain knowledge on applying data structures in real world problems.

Course Outcomes:

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

1. Demonstrate Classes, Objects, linear data structures, nonlinear data structures.
2. Store, retrieve and visualize datasets using Python built-in packages.
3. Evaluate the performance of sorting techniques.
4. Build optimal solutions using linear data structures, nonlinear data structures and hashing.
5. Apply pattern matching algorithms for real time problems.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PS O4
CO1	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-

List of Experiments

1. Demonstration of class and objects.
2. Read a dataset, describe, visualize and provide inference.
3. Implement the Sorting algorithms: Selection Sort, Merge Sort, Quick Sort, Radix Sort.
4. Define Single Linked List ADT: Insertions, Deletions, Display
5. Define Doubly Linked List ADT and perform all standard operations.
6. Define Stack and Queue ADTs and implement standard operations
7. Implementation of Binary Search Tree: Insertion, Deletion, Traversal
8. Implementation of Graph traversal techniques.
9. Implementation of Hashing.
10. Implementation of Rabin-Karp algorithm

Text Books:

1. NarasimhaKarumanchi,"DataStructuresandAlgorithmicThinkingWithPython",CareerMonkPublications, 2016
2. Jake VanderPlas, Python Data Science Handbook, OReilly, 2017

Suggested Reading:

1. MichaelT.Goodrich,RobertoTamassia,MichaelH.Goldwasser,“DataStructureandAlgorithms in Python”, Wiley, 2013.
2. KennethA.Lambert,"FundamentalsofPython:DataStructures",CengageLearning,2018.
3. Narasimha Karumanchi, “Data Structures and Algorithms for GATE”, CareerMonk Publications,2011.
4. Wes McKinney, “Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython”,2nd Ed, OReilly, 2018.

Online Resources:

1. https://www.geeksforgeeks.org/data-structures/
2. https://www.coursera.org/specializations/data-structures-algorithms3.
3. https://nptel.ac.in/courses/106/106/106106182/
4. https://www.cs.usfca.edu/~galles/visualization/Algorithms

22MEC08

HEAT TRANSFER LAB

Instruction	2 P Hours per week
Duration of Semester End Examination	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives: Student will understand

1. The concepts of thermal conductivities and thermal resistances; significance of insulating and conducting materials.
2. The procedure of determining the heat transfer coefficients under natural and forced convection phenomena
3. Method of measuring the emissivity of a given plate and determining Stefan-Boltzmann constant.
4. The procedure of determining the heat transfer coefficient of a heat exchanger.
5. The concepts of phase change heat transfer.

Course Outcomes: At the end of the course, student will be able to

1. Determine thermal conductivities, thermal resistances of conducting and insulating materials.
2. Determine the experimental value of heat transfer coefficients in natural and forced convection modes and compare the results with analytical values.
3. Determine the Stefan-Boltzmann constant and the value of emissivity of a grey plate.
4. Calculate the heat transfer coefficient of heat exchanger for various configurations.
5. Calculate the heat transfer coefficient in boiling and condensation heat transfer.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	1	1	1	1
CO2	1	1	-	-	-	-	-	-	-	-	-	1	1	1	1
CO3	1	1	2	1	-	-	-	-	-	-	-	1	1	1	1
CO4	1	1	1	1	-	-	-	-	1	1	-	1	1	1	1
CO5	1	1	2	1	1	1	-	-	1	1	-	1	1	1	1

List of the experiments:

1. Determination of thermal conductivity of Insulating Powder.
2. Determination of thermal conductivity of composite wall.
3. Determination of thermal conductivity of metal rod.
4. Determination of convective heat transfer coefficient under Natural convection phenomena.
5. Determination of convective heat transfer coefficient under Forced convection phenomena.
6. Determination of Emissivity of a given plate.
7. Determination of the value of Stefan-Boltzmann constant.
8. Determination of Heat transfer coefficient in parallel flow heat exchanger.

9. Determination of Heat transfer coefficient in counter flow heat exchanger.
10. Determination of heat transfer coefficient in Film wise and Drop wise condensation
11. To determine the effectiveness of Cross flow Heat Exchanger.
12. Heat Pipe Demonstration.
13. Determination of thermal capacity of solid and liquid.
14. Determination of critical heat flux for copper wire in water.

Note: A minimum of 10 experiments need to be done.

Text Books:

1. J.P. Holman, –Heat Transfer, McGraw Hill Publication, New Delhi, 2009.

Suggested Reading:

1. D.S. Kumar, ‖ Heat Transfer, S K Kataria Publishers, 2015.

With Effect from the Academic Year 2023 – 2024

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

Scheme of Instruction as per R22 Curriculum

B.E. (MECHANICAL ENGINEERING)

SEMESTER – IV

S. No.	Course Code	Title of the Course	Scheme of instruction			Scheme of examination			Credits
			Hours per week			Duration in Hrs	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MEC09	Kinematics of Machines	3	1	--	3	40	60	4
2	22MEC10	Applied Thermodynamics	2	--	--	3	40	60	2
3	22MEC11	Fluid Mechanics and Hydraulic Machines	3	-	--	3	40	60	3
4	22MEC12	Manufacturing Processes	3	-	--	3	40	60	3
5		Professional Elective - I	3	--	--	3	40	60	3
6	22EGM01	Indian Constitution and Fundamental Principles	2	--	--	2	--	50	*Non Credit
PRACTICALS									
7	22MEC13	Computer Aided Machine drawing	--	1	2	3	50	50	2
8	22MEC14	Fluid Mechanics and Hydraulic Machines Lab	--	--	2	3	50	50	1
9	22MEC15	Manufacturing Processes Lab	--	--	2	3	50	50	1
10	22MEC16	Applied Thermodynamics Lab	--	--	2	3	50	50	1
TOTAL			**16**	**02**	**08**	--	**400**	**550**	**20**

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**
CIE - Continuous Internal Evaluation **SEE – Semester End Examination**

Professional Elective – I		
S. No	**Course Code**	**Title of the Course**
1	22MEE01	Power Plant Engineering
2	22MEE02	Production and Operations Management
3	22MEE03	Entrepreneurship
4	22MEE04	Mechatronics and Automation

22MEC09

KINEMATICS OF MACHINES

Instruction	3L+1T Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives: At the end of the course, student will be able to understand

1. Basic elements of mechanisms and their motion characteristics, DOF
2. Velocity and Acceleration analysis of various mechanisms.
3. Principles involved in functioning of pivots, collars, clutches, belts, brakes and dynamometers
4. Drawing displacement diagrams and cam profile diagram for followers executing different types of motions and various configurations of followers.
5. Selecting gear and gear train depending on application**.**

Course Outcomes: At the end of the course, student will be able to

1. Understand basic elements of mechanisms and their motion characteristics, DOF.
2. Analyze Velocity and Acceleration of various mechanisms.
3. Understand and Evaluate Principles involved in functioning of pivots, collars, clutches, belts, brakes and dynamometers.
4. Design displacement diagrams and cam profile diagram for followers executing different types of motions and various configurations of followers.
5. Select gear and gear train depending on application.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	2	-	1	-	-	-	-	1	-	2	-
CO2	3	3	2	1	2	-	1	-	-	-	-	1	-	2	-
CO3	3	3	2	1	1	-	1	-	-	-	-	1	-	2	-
CO4	3	3	2	1	2	-	1	-	-	-	-	1	-	2	-
CO5	3	3	2	1	1	-	1	-	-	-	-	1	-	2	-

UNIT - I

Basics of Mechanisms: Definition of kinematic link, Pair, Kinematic chain, Mechanism and machine, Degrees of freedom, Grubler's criterion, Inversions of four bar mechanism, Inversions of single and double slider crank chains.

Mechanism with Lower Pairs and Straight Line Motion Mechanism: Pantograph and Geneva mechanisms. Ackerman and Davis steering gear mechanisms and Hooke's Joint. Peaucellier, Hart, Scott-Russel, Watt and Tchebicheff mechanisms.

UNIT - II

Velocity and Acceleration of Mechanisms: Velocities of mechanisms by instantaneous centre, Body centrode, Space centrode, Kennedy's theorem, Determination of velocity and acceleration of Four bar, Single slider crank and Slotted lever mechanisms by relative velocity method including Coriolis component of acceleration, Freudenstein's method for synthesis of four bar linkage.

UNIT- III

Friction: Friction in pivots, Collars. Clutches - Single and Multi-plate, Cone and centrifugal clutches.

Brakes and Dynamometers: Block or shoe, Band, Band and block, Internal expanding shoe brakes. Prony

brake, Rope brake, Belt transmission and torsion dynamometers.

UNIT - IV

Cams: Types of cams and followers, Displacement diagrams for followers, Uniform motion, Parabolic motion, Simple harmonic motion, Cycloidal motion, Drawing cam profile with knife edge follower, Translating roller follower and translating flat follower, Cams of specified contours, Tangent cam with roller follower, Circular arc (convex) cam with roller follower.

UNIT - V

Gears: Classification of gears, Spur gears, Nomenclature, Law of gear tooth action, Involute as gear tooth profile, Interference of involute gears, Minimum number of teeth to avoid interference, Contact ratio, Cycloidal tooth profile, Comparison of involute and cycloidal tooth profile.
Gear Trains: Gear trains, Simple, Compound, Reverted and epicyclic gear trains, Differential of an automobile.

Text Books:

1. Thomas Bevan., Theory of Machines, CBS Publishers, 2009.
2. S.S. Rattan., Theory of Machines, 4th edition, Tata McGraw Hill Publishers, 2017.

Suggested Reading:

1. C.S. Sharma and Kamlesh Purohit., Theory of Mechanisms and Machines, PHI Learning Pvt. Limited, 2006.
2. Amitabh Ghosh and A.K.Mallik., Theory of Machines, 3rd edition, East WestPublications, 2009.
3. J.E. Shigley, Theory of Machines, 3rd edition, Tata Mc.Graw Hill Publishers, NewDelhi, 2014

22MEC10

APPLIED THERMODYNAMICS

Instruction	2 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Course Objectives: At the end of the course, student will be able to understand

1. The working principle of single and multi-stage reciprocating air compressor.
2. The working principle of diesel and petrol engines.
3. The combustion phenomena in IC Engines, parameters leading to abnormal combustion; cooling, lubrication and ignition systems.
4. The working principles of steam boilers.
5. The efficiency improvement methods of Rankine cycle and functioning of nozzles.

Course Outcomes: At the end of the course, the students will be able to

1. Estimate the power required and efficiency of reciprocating air compressor using the principles of thermodynamics.
2. Understand the working principle of I.C engines and their performance evaluation.
3. Understand the concepts of normal, abnormal combustion and the functioning of engine systemslike cooling, lubrication and ignition.
4. Understand the types of boilers and their performance.
5. Determine the efficiency of Rankine cycle with performance improvement techniques; Understand the nozzle performance and the condition for the maximum discharge.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	-	1	-	-	-	-	-	-	1	1	-	1
CO2	2	2	2	-	1	1	-	-	-	-	-	1	1	-	1
CO3	2	2	2	1	1	1	-	1	-	-	-	1	1	-	1
CO4	2	1	2	-	1	-	-	-	-	-	-	1	1	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-	1	1	-	2

UNIT – I

Reciprocating Air Compressors: Classification of compressors, applications of compressed air, working principle of reciprocating compressors - single stage and multi stage compressors with and without clearance, concept of optimum pressure ratio, minimum work input, various efficiencies of multi stage compressors, simple problems on reciprocating compressors.

UNIT - II

Internal Combustion Engines: Classification, working principles of 2-stroke, 4-stroke SI and CI engines, valve and port timing diagrams, performance of IC engines, Morse test, various methods of determining frictional power, various efficiencies, heat balance sheet.

UNIT - III

Combustion Phenomena: Stages of combustion in SI and CI engines, factors affecting, normal and abnormal combustion phenomenon in SI and CI engines, octane and cetane number, cooling systems,

lubrication systems, batteryand magneto ignition systems of IC engines.

UNIT – IV

Steam Boilers: Classification of boilers-Fire tube boilers- Cochran boiler, Locomotive boiler and Lancashire boiler, Water tube boilers- Babcock and Wilcox boiler. Boiler mountings and accessories. Boiler performance, Types of condensers- Jet and Surface condensers.

UNIT-V

Steam power plant: Modified Rankine cycle, Cycle efficiency improvement methods, Reheating, Regeneration and Cogeneration.

Steam nozzles: Types of nozzles, Nozzle efficiency, Velocity of steam flowing through the nozzle, Mass of steam discharged from the nozzle, Condition for maximum discharge, Critical pressure ratio, Diameters of nozzle throat and exit for maximum discharge

Text Books:

1. Mahesh M. Rathore, Thermal Engineering, TMH, New Delhi, 2016
2. V. Ganeshan, Internal Combustion Engines, Tata McGraw Hill Publishing, New Delhi,2015
3. R.K. Rajput., Thermal Engineering, Laxmi Publishers, New Delhi, 2014

Suggested Readings:

1. Heywood, J.B. “Internal Combustion Engine Fundamentals”, TMH, New York, 2004
2. Soman, Thermal Engineering, PHI, 2011.
3. Kulshrestha S.K., ‘Thermal Engineering’, Vikas Publishing, 2nd Edition, 2011

22MEC11

FLUID MECHANICS AND HYDRAULIC MACHINES

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: At the end of the course, student will be able to

1. Learn the fluid statics and properties of fluids.
2. Understand the laws related to fluid flow and their applications
3. Understand various principles and performance characteristics related to Reciprocating pumps.
4. Learn the working principle and efficiencies of hydraulic turbines
5. Come to know the working principles and performance characteristics of Centrifugal pumps.

Course Outcomes: At the end of the course, the students will be able to

1. Determine the various properties of fluids
2. Understand the laws related to fluid flow and their applications
3. Acquire the knowledge of the functionality and performance of reciprocating pumps.
4. Acquire knowledge in the functionality, performance and testing of hydraulic turbines
5. Estimate the performance and testing of centrifugal pumps.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	-	2	-	3	-	3	-	-	-
CO2	2	-	-	-	-	-	-	2	-	3	-	3	-	-	-
CO3	2	-	-	-	-	-	-	2	-	3	-	3	2	-	-
CO4	2	-	-	-	-	-	-	2	-	3	-	3	2	-	-
CO5	2	-	-	-	-	3	3	2	3	3	3	3	2	-	3

UNIT - I

Static Forces on Surface and Buoyancy:

Fluids, ideal and real fluids, incompressible and compressible fluids, stream lines, path lines, stream function and velocity potential, fluid statics, action of fluid pressure on surface, resultant force and center of pressure on a plane surface under uniform pressure, Equilibrium of floating bodies, stability of a submerged body, stability of floating bodies, determination of the metacentric height, determination of the position of the metacenter relative to the center of buoyancy.

Properties of fluids: Density, specific weight, specific gravity, specific volume, viscosity, Newton's law of viscosity, dynamic and kinematic viscosity, pressure

UNIT-II

Laws of Fluid Flow: Continuity theorem, Bernoulli's theorem, applications of Bernoulli's theorem, Pitot tube theoretical discharge, actual discharge and coefficient of discharge of Venturimeter, notches-rectangular, triangular, trapezoidal and stepped notches

Viscous Flow: Nature of flow-laminar, turbulent and transient flows, Reynolds number and its significance

Flow through Pipes: Head losses in pipes, pipe bends, major energy losses, loss of head due to friction in the pipe, Darcy-Weisbach equation, hydraulic gradient and total energy lines, pipes in series and parallel.

UNIT- III

Reciprocating Pumps: Classification and working principle, discharge, slip, coefficient ofdischarge, power required to drive the pump and efficiency, variation of pressure head due to acceleration of piston and pipe

friction, ideal and actual indicator diagrams, separation, safe speed to avoid separation, air vessels, work saved, quantity of water entering into or coming out of air vessels and performance characteristic curves.

UNIT-IV

Hydraulic machines and impact of jet on vanes: Types of hydraulic machines, impulse-momentum equation and its applications, layout of hydraulic power plant-working principle, velocity triangles, impact force exerted, power developed and efficiency of jet striking at the center and at one end of a single and series of unsymmetrical moving curved vanes

Hydraulic Turbines: Classification and working, Velocity triangles, Power developed and efficiencies of Pelton wheel, Francis turbine and Kaplan turbines, Design of hydraulic turbines, Specific speed, Physical significance, Unit testing, Unit quantities, Model testing, Conditions for similarity and performance characteristic curves.

UNIT - V

Centrifugal Pumps: Classification and working principle, Comparison over reciprocating pumps, Velocity triangles, Head equivalent of workdone, Efficiencies, Pressure rise, Minimum starting speed, Specific speed, Physical significance, Model testing, Conditions of similarity, Priming, Performance characteristic curves, Common operational problems (troubles), reasons and remedies.

Text Books:

1. P.N. Modi and S.M. Seth., Hydraulics and Fluid Mechanics Including Hydraulic Machines, 22nd edition, Standard Book House, New Delhi, 2019.
2. R.K. Bansal., A Text Book of Fluid Mechanics and Hydraulic Machines, 9th edition, Laxmi Publications (P) Ltd., New Delhi, 2015.

Suggested Reading:

1. R.S. Khurmi and N. Khurmi., Hydraulics, Fluid Mechanics and HydraulicMachines, 20th edition, S.Chand publishing, 2014
2. S. Ramamrutham., Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai and Sons, New Delhi, 2004.
3. Madan Mohan Das., Fluid Mechanics and Turbomachines, PHI Learning Private Limited, New Delhi, 2009.

22MEC12

MANUFACTURING PROCESSES

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: At the end of the course, student will be able to understand

1. Understand various terms related to manufacturing processes
2. Understand various manufacturing processes
3. Provide the ability to solve simple problems such as riser design and sheet metal calculations
4. Compare various Manufacturing processes
5. Select suitable manufacturing process for a given component.

Course Outcomes: At the end of the course, the students will be able to

1. Define various terms related to manufacturing processes
2. Demonstrate the understanding of various manufacturing processes
3. Solve simple problems such as riser design and sheet metal calculations
4. Compare various manufacturing processes
5. Choose suitable manufacturing process for a given component

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	1	-	-	3	2	-
CO2	1	2	1	1	-	-	-	-	-	-	-	1	3	1	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-	3	1	-
CO4	1	2	-	-	-	-	1	-	-	-	-	-	1	3	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	3	-

UNIT – I

Manufacturing Processes: Classification and importance.

Casting: Introduction, Classification of casting processes, Merits and demerits of casting process. Pattern materials, Pattern allowances, Elements of gating system, Types of gates:top gate, bottom gate, parting gate and step gate. Gating ratio and choke. Application of Bernouli principle and continuity equation to the flow in gating system. Mould filling time calculations, Pressurised and unsurprised gating systems.

UNIT - II

Riser design: Purpose and requirements of riser, Chvorinov's rule, Optimum shape and dimensions of riser, Riser design by Modulus method.

Special Casting Processes: Pressure die casting, Centrifugal casting, shell moulding, Investment casting.

UNIT- III

Arc Welding: Introduction to welding, Classification of welding processes, shielded metal arc welding, Submerged arc welding, Gas Tungsten arc welding, gas metal arc welding and Cold metal transfer.
Resistance Welding: Principle, Spot, Projection, Seam, Butt and percussion welding processes.

Solid State Welding: Friction welding, Ultrasonic welding and explosive welding

Other Welding Processes: Laser beam welding, Electron beam welding, Soldering and brazing.

UNIT – IV

Bulk Deformation Processes: Open die, Closed die and isothermal forging processes, Rolling process, Nomenclature of rolling, Geometric relationships in rolling, Direct, indirect, hydrostatic and impact extrusion processes, Wire drawing process

Sheet Metal Operations: Shearing process, Shearing load, Energy required, Types of shearingprocesses, Cup drawing process, Calculation of blank diameter for a given cup, Drawing load,Sheet bending process and bend allowance.

UNIT – V

Additive Manufacturing: Introduction, Stereo lithography, Fused deposition modeling, Selective laser melting, Powder bed fusion, Direct metal deposition and applications of additive manufacturing
Powder Processing: Introduction, Production of powders, Mixing, Blending, Compacting andSintering, Merits, Demerits and application of powder metallurgy products.
Processing of Plastics, Ceramics and Composites: Injection moulding, Blow moulding andthermoforming of plastics, Injection moulding and slip casting of ceramics, Roll bending andfilament winding of composites.

Text Books:

1. G.K. Lal and S.K. Choudhury., Fundamentals of Manufacturing Processes, Alpha scienceInternational Ltd., 2005.
2. Mikell P.Grover., Principle of Modern Manufacturing, 5th edition, Wiley , 2014,

Suggested Reading:

1. P.N. Rao., Manufacturing Technology, Vol.1, 3rd edition, Tata McGraw Hill Publ., 2011.
2. John Schey., Introduction to Manufacturing Processes, 2nd edition, McGraw Hill Education, 1999
3. Amitabh Ghosh and Mallick., Manufacturing Science, 4th edition, Assoc. East West PressPvt. Ltd., 2011.

22MEE01

POWER PLANT ENGINEERING

(Professional Elective - I)

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: At the end of the course, student will be able to understand

1. Different types of power plants and their site selection criteria
2. Operation of thermal power plant
3. About hydraulic power plants, dams and spillways
4. Different types of nuclear power plants including Pressurized water reactor, Boiling water reactor, Liquid metal fast breeder reactor and Gas cooled reactor
5. The power plant economics, environmental and safety aspects of power plantoperation.

Course Outcomes: At the end of the course, the students will be able to

1. Identify different handling equipment used in steam plant.
2. Understand various coal combustion methods.
3. Recognize different types of dams, spill ways and hydroelectric power plants.
4. Classify nuclear power plants based on moderator and coolant.
5. Analyze economics related to power plants and effect of pollutants

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	1	-	-	3	2	-	-	2	-	3	1	1	2
CO2	1	-	1	-	-	3	2	-	-	2	-	3	1	1	2
CO3	1	-	1	-	-	3	2	-	-	2	-	3	1	2	1
CO4	1	-	1	-	-	3	2	-	-	2	-	3	0	1	2
CO5	0	1	0	-	-	3	2	1	-	2	1	3	1	2	2

UNIT – I

Introduction: Energy and power, Sources of energy, Classification of power plants, Power development in India.

Steam power plant: Plant Layout, Site selection factors, Types of coal, Requirements of good coal handling plant, Coal and ash handling systems, Removal of dust and dust collectors.

UNIT II

Coal Combustion and Firing Methods: Overfeed stoker, Chain grate and spreader stokers, Underfeed stoker, Multi-retort stoker, Unit system, Central bin system, Pulverized fuel burners, Cyclone burner, Fluidized bed combustion.

UNIT III

Hydro Electric Power Plant: Hydrological cycle, Recording and non-recording rain gauges, Run-off flow measurement, Flow and mass duration curves, Site selection, Components and layout of hydro power plant, Types of dams and spillways, Classification of hydroelectric plants.

UNIT - IV

Nuclear Power Plant: Breeding and fertile materials, Comparison of fission and fusion processes, Essential components of a nuclear reactor, Pressurized water reactor, Boilingwater reactor, Gas cooled reactor, Liquid metal cooled reactors, Breeder reactor, Radioactive waste disposal.

UNIT - V

Power Plant Economics: Terms and definitions, Types of loads, Load curve, Load duration curve, Fixed and operating costs, methods to find depreciation cost, Various types of tariffs. **Environmental considerations:** Effluents from power plants and impact on environment.

Text Books:

1. R.K. Rajput, A Text Book of Power Plant Engineering, 5th edition, Laxmi Publications (P) Ltd, New Delhi, 2016.
2. P.K. Nag, Power Plant Engineering, 4th edition, McGra Hill Education (India) Private Limited, New Delhi, 2014.

Suggested Reading:

1. R. Yadav, Fundamentals of Power Plant Engineering, Central Publishing House,Allahabad, 2012.
2. R.K. Hegde, Power Plant Engineering, Pearson Education India, 2015.
3. P.C. Sharma, A Text Book of Power Plant Engineering, S.K. Kataria & sons, NewDelhi, 2016.

22MEE02

PRODUCTION AND OPERATIONS MANAGEMENT

(Professional Elective - I)

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: At the end of the course, student will be able to understand

1. Understand plant layout design to facilitate material flow and processing of a product in the most efficient manner
2. Gain some ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy.
3. Understand how Materials Requirement Planning and MRPII systems are used in managing operations
4. Recognize the importance of Inventory control to ensure their availability with minimum capital lock up.
5. Evaluate the quality processes in manufacturing and service sector to improve the operational performance

Course Outcomes: At the end of the course, the students will be able to

1. Understand the role of production system and its design in production and operationsmanagement.
2. Apply forecasting techniques for predicting demand
3. Use aggregate planning, master scheduling and materials requirement planning in aproduction system
4. Compare various inventory control techniques used in production system.
5. Apply the quality control tools to improve performance of production system.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	0	1	3	1	0	3	2	0	0	0	1	0	1	2	0
CO2	2	3	0	1	0	0	0	0	0	0	1	0	1	1	0
CO3	1	3	1	2	0	0	0	0	0	1	1	0	1	1	0
CO4	1	2	1	2	0	0	0	0	0	0	0	0	1	1	0
CO5	2	2	0	3	0	3	0	0	0	0	0	0	1	1	0

UNIT-I

Introduction: Production systems, Classification and characterisation

Plant Location and Layout: Factors affecting plant location, Objectives of plant layout, Types of layouts, Merits and demerits.

Work Study: Productivity, Introduction to method study and work measurement, Standard time calculations, Work sampling.

UNIT-II

Forecasting: Introduction, Forecasting objectives and uses, Demand patterns, Qualitative models, Market survey, Delphi method, Quantitative models, Moving average, Weighted
moving average, Simple exponential smoothing, Trend adjusted exponential smoothing, Simple regression.

Forecast Errors: Mean absolute deviation, Mean square error, Mean forecast error, Mean absolute percentage error

UNIT-III

Aggregate Planning and Master Scheduling: Introduction, Objectives of aggregate planning, Cost in aggregate planning, Strategies in aggregate planning, Master production scheduling.

Materials Requirement Planning: Importance, MRP system, Inputs and outputs, Bill of materials.

UNIT-IV

Inventory Control: Importance, Inventory control systems, Types of Inventories, Inventory costs, Deterministic Inventory models, Basic purchase model, Purchase model with instantaneous replenishment and with shortages, Basic production model, Production model with shortages, Inventory model with price breaks, Just-in-time system evolution and its characteristics.

UNIT-V

Quality Control: Introduction, Quality gurus and their contributions, Quality tools, Process capability, Quality control by control charts, Sampling plans, Operating characteristic curve, Introduction to total quality management and six-sigma.

Text Books:

1. Joseph G. Monks., Operations Management: Theory and Problems, 3rd edition, McGraw Hill International Edition, 1987.
2. William J. Stevenson., Operations Management, 8th edition, Tata McGraw Hill Edition, 2005.

Suggested Reading:

1. Everrete E. Adam and Ronald J. Ebert., Production & Operations Management, 5th edition, Prentice Hall of India, 2005.
2. R. Panneerselvam., Production and Operations Management, 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2006.
3. Elwood S. Buffa., Modern Production/Operations Management, 5th edition, John Wiley Publishers, Singapore, 2002

22MEE03

ENTREPRENEURSHIP
(Professional Elective - I)

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: At the end of the course, student will be able to understand

1. Concept and procedure of idea generation.
2. The nature of industry and related opportunities and challenges.
3. Elements of business plan and it s procedure.
4. Project management and its techniques.
5. Behavioural issues and Time management.

Course Outcomes: At the end of the course, the students will be able to

1. Understand the concept and essence of entrepreneurship.
2. Identify business opportunities and nature of enterprise.
3. Analyze the feasibility of new business plan.
4. Apply project management techniques like PERT and CPM for effective planning and execution of projects.
5. Use behavioral, leadership and time management aspects in entrepreneurial journey.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	1	2	1	1	2	3	-	-	-
CO2	-	-	-	-	-	-	-	2	3	3	3	3	-	-	-
CO3	1	-	-	1	-	-	1	2	3	3	3	3	1	-	-
CO4	2	-	-	-	-	-	1	2	1	3	3	3	2	-	-
CO5	-	-	-	-	-	-	2	2	1	2	1	3	-	-	-

UNIT-I

Entrepreneurship: Definition, Functions of entrepreneurs, Qualities of entrepreneurs, Entrepreneur vs intrapreneur, First generation entrepreneurs, Women entrepreneurs, Innovation, Creativity, Intellectual property in entrepreneurial journey, Conception and evaluation of ideas and their sources, Need and importance of startups and incubation centers.

UNIT-II

Indian Industrial Environment: Competence, Opportunities and challenges, Entrepreneurship and economic growth, Small scale industry in India, Objectives, Linkage among small, medium and large scale industries, Types of enterprises, Corporate social responsibility.

UNIT-III

Formulation of Business Plan: Introduction, Business model canvas, Elements of business plan and its salient features, Technical analysis, Profitability and financial analysis, Marketing analysis, Executive summary. Choice of technology and collaborative interactions, Sources of finance and Incentives for entrepreneurs. Busines firm registration procedures.

UNIT-IV

Project Management: Meaning and definition of project, Project organization, Project planning, Execution and control using CPM and PERT techniques, Human aspects of project management, Assessment of tax burden, Environmental issues

UNIT-V

Behavioral Aspects of Entrepreneurs: Personality determinants, Maslow's hierarchy of needs, Leadership concepts and models, Values and attitudes, Motivation aspects, Change behavior.

Time Management: Approaches of time management, Strengths and weaknesses, Time management matrix and the urgency addiction

Text Books:

1. Vasant Desai., Dynamics of Entrepreneurial Development and Management, 6th edition, Himalaya Publishing House, Mumbai, 1997.
2. Prasanna Chandra., Projects: Planning, Analysis, Selection, Implementation and Review, 8th edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1995.

Suggested Reading:

1. Robert D. Hisrich and Michael P. Peters., Entrepreneurship, 5th edition, Tata McGraw Hill Publishing Company Ltd., New Delhi,2005.
2. Stephen R. Covey., First Things First, 1st edition, Free press, New York, 2003.
3. S.S. Khanka., Entrepreneurial Development, 4th edition, S. Chand & Co. Pvt. Ltd., New Delhi, 2012.

22MEE04

MECHATRONICS AND AUTOMATION

(Professional Elective - I)

Instruction	3 L Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: At the end of the course, student will be able to

1. Understand the elements of mechatronics systems and their interconnection with sensors and transducers
2. Understand the concept of mechanical and electrical actuators
3. Interfacing of a microcontroller and microprocessor with its constituents and study of various controllers
4. Study of various automated systems for industrial applications
5. Study of robotic automated systems using AI and IOT for various industrial applications

Course Outcomes: At the end of the course, the students will be able to

1. Apply the methodology of choosing the suitable sensor for a mechatronics system.
2. Select the suitable actuator for various electrical and mechanical systems.
3. Design a microcontroller and microprocessor with emphasis on process controllers (P, PD, PI and PID) for a mechatronics system
4. Design an automated system for industrial applications.
5. Integrate the concepts of AI and IOT while designing a robotic automated system for various industrial applications.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	1	2	1	1	1	2	2	1	1	3	1	2
CO2	2	2	3	1	2	1	-	1	2	1	1	1	3	1	2
CO3	2	2	3	1	2	2	-	2	2	1	2	2	3	1	2
CO4	2	2	3	1	2	1	-	1	2	2	2	2	3	1	3
CO5	2	2	3	1	2	2	1	2	2	2	2	2	3	1	3

UNIT - I

Introduction to Mechatronics Systems: Need of interface of electrical & electronic devices with mechanical elements, Concept of mechatronics, Flow chart of mechatronics system, Elements of mechatronics system, Drive mechanisms, Actuators, Feedback devices and control system application in industries and systems development.

Sensors and Transducers: Sensors for displacement, Position and proximity, Velocity,Motion, Force, Fluid pressure, Liquid flow, Liquid level, Temperature, (thermistor, thermocouple), Light sensors and selection of sensors.

UNIT – II

Pneumatic and Hydraulic Actuation Systems: Valves, Pumps and accessories, Hydraulic circuits, Mechanical servo control circuits, Electro-hydraulic servo control and hydro pneumatic circuits with examples.

Mechanical Actuation Systems: Cams, Gear trains, Ratchet and pawl.

Electrical Actuation Systems: Mechanical switches, Solenoids, DC motors, AC motors, Stepper motors and servo motors.

UNIT - III

Microprocessor Technology: Introduction, Architecture, Configuration, Programming and using of 8051 controller with 'C' language, Interfacing input and output devices for various applications.

Process Controllers: Controllers, Uses of controllers, Open loop and closed loop control, Proportional, PD, PI, PID controllers, Analog and digital methods of control.

UNIT - IV

Introduction to Automation: Importance of automation, Use of mechatronics, Systems required, Purpose of automatic control, Implementation of industrial control system, Introduction to automatic control theory

Design of an Automated System: Building blocks of an automated system, Working principle, Selection of various components of an automated system, Specifications of various elements, Use of design data books and catalogues.

UNIT - V

Case Studies of Mechatronics Systems; Pick and place robot, Automatic car park systems, Automatic washing machine and engine management systems.

Introduction to robotic automation: Artificial Intelligence (AI) based systems, IOT in manufacturing industries.

Text Books:

1. William Bolton., Mechatronics: Electronic control systems in mechanical andelectrical engineering, 6th edition, Pearson Education, 2015
2. Ronald P. Hunter., Automated process control systems – concepts and Hardware, 2nd edition, PHI, 1987.

Suggested Reading:

1. Devdas Shetty and Richard A. Kolk., Mechatronics System Design, Cengage Learning,2010.
2. A.K Sawhney., A course on Electrical and Electronic Measurements andInstrumentation, Dhanapatrai & co, 2015

22EGM01

INDIAN CONSTITUTION AND FUNDAMENTAL PRINCIPLES

(BE/B.Tech - Common to all branches)

Instruction	2 L Hours per week
Duration of Semester End Examination	2 Hours
SEE	50 Marks
CIE	--
Credits	--

Prerequisite: Basic Awareness of Indian Constitution and Government.

Course Objectives
The course will introduce the students to:

1. Understand the history of framing of the Indian Constitution.
2. Awareness on Fundamental Rights, Duties and Directive Principles of State Policy.
3. Explore the organization of Union Government, and functions of President and Prime Minister.
4. Gain an insight into the inter-functionality of Union Legislature and Judiciary
5. Educate on the local governance and problems in development of rural and urban areas.

Course Outcomes
After successful completion of the course the students will be able to:

1. Understand the history of framing of the Indian Constitution and its features.
2. Assess the realization of Fundamental Rights and Directive Principles of State Policy.
3. Analyze the challenges to federal system and position of the President and the Prime Minister in the Union Government.
4. Underline the role of the Legislature and the Judiciary in Union Government and their mutual relations.
5. Evolve the development of the local governments in India and assess the role of Collector in district administration.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	1	-	-	1	1	1	1	-	-	-	-	-	-
CO2	-	-	2	-	-	3	2	2	1	-	-	-	-	-	2
CO3	-	-	1	-	-	1	1	-	-	-	-	-	-	-	-
CO4	-	-	1	-	-	1	1	-	-	-	-	-	-	-	2
CO5	-	-	2	-	-	3	2	1	1	-	-	-	-	-	2

UNIT-I

Constitutional History and Framing of Indian Constitution

East India Company rule (1757-1857): Social, Economic, Political and Administrative impact of Company rule in India. British Rule (1858-1947): Indian National Movement, Government of India Acts 1909, 1919 and 1935, and Indian Independence Act 1947. Framing of the Indian Constitution: Constituent Assembly, Preamble and Salient Features.

UNIT-II

Fundamental Rights, Duties and Directive Principles of State Policy

The Fundamental Rights**:** Features and significance of Rights. Fundamental Duties: Importance and the legal status of Duties. Directive Principles of State Policy: Socialist, Gandhian and Liberal-intellectual principles, importance and relevance.

UNIT-III

Union Government and its Administration

Federalism: Division of legislative and financial powers between the Union and the State. Union Executive: Role and position of President, Prime Minister and Council of Ministers. Emergency Provisions: National Emergency, Constitutional Emergency and Financial Emergency.

UNIT-IV

Union Legislature and Judiciary

Union Legislature: Parliament of India-Composition and functions of Parliament, and Parliamentary Committees. Union Judiciary: Supreme Court of India-Composition and Functions.

UNIT-V

Local Self Governments

Rural Local Governments: Zilla Parishad- CEO and functions of Zilla Parishad, Mandal Parishad- Role of Elected and Officials, Gram Panchayat- Sarpanch, Secretary and Gram Sabha. Urban Local Governments: Structure and functions of Municipalities and Municipal Corporations. District Collector: Powers and functions of Collector.

Text Books:

1. Sastry Ravindra, (Ed), "Indian Government & Politics", Telugu Akademy, 2nd edition, 2018.
2. "Indian Constitution at Work", NCERT, First edition 2006, Reprinted in 2022.

Suggested Reading:

1. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. Granville Austin, "The Indian Constitution: The Cornerstone of a Nation", OUP, 2nd Edition, 1999.
4. M.V. Pylee, "India's Constitution", S. Chand Publishing, 16th Edition, 2017.
5. Rajeev Bhargava (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.

Online Resources:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

22MEC13

COMPUTER AIDED MACHINE DRAWING

Instruction	1T+2P Hours per week
Duration of Semester End Examination	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	2

Course Objectives: student will learn

1. The conventions and rules to be followed by engineers for making accurate Drawings.
2. The Modeling of different machine components using CAD software.
3. Shape and structure of different types of screws, keys, couplings, and rivets.
4. Modeling of the assemblies of the machine components
5. To prepare the process sheets for the components.

Course Outcomes: At the end of the course, student will be able to

1. Understand the representation of materials and conventions used in machine drawing
2. Draw the orthographic projections and sectional views of machine parts.
3. Draw the different types of fasteners.
4. Construct an assembly drawing using part drawings of machine components.
5. Represent tolerances and the levels of surface finish of machine elements and prepare the process sheet.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	-	3	-	-	-	2	2	-	2	2	2	3
CO2	2	3	2	-	3	-	-	-	2	3	-	2	2	2	3
CO3	2	3	2	-	3	-	-	-	2	3	-	2	2	2	3
CO4	2	2	2	-	3	-	-	-	2	3	-	2	2	2	3
CO5	2	2	2	-	3	-	-	-	2	3	-	2	2	2	3

1. Machine Drawing

Format of drawing sheet, title block, conventions of drawing lines and dimensions, First and third angles projections, Conventional representation of Engineering materials and various machine components, methods of indicating notes on drawing, conversion of Pictorial view to orthographic views, convention for sectional views. Orthographic projections including sectional views of simple machine elements. Study of various commands/ tool bars using solid modelling package (solid works).

Component Drawings Of Fasteners, Joints And Couplings - Bolts and Nuts, Keys and Cotter joints, Knuckle Joint, Riveted joints, Shaft Couplings and Bearings. Assembly drawings of Connecting rod, Stuffing box, Screw jack, Lathe single Tool Post, Pedestal bearing (Plummer block). Revolving centre, Steam Engine Cross Head

2. Production Drawing

Introduction to production drawing- importance and need in industries , limit system and types of fits, geometrical tolerances, form and positional tolerances, surface roughness and its indication, process sheet preparation.

List of Exercises:

1. Part Modelling of machine components and finding their mass properties
2. Drawing the view from the front, top and left of the objects.
3. Drawing the sectional views of a components
4. Part Modelling of threaded fasteners
5. Creation of a double row chain type riveted lap joint from parts and views of the assembly
6. Creation of cotter joint assembly model from parts and views of the assembly
7. Creation of flange coupling assembly model from parts and views of the assembly
8. Creation of Stuffing box assembly model from parts and views of the assembly
9. Creation of Screw Jack assembly model from parts and views of the assembly
10. Creation of component drawings with suitable tolerances and fits, surface roughness, bill of materials etc., for Foot step bearing assembly
11. Creation of component drawings with suitable tolerances and fits, surface roughness, bill of materials etc., for Revolving center assembly
12. Creation of component drawings with suitable tolerances and fits, surface roughness, bill of materials etc., for Square tool post assembly

Note: Students should complete minimum of 10 drawings

Text Books:

1. K.L. Narayan, P. Kanniah, K. Venkat Reddy, *Machine Drawing*, New Age International (P) Ltd., 4th edition 2018.
2. K.L. Narayan, P. Kanniah, K. Venkat Reddy, *Production Drawing*, New Age International (P) Ltd., 4th edition 2018.
3. N. Siddeshwar, *Machine Drawing*, Tata McGraw Hill Publishing Co., Ltd., 5th edition, 2004.

Suggested Reading:

1. K.C. John, *Text book of Machine Drawing*, PHI Learning, 2010.
2. Ajeet Singh, *Machine Drawing*, Galgotia Publications, 2010.
3. N. D. Bhatt, V. M. Panchal Machine drawing [including computer aided drafting first-angle projection method], Charotar publishing house, 50th edition, 2016

22MEC14

FLUID MECHANICS AND HYDRAULIC MACHINES LAB

Instruction	2 P Hours per week
Duration of Semester End Examination	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives: At the end of the course, student will be able to understand

1. Determine discharge of fluid flow.
2. Verify fluid laws like Bernoulli's equation and determine losses through pipes.
3. Determine impact force of jet on the vanes
4. Evaluate the performance characteristics of turbines
5. Demonstrate knowledge in evaluating performance characteristics of pumps

Course Outcomes: At the end of the course, a student will be able to

1. Carry out discharge measurements
2. Determine the energy loss in conduits.
3. Calculate forces and work done by a jet on fixed or moving, flat and curved blades.
4. Demonstrate the characteristics curves of turbines.
5. Evaluate the performance characteristics of pumps.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	-	2	3	3	-	3	-	-	-
CO2	2	-	-	-	-	-	-	2	3	3	-	3	-	-	-
CO3	2	-	-	-	-	-	-	2	3	3	-	3	-	-	-
CO4	2	-	-	-	-	-	-	2	3	3	-	3	2	-	-
CO5	2	-	-	-	-	3	3	2	3	3	3	3	-	-	3

List of the Experiments:

1. Verification of Bernoulli's equation.
2. Determination of Darcy's friction factor and nature of water flow through pipes
3. Determination of coefficient of discharge for Venturimeter
4. Determination of coefficient of discharge for V- notch
5. Performance and characteristic curves of Reciprocating pump
6. Determination of impact force of jet on fixed flat and fixed curved vanes
7. Performance and characteristic curves of Pelton wheel
8. Performance and characteristic curves of Francis Turbine
9. Performance and characteristic curves of Kaplan turbine
10. Performance and characteristic curves of Centrifugal pump
11. Performance and characteristic curves of Self priming pump.
12. Performance and characteristic curves of Gear pump.

Note: A minimum of 10 experiments need to be conducted.

Suggested Reading:

1. P.N. Modi and S.M. Seth., Hydraulics and Fluid Mechanics Including Hydraulic Machines, 22nd edition, Standard Book House, New Delhi, 2019.
2. R.K. Bansal., A Text Book of Fluid Mechanics and Hydraulic Machines, 9th edition, Laxmi Publications (P) Ltd., New Delhi, 2015
3. Virtual labs – Fluid Machinery Lab, NITK SURATHKAL

22MEC15

MANUFACTURING PROCESSES LAB

Instruction	2 P Hours per week
Duration of Semester End Examination	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives: At the end of the course, student will be able to understand

1. Test the moulding sand and analyze the same.
2. Test the bead geometry and correlate the results to the input parameters.
3. Use TIG, MIG and Spot welding machines and experiment with them.
4. Test the formability characteristics of a given sheet metal and study different types of dies.
5. Understand the various type of sheet metal forming dies

Course Outcomes: At the end of the course, a student will be able to

1. Test the moulding sand and analyze the same.
2. Test the bead geometry and correlate the results to the input parameters.
3. Use TIG, MIG and spot welding machines and experiment with them.
4. Test the formability characteristics of a given sheet metal.
5. Demonstrate the understanding of various types of dies.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	-	1	-	-	-	-	2	-	-	-	1	1	-
CO2	1	-	-	1	-	-	-	-	2	-	-	-	1	1	-
CO3	1	-	-	1	-	-	-	-	2	-	-	-	1	1	-
CO4	1	-	-	1	-	-	-	-	2	-	-	-	1	1	-
CO5	1	-	-	1	-	-	-	-	2	-	-	-	1	1	-

List of the Experiments:

Casting:

1. Study of Ingredients of moulding sand and mould preparation for single piece
2. Study of core, core prints and moulding for split pattern.
3. Design of a simple pattern with various allowances.
4. Study of required properties of moulding sand and testing the properties of moulding sand
5. Study on the effect of the effect of grain fineness on moulding sand properties and Finding out the GFN of a given sand sample.
6. Demonstration of Melting and Pouring of Aluminium.

Welding:

1. Study of Arc welding process, comparison of the bead geometry with DCSP, DCRP andA.C.
2. Study of Gas Welding process, types of flames and making a butt joint with gas welding.
3. Study of resistance welding process and spot welding of MS Sheets.
4. Study of TIG welding process and plotting cooling curve in TIG welding process
5. Study of SAW Welding process and finding out deposition efficiency of the process.
6. Study of MIG welding process and testing of weld bead formed by MIG welding.

Metal Forming:

1. Evaluation of Formability of a given sheet material using Erichsen cupping test.
2. Study of cup drawing process, estimation of blank size for given cup and drawing a cup using simple die.
3. Study of Progressive die design and manufacturing of washer components using thesame on a fly press (capacity 6 Tons) and estimation of forces.
4. Study of Compound die design and manufacturing of washer components using the same on double body fly press (capacity 8 Tons) and estimation of forces.
5. Study of Combination die design and manufacturing of cylindrical cups using the sameon a hydraulic power press (capacity 50 Tons) and estimation of drawing force.
6. Study of extrusion dies and demonstration of extruding lead material

Note: A minimum of 12 experiments need to be conducted.

Suggested Reading:

1. P.N. Rao., Manufacturing Technology, Vol.1, 3rd edition, Tata McGraw Hill Publ., 2011.
2. Amitabh Ghosh and Mallick., Manufacturing Science, 4th edition, Assoc. East West PressPvt. Ltd., 2011.
3. Metal Forming Virtual Simulation Lab, Dayalbagh Educational Institute, Agra

22MEC16

APPLIED THERMODYNAMICS LAB

Instruction	2 P Hours per week
Duration of Semester End Examination	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives:

1. To demonstrate basic knowledge and exposure to determine valve and port diagram and also to evaluate the performance of the petrol engine and diesel engine.
2. Student will know the importance of heat balance sheet of IC engine.
3. Students will acquire knowledge in evaluating the performance of multi-stage reciprocating compressor.
4. Student will acquire knowledge in determination of fuel properties
5. Student will acquire knowledge regarding pollution levels of various alternative fuels

Course Outcomes: At the end of the course, a student are able to

1. Evaluate the performance of petrol and diesel engines.
2. Estimate the conversion of heat supplied by the fuel to various other forms of energy in an I.C engine.
3. Determine the performance of multi stage reciprocating air compressor.
4. Determination of fuel properties of liquids fuels
5. Determination of performance parameters and pollution levels of an alternative fuel.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	-	1	1	-	-	-	-	1	1	-	1
CO2	2	1	2	1	-	1	1	-	-	-	-	1	1	-	1
CO3	2	1	1	-	-	-	-	-	-	-	-	1	1	-	-
CO4	2	1	1	-	-	1	-	-	-	-	-	1	1	-	-
CO5	2	1	2	1	-	2	2	-	-	1	-	1	1	-	1

List of the Experiments:

Applied Thermodynamics

1. Determination of Valve timing diagram and Port timing diagram of IC engine.
2. Determination of Performance characteristics of a multi-cylinder petrol engine.
3. To conduct Morse test on multi cylinder petrol engine.
4. To conduct performance test on a variable compression ratio petrol engine.
5. To conduct performance test on single cylinder diesel engine
6. To conduct heat balance test on single cylinder diesel engine.
7. To conduct heat balance test on multi cylinder I.C. engine.
8. To determine volumetric efficiency, isothermal efficiency of multi -stage reciprocating air compressor.
9. Determination of Fuel properties like Flash point and Fire point of fuels.
10. Determination of Viscosity of fuels.
11. Determination of Calorific value of fuel by Bomb calorimeter.
12. To conduct performance test on Homogeneous Charge Compression Ignition (HCCI) Engine.
13. Evaluate the performance parameters and pollution levels of an alternative fuel on a four stroke single cylinder diesel engine.

Note: A Minimum of 10 experiments need to be done.

Text Books:

1. Mahesh M. Rathore, –Thermal Engineering, TMH, New Delhi, 2010
2. V. Ganeshan,–Internal Combustion Engines, Tata Mcgraw Hill Publishing, New Delhi, 2015

Suggested Reading:

1. R.K. Rajput., Thermal Engineering, Laxmi Publishers, New Delhi, 2014.