Scheme of Instruction and Syllabi

Bachelor of Engineering

A FOUR YEAR (I – VIII Semesters) UG Program

in

MECHANICAL ENGINEERING

(Revised AICTE Model Curriculum with effect from AY)

R–22 Regulation

DEPARTMENT OF MECHANICAL ENGINEERING

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

(Autonomous Institution under UGC, Affiliated to Osmania University)

Accredited by NBA and NAAC-UGC

Chaitanya Bharathi (Post), Gandipet, Hyderabad–500075

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY

B.E. (MECHANICAL ENGINEERING)

SEMESTER – I

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC02	Calculus	3	1	-	3	40	60	4
2	22CYC01	Chemistry	3	-	-	3	40	60	3
3	22EEC01	Basic Electrical Engineering	2	1	-	3	40	60	3
4	22CSC01	Problem Solving and Programming	2	1	-	3	40	60	3
PRACTICAL									
5	22CYC02	Chemistry Lab	-	-	3	3	50	50	1.5
6	22MBC02	Community Engagement	-	-	3	-	50	-	1.5
7	22CSC02	Problem Solving and Programming Lab	-	-	3	3	50	50	1.5
8	22MEC37	Robotics & Drones Lab	-	2	2	-	100	-	3
9	22EEC02	Basic Electrical Engineering Lab	-	-	2	3	50	50	1
TOTAL			**10**	**5**	**13**	**-**	**460**	**390**	**21.5**
Clock Hours Per Week: 28									

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

22MTC02 CALCULUS
(Common to ECE, EEE, MECH, CHEM, CIVIL)

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

Course Objectives:

1. To explain the solutions of system of linear equations by Matrix Methods.
2. To discuss mean value theorems.
3. To explain the Partial Derivatives and the extreme values of functions of two variables.
4. To explain the shape of curves, their areas and volumes of revolutions.
5. To discuss the convergence and divergence of the series.

Course Outcomes: Upon completing this course, students will be able to

1. Apply the Matrix Methods to solve system of linear equations.
2. Analyze the geometrical interpretation of Mean value theorems and curvature.
3. Determine the extreme values of functions of two variables.
4. Find the shape of the curve, surface areas and volumes of revolution.
5. Examine the convergence and divergence of infinite Series.

UNIT-I

Matrices: Rank of a matrix, Echelon form, and consistency of linear system of equations, Linear dependence and independence of vectors. Eigen values, Eigenvectors, Properties of Eigen values and Eigen vectors, Cayley Hamilton theorem, Quadratic form, Reduction of quadratic form to canonical form by linear transformation, Nature of quadratic form.

UNIT-II

Calculus: Rolle's Theorem, Lagrange's Mean value theorem, Cauchy's Mean value theorem (without proofs). Curvature, Radius of curvature, Centre of curvature, Evolute and Involute, Envelopes.

UNIT-III

Partial Differentiation and Its Applications: Functions of two or more variables, Partial derivatives, Higher order partial derivatives, Total derivative, Differentiation of implicit functions, Jacobians, Taylor's expansion of functions of two variables, Maxima and minima of functions of two variables.

UNIT-IV

Applications of definite integrals: Curve tracing of standard curves (Cartesian only), Applications of definite integrals to evaluate length of curves, surface areas and volumes of revolutions.

UNIT-V

Sequences and Series: Convergence of sequence and series. Tests for convergence of series: Comparison test, limit comparison test, D'Alembert's ratio test, Raabe's test, Cauchy's root test, Alternating series, Leibnitz's series, absolute and conditional convergence**.**

Text Books:

1. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Suggested Reading:

1. B.V.Ramana., Higher Engineering Mathematics, Tata McGraw-Hill, New Delhi, 11th Reprint, 2010.
2. R.K.Jain, S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5th edition, 2016.
3. David.Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/ Cole, 2005.

With effect from the Academic Year 2022-23

22CYC01

CHEMISTRY

(Common to All Branches)

Instruction:	3L Hours per Week
Duration of SEE:	3 Hours
SEE	60 Marks
CIE:	40 Marks
Credits:	3

Course Objectives

1. This syllabus helps at providing the concepts of chemical bonding and chemical kinetics to the students aspiring to become practicing engineers
2. Thermodynamic and Electrochemistry units give conceptual knowledge about processes and how they can be producing electrical energy and efficiency of systems.
3. To teach students the value of chemistry and to improve the research opportunities knowledge of stereochemistry and organic reactions is essential.
4. Water chemistry unit impart the knowledge and understand the role of chemistry in the daily life.
5. New materials lead to discovering of technologies in strategic areas for which an insight into Polymers, nanomaterials and basic drugs of modern chemistry is essential.

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

1. Identify the microscopic chemistry in terms of molecular orbitals, intermolecular forces and rate of chemical reactions.
2. Discuss the properties and processes using thermodynamic functions, electrochemical cells and their role in batteries and fuel cells.
3. Illustrate the major chemical reactions that are used in the synthesis of organic molecules.
4. Classify the various methods used in treatment of water for domestic and industrial use.
5. Outline the synthesis of various Engineering materials & Drugs.

UNIT-I

Atomic and molecular structure and Chemical Kinetics:

Atomic and molecular structure: Molecular Orbital theory - atomic and molecular orbitals. Linear combination of atomic orbitals (LCAO) method. Molecular orbitals of diatomic molecules. Molecular Orbital Energy level diagrams (MOED) of diatomic molecules & molecular ions (H_2 , He_2^+ ,N_2 , O_2 , O_2^- , CO, NO). Pi- molecular orbitals of benzene and its aromaticity.

Chemical Kinetics: Introduction, Terms involved in kinetics: rate of reaction, order & molecularity; First order reaction-Characteristics: units of first order rate constant & its half-life period, second order reaction-Characteristics: units of second order rate constant & its half- life period. Numericals.

UNIT-II

Use of free energy in chemical equilibria

Use of free energy in chemical equilibria: Thermodynamic functions: Internal energy, entropy and free energy. Significance of entropy and free energy (criteria of spontaneity). Free energy and emf (Gibbs Helmholtz equations and its applications). Cell potentials, electrode potentials, – Reference electrodes (NHE, SCE)-electrochemical series. Nernst equation and its applications. Determination of pH using combined Glass & Calomel electrode. Potentiometric Acid base & Redox Titrations. Numericals.

Battery technology: Rechargeable batteries & Fuel cells.

Lithium batteries: Introduction, construction, working and applications of Li-MnO_2 and Li-ion batteries.
Fuel Cells: Introduction, difference between conventional cell and fuel cell, limitations & advantages.
Construction, working & applications of methanol-oxygen fuel cell.

UNIT- III

Stereochemistry and Organic reactions

Stereochemistry: Representations of 3 dimensional structures, Types of stereoisomerism- Conformational isomerism – confirmations of n-butane (Newman and sawhorse representations), Configurational isomerism - Geometrical (cis-trans) isomerism & Optical isomerism- optical activity, Symmetry and chirality: Enantiomers (lactic acid) & Diastereomers (Tartaric acid), Absolute configurations, Sequence rules for R&S notation.

Types of Organic reactions: Substitution Reactions- Electrophilic substitution (Nitration of Benzene); Nucleophilic Substitution (S_N1& S_N2); Free Radical Substitution (Halogenation of Alkanes)
Addition Reactions: Electrophilic Addition – Markonikoff's rule, Free radical Addition - Anti Markonikoff's rule (Peroxide effect), Nucleophilic Addition – (Addition of HCN to carbonyl compounds)
Eliminations-E1 and E2 (dehydrohalogenation of alkyl halides)
Cyclization (Diels - Alder reaction)

UNIT–IV
Water Chemistry:
Hardness of water – Types, units of hardness, Disadvantages of hard water, Alkalinity and Estimation of Alkalinity of water, Boiler troubles - scales & sludge formation, causes and effects, Softening of water by lime soda process (Cold lime soda process),ion exchange method and Reverse Osmosis. Specifications of potable water & industrial water. Disinfection of water by Chlorination; break point chlorination, BOD and COD definition, Estimation (only brief procedure) and significance, Numericals.

UNIT-V
Engineering Materials and Drugs:
Introduction, Terms used in polymer science; Thermoplastic polymers (PVC) &Thermosetting polymers (Bakelite); Elastomers (Natural rubber). Conducting polymers- Definition, classification and applications.
Polymers for Electronics: Polymer resists for integrated circuit fabrication, lithography and photolithography.
Nano materials-Introduction to nano materials and general applications, basic chemical methods of preparation-Sol-gel method. Carbon nanotubes and their applications. Characterisation of nanomaterials by SEM and TEM (only Principle).
Drugs-Introduction, Synthesis and uses of Aspirin (analgesic), Paracetamol (Antipyretic), Atenolol (antihypertensive).

Text Books:

1. P.C. Jain and M. Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company Ltd.,New Delhi,16th edition (2015).
2. W.U. Malik, G.D.Tuli and R.D.Madan, "Selected topics in Inorganic Chemistry", S Chand & Company Ltd, New Delhi, reprint (2009).
3. R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, "Organic Chemistry", Pearson,Delhi, 7th edition(2019).
4. A Textbook of Polymer Science and Technology , Shashi Chawla,Dhanpat Rai & Co. (2014)
5. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill Education, Delhi, 2012
6. G.L. David Krupadanam, D. Vijaya Prasad, K. Varaprasad Rao, K.L.N. Reddy and C.Sudhakar, "Drugs", Universities Press (India) Limited, Hyderabad (2007).

Suggested Readings:

1. B. H. Mahan, "University Chemistry", Narosa Publishing house, New Delhi, 3rd edition (2013).
2. B.R. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Company Ltd., 46thedition(2013).
3. T.W. Graham Solomons, C.B. Fryhle and S.A. Snyder, "Organic Chemistry", Wiley,12th edition (2017).
4. P.W. Atkins, J.D. Paula, "Physical Chemistry", Oxford, 8th edition (2006).

With effect from the Academic Year 2022-2023

22EEC01

BASIC ELECTRICAL ENGINEERING

Instruction	2L + 1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

1. To understand the behaviour of different circuit elements R, L & C, and the basic concepts of electrical AC circuit analysis
2. To comprehend the basic principle of operation of AC and DC machines
3. To infer about different types of electrical wires and cables, domestic and industrial wiring. safety rules and methods of earthling.

Course Outcomes: After the completion of this course, the student will be able to

1. Understand the concepts of Kirchhoff's laws and their application various theorems to get solution of simple dc circuits.
2. Predict the steady state response of RLC circuits with AC single phase/three phase supply.
3. Infer the basics of single phase transformer
4. Describe the construction, working principle of DC machine and 3-phase Induction motor.
5. Acquire the knowledge of electrical wires, cables, earthing, Electrical safety precautions to be followed in electrical installations and electric shock and its safety and energy calculations.

UNIT-I

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin's and Norton's Theorems

UNIT-II

AC Circuits: Representation of sinusoidal waveforms, peak and RMS values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, series RL and RC. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III

Single Phase Transformer: Construction, Working principle, EMF Equation, Ideal and Practical transformer, Equivalent circuit of Transformer, OC and SC tests on a transformer, Efficiency and Regulation

UNIT-IV

DC and AC Machines: DC Generators: Construction, Principle of operation, EMF equation, Classification, Characteristics of shunt generators. DC Motors: Classification, Torque Equation, Characteristics and Speed control of DC Shunt and Series Motors, Losses and efficiency Three - Phase Induction Motors: Principle of operation, Applications

UNIT-V

Electrical Installations: Electrical Wiring: Types of wires and cables, Electrical Safety precautions in handling electrical appliances, electric shock, first aid for electric shock, safety rules. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, Earthing (Elementary Treatment only), Elementary calculations for energy consumption

Text Books:

1. L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
2. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.

Suggested Reading:

1. D. P. Kothari & I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989
3. D.C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009
4. P.V. Prasad, S. Sivanagaraju, R. Prasad, "Basic Electrical and Electronics Engineering" Cengage Learning, 1st Edition, 201

With effect from the Academic Year 2022-23

22CSC01

PROBLEM SOLVING AND PROGRAMMING

Instruction	2L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of this course are to:

1. Develop logical skills and basic technical skills so that students should be able to solve basic computational problems.
2. Learn any basic programming language.

Course Outcomes: After completion of course, students would be able to:

1. Understand real world problems and develop computer solutions for those problems.
2. Understand the basics of Python.
3. Apply Python for solving basic programming solutions.
4. Create algorithms/flowcharts for solving real-time problems.
5. Build and manage dictionaries to manage data
6. Handle data using files

UNIT I:

Introduction to Programming - Evolution of languages: Machine, Assembly and High-level languages. Software requirements for programming: OS, compiler, linker, loader, editor. Design specification: Algorithms and Flowcharts.

UNIT II:

Data Types and Operators, Variable, Sequences and Iteration - Data types, Expressions, Precedence Rules, Operators: arithmetic, relational, logical, bit-wise and miscellaneous operators; local variable, global variables, List, String, Tuples, Sequence mutation and accumulating patterns.

UNIT III:

Conditional Statement, Loops, Arrays and Strings, user-defined Data Types -if..else, for, while, nested iteration, Concept and use of arrays, declaration and usage of arrays, 2-dimensional arrays, different types of user defined data types.

UNIT IV:

Dictionaries and Dictionary Accumulation, Functions/Methods - Dictionary basics, operations, methods, accumulation, advantages of modularizing program into functions, function definition and function invocation. Positional parameters passing arrays to functions, recursion, library functions.

UNIT V:

File Handling and Memory Management - Concepts of files and basic file operations, writing/reading data to/from a .csv file, Memory Management Operations.

Text Books and References:

1. R.S. Salaria, Khanna , “Programming for Problem Solving”, Book Publishing Co., Delhi.
2. Jeeva Jose, Khanna , “Taming Python by Programming”, Book Publishing Co., Delhi.
3. Mark Lutz, “Learning Python”, 5th Edition, , O'Reilly Media, Inc.,
4. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by No Starch Press.
5. Eric Matthes,, “Programming in Python”, R.S. Salaria, Khanna Book Publishing Co., Delhi.
6. https://www.coursera.org/specializations/python-3-programming.

NPTEL/SWAYAM Course:

1. Introduction to Problem Solving and Programming, Video Lectures, Prof. D Gupta , IIT Delhi.
2. Problem Solving Aspects and Python Programming, Dr. S Malinga, Dr Thangarajan, Dr. S V Kogilavani, Kongu Engineering College.

With effect from the Academic Year 2022-23

22CYC02

CHEMISTRY LAB

(Common to All Branches)

Instruction:	3P Hours per Week
Duration of SEE	3 Hours
SEE:	50 Marks
CIE	50 Marks
Credits:	1.5

Course Objectives

1. To impart fundamental knowledge in handling the equipment / glassware and chemicals in chemistry laboratory.
2. To provide the knowledge in both qualitative and quantitative chemical analysis
3. The student should be conversant with the principles of volumetric analysis
4. To apply various instrumental methods to analyse the chemical compounds and to improve understanding of theoretical concepts.
5. To interpret the theoretical concepts in the preparation of new materials like drugs and polymers.

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

1. Identify the basic chemical methods to analyse the substances quantitatively & qualitatively.
2. Estimate the amount of chemical substances by volumetric analysis.
3. Determine the rate constants of reactions from concentration of reactants/ products as a function of time.
4. Calculate the concentration and amount of various substances using instrumental techniques.
5. Develop the basic drug molecules and polymeric compounds.

Chemistry Lab

1. Introduction: Preparation of standard solution of oxalic acid and standardisation of NaOH.
2. Estimation of metal ions (Co^{+2}& Ni^{+2}) by EDTA method.
3. Estimation of temporary and permanent hardness of water using EDTA solution
4. Determination of Alkalinity of water
5. Determination of rate constant for the reaction of hydrolysis of methyl acetate. (first order)
6. Determination of rate constant for the reaction between potassium per sulphate and potassium Iodide. (second order)
7. Estimation of amount of HCl Conductometrically using NaOH solution.
8. Estimation of amount of HCl and CH_3COOH present in the given mixture of acids Conductometrically using NaOH solution.
9. Estimation of amount of HCl Potentiometrically using NaOH solution.
10. Estimation of amount of Fe^{+2} Potentiometrically using $KMnO_4$ solution
11. Preparation of Nitrobenzene from Benzene.
12. Synthesis of Aspirin drug and Paracetamol drug.
13. Synthesis of phenol formaldehyde resin.

Text Books:

1. J. Mendham and Thomas, "Vogel's text book of quantitative chemical analysis", Pearson education Pvt.Ltd. New Delhi ,6^{th} ed. 2002.
2. Senior practical physical chemistry by B.D.Khosla, V.C.Garg&A.Gulati,; R. Chand & Co. : New Delhi (2011).

Suggested Readings:

1. Dr.Subdharani , "Laboratory Manual on Engineering Chemistry", Dhanpat Rai Publishing, 2012.
2. S.S. Dara , "A Textbook on experiment and calculation in engineering chemistry", S.Chand and Company, 9^{th} revised edition, 2015.

With effect from the Academic Year 2022-23

22MBC02

COMMUNITY ENGAGEMENT

Instruction	3P Hours per week
SEE	Nil
CIE	50 Marks
Credits	1.5

Course Objectives: The main Objectives of this Course are to:
1. Develop an appreciation of Rural culture, life-style and wisdom among the Students.
2. Learn about the various livelihood activities that contribute to Rural economy.
3. Familiarize the Rural Institutions and the Rural Development Programmes in India.

Course Outcomes: After the completion of this Course, Student will be able to:
1. Gain an understanding of Rural life, Culture and Social realities.
2. Develop a sense of empathy and bonds of mutuality with Local Communities.
3. Appreciate significant contributions of Local communities to Indian Society and Economy.
4. Exhibit the knowledge of Rural Institutions and contributing to Community's Socio-Economic improvements.
5. Utilise the opportunities provided by Rural Development Programmes.

Module IAppreciation of Rural Society
Rural life style, Rural society, Caste and Gender relations, Rural values with respect to Community, Nature and Resources, elaboration of 'soul of India lies in villages' (Gandhi), Rural Infrastructure.

Module II Understanding Rural Economy and Livelihood
Agriculture, Farming, Landownership, Water management, Animal Husbandry, Non-farm Livelihood and Artisans, Rural Entrepreneurs, Rural markets, Rural Credit Societies, Farmer Production Organization/Company.

ModuleIII Rural Institutions
Traditional Rural organizations, Self-Help Groups, Panchayati Raj Institutions (Gram Sabha), Gram Panchayat, Standing Committees, Local Civil Society, Local Administration.

ModuleIV Rural Development Programmes
History of Rural Development in India, Current National Programmes: SarvaShikshaAbhiyan, BetiBhachao, BetiPadhao, Ayushman, Bharat, Swachh Bharat, PM AwasYojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA etc.

Text Books:

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015, un.org/sdgs
4. M.P Boraia, Best Practices in Rural Development, Shanlax Publishers, 2016.

Journals:

1. Journal of Rural development (published by NIRD & PR, Hyderabad).
2. Indian Journal of Social Work, (by TISS, Bombay).
3. Indian Journal of Extension Educations (by Indian Society of Extension Education).
4. Journal of Extension Education (by Extension Education Society).
5. Kurukshetra (Ministry of Rural Development, GOI).
6. Yojana (Ministry of Information & Broadcasting, GOI).

With effect from the Academic Year 2022-23

22CSC02

PROBLEM SOLVING AND PROGRAMMING LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives: The objectives of this course are to:

1. Master the fundamentals of writing Python scripts
2. Learn Python elements such as variables, flow controls structures, and functions
3. Discover how to work with lists and sequence data, and files

Course Outcomes: After completion of course, students would be able to:

1. Understand various Python program development Environments
2. Demonstrate the concepts of Python.
3. Implement algorithms/flowcharts using Python to solve real-world problems.
4. Build and manage dictionaries to manage data.
5. Write Python functions to facilitate code reuse.
6. Use Python to handle files and memory.

Laboratory / Practical Experiments:

1. Explore various Python Program Development Environments.
2. Demonstration of input/output operations
3. Demonstration of operators
4. Demonstration of selective control structures
5. Demonstration of looping control structures
6. Demonstration of Python Dictionaries.
7. Implementation of searching and sorting techniques.
8. Implementation of string manipulation operations
9. File handling and memory management operations

Text Books and References:

1. R.S Salaria, Khanna, (Programming for Problem Solving", Book Publishing Co., Delhi
2. Jeeva Jose, Khanna,, "Taming Python by Programming", Book Publishing Co., Delhi

With effect from the Academic Year 2022–23

22MEC37

ROBOTICS AND DRONES LAB

(Common to All Branches)

Instruction	2T + 2P Hours per week
CIE	100
Credits	3

Objectives: The objectives of this course are to:

1. To develop the students' knowledge in various robot and drone structures and their workspace.
2. To develop multidisciplinary robotics that have practical importance by participating in robotics competitions
3. To develop students' skills in performing spatial transformations associated with rigid body motions, kinematic and dynamitic analysis of robot systems.
4. Through projects done in lab, increase the true hands-on student learning experience and enhance their conceptual understanding, increase students' ability, competence and teamwork skills on dealing with real-life engineering problems

Outcomes: After completion of course, students would be able to:

1. Demonstrate knowledge of the relationship between mechanical structures of robotics and their operational workspace characteristics
2. Understand mechanical components, motors, sensors and electronic circuits of robots and build robots.
3. Demonstrate knowledge of robot controllers.
4. Use Linux environment for robotic programming.
5. Write Python scripts to control robots using Python and Open CV.

Lab Experiments:

1. Assembling of robot mechanical components, mounting of motors, sensors, electronic circuits to the chassis.
2. Connecting to electronic circuitry: motor drivers, incremental encoders proximity sensors, micro controller,
3. Different types of batteries, selection of suitable battery for application, safety precaution.
4. Introduction to Linux Command Line Interface: basic file and directory management and other useful commands
5. Controlling robot using Python: i) Move robot using Python code, ii) Make robot move in patterns using Python
6. Robot programming with Sensor inputs:i) Read sensor data using Python, ii) Visualize sensor data using Python, iii) Code robot to avoid obstacles by using sensor data
7. Open CV: i) Create an Image and display an image; ii) Read and change pixel values; iii) Create colored shapes and save image; iv) Extract the RGB values of a pixel; v) Reading and Writing Videos
8. Open CV: i) Extraction of Regions of Interest; ii) Extraction of RGB values of a pixel
9. Coding robot to work with colors, follow colored objects, identifying shape of the object-oriented
10. Projects: i)Making a line follower robot using a Camera; ii) Writing code for a complex function
11. Assembly of a drone

Suggested readings

1. https://www.geeksforgeeks.org/robotics-introduction/
2. https://www.ohio.edu/mechanical-faculty/williams/html/PDF/IntroRob.pdf
3. https://www.idtechex.com/en/research-report/new-robotics-and-drones-2018-2038-technologies-forecasts-players/584
4. https://dronebotworkshop.com/

With effect from the Academic Year 2022-2023

22EEC02

BASIC ELECTRICAL ENGINEERING LAB

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

Course Objectives:

1. To acquire the knowledge on different types of electrical elements and to verify the basic electrical circuit laws and theorems.
2. To determine the parameters and power factor of a coil, calculate the time and frequency responses of RLC circuits and to familiarize with measurement of electric power & energy.
3. To determine the characteristics of Transformers, dc, ac machines and switch gear components

Course Outcomes: At the end of the course, the students are expected to

1. Comprehend the circuit analysis techniques using various circuital laws and theorems.
2. Analyse the parameters of the given coil and measurement of power and energy in AC circuits
3. Determine the turns ration/performance parameters of single-phase transformer
4. Infer the characteristics of DC shunt motor different tests.
5. Illustrate different parts and their function of electrical components, equipment and machines.

List of Laboratory Experiments/Demonstrations:

1. Verification of KCL and KVL.
2. Verification of Thevenin's theorem.
3. Verification of Norton's theorem.
4. Charging and discharging of Capacitor.
5. Determination of parameters of a choke or coil by Wattmeter Method.
6. Power factor improvement of single-phase AC System.
7. Active and Reactive Power measurement of a single-phase system using
   (i) 3-Ammeter method (ii) 3-Voltmeter method
8. Measurement of 3-Phase Power in a balanced system
9. Calibration of single-phase energy meter.
10. Verification of Turns/voltage ratio of single-phase Transformer.
11. Open Circuit and Short Circuit tests on a given single phase Transformer
12. Brake test on DC Shunt Motor
13. Speed control of DC Shunt Motor
14. Demonstration of Measuring Instruments and Electrical Lab components.
15. Demonstration of Low-Tension Switchgear Equipment/Components
16. Demonstration of cut - out section of Machines like DC Machine, Induction Machine etc.

Note: TEN experiments to be conducted to cover all five Course Outcomes.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY

B.E. (MECHANICAL ENGINEERING)

SEMESTER – II

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC05	Vector Calculus and Differential Equations	3	1	-	3	40	60	4
2	22PYC05	Mechanics and Materials Science	3	-	-	3	40	60	3
3	22CEC01	Engineering Mechanics	3	1	-	3	40	60	4
4	22EGC01	English	2	-	-	3	40	60	2
PRACTICAL									
5	22PYC08	Mechanics and Materials Science Lab	-	-	3	3	50	50	1.5
6	22EGC02	English lab	-	-	2	3	50	50	1
7	22MEC01	CAD AND DRAFTING	-	1	3	3	50	50	2.5
8	22MEC38	Digital Fabrication Lab	-	-	3	3	50	50	1.5
TOTAL			**11**	**3**	**11**	**-**	**360**	**440**	**19.5**
Clock Hours Per Week: 25									

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**

CIE - Continuous Internal Evaluation **SEE – Semester End Examination**

With effect from the Academic Year 2022-23

22MTC05

VECTOR CALCULUS AND DIFFERENTIAL EQUATIONS
(Common to ECE, EEE, MECH, CHEM, CIVIL)

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

Course Objectives:

1. To explain scalar and vector functions with its Physical interpretations.
2. To discuss vector line, surface and volume integrals.
3. To explain relevant methods to solve first order differential equations.
4. To discuss the solution of higher order Differential Equations
5. To learn Numerical solution of ODE and Engineering problems.

Course Outcomes: Upon completing this course, students will be able to

1. Apply the vector differential operators to Scalars and Vector functions.
2. Solve line, surface & volume integrals by Greens, Gauss and Stoke's theorems.
3. Calculate the solutions of first order linear differential equations.
4. Solve higher order linear differential equations.
5. Find solution of algebraic, transcendental and ODE by Numerical Methods.

UNIT-I

Vector Differential Calculus and multiple Integrals: Scalar and Vector point functions, vector operator Del, Gradient, Directional derivative, Divergence, Curl, Del applied twice to point functions, Del applied to product of point functions (vector identities), Irrotational fields and Solenoidal fields, Double integral, Change of order of integration and Triple integrals.

UNIT-II

Vector Integral Calculus: Line integral, Surface integral and Volume integral. Verification of Green's theorem in a plane (without proof), verification of Stroke's theorem (without proof) and Gauss's divergence theorem (without proof).

UNIT-III

First Order Ordinary Differential Equations: Exact differential equations, Equations reducible to exact equations, Linear equation, Bernoulli's equation, Clairaut's equation, Riccati's equation, Orthogonal trajectories, Rate of decay of Radio-active materials**.**

UNIT-IV

Higher Orders Linear Differential Equations: Higher order linear differential equations with constant coefficients, rules for finding Complementary function, Particular Integral and General solution. Method of variation of parameters, solution of Cauchy- Euler equation , LR and LCR circuits

UNIT-V

Numerical Methods: Solution of Algebraic and transcendental equations by Bisection method, Regula-Falsi method Newton-Raphson method. Numerical Solutions of First Order Ordinary differential equations by Taylor's series method, Euler's method, Modified Euler's method and Runge-Kutta method of fourth order.

Text Books:

1. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Suggested Reading:

1. N.P.Bali and Dr. Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 9th edition, 2017.
2. R.K.Jain, S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5th edition, 2016.

With effect from Academic Year 2022-23

22PYC05

MECHANICS AND MATERIALS SCIENCE
(Civil & Mechanical)

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

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

1. Acquire knowledge about physics of oscillations and rotational motion
2. Understand the physical properties of crystalline and magnetic materials
3. Aware of characteristic properties of dielectric materials and superconductors
4. Familiarize with coherent properties of light waves.

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

1. Compare the various types of oscillations
2. Demonstrate rotational motion of rigid body
3. Classify different types of crystals and their imperfections
4. Identify magnetic and dielectric materials for engineering applications
5. Make use of lasers and superconductors in technological applications

UNIT-I

Oscillations: Simple harmonic motion–Harmonic oscillator–Damped harmonic motion – over damped, critically damped and under damped oscillators–Forced oscillations and resonance.

UNIT-II

Rigid body Dynamics: Definition of rigid body–Rotational kinematic relations–Angular momentum and torque–Equation of motion for a rotating rigid body–Inertia tensor and its properties– Euler's equations and applications: law of energy conservation and law of conservation of angular momentum.

UNIT-III

Crystallography: Space lattice –Unit cell –Crystal systems –Bravais lattices –Number of atoms per unit cell – Coordination number –Atomic radius –Packing fraction (for sc, bcc, fcc) –Lattice planes – Miller indices – Bragg's law –Experimental determination of lattice constant of a cubic crystal by powder X-ray diffraction method–Structure of NaCl.

Crystal Imperfections: Classification of defects –Point defects –Concentration of Schottky and Frenkel defects.

UNIT-IV

Dielectric Materials: Introduction –Dielectric polarization –Types of dielectric polarization: electronic & ionic polarizations (quantitative); orientation & space-charge polarizations (qualitative) –Frequency and temperature dependence of dielectric polarization –Determination of dielectric constant (Schering bridge method) – Ferroelectricity–Barium titanate–Applications of ferroelectrics.

Magnetic Materials: Origin of magnetism – Magnetic moment - Bohr magneton–Classification of magnetic materials: dia, para, ferro, anti-ferro and ferr imagnetic materials – Weiss molecular field theory –Domain theory –Hysteresis curve, soft and hard magnetic materials –Applications.

UNIT-V

Lasers: Characteristics of lasers – Einstein's coefficients – Amplification of light by population inversion - Ruby**,** He-Ne, semiconductor laser – Applications of lasers in engineering and medicine.

Fiber Optics: Introduction – Construction – Principle – Propagation of light through an optical fiber – Numerical aperture and acceptance angle – Step-index and graded-index fibers – Pulse dispersion – Fiber losses – Fiber optic communication system – Applications

Superconductors: General properties of superconductors – Meissner's effect – Type I and Type II superconductors – BCS theory (qualitative) – Applications.

TEXT BOOKS:

1. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Publications, 2012.
2. M.N. Avadhanulu and P.G. Kshirsagar, A Text Book of Engineering Physics, S. Chand Publications, 2014.
3. M. Arumugam, Materials Science, Anuradha Publications, 2015.
4. S.L. Gupta and Sanjeev Gupta, Modern Engineering Physics, Dhanpat Rai Publications, 2011.

SUGGESTD READING:

1. R. Murugeshan and Kiruthiga Sivaprasath, Modern Physics, S. Chand Publications S. Chand Publications, 2014.
2. V. Rajendran, Engineering Physics, McGraw-Hill Education Publications, 2013.
3. P.K. Palanisamy, Engineering Physics, Scitech Publications, 2012.
4. V. Raghavan, Materials Science and Engineering, Prentice Hall India Learning Private Limited; 6th Revised edition, 2015.

With effect from the Academic Year 2022-23

22CE C01

ENGINEERING MECHANICS

Instruction	3L+1T Periods per week
Duration of End Examination	3 Hours
End Examination	60 Marks
Sessional	40 Marks
Credits	4

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

1. Calculate the components and resultant of coplanar forces system and Draw free body diagrams to analyze the forces in the given structure
2. Understand the mechanism of friction and can solve friction problems
3. Analyse simple trusses for forces in various members of a truss.
4. Determine the centroid of plane areas, composite areas and centres of gravity of bodies.
5. Determine moments of inertia, product of inertia of plane and composite areas and mass moments of inertia of elementary bodies,

UNIT – I

Resolution and Resultant of Force System: Basic concepts of a force system. Components of forces in a plane. Resultant of coplanar concurrent force system. Moment of a force, couple and their applications. Resultant of coplanar non-concurrent force system

Equilibrium of force system: Free body diagrams, equations of equilibrium of planar force systems and its applications. Problems on general case of coplanar force systems.

UNIT – II

Theory of friction: Introduction, types of friction, laws of friction, application of friction to a single body & connecting systems. Wedge and belt friction

UNIT – III

Analysis of Simple Trusses: Introduction to trusses, Assumptions, analysis of simple trusses using method of joints and method of sections.

UNIT– IV

Centroid: Significance of centroid, moment of area, centroid of line elements, plane areas, composite areas, theorems of Pappus & its applications. Center of gravity of elementary and composite bodies

UNIT – V

Moment of Inertia: Definition of MI, Area MI. Polar Moment of Inertia, radius of gyration, transfer theorem, Moment of Inertia of elementary & composite areas, and Product of inertia. Mass moments of inertia of elementary bodies.

Text Books:

1. K. Vijay Kumar Reddy and J. Suresh Kumar, Singer's Engineering Mechanics, BS Publications, Hyderabad, 2011.
2. Ferdinand L Singer, Engineering Mechanics, Harper and Collins, Singapore, 1904.

Suggested Reading:

1. A. Nelson, Engineering Mechanics, Tata McGraw Hill, New Delhi, 2010.
2. S. Rajashekaran & G. Sankarasubramanyam, Engineering Mechanics, Vikas publications, Hyderabad, 2002.
3. S.B. Junarkar and H.J Shah, Applied Mechanics**,** Charotar publishers, New Delhi, 2001.
4. Basudeb Bhattacharyya, Engineering Mechanics, Oxford University Press, New Delhi, 2008.
5. A K Tayal, Engineering Mechanics, Umesh Publications, New Delhi, 2010

With effect from the Academic Year 2022-23

22EGC01

ENGLISH

(Common to All Branches)

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

Course Objectives: This course will introduce the students

1. To the role and importance of communication while developing their basic communication skills in English.
2. To basics of writing coherent paragraphs and formal emails.
3. To techniques of writing a précis and formal letters by using acceptable grammar and appropriate vocabulary.
4. To description, definition and classification of processes while enabling them to draft formal reports following a proper structure.
5. To gaining adequate reading comprehension techniques.

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

1. Illustrate the nature, process and types of communication and communicate effectively without barriers.
2. Construct and compose coherent paragraphs, emails and adhering to appropriate mobile etiquette.
3. Apply techniques of precision to write a précis and formal letters by using acceptable grammar and appropriate vocabulary.
4. Distinguish formal from informal reports and demonstrate advanced writing skills by drafting formal reports.
5. Critique passages by applying effective reading techniques

UNIT-I

Understanding Communication in English:

Introduction, nature and importance of communication; Process of communication; Types of communication - verbal and non-verbal; Barriers to communication; Intrapersonal and interpersonal communication; Understanding Johari Window.

Vocabulary &Grammar: The concept of Word Formation; Use of appropriate prepositions and articles.

UNIT-II

Developing Writing Skills I:

Paragraph writing. – Structure and features of a paragraph; Cohesion and coherence. Rearranging jumbled sentences. Email and Mobile etiquette.

Vocabulary & Grammar: Use of cohesive devices and correct punctuation.

UNIT-III

Developing Writing Skills II:

Précis Writing; Techniques of writing precisely. Letter Writing – Structure, format of a formal letter; Letter of request and the response

Vocabulary and Grammar: Subject-verb agreement. Use of prefixes and suffixes to form derivatives. Avoiding redundancies.

UNIT-IV

Developing Writing Skills III:

Report writing – Importance, structure, elements of style of formal reports; Writing a formal report.

Vocabulary and Grammar: Avoiding ambiguity - Misplaced modifiers. Use of synonyms and antonyms.

UNIT-V

Developing Reading Skills:

The reading process, purpose, different kinds of texts; Reading comprehension; Techniques of comprehension – skimming, scanning, drawing inferences and conclusions.

Vocabulary and Grammar: Words often confused; Use of standard abbreviations.

Text Books:

1. Language and Life: A Skills Approach, Board of Editors, Orient Black Swan,2017.
2. Swan Michael, Practical English Usage.OUP.1995.

Suggested Readings:

1. Wood F.T, Remedial English Grammar,Macmillan,2007
2. Zinsser William, On Writing Well, Harper Resource Book, 2001
3. Sanjay Kumar and PushpLata, Communication Skills. Oxford University Press,2011.

With effect from the Academic Year 2022-23

22PYC08

MECHANICS AND MATERIALS SCIENCE LABORATORY
(Civil & Mechanical)

Instruction	3P Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	1.5

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

1. Apply the concepts of physics while doing experiments
2. Learn the working of lasers and optical fibers
3. Understand the properties of magnetic and dielectric materials
4. Capable of measuring mechanical properties of solids and liquids
5. Understand the motion electrons in electric and magnetic fields

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

1. Estimate the error in an experimental measurement
2. Make use of lasers and optical fibers in engineering applications
3. Recall the physical properties of dielectrics and magnetic materials
4. Find the mechanical properties of solids and viscosity of liquids
5. Demonstrate the motion of electrons in electric and magnetic fields

Experiments

1.	Error Analysis	:	Estimation of errors in the determination of time period of a torsional pendulum
2.	Flywheel	:	Determination of moment of inertia of given flywheel
3.	Compound Pendulum	:	Determination of acceleration due to gravity
4.	Young's Modulus	:	Determination of Young's modulus of the given steel bar/wooden scale by non-uniform bending method
5.	Helmholtz's Resonator	:	Determination of resonating volume of air and neck correction
6.	Melde's Experiment -	:	Determination of frequency of the electrically maintained vibrating bar/fork
7.	Viscosity of Liquid	:	Determination of viscosity of a given liquid by oscillating disc method
8.	Coupled Oscillator	:	To determine the coupling constant of a coupled oscillator performing parallel and antiparallel oscillation
9.	Dielectric Constant	:	Determination of dielectric constant of given PZT sample
10.	M & H Values	:	Determination of magnetic moment M of a bar magnet and absolute value H of horizontal component of earth's magnetic field
11.	B-H Curve	:	Determination of hysteresis loss of given specimen
12.	Thermoelectric Power	:	Determination of thermoelectric power of given sample
13.	Laser	:	Determination of wavelength of given semiconductor laser
14.	Optical Fiber	:	Determination of numerical aperture and power losses of given optical fiber
15.	e/m of an electron	:	Determination of specific charge of an electron by J.J. Thomson method

NOTE: A minimum of TWLVE experiments should be done.

With effect from the Academic Year 2022-23

22EGC02

ENGLISH LAB

(Common to All Branches)

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

Course Objectives: This course will introduce the students:

1. To nuances of Phonetics and give them sufficient practice in correct pronunciation.
2. To word stress and intonation.
3. To listen to listening comprehension material for honing their listening skills.
4. To activities enabling them overcome their inhibitions while speaking in English with the focus being on fluency rather than accuracy.
5. To team work, role behavior while developing their ability to discuss in groups and making oral presentations.

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

1. Define the speech sounds in English and understand the nuances of pronunciation in English
2. Apply stress correctly and speak with the proper tone, intonation and rhythm.
3. Analyze listening comprehension texts to enhance their listening skills.
4. Determine the context and speak appropriately in various situations.
5. Design and present effective posters while working in teams ,and discuss and participate in Group discussions.

Exercises

1. **Introduction to English Phonetics**: Introduction to auditory, acoustic and articulatory phonetics, organs of speech: the respiratory, articulatory and phonatory systems.
2. **Sound system of English**: Phonetic sounds and phonemic sounds, introduction to international phonetic alphabet, classification and description of English phonemic sounds, minimal pairs . The syllable: types of syllables, consonant clusters.
3. **Word stress**: Primary stress, secondary stress, functional stress, rules of word stress.
4. **Rhythm & Intonation** : Introduction to Rhythm and Intonation. Major patterns, intonation of English with the semantic implications.
5. **Listening skills** – Practice with Software available in (K-van solutions)
6. **Public speaking –** Speaking with confidence and clarity in different contexts on various issues.
7. **Group Discussions -** Dynamics of a group discussion, group discussion techniques, body language.
8. **Pictionary –** weaving an imaginative story around a given picture.
9. **Information Gap Activity –** Writing a brief report on a newspaper headline by building on the hints given
10. **Poster presentation –** Theme, poster preparation, team work and representation.

Suggested Reading

1. T Balasubramanian. A Textbook of English Phonetics for Indian Students, Macmillan,2008.
2. J Sethi et al. A Practical Course in English Pronunciation (with CD), Prentice Hall India,2005.
3. PriyadarshiPatnaik. Group Discussions and Interviews, Cambridge University Press Pvt Ltd2011
4. ArunaKoneru, Professional Speaking Skills, Oxford University Press,2016

With effect from the Academic Year2020-21

22MEC01

CAD AND DRAFTING

Instruction	1 T + 3 D Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	2.5

Course Objectives:

1. To get exposure to a cad package and its utility.
2. Understanding orthographic projections.
3. To visualize different solids and their sections in orthographic projection
4. To prepare the student to communicate effectively by using isometric projection.
5. To prepare the student to use the techniques, skills, and modern tools necessary for practice.

Outcomes: At the end of the course, the Students are able to

1. Become conversant with appropriate use of CAD software for drafting.
2. Recognize BIS, ISO Standards and conventions in Engineering Drafting.
3. Construct the projections of points, lines, planes, solids
4. Analyse the internal details of solids through sectional views
5. Create an isometric projections and views

List of Exercises:

1. Introduction to CAD package: Settings, draw, modify tools, dimensioning and documentation
2. Construction of Conic Sections by General method
3. Orthographic projection: Principles, conventions, Projection of points
4. Projection of straight lines: Simple position, inclined to one plane
5. Projection of straight lines inclined to both the planes (without traces and mid-point)
6. Projection of planes: Perpendicular planes
7. Projection of planes: Oblique planes
8. Projection of solids: Simple position
9. Projection of solids: Inclined to one plane
10. Sections of solids: Prism, pyramid in simple position
11. Sections of solids: Cone and cylinder in simple position
12. Isometric projections and views
13. Conversion of isometric views to orthographic projections and vice-versa.

Text Books:

1. N.D.Bhatt, “Elementary Engineering Drawing”, Charotar Publishers,2012.
2. K.Venugopal, “Engineering Drawing and Graphics + AutoCAD”,New Age International Pvt.Ltd,2011.
3. Basanth Agrawal and C M Agrawal, “Engineering Drawing”, 2/e, McGraw-Hill Education (India) Pvt.Ltd.

Suggested Reading:

1. Shaw M.B and Rana B.C., “Engineering Drawing”, 2/e, Pearson,2009.
2. K.L. Narayana and P.K. Kannaiah, “Text Book of Engineering Drawing”, Scitech Publications,2011.

With Effect from the Academic Year 2022–23

22MEC38

DIGITAL FABRICATION LAB

Instruction	3P Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	1.5

Objectives: The objectives of this course are to:

1. Give a feel of Engineering Practices & develop holistic understanding of various Engineering materials and Manufacturing processes.
2. Develop skills of manufacturing, safety, precision, quality, intelligent effort, optimization, positive &team work attitude to get things right the first time.
3. Provide basic knowledge of Steel, Plastic, Composite and other materials for suitable applications.
4. Study of Principle and hands on practice on techniques of fabrication, welding, casting, manufacturing, metrology, and allied skills.
5. Advance important hard & pertinent soft skills, productivity, create skilled manpower which is cognizant of industrial workshop components and processes and can communicate their work in a technical, clear and effective way.

Outcomes: After completion of course, students would be able to:

1. Understand safety measures to be followed in workshop to avoid accidents.
2. Identify various tools used in fitting, carpentry, tin smithy, house wiring, welding, casting and machining processes.
3. Make a given model by using workshop trades including fitting, carpentry, tinsmithy and House wiring.
4. Perform various operations in welding, machining and casting processes.
5. Conceptualize and produce simple device/mechanism of their choice.

List of exercises:
Group-1

1. To make a lap joint on the given wooden piece according to the given dimensions.
2. To make a dove tail-joint on the given wooden piece according to the given dimensions.
3. a)Wiring of one light point controlled by one single pole switch, a three pin socket controlled by a single pole switch
   b) Wiring of two light points connected in series and controlled by single pole switch. Verify the above circuit with different bulbs. Wiring of two light points connected in parallel from two single pole switches and a three pin socket
4. Stair case wiring-wiring of one light point controlled from two different places independently using two 2- way switches.
5. To make external threads for GI pipes using die and connect the GI pipes as per the given diagram using taps, couplings & bends.
6. To connect the GI pipes as per the given diagram using, couplings, unions, reducer & bends.
   To connect the GI pipes as per the given diagram using shower, tap & valves and Demonstrate by giving water connection

Group- 2

1. To Study the method of Additive Manufacturing process using a 3D printer
2. To create a 3D CAD model of a door bracket using a modeling software
3. To Print a door bracket using an extruder type 3D Printer.
4. To create a 3D CAD model by reverse Engineering
5. To Design an innovative component using the CAD software
6. To Print the selected innovative component by the students using a 3D printer

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology, Vol. I, 2008 and Vol. II, Media promoters and publishers private limited, Mumbai, 2010.
2. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
3. Sachidanand Jha , 3D PRINTING PROJECTS: 200 3D Practice Drawings For 3D Printing On Your 3D Printer , June 7, 2019.

Suggested Reading:

1. Gowri P. Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Oliver Bothmann , 3D Printers: A Beginner's Guide , January 1, 2015

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY

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
13	22MEI01	MOOCs/Training/Internship	2-3 weeks/90 hours				50	-	2
TOTAL			**18**	**03**	**08**	-	**490**	**610**	**23+2**
Clock Hours Per Week: 29									

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: This course aims to

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: Upon completion of this course, students will 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.

CO-PO-PSO Articulation Matrix

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 Differential 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.

CO-PO-PSO Articulation Matrix

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	PS O 1	PS O 2	PS O3
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: This course aims to

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: Upon completion of this course, students 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**.**

CO-PO-PSO Articulation Matrix

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 plaincarbon 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: This course aims to

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: Upon completion of this course, students 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**.**

CO-PO-PSO Articulation Matrix

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: This course aims to
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: Upon completion of this course, students 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**.**

CO-PO-PSO Articulation Matrix

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: This course aims to
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: Upon completion of this course, students 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**.**

CO-PO-PSO Articulation Matrix

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: This course aims 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: Upon completion of this course, students 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.

CO-PO-PSO Articulation Matrix

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: This course aims to

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: Upon completion of this course, students 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**.**

CO-PO-PSO Articulation Matrix

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: This course aims to

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: Upon completion of this course, students 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.

CO-PO-PSO Articulation Matrix

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 cast iron 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 structural observation
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: This course aims to

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: Upon completion of this 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**.**

CO-PO-PSO Articulation Matrix

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.

CO-PO-PSO Articulation Matrix

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	-	-	-	-	-	-	-	-	-	-	-	-
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: This course aims to

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: Upon completion of this course, students 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.

CO-PO-PSO Articulation Matrix

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:

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

Suggested Reading:

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

22MEI01

MOOCs/TRAINING/INTERNSHIP

Instruction / Demonstration /Training	3-4 Weeks / 90 Hours
Duration of Semester End Presentation	--
SEE	--
CIE	50 Marks
Credits	2

Prerequisite: Knowledge of Basic Sciences and Engineering Science.

Course Objectives: This course aims to
1. Exposing the students to the industrial environment.
2. Create awareness with the current industrial technological developments relevant to program domain.
3. Provide opportunity to understand the social, economic and administrative considerations in organizations.

Course Outcomes: Upon completion of this course, students will be able to
1. Understand Engineer's responsibilities and ethics.
2. Use various materials, processes, products and quality control.
3. Provide innovative solutions to solve real world problems.
4. Acquire knowledge in technical reports writing and presentation.
5. Apply technical knowledge to real world industrial/rural situations

CO-PO-PSO Articulation Matrix

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	3	3	1	3	1	3	3	1	1	3
CO2	1	1	1	3	3	1	2	1	1	1	1	1	3	3	1
CO3	2	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO4	1	1	1	1	1	3	1	1	3	3	1	1	1	1	3
CO5	1	3	3	3	3	2	3	1	1	1	1	1	3	3	3

For implementation procedures and letter formats, Annexures I and III of Internship document may be referred.

Evaluation of Internship: The Industrial training / Internship of the students will be evaluated in three stages:

a) Evaluation by the Industry (in the scale of 1 to 10 where 1-Unsatisfactory; 10-Excellent).
b) Evaluation by faculty Mentor on the basis of site visit(s) or periodic communication (15 marks).
c) Evaluation through seminar presentation/Viva-Voce at the Institute by the constituted committee (25 marks).

Evaluation through Seminar presentation / Viva-Voce at the institute: Students shall give a seminar before an Expert Committee constituted by college (Director, HoD/Senior faculty, mentor and faculty expert from the same department) based on his/her training/internship carried out.

The evaluation will be based on the following criteria:

- Quality of content presented.
- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall be analyzed along with the Internship report.

Monitoring / Surprise Visits: During the internship program, the faculty mentor makes a surprise visit to the intern- ship site, to check the student's presence physically. If the student is found to be absent without prior intimation to the concerned industry, entire training / internship may be canceled. Students should inform through email to the facultymentor as well as the industry supervisor at least one day prior to avail leave.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY

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
11	22MEU01	Up-skill Certification Course - I	-				25	-	0.5
TOTAL			**16**	**02**	**08**	-	**400**	**550**	**20.5**
Clock Hours Per Week: 26									

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: This course aims to
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: Upon completion of this course, students 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.

CO-PO-PSO Articulation Matrix

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: This course aims to
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: Upon completion of this course, 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.

CO-PO-PSO Articulation Matrix

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: This course aims 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: Upon completion of this course, 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.

CO-PO-PSO Articulation Matrix

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 of discharge, 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: This course aims to
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: Upon completion of this course, 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

CO-PO-PSO Articulation Matrix

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: This course aims to

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: Upon completion of this course, 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

CO-PO-PSO Articulation Matrix

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	-	1	2
CO5	-	1	-	-	-	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: This course aims to

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: Upon completion of this course, 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.

CO-PO-PSO Articulation Matrix

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	-	3	2	-	-	-	1	-	1	2	-
CO2	2	3	-	1	-	-	-	-	-	-	1	-	1	1	-
CO3	1	3	1	2	-	-	-	-	-	1	1	-	1	1	-
CO4	1	2	1	2	-	-	-	-	-	-	-	-	1	1	-
CO5	2	2	-	3	-	3	-	-	-	-	-	-	1	1	-

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: This course aims to

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: Upon completion of this course, 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.

CO-PO-PSO Articulation Matrix

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: This course aims 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: Upon completion of this course, 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.

CO-PO-PSO Articulation Matrix

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, 6^{th} edition, Pearson Education, 2015
2. Ronald P. Hunter., Automated process control systems – concepts and Hardware, 2^{nd} 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: This course aims 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 : Upon completion of this course, 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.

CO-PO-PSO Articulation Matrix

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: This course aims to

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: Upon completion of this course, students 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.

CO-PO-PSO Articulation Matrix

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: This course aims to
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: Upon completion of this course, students 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.

CO-PO-PSO Articulation Matrix

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: This course aims 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 and study different types of dies.
5. Understand the various type of sheet metal forming dies

Course Outcomes: Upon completion of this course, students 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.

CO-PO-PSO Articulation Matrix

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: This course aims to

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: Upon completion of this course, students will be 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.

CO-PO-PSO Articulation Matrix

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:

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:

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

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY

B.E. (MECHANICAL ENGINEERING)

SEMESTER – V

S. No.	Course Code	Title of the Course	Scheme of instruction			Scheme of examination			Credits
			Hours per week			Duration in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MEC17	Dynamics of Machines	3	-	-	3	40	60	3
2	22MEC18	Metal Cutting and Machine Tool Engineering	3	-	-	3	40	60	3
3	22MEC19	Design of Machine Elements	3	1	-	3	40	60	4
4	22MEC20	CAD/CAM	3	-	-	3	40	60	3
5		Professional Elective - II	3	-	-	3	40	60	3
6		Open Elective - I	3	-	-	3	40	60	3
PRACTICALS									
7	22MEC21	Dynamics and Vibrations Lab	-	-	2	3	50	50	1
8	22MEC22	Metal Cutting and Machine Tool Engineering Lab	-	-	2	3	50	50	1
9	22MEC23	CAD/CAM Lab	-	-	2	3	50	50	1
10	22EGC03	Employability Skills Lab	-	-	2	3	50	50	1
11	22MEI02	Industrial/Rural Internship	3-4 Weeks/90 Hours				50	-	2
TOTAL			**18**	**01**	**08**	-	**490**	**560**	**23+2**
Clock Hours Per Week: 27									

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**

CIE - Continuous Internal Evaluation **SEE – Semester End Examination**

SEMESTER – V

Professional Elective – II		
S. No	**Course Code**	**Title of the Course**
1	22MEE05	Refrigeration and Air Conditioning
2	22MEE06	Robotic Engineering
3	22MEE07	Engineering Research Methodology
4	22MEE08	Product Design and Process Planning

Open Elective – I		
S. No	**Course Code**	**Title of the Course**
1	22CAO01	Foundations of Artificial Intelligence and Machine Learning
2	22CSO02	Introduction to Data Base Management Systems
3	22CIO03	Basics of Cyber Security
4	22EGO03	Indian Traditional Knowledge

22MEC17

DYNAMICS OF MACHINES

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Kinematics of Machines, Engineering Mathematics**.**

Course Objectives: This Course aims to

1. To understand force analysis of single slider crank mechanism and turning moment Diagrams for Flywheels
2. To understand the Gyroscopic effect and the performances of Governors
3. To know the Balancing of rotating and reciprocating masses.
4. To determine natural frequencies of undamped, damped and forced vibrating systems of single degree of freedom systems.
5. To understand the modes of vibrations, Two degree of Freedom linear and Torsional Vibrations

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

1. Apply the concept of dynamically equivalent link and determine the fluctuation of energy for flywheel applications in engines.
2. Understand the gyroscopic effects in ships, aero planes and two wheelers and also able to Analyze the characteristics of various centrifugal governors.
3. Analyze balancing problems in rotating and reciprocating machinery
4. Understand free and forced vibrations of single degree freedom systems
5. Understand free and forced vibrations of two-degreefreedom linear and Torsional systems.

CO-PO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	1	1	1	-	2	-	2	-	3	3	1	2
CO2	3	3	3	1	1	1	-	2	-	2	-	3	3	1	2
CO3	3	3	3	1	1	1	-	2	-	2	-	3	3	1	2
CO4	3	3	3	1	1	1	-	2	-	2	-	3	3	1	2
CO5	3	3	3	1	1	1	-	2	-	2	-	3	3	1	2

UNIT- I

Force analysis: D Alembert's Principle, Dynamic force analysis of single slider crank mechanism, concept of dynamically equivalent link.

Flywheels: Working principle of flywheel, turning moment on the crank shaft, turning moment diagrams, maximum fluctuation of energy and its determination of coefficient of fluctuation of speed. Applications of flywheels in engines.

UNIT- II

Gyroscope: Principle of gyroscope, roll, yaw and pitch motions, gyroscopic effect in a two-wheeler, ship and aeroplane.

Governors: Necessity of governor, different types of governors, working principle of centrifugal governors, characteristics of Watt, Porter governor, Hartnell governor, controlling force diagram,. Sensitivity, stability and hunting of governor, concept of isochronism of governors. Effort and power of governor.

UNIT- III

Balancing of Rotating masses: Balancing and its types, rotor balancing, single plane and two plane balancing, unbalanced forces and couples, static and dynamic balancing, balancing of rotors by analytical and graphical methods.

Balancing of reciprocating machines: Primary and secondary unbalanced forces, balancing of single, two and multi cylinder in line engines.

UNIT - IV

Vibrations: Vibrations of single degree freedom system (axial, transverse and torsional). Natural frequencyof equivalent system of combination of springs.

Damped Vibrations: Types of damping, vibrations with viscous damping.

Forced Vibrations: Vibrations with harmonically applied force with viscous damping, dynamic magnifier, resonance, vibration isolation and transmissibility.

UNIT –V

Two and three degree freedom systems: Natural frequencies of two degree freedom linear systems. Torsionally equivalent shafts. Whirling speed of shafts. Nodes in two and three rotor systems, modes of vibration, Dunkerley's and Rayleigh's approximate methods.

Text Books:

1. S.S. Rattan, Theory of Machines, 4th edition ,Tata-Mc Graw Hill, ,2014
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, Theory of Machines & Mechanisms, Oxford University press, 2003. .
3. William T.Thomson, Theory of Vibration with Application, 5th edition, Pearson education 2008

Suggested Reading:

1. Ghosh and Mallick, Theory of mechanisms and machines, affiliated to E-W Press, 1988.
2. J.S. Rao and Gupta, Theory and Practice of Mechanical Vibrations, PHI, 1984

Online Recourses:

https://archive.nptel.ac.in/courses/112/104/112104114/

22MEC18

METAL CUTTING AND MACHINE TOOL ENGINEERING

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Nil

Course Objectives: This course aims to

1. Make understand the concepts of metal cutting, tool material geometry, materials, and parameters.
2. Make understand the concept of thermal aspects, machinability, and economics of machining.
3. Familiarize various machine tools, jig and fixtures, unconventional machining methods.

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

1. Describe tool geometry, select tool material for machining of various materials and identify the types of chips. Calculate cutting forces, MRR, power consumption under different cutting conditions.
2. Classify the mechanisms of tool wear, estimate tool life using Taylor's equation under various cutting conditions and the application of cutting fluid.
3. Identify the basic parts, specifications, operations of various machine tools.
4. Describe the finishing and super finishing operations and the framework required.
5. Analyze methods of unconventional machining and identify suitable method for a given component and understand jigs & fixtures.

CO-PO Articulation Matrix

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
CO 1	3	2	2	1	2	1	2	1	2	1	1	1	2	3	1
CO 2	2	2	2	1	2	1	1	1	2	1	1	1	3	3	1
CO 3	3	2	3	2	2	1	1	1	2	1	1	1	2	3	1
CO 4	2	2	2	2	2	1	1	1	1	1	1	1	2	3	2
CO 5	3	2	2	2	2	1	2	1	1	1	1	1	2	3	2

Unit-I

Basic chip formation process. **Cutting tool materials**: High carbon steel, HSS, Stellite, Carbides, Coated carbides, Diamond. **Tool geometry**: Nomenclature of single point cutting tool by ASA and ORS. Geometry of drills, Milling cutters and broaches. Recommended Tool angles. Chip formation: Types of chips, BUE, Chip breakers. **Machining:** Orthogonal and oblique cutting, Mechanics of metal cutting, Merchant's analysis, Shear angle Solutions of Merchant and Lee & Shafer.

Unit-II

Thermal aspects of metal cutting: Sources of heat and heat distribution, various methods of measurement of temperature, Cutting fluids and applications. **Tool wear, Tool life & Machinability**: Types of wear, mechanism of tool wear, Tool life & Machinability. Effects of process parameters on Tool life. Taylor's tool life equation. Economics of machining: Tool life for maximum production and minimum cost.

Unit-III

Constructional features and specifications of machine tools: Various operations on Lathe, Types of Lathes and special attachments on a Centre Lathe. Drilling, Milling operations. Indexing methods. Shaper, planer and slotter and their differences. Quick return mechanisms, Automatic feed devices. Jig Boring machines- Differences between horizontal and vertical jig boring machines.

Unit- IV

Grinding machines: Types of grinding, Abrasives and bonds used for grinding wheels. Specification and selection of wheels. Principles of Broaching, Lapping, Honing, Polishing, Buffing, Super finishing and burnishing.

Screws and gear manufacturing: Screw making by tapping, Chasers, Thread rolling, Thread milling, Thread grinding. Gear shaping, Gear hobbing, Gear shaving and grinding

Unit-V

Jigs and Fixtures: Design principles for location and clamping. Tool holding and work holding devices. Quick clamping devices. Types of Jigs and fixtures.

Unconventional machining: Principles of working and applications of USM, AJM, EDM, ECM, LBM and EBM.

Text Books:

1. B.L. Juneja, Shekhon G.S. and Seth Nitin, Fundamentals of Metal Cutting & Machine tools, New Age Publishers, 2017.
2. P.N. Rao, Manufacturing Technology – Metal Cutting & Machine Tools, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2018.

Suggested Reading:

1. B. Chattopadhyay , Machining and Machine Tools, Wiley, 2nd Edition, 2017
2. David A. Stephenson, John S. Agapiou, Metal Cutting Theory and Practice, CRC Press, 3rd Edition, March 2016

Online Resources:

1. https://nptel.ac.in/courses/112105126
2. https://nptel.ac.in/courses/112105306

22MEC19

DESIGN OF MACHINE ELEMENTS

(DATA BOOK IS REQUIRED)

Instruction	3L+1T Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Prerequisite: Knowledge on Strength of Materials

Course Objectives: This course aims to

1. To understand the principles of machine design and design of components for static loads.
2. To design machine members for fluctuating loads and impact loads
3. Learn the design principles of shafts, keys, couplings, belt drives and pulleys.
4. Understand the principles of design of permanent joints such as riveted and welded joints.
5. Understand the principles of design of bolted joints, power screws and gasket joints.

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

1. Understand the standards, codes, various design considerations, failure criteria of members and design for static loads.
2. Design machine members subjected to fluctuating and impact loads.
3. Recommend suitable shafts, couplings and belt drives for a given application.
4. Design and suggest permanent joints for a given application.
5. Design of temporary fasteners.

CO-PO Articulation Matrix

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
CO 1	2	3	2	1	2	-	1	-	-	-	-	1	2	1	1
CO 2	3	3	2	1	2	-	1	-	-	-	-	1	2	1	1
CO 3	3	3	2	1	1	-	1	-	-	-	-	1	2	1	1
CO 4	3	3	2	1	2	-	1	-	-	-	-	1	2	1	1
CO 5	3	3	2	1	1	-	1	-	-	-	-	1	2	1	1

UNIT – I

Introduction: Materials used in machine components and their specifications to Indian standards. Codes andstandards used in design. Reliability, Principles of Ergonomics and Manufacturing considerations, preferred numbers, Types of loads and corresponding stresses. Theories of elastic failure, Stress concentration factor, factor of safety, Design of components for static loads.

UNIT – II

Design for Fatigue and Impact loads: Importance of fatigue in design, Fluctuating stresses, fatigue strengthand endurance limit. Factors affecting fatigue strength. S-N Diagram, Soderberg and Modified Goodman's diagrams for fatigue design. Cumulative fatigue, Miner's rule, Design of components for fatigue. Design of components for impact loading.

UNIT - III

Design of shafts: Solid, hollow and splined shafts under torsion and bending loads.

Design of Keys &**Couplings**: Keys, Muff and Split muff Couplings, Flange, Flexible and Marinetype of couplings.

Design of Belt Drive Systems: Design of flat belt pulleys.

UNIT – IV

Design of Riveted Joints: Types of riveted joints, efficiency of the joint. Design of joints subjected todirect and eccentric loads.

Welded Joints: Types of joints, Design of welded joints subjected to direct and eccentric loading.

UNIT – V

Design of temporary fasteners: Cotter and knuckle joints.Design of bolts and nuts. Locking devices, boltof uniform strength. design of gasket joints, Design of power screws and screw jack.

Text Books:

1 V.B. Bhandari, "Design Machine Elements", McGraw Hill Publication, 2017.
2 J.E. Shigley, C.R. Mischne, "Mechanical Engineering Design", Tata McGraw Hill Publications, 2015.
3 R.S.Khurmi and J.K.Gupta, "Machine design", 34/e, S Chand publications, 2018.

Suggested Reading:

1 Robert L. Norton, "Machine Design: An Integrated Approach", 2/e Pearson Education, 2013
2 P. Kannaiah, "Machine Design", Science-Tech Publications, 2010
3 M.F. Spotts, "Design of Machine Elements", Prentice Hall of India, 2013.

M**achine Design Data Hand Books:**

1 K. Mahadevan, K. Balaveera Reddy., "Design Data Hand book for Mechanical Engineers", 3/e, CBSPublisher,
2 PSG College, "Design Data book", 2012
3 V.B. Bhandari, "Machine Design Data Book", McGraw Hill Education, 2015

22MEC20

CAD/CAM

Instruction	3L	Hours per Week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Prerequisite: Engineering Graphics, Basic Manufacturing Processes.

Course Objectives: This Course aims to

1. Teach the scope of CAD/CAM ,basic design process and the importance and types of geometric transformations in CAD
2. Teach the theory for modelling of surface and solid modeling techniques
3. Impart the basic knowledge in writing CNC part programming
4. Teach basic configurations of robot Manipulator.
5. Teach concepts of part classification coding, computer aided process planning, automated inspection methods

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

1. Understand the applications of computer in design, manufacturing, and geometric transformation techniques
2. Demonstrate the knowledge of mathematical representation of various curves and surfaces and understand the concepts of solid modelling techniques.
3. Write the CNC part program for simple components.
4. Distinguish various NC systems and demonstrate the fundamentals knowledge of robotics
5. Understand the elements of an automated manufacturing environment

CO-PO Articulation Matrix

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
CO 1	3	3	1	2	3	-	1	1	3	2	1	2	3	3	1
CO 2	3	3	2	2	3	-	1	1	3	2	1	2	3	3	2
CO 3	3	3	2	2	3	-	1	1	3	2	1	2	3	3	2
CO 4	3	3	2	2	3	-	1	1	3	2	1	2	3	3	2
CO 5	3	3	3	2	3	-	1	1	3	2	1	2	3	3	3

UNIT-I

Introduction: Definition and scope of CAD/CAM, Product Life cycle, Design Process, Design criteria, CAD Data Exchange Formats (IGES, STEP).

Geometric Transformations: Introduction, Translation, Rotation, Scaling, Reflection Transformations, Homogeneous representation of transformation, Concatenation of transformations, Transformations about arbitrary point.

UNIT-II

WireFrame Modeling: Wireframe entities and their definition, interpolating and approximating curves. Parametric and non-parametric representation - line, circle and Helix curves. Synthetic curves: Properties of splines, continuity of curves, Parametric representation of Cubic Spline, Bezier and B-spline curves, Introduction to non-uniform rational B-splines.

Surface Modeling:

Analytic surfaces: Definition of Plane surface, Ruled surface, Surface of revolution, Tabulated cylinder

Synthetic Surfaces: Hermite cubic and Bezier surfaces.

Solid Modeling: Solid entities, Boolean operations, B– rep and CSG approaches, Feature Based and Parametric Modelling.

UNIT-III

Numerical Control of Machine Tools: Features and elements of NC, Types of NC systems: PTP, straight Cut and Contouring. Definition of axes and interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual part programming and Introduction to Computer-aided part programming

UNIT-IV

CNC: Introduction to CNC, Typical configurations, Machining center.

DNC: Typical configurations, CNC vs DNC.

Adaptive Control Systems: ACO and ACC.

Industrial Robots: Robot anatomy, configurations, control systems, drivers, accuracy and repeatability, end effectors, Applications

UNIT-V

GT: Part families, layout, part classification and coding system- OPITZ

CAPP: Variant and Generative process planning.

FMS and CIM: FMS equipment, FMS layouts, benefits of FMS, Elements of CIM.

Computer Aided Inspection and QC: Automated inspection- Off-line, On-line, Contact (Co-ordinate measuring machine), Non-contact inspection (Machine Vision, Scanning LASER Beam, Photogrammetry).

Additive Manufacturing: Process chain, Introduction to slicing

Textbooks:

1. Ibrahim Zeid, "CAD/ CAM Theory and Practice", McGraw Hill Inc, New York, 2011.
2. Mikell P.Groover, "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Publication, 4/e, 2016.
3. P.N. Rao, "CAD/CAM - Principles and Applications", 2/e, Tata McGraw Hill, New Delhi, 2004.

Suggested Reading:

1. Yoram koren, "Computer Control of Manufacturing Systems", McGraw Hill Int, New York, 1994.
2. C. Elanchezhian, T. Sunder Selwyn, G. Shanmuga Sunder, "Computer Aided manufacturing", 2/e, Laxmi Publications (P) Ltd, New Delhi 2007.

22MEE05

REFRIGERATION AND AIR CONDITIONING

(Professional Elective-II)
(Use of data book is permitted)

Instruction	3L	Hours per Week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Prerequisite: Knowledge on Thermodynamics and Applied Thermodynamics.

Course Objectives: This course aims to

1. Acquire the basic knowledge about the importance of refrigeration, its applications in aircraft refrigeration.
2. Demonstrate basic knowledge of vapor compression refrigeration system, cascade and compound refrigeration.
3. Understand various types of absorption refrigeration systems like ammonia, Electrolux and lithium bromide refrigeration systems.
4. Acquire the basic knowledge on various psychrometric processes and comfort air conditioning.
5. Acquire knowledge in estimating air conditioning loads.

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

1. Distinguish different types of refrigerants and evaluate the performance of different aircraft refrigeration systems
2. Analyze the performance of vapour compression refrigeration systems and improvement methods.
3. Understand the Vapour absorption, steam-jet and non-conventional refrigeration systems.
4. Analyze air-conditioning processes using the principles of Psychrometry.
5. Evaluate heating and cooling loads in air-conditioning systems.

CO-PO Articulation Matrix

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
CO 1	3	3	2	-	-	1	2	-	-	-	-	2	1	-	3
CO 2	3	3	3	3	-	1	2	-	-	-	-	2	1	2	3
CO 3	3	2	2	-	-	1	1	-	-	-	-	2	2	2	-
CO 4	3	3	2	2	-	1	1	-	-	-	-	2	3	2	3
CO 5	3	3	3	3	-	1	2	-	-	-	-	2	3	2	-

UNIT – I

Introduction to Refrigeration: Application of Refrigeration, Definition of COP, Tonne of Refrigeration, Designation, Carnot cycle, Eco-friendly Refrigerants, Properties of Refrigerants.

Air Refrigeration Systems: Analysis of Bell-Coleman Cycle, Application to aircraft refrigeration, Simple cooling system, Bootstrap simple evaporating system, Regenerative cooling system and Reduced ambient cooling system.

UNIT - II

Vapour Compression System: Working principle and analysis of Simple vapor compression Refrigeration cycle. Effect of operating conditions like evaporating pressure, condenser pressure, Liquid sub-cooling and Vapor super heating, Performance of the system. Low temperature refrigeration system (with single load system), Compound compression with water inter cooler and Flash intercooler, Cascade refrigeration system-Analysis and advantages.

UNIT - III

Vapour Absorption Refrigeration System: Simple absorption systems, COP, Practical ammonia absorption refrigeration system, Lithium bromide absorption system, Electrolux refrigerator, Common refrigerants and absorbents properties, Comparison with vapor compression refrigeration system.

Steam Jet Refrigeration: Principle of working**,** Analysis of the system, Advantages, limitations and applications.

Thermoelectric refrigeration systems: Seebeck effect, Peltier effect and Thompson effect, Analysis of the thermoelectric refrigeration systems using Peltier effect, Expression for COP, Vortex tube refrigeration – principle and working.

UNIT - IV

Psychrometry: Psychrometric properties, Psychrometric chart, construction, Representation of various Psychrometric processes on the chart.

Introduction to Air Conditioning: Requirements of comfort air conditioning, Thermodynamics of human body, ASHRE comfort chart, Effective temperature.

UNIT - V

Cooling Load Calculations in Air Conditioning: Concept of bypass factor, Sensible heat factor, Apparatus Dew Point, Various Heat Loads.

Design of air conditioning systems: Simple Problems on summer, winter and year Round Air conditioning systems Energy conservation in air conditioned building.

Air Conditioning Systems: Components of air conditioner equipments, Humidifier, Dehumidifier, Filter.

Text Books:

1. C.P. Arora, "Refrigeration and Air conditioning", Tata McGraw Hill, New Delhi, 2017.
2. Stoecker, W.F., and Jones, J.W., Refrigeration and Air-Conditioning, Mc.Graw Hill, New Delhi, 2014.
3. R.K. Rajput, "Refrigeration and Air Conditioning", Laxmi Publications, New Delhi, 2013.

Suggested Reading:

1. V.K. Jain, "Refrigeration and Air Conditioning", S Chand & Company, New Delhi, 2019.
2. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, Allahabad, 2015.

Refrigeration and air conditioning data books:

1. Manohar Prasad, "Refrigeration and Airconditioning Data Book", New Age International Publishers, 2010.

Online Resources :

1. https://archive.nptel.ac.in/courses/112/105/112105129/
2. https://archive.nptel.ac.in/courses/112/107/112107208/

22MEE06

ROBOTIC ENGINEERING

(Professional Elective-II)

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

Prerequisites: Kinematics of Machines.

Course Objectives: This Course aims to

1. Principle of working of a robot, types and specifications, configuration, work envelop and motion controls and applications
2. Transformations, kinematics and dynamics of robotic systems
3. Singularities, Jacobian and trajectory planning of a robot to prepare the robot for various tasks
4. Design of end effectors, drives, working of sensors and controllers for finding position andorientation.
5. Robot vision for image acquisition and processing and plan for various tasks and variousLanguages and Programming methods of robot.

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

1. Understand the basic components and specifications of the Robots
2. Solve the problems of transformations, direct and inverse kinematics of robots
3. Analyze forces in links and joints of a robot and find the singularities, Jacobian and trajectory planning of a robot for various tasks
4. Recommend sensors and controllers for finding position and orientation to take corrective action based on feedback
5. Design an intelligent robot using machine vision and sensors to perform an assigned task.

CO-PO Articulation Matrix

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
CO 1	2	3	2	1	2	-	1	-	-	-	-	1	-	2	-
CO 2	3	3	2	1	2	-	1	-	-	-	-	1	-	2	-
CO 3	3	3	2	1	1	-	1	-	-	-	-	1	-	2	-
CO 4	3	3	2	1	2	-	1	-	-	-	-	1	-	2	-
CO 5	3	3	2	1	1	-	1	-	-	-	-	1	-	2	-

UNIT - I

Overview of Robots and Subsystems: Brief History, Types of robots, resolution, repeatability and accuracy, degrees of freedom of robots, Robot configurations, Workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping, Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT – II

Direct Kinematics: Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT - III

Inverse Kinematics: inverse orientation, inverse locations, Singularities, Jacobian, **Trajectory Planning:** joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning, micro controllers to control servomotors.

UNIT - IV

Analysis of RP and RR Type Robots: Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots.

Controllers : Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control

UNIT - V

Sensors : Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder.

Robot vision: image processing fundamentals for robotic applications, image acquisition and preprocessing. Object recognition by image matching and based on features, Animatronics – Introduction.

Text Books:

1. Nagrath and Mittal, Robotics and Control, Tata McGraw-Hill, 2003.
2. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley and sons, 2008.
3. Mikell P. Groover, Industrial Robotics, McGraw-Hill, 2008.

Suggested Reading:

1. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence,McGraw Hill International, 1987
2. Steve LaValle, Planning Algorithms, Cambridge Univ. Press, New York, 2006

22MEE07

ENGINEERING RESEARCH METHODOLOGY

(Professional Elective – II)

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

Prerequisite: Nil

Course Objectives: This course aims to

1. Make the students to formulate the research problem
2. Identify various sources for literature review and data collection.
3. Prepare the research design
4. Equip the students with good methods to analyze the collected data
5. Introduce students to the concepts of innovation

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

1. Define research problem
2. Review and assess the quality of literature from various sources.
3. Understand and develop various research designs.
4. Collect and analyze the data using statistical techniques.
5. Apply creative thinking and innovative skills.

CO-PO Articulation Matrix

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
CO 1	1	2	1	1	-	1	-	-	1	2	2	2	2	2	2
CO 2	-	2	1	2	1	1	-	1	1	3	2	2	2	1	2
CO 3	1	2	3	2	2	1	-	-	1	2	-	1	2	1	2
CO 4	2	2		3	2	-	-	-	-	2	1	1	2	3	2
CO 5	2	2	3	2	3	1	-	-	-	-	-	3	1	1	2

UNIT – I:

Research Methodology: Objectives, Motivation and Significance of Research, Types of Research, Research Methods verses Methodology, Research process, Criteria of Good Research, Problems Encountered by Researchers in India, Technique involved in defining a problem.

UNIT–II

Literature Survey: Importance of Literature Survey, Sources of Information Primary, Secondary and tertiary, Assessment of Quality of Journals and Articles, Information through Internet

Research writing: Format of the Research report, Writing a Synopsis, Dissertation, Research Proposal and Research Report

UNIT – III

Research Design: Meaning and Need of Research Design, Terminology used in Research Design, Features of a Good Research Design, Formulation of hypothesis, **O**perationalizing the research question, Different Research Designs – exploratory, descriptive, diagnostic and hypothesistesting research studies, Basic Principles of Experimental Design, Steps in Sample design

UNIT – IV

Data Collection and Analysis: Collection of primary dataObservation, Interview and Questionnaire methods, Secondary data, Measures of central tendency, Measures of dispersion, Measures of asymmetry, Important parametric testsz, t, F, ChiSquare, ANOVA significance.

UNIT – V

Innovation: Creativity, Innovation and its difference, Blocks for creativity and innovation, overcoming obstacles, Examples of innovation, Being innovative, Steps for Innovation, right climate for innovation, Design led innovation, Gross root innovation, Frugal and flexible approach to innovation.

Text Books:

1. C.R Kothari, "Research Methodology Methods & Technique", New Age International Publishers, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011
3. The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008

Suggested Reading:

1. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
2. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.
3. JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.

Online Resources:

1. https://archive.nptel.ac.in/courses/127/106/127106227/
2. https://archive.nptel.ac.in/courses/107/101/107101088/

22MEE08

PRODUCT DESIGN AND PROCESS PLANNING

(Professional Elective-II)

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

Prerequisite: Nil.

Course Objectives: This course aims to

1. Familiarize the essence of innovation in product development.
2. Make understand the human machine interactions (ergonomics).
3. Understand the various Intellectual Property Rights.
4. Understand the interaction between Design, Manufacturing, Quality and Marketing.
5. Create awareness about overall view of Process Planning.

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

1. Define the needs of the customer while designing a new product or modifying existing product in the competitive environment.
2. Understand creativity, brainstorming and ergonomic concepts.
3. Apply the concept of design for manufacture, assembly, maintenance, reliability and product life cycle in developing a product.
4. Implement the Intellectual Property Rights to a new product or a process.
5. Evaluate and recommend an effective Process Plan and principles of value engineering to new product development.

CO-PO Articulation Matrix

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
CO 1	2	1	2	-	-	1	-	-	-	2	2	2	3	1	-
CO 2	2	3	3	2	2	-	-	-	-	1	2	2	2	1	-
CO 3	3	2	3	2	3	-	-	-	-	1	2	2	1	-	-
CO 4	3	2	2	1	2	-	-	-	-	-	1	2	2	-	-
CO 5	3	2	2	3	3	1	-	-	-	2	1	2	1	-	-

UNIT - I

Product Design and Process Design: Functions, Essential factors of product design, Selection of right product, Systematic procedure of product innovation, function of design, value of appearance, colors and laws of appearance, market research and identifying market opportunities.

UNIT - II

Product Selection and Evaluation: Need for creativity and innovation. Techniques of innovation like brainstorming and Delphi techniques, collection of ideas, Selection criteria - screening ideas for new products using evaluation techniques, Principles of ergonomics, Anthropometry, Design with Human Machine Interaction (HMI).

UNIT - III

New Product Planning and Development: Interaction between the functions of design, manufacture, and marketing, design and material selection, Steps for introducing new products after evaluation, Product life cycle, Research and new product development.

UNIT - IV

Intellectual Property Rights (IPR): Patents, definitions, Types of Patent, Patent search, Patent laws, Preparing patent disclosure. International code for patents, Trademark, Trade Secret and Copy Rights.

Process Planning: Need and significance of process planning, Process capability studies, Process sheets, Benefits and Types of Computer Aided process planning.

UNIT - V

Process Selection and Planning: Selection of manufacturing process, co selection of materials and processes, Design for manufacturability and assembly, Estimation of costs for manufacture, value engineering in product design, Group technology, and concepts of concurrent engineering, startups, innovation and its importance, quality function deployment and quality engineering.

Text Books:

1. B.W. Niebel & A.B. Draper, Production Design & Process Engg, McGraw Hill, 1974.
2. K. G. Swift & J. D. Booker, Process Selection: From Design to Manufacture, Butterworth-Heinemann Ltd; Revised 2nd edition, 2003.
3. Bhaskaran Gopalakrishnan, Product Design and Process Planning in CE (Design &Manufacturing, Chapman and Hall publishers, 1994.

Suggested Reading:

1. A.K. Chitale& R.C. Gupta, Product Design & Manufacturing, PHI, 1997.
2. Karl T. Ulrich, Stephen Eppinger, Product Design and Development, Mc-GrawHill Publication,

22CAO01

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Probability and Statistics

Course Objectives:

1. The objective of the course is to provide a strong foundation of fundamental concepts in Artificial Intelligence
2. A basic exposition to the goals and methods of Artificial Intelligence, and fundamentals of machine learning

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

1. Enumerate the history and foundations of Artificial Intelligence.
2. Apply the basic principles of AI in problem solving.
3. Choose the appropriate representation of Knowledge.
4. Enumerate the Perspectives and Issues in Machine Learning.
5. Identify issues in Decision Tree Learning.

CO-PO Articulation Matrix

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
CO 1	1	1	1	1	-	2	-	2	1	1	-	1	-	-	-
CO 2	1	2	-	-	-	1	-	1	-	-	-	1	1	1	1
CO 3	1	1	1	-	-	-	1	1	-	-	-	1	-	-	-
CO 4	2	2	-	-	1	-	1	2	1	1	1	2	1	1	1
CO 5	1	1	1	1	1	2	1	1	2	1	1	2	-	-	-

UNIT- I

Introduction: What Is AI?, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

UNIT - II

Problem Solving: Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions.

UNIT - III

Knowledge Representation: Knowledge-Based Agents, Logic, Propositional Logic: A Very Simple Logic, Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, The Internet Shopping World.

UNIT - IV

Introduction to Machine Learning: Well-Posed Learning Problem, Designing a Learning system, Perspectives and Issues in Machine Learning. Concept Learning and The General-to-Specific Ordering: Introduction, A

Concept Learning Task, Concept Learning as Search, FIND-S: Finding a Maximally Specific Hypothesis, Version Spaces and the Candidate Elimination Algorithm, Remarks on Version spaces and Candidate-Elimination, Inductive Bias

UNIT - V

Decision Tree Learning: Introduction, Decision Tree Representation, Appropriate Problems for Decision Tree Learning, The Basic Decision Tree Learning Algorithm, Hypothesis Space Search in Decision Tree Learning, Inductive Bias in Decision Tree Learning, Issues in Decision Tree Learning.

Textbooks:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Pearson.
2. Tom M. Mitchell, Machine Learning, McGraw Hill Edition, 2013

Reference Books:

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011.
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill.
3. David Poole and Alan Mackworth, "Artificial Intelligence: Foundations for Computational Agents", Cambridge University Press 2010.)
4. Trivedi, M.C., "A Classical Approach to Artifical Intelligence", Khanna Publishing House, Delhi.
5. Christopher Bishop, Pattern Recognition and Machine Learning (PRML) , Springer, 2007.
6. ShaiShalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms (UML), Cambridge University Press, 2014.

Web Resources:

1. https://nptel.ac.in/courses/106105077
2. https://nptel.ac.in/courses/106106126
3. https://aima.cs.berkeley.edu
4. https://ai.berkeley,edu/project_overview.html
5. http://www.zuj.edu.jo/download/machine-learning-tom-mitchell-pdf/
6. http://www.ntu.edu.sg/home/egbhuang/pdf/ieee-is-elm.pdf
7. https://swayam.gov.in/nd1_noc20_cs73/preview

22CSO02

INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS

(Open Elective)

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

Course Objectives: This course aims to

1. Learn data models, conceptualize and depict a database system using E-R diagrams.
2. Understand the internal storage structures in a physical DB design.
3. Learn the fundamental concepts of transaction processing techniques.

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

1. Understand the fundamental concepts of database and design using ER model.
2. Apply SQL to find solutions to basic queries.
3. Identify the inference rules for functional dependencies and apply the principles of normal forms to decompose the relations in a database.
4. Understand the concepts like data storage, indexing and transaction processing.
5. Analyze concurrency control and recovery mechanisms.

CO-PO Articulation Matrix

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
CO 1	2	3	-	1	-	-	-	-	-	-	-	2	2	2	2
CO 2	3	2	1	2	-	-	-	-	-	-	-	1	1	1	1
CO 3	3	2	1	1	-	-	-	-	-	-	-	1	1	1	1
CO 4	3	3	1	2	-	-	-	-	-	-	-	1	1	1	1
CO 5	3	2	1	2	2	-	-	-	-	-	-	2	-	-	1

UNIT - I

Introduction: Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Users and Administrators Database System Architecture, Application Architectures.

Database Design and E-R Model: Basic concepts, Constraints, E-R Diagrams, E-R Design Issues, Extended E-R Features, Specialization and Generalization.

UNIT - II

Relational Model: Structure of Relational Databases, Database Schema, Keys.

Structured Query Language: Overviews, SQL Data Types, SQL Queries, Data Manipulation Language Set Operations, Aggregate Functions, Data Definition Language, Integrity Constraints, Null Values, Views, Join Expression.

UNIT - III

Relational Database Design: Undesirable Properties in Relational Database Design, Functional Dependencies, Trivial and Nontrivial Dependencies, Closure of Set of Functional Dependencies, Closure of Set of Attributes, Irreducible Set of Functional Dependencies, Normalization – 1NF, 2NF, and 3NF, Dependency Preservation, BCNF, Comparison of BCNF and 3NF.

UNIT - IV

Indexing: Basic concepts, Dense and Sparse Indices, Secondary Indices, Tree-Structured Indexing, Indexed Sequential Access Method (ISAM), B+ Tree Index Files.

Transaction Management: Transaction Concept – ACID Properties, States of Transaction, Implementation of Atomicity and Durability, Serializability.

UNIT - V

Concurrency Control: Introduction, Lock-Based Protocols, Timestamp-Based Protocols.
Deadlocks Handling: Deadlock Detection and Prevention.
Recovery System: Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery.

Text Books:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, "Database System Concepts", McGraw-Hill International Edition, 6th Edition, 2011.
2. Date CJ, Kannan A, Swamynathan S, "An Introduction to Database Systems", Pearson Education, 8th Edition, 2006.

Suggested Reading:

1. Raghu Ramakrishnan, JohnnesGehrke, "Database Management Systems", 3rd Edition, McGraw Hill, 2003.
2. Ramez Elmasri, Durvasul VLN Somayazulu, Shamkant B Navathe, Shyam K Gupta, "Fundamentals of Database Systems", Pearson Education, 4th Edition, 2006.

Online Resources:

1. https://nptel.ac.in/courses/106104135

22CIO03

BASICS OF CYBER SECURITY

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

Pre-requisites: Basic knowledge on computer hardware and software components.

Course Objectives: This course aims to

1. To describe the foundational concepts of cybersecurity, including the CIA triad (Confidentiality, Integrity, Availability), and explain their importance in information security practices.
2. To demonstrate understanding of various cyber offenses by explaining the methods used by criminals to plan and execute cyber-attacks.
3. To understand the legal perspective of Cyber Security.
4. To collect, process, analyse and present Computer Forensics Evidence.
5. To understand organizational implications of Cyber Security

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

1. Demonstrate an understanding of cybersecurity by effectively analysing and evaluating the security implications of various scenarios.
2. Identify and describe different types of cyber offenses, understand the techniques used by cybercriminals, and analyse the potential impact of these attacks on individuals, organizations, and society.
3. Analyse and evaluate the legal framework of cyber laws in India.
4. Analyse the significance of digital evidence in cyber forensics.
5. Evaluate the organizational implications of cyber security by assessing the costs associated with cybercrimes

CO-PO Articulation Matrix

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
CO 1	2	2	2	2	2	3	1	3	3	3	2	3	-	-	1
CO 2	2	3	2	2	3	3	1	3	3	3	2	3	-	-	1
CO 3	1	2	2	2	1	3	1	3	2	3	3	3	-	-	1
CO 4	2	2	2	2	3	3	1	3	3	3	3	3	-	-	-
CO 5	2	2	2	2	2	3	1	3	3	3	3	3	-	-	1

UNIT- I

Introduction to Cyber Crime: Cyber Crime: Definition and Origins of the Word, Cybercrime and Information Security, Classification of Cyber Crimes.

Cyber Security Fundamentals: Definition and importance of cybersecurity, CIA triad: Confidentiality, Integrity, Availability, Security design principles: defence-in-depth, least privilege, separation of duties.

UNIT - II

Cyber Offenses: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber Cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector.

Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Password Managers, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

UNIT - III

Cyber Laws: The Legal Perspectives, Need of Cyber laws: the Indian Context, The Indian IT Act, Amendments of Indian IT Act, Challenges to Indian Law and Cyber Crime Scenario in India.

UNIT - IV

Understanding Cyber Forensics: Need for Computer Forensics, Cyber Forensics and Digital Evidence, Forensics Analysis of Email, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Cyber Forensics Investigation, Challenges in Computer Forensics

UNIT - V

Cyber Security Organizational Implications: Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations.

Capstone Project: Group project: analyse a real-world cyber-attack, develop a mitigation strategy, and present findings to the class.

Textbooks:

1. Sunit Belpre and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt.Ltd, 2011.
2. William Stallings," Cryptography and Network Security - Principles and Practice", Pearson Education, 6th Edition,2013.
3. Whitman, M., & Mattord, H."Principles of information security" (6th ed.). CENGAGE Learning Custom Publishing, 2017

Reference Books:

1. Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar, "Cyber Security and Cyber Laws", Paperback – 2018.
2. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGraw Hill, 2006

Web Resources:

1. https://www.coursera.org/courses?query=cybersecurity&productDifficultyLevel=Beginner
2. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview

22EGO03

INDIAN TRADITIONAL KNOWLEDGE

22MEC21

DYNAMICS AND VIBRATIONS LAB

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

Prerequisite: Kinematics of Machines, Engineering Mathematics

Course Objectives: This Course aims to
1. To demonstrate basic principle and exposure to evaluate CAM Follower Motion and Gyroscopic effects.
2. The importance of static and dynamic balancing.
3. The methods of controlling speeds of prime movers
4. To acquire the knowledge in evaluating the stability of vehicles
5. Frequency response of spring mass system with damping and without damping - Undamped torsional vibrations of single and double rotor systems

Course Outcomes: Upon completion of this course, students will be able to
1. Analyze the cam profile for different motion characteristics.
2. Examine the performance of governors and the gyroscopic effect on vehicles.
3. Evaluate the static and dynamic balancing masses in a rotating mass system.
4. Determine the natural frequency of different single degree freedom vibrating systems.
5. Determine the natural frequency of two degree freedom vibrating systems

CO-PO Articulation Matrix

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
CO 1	3	3	1	1	-	-	-	1	3	2	-	3	3	-	2
CO 2	3	3	1	1	-	-	-	1	3	2	-	3	3	-	2
CO 3	3	3	1	1	-	-	-	1	3	2	-	3	3	-	1
CO 4	3	3	1	1	-	-	-	1	3	2	-	3	3	-	2
CO 5	3	3	1	1	-	-	-	1	3	2	-	3	3	-	2

List of the Experiments

1. To study the motion of follower with the given profile of the cam. To plot the follower displacement vs angle of rotation curves for different cam follower pairs.
2. To study the gyroscopic effect on a rotating disc.
3. Study the effect of varying mass on the centre of sleeve in Porter governor.
4. Study the effect of varying the initial spring compression in Hartnell governor.
5. Static and Dynamic balancing in a rotating mass system.
6. To study the longitudinal vibrations of helical coiled spring.
7. To find damping by logarithmic decrement on spring mass system.
8. Determination of the frequency of single rotor torsional vibrations.
9. Determination of the frequency of double rotor system torsional vibrations.
10. To verify the Dunkerley's principle for lateral vibration of beam.
11. Determination of critical speed of the given shaft with the given end conditions (Whirling of Shafts).
12. Frequency response of spring mass system with damping.
13. Determine the equivalent link parameters and centre of mass of connecting rod theoretically and validate the result by experiment by choosing suitable methods and devices.

Note: Students should complete a minimum of 10 experiments including experiment 13 which is compulsory.

Text Books:

1. S.S. Rattan, “Theory of Machines”, Fourth edition Tata-Mc Graw Hill, ,2014
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, “Theory of Machines & Mechanisms”, Oxford University Press, 2003.
3. William T.Thomson “Theory of Vibration with Application”, 5th edition, Pearson education 2008

Suggested Reading:

1. Robert L. Norton, “Design of Machinery”, Tata Mc Graw Hill, 2005.
2. Benson H. Tangue, “Principles of Vibration”, 2/e, Oxford University Press, 2007

Online Recourses:

1. https://archive.nptel.ac.in/courses/112/104/112104114/

22MEC22

METAL CUTTING AND MACHINE TOOL ENGINEERING LAB

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

Prerequisite: Nil

Course Objectives: This course aims to
1. Grind single point cutting tool using HSS as cutting tool
2. Familiarize various operations on lathe, milling, drilling, grinding machine tools
3. Measure cutting forces during machining on Lathe machine, milling

Course Outcomes: Upon completion of this course, the students are able to
1. Identify tool geometry and grind to a given tool signature.
2. Perform various machining operations to produce components of different shapes and using jigs &fixtures.
3. Determine the shear angle at various cutting conditions.
4. Evaluate cutting forces using dynamometer, estimate MRR & power consumption under different cutting conditions.
5. Plan and create components of utility using various manufacturing facilities in the laboratory.

CO-PO Articulation Matrix

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
CO 1	3	3	2	2	2	1	1	1	2	1	1	2	2	3	1
CO 2	3	2	2	1	2	1	1	1	1	1	1	2	3	3	1
CO 3	2	2	2	1	2	1	1	1	2	1	1	2	3	3	1
CO 4	3	2	2	1	2	1	1	1	2	1	1	2	3	3	1
CO 5	3	2	2	3	2	1	1	1	2	1	1	2	2	3	1

List of the Experiments

1. Introduction to Machine Tools like Lathe, Drilling, Milling and Shaper.
2. Plain turning operation on Lathe.
3. Step turning and Knurling on Lathe.
4. Taper turning on Lathe.
5. Drilling and Boring on Lathe.
6. Thread Cutting on Lathe.
7. Grinding of Single Point Cutting Tool.
8. Gear cutting using (a) Plain Indexing. (b) Compound Indexing using universal dividing head.
9. Measurement of Cutting forces machine during machining on Lathe machine, milling.
10. Finding Shear angle experimentally in turning operation.
11. Grinding flat surfaces using surface grinding machine and measurement of surface finish.
12. Process parameters of Electro Discharge Machining (EDM).
13. Design utility component, prepare process sheet for the manufacturing of the same and produce the component in the lab.

Note: Student should complete a minimum of 10 experiments including experiment number 13 which is compulsory.

Text Books:

1. B.L. Juneja, Shekhon G.S. and Seth Nitin, Fundamentals of Metal Cutting & Machine tools, New Age Publishers, 2017.
2. P.N. Rao, Manufacturing Technology – Metal Cutting & Machine Tools, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2018.

Suggested Reading:

1. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2nd Edition, 2017
2. David A. Stephenson, John S. Agapiou, Metal Cutting Theory and Practice, CRC Press, 3rd Edition, March 2016

Online Resources:

1. https://nptel.ac.in/courses/112105126
2. https://nptel.ac.in/courses/112105306

22MEC23

CAD/CAM LAB

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

Prerequisite: Nil.

Course Objectives: This Course aims to

1. Teach the basic design process and the importance and types of geometric modelling techniques
2. Generate orthographic views of components and assemblies.
3. Demonstrate the Indication of size, form, and positional tolerances on the drawing sheets
4. Demonstrate the working of CNC machines and write part programs for different operations

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

1. Make use of Apply constraints to assemble the components using CAD software
2. Demonstrate the knowledge splines
3. Demonstrate the knowledge of surface modelling
4. Select tools required for performing specific job on CNC mill and CNC lathe
5. Write CNC part program to generate tool path for different machining operations

CO-PO Articulation Matrix

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
CO 1	3	3	1	3	3	3	1	-	3	3	1	2	3	1	3
CO 2	3	3	2	3	3	3	1	-	3	3	1	3	3	1	3
CO 3	3	3	2	3	3	3	1	-	3	3	1	3	3	1	3
CO 4	3	3	2	3	3	3	1	-	3	3	1	3	3	1	3
CO 5	3	3	3	3	3	3	1	-	3	3	1	3	3	1	3

List of the Exercises:

1. Working with Splines : Splines, Style, Splines Equation Driven Splines
2. Surface Modeling : Extruded , Revolved , Swept and Lofted Surfaces
3. Solid Modeling practice: Parametric and Variational Modeling, Feature Based Modeling. Assembly Modeling with Constraints
4. Implementation of Geometric Transformations using MATLAB
5. Implementation of Bezier curves using MATLAB
6. Contouring on CNC Milling Machine
7. Rectangular Pocketing and Circular Pocketing on CNC Milling Machine
8. Step Turning and Taper Turning on CNC Lathe Machine
9. Multiple Turning on CNC Lathe Machine
10. Demonstration of SLA machine
11. Automatic part program generation for a 3-D model using manufacturing software
12. Design a product and Manufacture using 3D Printing / generate CNC Machining tool path for its components

Text books:

1. P.N.Rao, ―CAD/CAM:Principles andApplication, TataMcGraw-Hill,July2017
2. N Mehta,―MachineToolDesign andNumericalControl, McGrawHillEducation, 3rd edition, 2017
3. DassaultSystems,―SOLIDWORKS Essentials:Training, SolidWorkscorp., 2011

Suggested Reading:

1. https://my.solidworks.com/solidworks/guide/SOLIDWORKS_Introduction_EN.pdf
2. https://help.solidworks.com

22EGC03

EMPLOYABILITY SKILLS

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

Prerequisite: Basic Knowledge of Soft skills in the professional setting.

Course Objectives: To help the students

1. Learn the art of communication, participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

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

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals, learn to manage time effectively and deal with stress.
4. Make the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

CO-PO-PSO Articulation Matrix

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
CO 1	-	1	-	-	-	1	-	2	3	3	1	3	1	1	1
CO 2	-	-	-	-	-	-	-	1	-	2	-	1	-	-	1
CO 3	-	-	-	-	-	1	-	1	2	1	1	3	1	1	1
CO 4	-	1	1	-	-	1	-	2	3	3	1	3	1	1	2
CO 5	-	-	-	-	-	-	-	1	2	2	1	3	-	-	-

UNIT I

Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences- Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT II

Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT

UNIT III

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management- **Corporate Culture** – Grooming and etiquette-Statement of Purpose (SOP).

UNIT IV

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT V

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

Text Books:

1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005.
2. Gulati and Sarvesh, "Corporate Soft Skills", New Delhi: Rupa and Co., 2006.
3. Edgar Thorpe and Showick Thorpe, "Objective English", 2nd edition, Pearson Education, 2007.
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010.

Suggested Reading:

1. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", NewYork: Palgrave Macmillan, 2004.
2. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", 2018.
3. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989.
4. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006.

22MEI02

INDUSTRIAL/RURAL INTERNSHIP

Instruction / Demonstration /Training	3-4 Weeks / 90 Hours
Duration of Semester End Presentation	--
SEE	--
CIE	50 Marks
Credits	2

Prerequisite: Knowledge of Basic Sciences and Engineering Science.

Course Objectives: This course aims to
1. Exposing the students to the industrial environment.
2. Create awareness with the current industrial technological developments relevant to program domain.
3. Provide opportunity to understand the social, economic and administrative considerations in organizations.

Course Outcomes: Upon completion of this course, students will be able to
1. Understand Engineer's responsibilities and ethics.
2. Use various materials, processes, products and quality control.
3. Provide innovative solutions to solve real world problems.
4. Acquire knowledge in technical reports writing and presentation.
5. Apply technical knowledge to real world industrial/rural situations

CO-PO-PSO Articulation Matrix

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
CO 1	1	1	1	1	1	3	3	1	3	1	3	3	1	1	3
CO 2	1	1	1	3	3	1	2	1	1	1	1	1	3	3	1
CO 3	2	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO 4	1	1	1	1	1	3	1	1	3	3	1	1	1	1	3
CO 5	1	3	3	3	3	2	3	1	1	1	1	1	3	3	3

For implementation procedures and letter formats, Annexures I and III of Internship document may be referred.

Evaluation of Internship: The Industrial training / Internship of the students will be evaluated in three stages:
d) Evaluation by the Industry (in the scale of 1 to 10 where 1-Unsatisfactory; 10-Excellent).
e) Evaluation by faculty Mentor on the basis of site visit(s) or periodic communication (15 marks).
f) Evaluation through seminar presentation/Viva-Voce at the Institute by the constituted committee (25 marks).

Evaluation through Seminar presentation / Viva-Voce at the institute: Students shall give a seminar before an Expert Committee constituted by college (Director, HoD/Senior faculty, mentor and faculty expert from the same department) based on his/her training/internship carried out.

The evaluation will be based on the following criteria:

- Quality of content presented.
- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall be analyzed along with the Internship report.

Monitoring / Surprise Visits: During the internship program, the faculty mentor makes a surprise visit to the intern-ship site, to check the student's presence physically. If the student is found to be absent without prior intimation to theconcerned industry, entire training / internship may be canceled. Students should inform through email to the facultymentor as well as the industry supervisor at least one day prior to avail leave.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY

B.E. (MECHANICAL ENGINEERING)

SEMESTER – VI

S. No.	CourseCode	Title of the Course	Scheme ofinstruction			Scheme of examination			Credits
			Hours per week			Duration in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MEC24	Metrology and Instrumentation	3	-	-	3	40	60	3
2	22MEC25	Machine Design	3	1	-	3	40	60	4
3	22MEC26	Thermal Turbo Machines	3	-	-	3	40	60	3
4	22MEC27	Finite Element Analysis	3	-	-	3	40	60	3
5	22MEC36	Fundamentals of Design Thinking	2	-	-	3	40	60	2
6		Professional Elective - III	3	-	-	3	40	60	3
PRACTICALS									
6	22MEC29	Metrology and Instrumentation Lab	-	-	2	3	50	50	1
7	22MEC30	Thermal Engineering Lab	-	-	2	3	50	50	1
8	22MEC31	Finite Element Analysis Lab	-	-	2	3	50	50	1
9	22MEC35	Mini Project	-	-	4	-	50	-	2
10	22MEU02	Up-skill Certification Course - II	-				25	-	0.5
TOTAL			**17**	**1**	**10**	-	**465**	**510**	**23.5**
Clock Hours Per Week: 28									

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**

CIE - Continuous Internal Evaluation **SEE – Semester End Examination**

SEMESTER – VI

Professional Elective – III		
S. No	**Course Code**	**Title of the Course**
1	22MEE09	Computational Fluid Dynamics
2	22MEE10	Additive Manufacturing
3	22MEE11	Modern Machining and Forming Methods
4	22MEE12	Industrial Safety and Maintenance

22MEC24

METROLOGY AND INSTRUMENTATION

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

Prerequisite: Knowledge on basics of Mathematics and Manufacturing Engineering.

Course Objectives: This course aims to

1. Familiarize with limits, fits & tolerances and fundamental concepts of measurements.
2. Provide adequate skill in the usage of various precision measuring instruments and the concepts of limit gauges.
3. Learn the importance of Geometric form and how to measure form errors.
4. Impart knowledge in the concepts of classification of instrument errors and their characteristics.
5. Make understand the working principles of various instruments used for the measurement of displacement, pressure and temperature.

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

1. Understand the need, accuracy and associated concepts of linear and angular measurements.
2. Select appropriate gauges for inspection and design.
3. Calculate surface roughness by using appropriate instruments.
4. Analyze and interpret the types of errors, strain measurement and instrument characteristics.
5. Evaluate measuring methods and devices for displacement, pressure & temperature.

CO-PO Articulation Matrix

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
CO 1	2	1	1	1	-	1	-	-	-	-	-	1	3	-	1
CO 2	2	3	2	1	2	1	1	-	-	-	-	1	3	-	1
CO 3	2	1	-	2	1	1	-	-	-	-	-	1	3	-	1
CO 4	2	1	1	1	-	-	-	-	-	-	-	1	2	-	1
CO 5	2	1	1	1	-	-	-	-	-	-	-	1	2	-	1

UNIT-I

Limits, Fits and Tolerances: Nominal size, limits, tolerances, allowance, fundamental deviation, unilateral and bilateral tolerances, impact of tolerances on the manufacturing processes, types of fits, alpha numeric designation of limits/fits, hole and shaft basis systems, interchangeability and selective assembly

Linear and angular measurement: Line and end standards, slip gauges, Tomlinson gauges and sine bar, 3D Coordinate measuring machine

UNIT-II

Design of limit gauges: Taylor's Principle for plain limit gauges, design of GO and NO GO gauges, use of plug, ring and snap gauges.

Comparators: Introduction, dial indicator, sigma mechanical comparator, back pressure type pneumatic comparator.

Optical measuring instruments: Optical projector principle and its uses, tool maker's microscope principle and its uses, interferometry.

UNIT-III

Straightness, Flatness and Roundness Measurement: Definitions, measurement by beam comparator, straight edge, spirit level, and bench centers.

Surface roughness measurements: Need for surface roughness measurement, Roughness and waviness, numerical assessment of surface roughness, surface roughness measurement by profilometer, Taylor Hobson Talysurf, ISI symbols for indication of surface finish.

UNIT-IV

Screw thread metrology: Basic terminology of screw thread, measurement of effective diameter by 2 wire and 3 wire methods, best wire size.

Gear tooth metrology: Spur gear nomenclature, gear tooth thickness measurement by gear tooth vernier.

Instrumentation: Static and dynamic characteristics of instruments, types of errors, strain measurement with strain gauges, gauge factor, rosette gauges.

UNIT-V

Transducers: Displacement measurement by L.V.D.T, pressure measurement by bourdon pressure gauge, bulk modulus pressure gauge, pirani gauge, temperature measurement by thermo couples, laws of thermo electricity, types of materials used in thermocouples.

Text Books:

1. R.K. Jain, Engineering Metrology, Khanna Publications, 1996.
2. Doeblin, Measurement Systems Application and Design, TMH, 5th edition, 2004.
3. Beckwith, Buck, Lienhard, Mechanical Measurements, PEA, 3rd Indian Reprint, 2001.

Suggested Reading:

1. Rega Rajendra, Principles of Engineering Metrology, Jaico Publishing House, Mumbai, 2008.
2. B.C. Nakra& K.K. Chaudhary, Instrumentation Measurement and Analysis, 3rd edition, McGrawhill,2014

22MEC25

MACHINE DESIGN

(Use of data book is permitted)

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

Prerequisites: Strength of Materials, Kinematics of Machines, Dynamics of Machines.

Course Objectives: This Course aims to

1. Understand the materials used for helical and leaf springs, learn design principles of closely coiled helical and leaf springs.
2. To become familiar with the design principles of gear drives for power transmission.
3. To become familiar with design principles of sliding contact bearings and selection of rolling contact bearings.
4. Design principles of IC engine components such as piston, connecting rod, crank shaft.
5. Analyze the curved beams and selection of chain drives used in power transmission.

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

1. Understand the design procedure of helical and leaf springs under static and fluctuating loads.
2. Design the spur and helical gears based on beam strength and wear strength.
3. Demonstrate the ability in designing sliding contact bearings & selection of rolling contact bearings.
4. Design of IC engine piston, connecting rod and crank shaft.
5. Analyze the curved beams and selection of chain drives for a given application.

CO-PO Articulation Matrix

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	2	1	1	2	-	2	-	2	-	3	3	-	2
CO2	3	3	2	1	1	2	-	2	-	2	-	3	3	-	2
CO3	3	3	2	1	1	2	-	2	-	2	-	3	3	-	2
CO4	3	3	2	1	1	2	-	2	-	2	-	3	3	-	2
CO5	3	3	2	1	1	2	-	2	-	2	-	3	3	-	2

UNIT-I

Mechanical Springs: Introduction, types of springs, Materials used for springs.

Helical Springs: stresses in springs, Wahl's factor, deflection and energy stored in spring. Design for static and dynamic loads.

Leaf Springs: modeling of leaf springs, stresses, deflection and nipping of Leaf springs. Design for static loads.

UNIT-II

Gears: Introduction to gear drives, types of gears, materials used for gears, Design of Spur and Helical gears. Lewis beam strength equation. Dynamic loads on gear tooth. Wear load and design for wear strength.

UNIT-III

Bearings: Introduction, classification of bearings, materials used for bearings, properties and types of lubricants.

Design of Sliding Contact Bearings: Hydrodynamic bearings, Design of journal bearing.

Selection of Rolling Contact Bearings: Types of rolling elements and their constructional details, static and dynamic load carrying capacity, Load-life relationship, selection of bearing for cyclic loads and speeds.

UNIT-IV

I.C. Engine Parts: Introduction, Materials used, Design of piston, connecting rod and overhang crank shaft.

UNIT-V

Design of Curved Beams: Introduction, stresses in curved beams, expression for radius of curvature of neutral axis for rectangular, circular, and trapezoidal sections, Design of crane Hook.

Selection of chain drives: Power rating of roller chains, Strength of roller chains.

Text Books:

1. V.B. Bhandari, –Design Machine Elements, 5th Edition, Mc Graw Hill Publication, 2020.
2. J.E. Shigley, C.R. Mischke, –Mechanical Engineering Design, Tata Mc Graw Hill Publications, 2015.
3. R.S.Khurmi and J.K.Gupta, –Machine design, S Chand publications, 2022.

Suggested Reading:

1. P. Kannaiah, –Machine Design, Sci-Tech Publications, 2010
2. M.F. Spotts, –Design of Machine Elements, Prentice Hall of India, 2013.

Machine Design Data Books:

1. K. Mahadevan, K. BalaveeraReddy.,–Design Data Hand book for Mechanical Engineers, 3/e, CBS Publisher, 2018.

22MEC26

THERMAL TURBO MACHINES

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

Prerequisite: Knowledge on Thermodynamics and Applied Thermodynamics.

Course Objectives: This course aims to
1. Acquire basic knowledge of functioning of nozzles and diffusers.
2. Understand the design of ducts with frictional flow.
3. Know the working principles of various rotary compressors.
4. Understand the working of steam turbines.
5. Acquire basic knowledge in the functioning of gas turbines.

Course Outcomes: Upon completion of this course, students will be able to
1. Design various configurations of nozzles and diffusers with the principles of Gas Dynamics.
2. Design the ducts for friction with the principles of Fanno Flow.
3. Estimate the power required for various types of rotary compressors
4. Determine the various efficiencies related to Steam Turbines.
5. Determine the power output of the Gas Turbine and understand the working principle of jet and rocket propulsion.

CO-PO ARTICULATION MATRIX

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
CO 1	2	2	-	-	-	-	-	2	-	3	-	3	-	-	-
CO 2	2	2	-	-	-	-	-	2	-	3	-	3	-	-	-
CO 3	2	2	-	-	-	-	-	2	-	3	-	3	2	-	-
CO 4	2	2	-	-	-	-	-	2	-	3	-	3	2	-	-
CO 5	2	2	-	-	-	3	3	2	3	3	3	3	2	-	3

UNIT-I

Introduction to Compressible Flows: bulk modulus, coefficient of compressibility, acoustic velocity, mach number, pressure field due to a moving source of disturbance, mach cone and mach angle. Isentropic flow through variable area devices: Energy equation for flow through nozzles and diffusers, Relations connecting stagnation and static properties-enthalpy, temperature, pressure and density. Effect of back pressure on nozzle performance.

UNIT-II.

Flow through Constant Area Ducts with Friction (Fanno Flow), Governing equations, Fanno line, Fanno relations for perfect gas, variation of Mach number with length of duct. Types of shocks-normal and oblique. Flow with Normal Shocks, governing equations, Prandtl – Meyer relation, Rankine-Hugoniot relations and Stagnation pressure ratio across shock.

UNIT-III

Rotodynamic Compressors: Introduction to Turbomachines, classification and applications. Comparisonof Reciprocating and Rotary compressors, Positive displacement Rotary compressors, Flow through rotary compressors. Static and total head quantities Thermodynamic cycles and work done, calculation of various

efficiencies, Velocity diagrams and prewhirl, Euler equation for energy transfer between fluid and rotor, Degree of reaction of rotary compressors, Chocking, Surging and Stalling.

UNIT-IV

Steam Turbines: Study of Steam nozzles; Classification of steam turbines, Impulse turbine, compounding of steam turbines, Pressure velocity variations across different compounding turbines, blade efficiency and work done by impulse turbine, degree of reaction of reaction turbine, blade efficiency and work done by reaction turbine, stage efficiency and nozzle efficiency and simple problems on impulse and reaction turbines, Governing of Turbines.

UNIT-V

Gas Turbines: Applications and classification of Gas Turbines- constant pressure and constant volume gas turbines, Joule cycle-configuration diagram and temp-entropy diagram, Thermal efficiency of Joules cycle, maximum pressure ratio in terms of temperature ratio, optimum pressure ratio for maximum work output with and without considering machine efficiencies, Improvement of gas turbine plant performance- Inter-cooling, Reheating and Regeneration. Simple problems on Joule cycle.

Air Craft Propulsion: Air craft engine types, air craft propulsion theory, Turbo jet engines, simple problems, Ramjet engines, Pulse jet engines.

Rocket Propulsion: Types of Propellants, types of Rocket engines, Rocket propulsion theory and its applications.

Text Books:

1. S M Yahya, Fundamentals of Compressible Flow, New Age International Publishers, 2014.
2. Mahesh M. Rathore, Thermal Engineering, TMH, New Delhi, 2010
3. M L Mathur & F S Mehta, Thermal Engineering, Jain Brothers, New Delhi, 2014

Suggested Reading:

1. V. Ganeshan, Gas Turbines, Tata Mc Graw Hills, New Delhi, 2010.
2. R Yadav, Steam and Gas Turbines, Central Publishing House Ltd, Allahabad, 2003.

Online resources

1. https://nptel.ac.in/courses/112106303
2. https://nptel.ac.in/courses/101101058

22MEC27

FINITE ELEMENT ANALYSIS

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

Prerequisite: Engineering Mathematics, Dynamics of machines, Machine design.

Course Objectives: This course aims to

1. Equip the students with the fundamental concepts of finite element analysis and its formulations.
2. Prepare the students to formulate the axial, truss, beam problems.
3. Enable the students to formulate 2D problems with special cases.
4. Make the students formulate quadrilateral element, understand numerical integration, Gaussian quadrature and one-dimensional dynamic problems.
5. Empower the students to understand the convergence requirements, heat transfer, formulate 3D problems and perform engineering simulations using Finite Element Analysis software (ANSYS)

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

1. Understand FE method for solving field problems using energy formulations.
2. Analyze bars, trusses and beams for static and dynamic analysis.
3. Formulate 2D structural components using triangular element for plane stress, plane strain and axi-symmetric problems.
4. Derive stiffness matrix for 4 node quadrilateral element for static analysis and 3 Delements.
5. Solve heat transfer problems and apply finite element analysis software for engineering solutions.

CO-PO Articulation Matrix

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
CO 1	3	3	1	2	3	-	1	1	3	2	1	2	3	3	1
CO 2	3	3	2	2	3	-	1	1	3	2	1	2	3	3	2
CO 3	3	3	2	2	3	-	1	1	3	2	1	2	3	3	2
CO 4	3	3	2	2	3	-	1	1	3	2	1	2	3	3	2
CO 5	3	3	3	2	3	-	1	1	3	2	1	2	3	3	3

UNIT - I

Fundamental concepts: Introduction to finite element method, stresses and equilibrium, boundary conditions, strain –displacement and stress – strain relationship. One dimensional problem: Finite element modeling co-ordinates and shape functions, virtual work and potential energy approach, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, analysis of axial element and quadratic element.

UNIT - II

Analysis of trusses: Element stiffness matrix for a truss member, analysis of plane truss with two degrees of freedom at each node.

Analysis of beams and frames: Element stiffness matrix for two nodes (two degrees of freedom per node), analysis of frames with two translations and rotational degrees of freedom per node.

UNIT - III

2D triangular elements: Plane stress, plane strain and axisymmetry, finite element modeling of two

dimensional stress analysis with constant strain triangles and treatment of boundary conditions, finite element modeling of axisymmetric solids subjected to axisymmetric loading.

UNIT - IV

Quadrilateral elements and Numerical Integration: Two dimensional four noded Quadrilateral elements, Numerical integration and Gaussian quadrature.
Dynamic Analysis: Consistent and lumped mass formulation, Evaluation of Eigen values and Eigen vectors for a stepped bar.

UNIT - V

Heat transfer analysis: Steady state heat transfer analysis, one dimensional analysis of a fin and two dimensional analysis of thin plate.
3D elements and FEA software: Introduction to finite element formulation of three-dimensional problems in stress analysis, convergence requirements.
Introduction to finite element analysis software: Modelling, Analysis , Pre and Post processing.

Text Books:

1. G. Ramamurthy, Applied Finite Element Analysis, I.K. International Publishing House Pvt. Ltd.,New Delhi, 2009.
2. Tirupathi R Chandraputla and Ashok D Belagundu, Introduction to Finite Elements in Engineering,Prentice Hall of India, 1997
3. Daryl L. Logan, A First Course in the Finite Element Method, Cengage Learning, 2011.

Suggested Reading:

1. S.S. Rao, The Finite Element Method in Engineering, Pergamon Press, 1989.
2. L. J. Segerlind, Applied Finite Element Analysis, Wiley Eastern, 1984

22MEC36

FUNDAMENTALS OF DESIGN THINKING

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Prerequisite: Nil

Course Objectives: This course aims to
1. Create awareness of design thinking approaches
2. Identify a systematic approach for defining/identifying a problem
3. Create design thinking teams and conduct design thinking sessions collaboratively
4. Apply both critical thinking and design thinking in parallel to solve problems
5. Motivate to apply design thinking concepts to their real life scenarios

Course Outcomes: upon completion of this course, the students are able to
1. Understand design thinking and its phases as a tool of innovation
2. Empathize on the needs of the users
3. Define the problems for stimulating ideation
4. Ideate on problems to propose solutions by working as a design thinking team
5. Prototype and test the proposed solutions focusing on local or global societal problems

CO-PO Articulation Matrix

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
CO 1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	2
CO 2	1	1	2	1	2	2	2	2	1	2	2	2	1	2	2
CO 3	1	1	2	2	1	2	2	2	1	2	2	1	2	2	2
CO 4	2	1	2	2	1	2	2	2	1	2	2	2	2	2	2
CO 5	2	1	2	2	1	2	2	2	1	2	2	2	2	2	2

UNIT – I

Introduction to Engineering & Thinking: Impact of science/engineering. Thinking and behaviour; Types of thinking – Linear thinking, lateral thinking, design thinking.

Introduction to Design Thinking: Importance of Design Thinking & Human centric approach – Phases in design thinking process, five-stage model as iterative method, applications of design thinking in various domains.

UNIT – II

Empathize phase: Understanding the unique needs of the user, empathize with the users, steps in empathize phase, developing empathy towards people, assuming a beginner's mind-set (what? why?), steps in immersion activity, body storming.

UNIT – III

Define phase: Define the problem and interpret the result, analysis and synthesis, Personas – Four different perspectives on Personas, steps to creating personas, problem statement, affinity diagrams, empathy mapping.

UNIT – IV

Ideation phase: What is ideation, need, uses, ideation methods; Brainstorming, rules for brainstorming; Mind maps, guidelines to create mind maps; Ideation games; Six Thinking Hats; use of doodling in expressing creative ideas.

UNIT – V

Prototyping phase: Types of prototyping, guidelines for prototyping, storytelling, characteristics of good stories, reaching users through stories, importance of prototyping in design thinking; guidelines to write value proposition.

Testing phase: Necessity to test, user feedback, conducting a user test, how to test, desirable, feasible and viable solutions, iterate phase.

Text Books:

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires, 1st Edition, HarperCollins, 2009.
2. Michael Luchs, Scott Swan, Abbie Griffin, Design thinking: New product development essentials from the PDMA. John Wiley & Sons, 2015.
3. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solv ing, Penguin Random House India Private Limited, 2020.

Suggested Reading:

1. Jeanne Liedtka, Andrew King, Kevin Bennett, Solving problems with design thinking: Ten stories of what works. Columbia University Press, 2013.
2. Bala Ramadurai, Karmic Design Thinking - A Buddhism-Inspired Method to Help Create Human-Centered Products & Services, Edition 1, 2020.

22MEE09

COMPUTATIONAL FLUID DYNAMICS

(Professional Elective-III)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Concepts of Fluid Mechanics and Hydraulic Machines and Mathematics.

Course Objectives: This course aims to

1. To understand governing equations of fluid flow
2. To understand turbulence and how to model them.
3. To know how to discretize governing equations of fluid flow by FDM and their stability.
4. To learn various iterative methods to solve N-S equation.
5. To understand FVM to solve fluid flow equations.

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

1. Describe and develop mathematical models for flow phenomena.
2. Apply Finite Difference Method for fluid flow and heat transfer problems Classify PDE for fluid flow and heat transfer applications.
3. Use different solvers based on applications
4. Solve fluid flow and heat transfer problems using commercial CFD tools for turbulence models
5. Formulate numerical equations by Finite Volume Method for fluid flow and heat transfer problems

CO-PO ARTICULATION MATRIX

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
CO 1	3	2	1	1	1	-	1	-	-	-	-	1	-	-	-
CO 2	3	3	1	1	1	-	1	-	-	-	-	1	-	-	-
CO 3	3	3	1	1	1	-	1	-	-	-	-	1	2	-	-
CO 4	3	3	1	1	1	-	1	-	-	-	-	-	2	-	-
CO 5	2	3	1	1	1	-	1	-	-	-	-	1	2	-	3

UNIT-I

Governing Equations of Fluid Dynamics and Heat Transfer:

Introduction to CFD, Models of Flow – Conservation and Non-conservation form - Continuity, Momentum and Energy Equation in conservation and non-conservation form (differential equations only)

UNIT-II

Classifications of Partial Differential Equations: Elliptic, parabolic and hyperbolic equations, Initial and boundary value problems.

Discretization and Finite Difference method: Forward, Backward and Central difference schemes, Transient one and two dimensional conduction - Explicit, implicit, semi-implicit and ADI methods - Stability analysis and error estimation.

UNIT-III

Elliptic Partial Differential Equations: Jacobi, Gauss Seidel methods, TDMA,

Viscous incompressible flow, Vorticity Stream function method.

UNIT-IV

Turbulence Modeling:

Types of Turbulence modeling-Reynolds and Favre averaged N-S equations, mixing length model, k-epsilon turbulence model.

Types of Turbulence modeling-Reynolds and Favre averaged N-S equations, mixing length model, k-epsilon turbulence model.

UNIT-V

Finite Volume Method: Finite volume formulation for diffusion equation, convection diffusion equation, Solution algorithm for pressure velocity coupling in steady flows, staggered grid, SIMPLE algorithm.

Text Books:

1. P.S. Ghoshdastidar, Computational Fluid Dynamics & Heat Transfer, Cengage Pub., 2018.
2. J.D. Anderson, Jr., Computational Fluid Dynamics: The Basic with Applications, McGraw Hill, Inc., 2012.
3. H. Versteeg and W. Malalasekra, An Introduction to Computational Fluid Dynamics : The Finite Volume Method, 3rd edition, Pearson, , 2016

Suggested Reading:

1. F. John Wendt (Editor), Computational Fluid Dynamics - An Introduction‖, Springer – Verlag, Berlin, 1992.
2. Charles Hirsch, Numerical Computation of Internal and External Flows‖, Vols. I and II. John Wiley & Sons, New York, 1988.

Online resources

1. https://dragonfly.tam.cornell.edu/teaching/mae5230-cfd-intro-notes.pdf
2. https://www.bakker.org/Lectures-Applied-CFD.pd

22MEE10

ADDITIVE MANUFACTURING

(Professional Elective-III)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge on the basic of Manufacturing Processes.

Course Objectives: This course aims to

1. Introduce students the basics of additive manufacturing including its advantages and limitations.
2. Familiarize the students with different additive manufacturing techniques.
3. Teach students about STL file issues and familiarize them with various modelling software.
4. Demonstrate various post processing techniques and rapid tooling concept.
5. Demonstrate the applications of rapid prototyping in various fields.

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

1. Understand the fundamental concepts of Additive manufacturing
2. Demonstrate the knowledge of various Additive Manufacturing Processes.
3. Analyze preprocessing and identify different post processing techniques in AM
4. Demonstrate the design rules for product development through Additive Manufacturing.
5. Create awareness of Additive manufacturing in various applications.

CO-PO Articulation Matrix

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
CO 1	2	1	1	-	1	2	-	2	-	2	1	2	1	1	-
CO 2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	2	1	1	2	2	2	1	2	1	1	1	1	2	1	1
CO 4	2	2	2	1	2	2	2	2	2	2	2	2	2	2	3
CO 5	2	1	2	1	1	2	2	2	-	1	-	1	1	1	1

UNIT-I

Overview: Additive Manufacturing (AM): Introduction and Importance, Additive Manufacturing Vs Traditional Manufacturing: Mass Customization, Reverse Engineering and Fundamental Fabrication Process, AM Process Chain, Classification of AM Process, Advantages and Limitations of AM.

UNIT-II

AM Technologies: Vat Photopolymerization: Stereolithography (SLA), Process Benefits and Drawbacks, Materials, Resin Curing Process, Applications.
Extrusion-Based AM Processes: Fused Deposition Modeling (FDM), Principles, Materials, Process Benefits and Drawbacks, Applications.
Sheet Lamination AM Processes: Laminated Object Manufacturing (LOM), Materials, Gluing, Thermal Bonding, Applications.
Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Selective Laser Melting (SLM), Electron Beam melting (EBM), Materials, Powder Fusion Mechanism, Metal and ceramic part creation, Applications.
Binder Jetting: Process Benefits and Drawbacks, Materials, Applications.
Directed Energy Deposition: Process Benefits and Drawbacks.
Material Jetting: Process Benefits and Drawbacks.

UNIT-III

Pre-processing in AM: STL File Format, STL File Problems, STL File Repairs.

Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-Thermal and Thermal Techniques.

AM Software: Features of various AM software like Materialise Magics, Materialise Mimics, Rhinoceros 3D.

UNIT-IV

Design for Additive Manufacturing (DfAM): DfAM Concepts and Objectives: Complex Geometry, Customized Geometry, Integrated Assemblies and Elimination of Conventional design for manufacture (DFM) Constraints. Rapid Manufacturing (RM), Unique Capabilities, Exploring Design Freedoms and Design Tools for AM, defects in additive manufacturing.

Guidelines for process selection: Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control.

UNIT-5

Rapid Tooling: Conventional Tooling vs Rapid Tooling, Classification of Rapid Tooling.

Indirect Rapid Tooling Methods: Spray Arc Metal Deposition, Investment Casting, 3D Keltool Process

Direct Rapid Tooling Methods: Direct AIM, EOS direct tool Process

AM Applications: Applications in Design Industry, Analysis and Planning, Application in Aerospace, Automobile Sectors, Forensic Applications, Arts & Culture Applications, Bio-medical Applications.

Text Books:

1. Chua Chee Kai, Leong Kah Fai, 3D Printing and Additive Manufacturing: Principles & Applications, 4th Edition, World Scientific, 2015.
2. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing‖, 2nd Edition, Springer, 2015
3. C. P. Paul, A. N. Jinoop, Additive Manufacturing, 1st Edition, McGraw Hill, 2021.

Suggested Reading:

1. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping andRapid Tooling, Springer 2001.
2. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
3. K. Venuvinod and Weiyin Ma, Rapid Prototyping: Laser-based and Other Technologies, Springer, 2004.

22MEE11

MODERN MACHINING AND FORMING METHODS

(Professional Elective-III)

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

Prerequisite: Knowledge on Machining processes

Course Objectives: This course aims to

1. Various non-conventional machining processes and their process parameters
2. The relative merits, limitations and applications of various non-conventional machining processes
3. The knowledge regarding working media and its functions of non-conventional machining processes
4. The concepts of non-conventional forming processes such as rubber pad forming, hydro forming, stretch forming, etc.,
5. The concepts of HERF and to provide the description of HERF process.

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

1. Select the non-conventional machining process for a particular application
2. Demonstrate the capability of comparison of various non-conventional machining methods
3. Describe the various non-conventional machining processes
4. Exhibit the proficiency of selecting working media for various non-conventional machining processes
5. Exhibit the basic understanding of non-conventional forming processes

CO-PO Articulation Matrix

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
CO 1	-	-	1	1	-	-	-	-	-	1	-	1	2	2	2
CO 2	-	-	1	1	1	1	1	-	1	1	-	1	2	2	2
CO 3	-	1	1	1	1	1	1	-	1	1	1	1	1	2	2
CO 4	-	-	-	-	-	-	1	-	1	1	-	1	1	1	1
CO 5	-	-	-	-	1	-	1	-	1	1	-	1	2	2	2

UNIT-I: Mechanical Energy Processes:

Ultrasonic Machining (USM):
Introduction, Process description, abrasive slurry, Abrasive materials and their characteristics, Functions of liquid medium in slurry, Types of transducers, effect of process parameters, applications and limitations

Abrasive Jet Machining (AJM):
Principle of operation, process details, process variables and their effect on MRR and accuracy, advantages, disadvantages and applications

Water Jet Machining (WJM):
Schematic diagram, equipment used, advantages and applications Abrasive

Water Jet Machining (AWJM):
Process, advantages, limitations and applications

UNIT-II: Thermal Processes:

Electro Discharge Machining (EDM):
Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, flushing, mechanism of metal removal, types of power supply circuits, mathematical

analysis of metal removal rate (MRR), equations for surface finish, characteristics of spark eroded surfaces, advantages, disadvantages and applications Wire **EDM:** Process description and applications

LASER Beam Machining (LBM):

Principle of LASER beam production, materials used, process parameters, advantages,limitations and applications,

Plasma Arc Machining (PAM):

Introduction, equipment used, process description and parameters, types of plasma arc:transferred arc and non transferred arc and process applications,

Electron Beam **Machining (EBM):** Schematic of the process, process parameters, principleof production of electron beam, equipment used, advantages, disadvantages and applications,

UNIT-III: Chemical and Other Machining Processes:

Electro-chemical machining (ECM): Schematic of process parameters, function and characteristics of electrolyte, MRR for pure metal and alloys, electrode feed rate (EFR), advantages, limitations and applications

Chemical Machining: Chemical blanking and chemical milling, advantages, limitations and applications

ION Etching: Process description, merits, limitations and applications.

UNIT-IV: High Energy Rate Forming Processes (HERF):

Introduction, applications, advantages, Explosive Forming**:** Principles, explosive materials, Equipment, types of explosive forming, standoff operation and contact operation.

Electro-Hydraulic Forming (EHF): Schematic of process, description and its applications,

Electro-Magnetic Forming (EMF): Process description, merits, limitations and applications

UNIT-V: Other Forming Processes:

Rubber Pad Forming: Principle of the process, process details and its types, Guerin, wheelon, Mar forming and Hydro forming processes and applications,

Stretch Forming: Introduction, types of stretch forming, stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming.

Tube spinning: introduction, methods of tube spinning, backward spinning, forwardspinning.

Test Books:

1. P.C. Pandey and H.S. Shah, Modern Machining Process Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980
2. J Paulo Davim, Modern Machining Technology, A Practical Guide, 1st Edition, Woodhead Publishing in Mechanical Engineering
3. Hassan Abdel-Gawad El-Hofy, Advanced Machining Processes, Nontraditional and Hybrid Machining Processes, McGraw Hill Publishing Co. Ltd.,

Suggested Reading:

1. Davies and Austin, Developments in High Speed Metal Forming, The Machinery Publishing Co. Ltd., 1985
2. Production Technology, HMT
3. A. Bhattacharya, New Technology, The Institution of Engineers (India), 1984

Note:

1. Text books and suggested reading (Any no. of books)
2. We may add online resources

22MEE12

INDUSTRIAL SAFETY AND MAINTENANCE

(Professional Elective-III)

Instruction	3 L	Hours per Week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Prerequisite: Nil

Course Objectives: This course aims to

1. Prevent industrial accidents and steps to be taken for prevention.
2. Impart fundamental concepts of Maintenance Engineering.
3. Familiarize about wear and corrosion along with preventive steps to be taken
4. Impart basic concepts and importance of fault tracing.
5. Make understand the steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

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

1. Identify the causes for industrial accidents and suggest preventive measures.
2. Identify the basic tools and requirements of different maintenance procedures.
3. Apply different techniques to reduce and prevent Wear and corrosion in Industry.
4. Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
5. Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc.

CO-PO Articulation Matrix

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
CO 1	3	3	2	2	1	1	1	1	2	3	1	3	3	2	3
CO 2	3	3	2	2	1	1	1	1	2	3	1	3	3	2	3
CO 3	3	3	2	2	1	1	1	1	2	3	1	3	3	2	3
CO 4	3	3	2	2	1	1	1	1	2	3	1	3	3	2	3
CO 5	3	3	3	2	1	1	1	1	2	3	1	3	3	2	3

UNIT - I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes, Fire prevention and firefighting, equipment and methods.

5S Techniques: Introduction, Significance, Objectives and benefits of 5S.

UNIT - II

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT - III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side

feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

UNIT - IV

Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

UNIT - V

Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment.

Condition monitoring and Basic concepts of Proactive maintenance for Industry 4.0.

Text Books:

1. H. P. Garg, "Industrial Maintenance", S. Chand and Company, may 1987
2. Das Akhil Kumar, Principles of Industrial Safety Management Understanding the Ws of Safety at Work, Second edition, PHI Learning Pvt Ltd, Jan 2020.
3. M.P. Poonia, S.C. Sharma, Khanna Publishing House - Technology & Engineering, year 2019.

Suggested Reading:

1. Parth B. Shah, Industrial Safety and Maintenance Engineering, Technical publications, 2021
2. Higgins & Morrow, "Maintenance Engineering Handbook", McGraw-Hill Education Eighth Edition, February 2014.

22MEC29

METROLOGY AND INSTRUMENTATION LAB

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

Prerequisite: Knowledge on basics of Mathematics and Manufacturing Engineering.

Course Objectives: This course aims to

1. Select the proper measuring instrument for the precise measurement of length, height anddiameter.
2. Classify the different measuring instruments used for the angular measurement.
3. Develop gear & screw thread parameters using optical projector and tool maker's microscope.
4. Analyze the limits, fits and tolerances for selection and design of gauges.
5. Determine the working principles in the measurement of Flatness, Roundness and Surfaceroughness.

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

1. Measure the linear dimension by using appropriate method & device.
2. Demonstrate the knowledge of angular measurements and use measuring instruments as per requirements.
3. Determine the gear and screw thread parameters using profile projector and tool makers' microscope.
4. Design and test plain limit gauges for a given specimen.
5. Evaluate and estimate the measurement of flatness, roundness and surface roughness.

CO-PO Articulation Matrix

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
CO 1	2	2	1	1	-	1	-	-	-	-	-	1	3	-	1
CO 2	2	2	2	1	2	2	-	-	-	-	-	1	3	-	1
CO 3	2	2	2	1	1	1	-	-	-	-	-	1	2	-	1
CO 4	3	1	2	1	-	-	-	-	-	-	-	1	2	-	1
CO 5	3	2	3	1	-	-	-	-	-	-	-	1	2	-	1

Experiments:

1. Measurement with inside, outside and depth micrometers.
2. Measurement with height gauges, height masters.
3. Measurement of linear and angular dimensions with Tool maker's microscope – diameter of thin wire and single point cutting tool angle.
4. Measurement with dial indicator and its calibration.
5. Measurement of angles with sine bar and clinometers.
6. Comparison of roundness errors with bench centers method.
7. Measurement of flatness errors of a surface plate with precision spirit level.
8. Measurement with optical profile projector.
9. Design of plug and snap gauges for a given component.
10. Surface roughness measurement by Taylor Hobson -Talysurf.
11. Measurement of gear tooth thickness by gear tooth vernier.
12. Displacement measurement with LVDT.
13. Analyze, assess, measure and document all measuring attributes of a selected component by using appropriate methods and devices.

Note: Student should complete a minimum of 10 experiments including experiment number 13 which is compulsory.

Text Books:

1. R.K. Jain, Engineering Metrology, Khanna Publications, 1996.
2. Doeblin, Measurement Systems Application and Design, TMH, 5th edition, 2004.
3. Beckwith, Buck, Lienhard, "Mechanical Measurements", PEA, 3rd Indian Reprint, 2001.

Suggested Reading:

1. Rega Rajendra, Principles of Engineering Metrology, Jaico Publishing House, Mumbai, 2008.
2. B.C. Nakra& K.K. Chaudhary, Instrumentation Measurement and Analysis, 3rd edition, McGraw-Hill,2014.

22MEC30

THERMAL ENGINEERING LAB

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

Prerequisite: Knowledge on Thermodynamics and Applied Thermodynamics.
Course Objectives: This course aims to

1. Demonstrate knowledge in finding the efficiency of Turbo compressors.
2. Know about performance parameters of refrigeration systems.
3. Understand the pressure distribution in convergent and divergent nozzle
4. Provide the knowledge pressure distribution over an airfoil surface.
5. Understand the concept of drag and lift coefficients for contoured bodies.

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

1. Determine the overall efficiency of Turbo compressors.
2. Evaluate the performance parameters of refrigeration systems.
3. Estimation of pressure distribution for convergent and divergent nozzle.
4. Measurement of pressure distribution over an airfoil surface using subsonic type wind tunnel.
5. Estimation of Lift and Drag forces of aerofoil structure using subsonic type wind tunnel.

CO-PO Articulation Matrix

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
CO 1	2	-	-	-	-	-	-	2	3	3	-	3	-	-	-
CO 2	2	-	-	-	-	-	-	2	3	3	-	3	-	-	-
CO 3	2	-	-	-	-	-	-	2	3	3	-	3	-	-	-
CO 4	2	-	-	-	-	-	-	2	3	3	-	3	2	-	-
CO 5	2	-	-	-	-	3	3	2	3	3	3	3	-	-	3

List of the Experiments

1. Determination of overall efficiency of centrifugal blower
2. Determination of overall efficiency of axial flow fan
3. Determine COP of refrigeration system using capillary tube /thermostatic expansion valve.
4. Determine COP of air conditioning system using AC tutor.
5. Study of psychometric process in Air conditioning system.
6. Determination of pressure distribution for convergent and divergent nozzle
7. Determination of pressure distribution for a cylinder
8. Determination of pressure distribution for a Symmetrical aerofoil.
9. Determination of pressure distribution for an Unsymmetrical aerofoil.
10. Study of fire tube and water tube boilers Boilers.
11. Determination of lift and drag coefficient for different contours.
12. Determination of Sensible and Latent heat loads for a classroom and validating the data with RAC software.

Note: Student should complete a minimum of 10 experiments.

22MEC31N

FINITE ELEMENT ANALYSIS LAB

Instruction	2P	Hours per Week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

Prerequisite: Engineering Mathematics, Dynamics of machines, Machine design.

Course Objectives: This course aims to

1. Generate finite element model of Trusses, Bars of constant cross section area, tapered cross section area and stepped bar.
2. Create Beams -Simply supported, cantilever, beams with UDL, and beams with varying load etc.
3. Perform stress analysis of a rectangular plate with a circular hole, axisymmetric problems.
4. Execute buckling analysis and Dynamic Analysis.
5. Understand steady state and Transient heat transfer analysis.

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

1. Apply basics of Theory of Elasticity to continuum problems.
2. Analyze finite elements for 1D, 2D and 3D structures subjected to linear static analysis.
3. Solve heat transfer problems.
4. Examine problems of limited complexity in buckling and dynamic analysis.
5. Evaluate solutions to practical problems by finite element analysis software.

CO-PO Articulation Matrix

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
CO 1	3	3	1	3	3	3	1	-	3	3	1	2	3	1	3
CO 2	3	3	2	3	3	3	1	-	3	3	1	3	3	1	3
CO 3	3	3	2	3	3	3	1	-	3	3	1	3	3	1	3
CO 4	3	3	2	3	3	3	1	-	3	3	1	3	3	1	3
CO 5	3	3	3	3	3	3	1	-	3	3	1	3	3	1	3

List of Exercises:

1. Analysis of plane truss with various cross sections and materials.
2. Beam analysis with different sections, different materials for different loads and boundary conditions.
3. Static analysis of plate with a hole.
4. Plane stress, plane strain (octagonal pipe) and axisymmetric loading on the in-plane members.
5. Static analysis of connecting rod with three-dimensional element
6. Static analysis of flat and curved shell due to internal pressure.
7. Buckling analysis of shell to estimate BF and modes.
8. Modal analysis of plates for natural frequencies and mode shapes.
9. Harmonic analysis of a shaft.
10. Steady state heat transfer analysis of chimney.
11. Transient analysis of casting.
12. Static/Buckling/Modal/Harmonic/Transient/Non-Linear/ heat transfer analysis of a selected component by ANSYS/MATLAB/any other relevant software.

Note:

1. Students should complete a minimum of 10 exercises including exercise number 12, which is compulsory.
2. Students may use any or combination of FEA software (ANSYS/ABAQUS/NASTRAN/NISA/CAEFEM/ADINA)

Suggested Reading:

1. Tadeusz, A. Stolarski, Y. Nakasone, S. Yoshimoto, Engineering Analysis with ANSYS Software, 1st edition, Elsevier Butterworth-Heinemann publications, 2007.
2. ANSYS Inc., User Manuals for Release 15.0.

22MEC35

MINI PROJECT

Instruction	4P Hours per Week
Duration of SEE	--
SEE	--
CIE	50 Marks
Credits	2

Prerequisite

Course Objectives: This course aims to

1. To equip students to learn by doing.
2. To enhance the capability to analyze and solve real time problems.
3. To inculcate out of the box innovative ideas.
4. To impart team building, right attitude and management skills.
5. To enable with writing and presentation skills.

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

1. Analyse and Interpret Literature insights with the purpose of formulating a problem definition.
2. Plan, analyze, Design and implement a project.
3. Find an optimum solution of problem defined by using latest Technologies.
4. Plan to complete the work as a team with passion and focus.
5. Prepare and present the Report in the department.

CO-PO Articulation Matrix

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
CO 1	3	2	1	1	2	1	1	2	3	3	1	3	2	1	2
CO 2	3	3	3	3	3	1	1	2	3	3	1	2	2	1	2
CO 3	3	3	3	3	3	1	1	2	3	3	1	2	2	1	2
CO 4	3	3	3	3	3	1	1	2	3	3	1	2	2	1	2
CO 5	3	3	3	2	2	1	2	3	3	3	3	2	2	1	2

A Mechanical engineering student with the capability to build mechanical mini project as part of their curriculum is essential in equipping oneself to be a qualified Mechanical engineer. The scope of the mini project that an individual build extends beyond their engineering curriculum. And helps greatly in improving their confidence while attending interviews or applying for higher studies admissions. But the main concern for most of the engineering students is the cost. That they have to incur in doing such innovative mini projects.

Schedule:

S. No.	Description	Duration (in weeks)
1	Choosing field of specialisation	1
2	Literature Survey	1
3	Problem Identification / Selection	1
4	Preparation of Abstract	1
5	Methodology	1
6	Experimentation/Analysis	2
7	Results and Discussion	2
8	Conclusions	1
9	Report preparation	1
10	Implementation and Inferences	1

Guidelines for award of Marks:

S. No.	Description	Duration (in weeks)
1	Report Writing	10
2	PPT preparation and presentation	5
3	Technical content	10
4	Question and Answers	5
	Total	**30**

Mini Project done by the students will be evaluated by the supervisor and the team appointed by the Head of the Department.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY

B.E. (MECHANICAL ENGINEERING)

SEMESTER – VII

S. No.	Course Code	Title of the Course	Scheme of instruction			Scheme of examination			Credits
			Hours per week			Duration in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MEC28	Operations Research	3	-	-	3	40	60	3
2		Professional Elective - IV	3	-	-	3	40	60	3
3		Professional Elective - V	3	-	-	3	40	60	3
4		Open Elective – II	3	-	-	3	40	60	3
5	22MBC01	Engineering Economics and Accountancy	3	-	-	3	40	60	3
6	22MEC32	Project Part - I	-	-	4	-	50	-	2
TOTAL			**15**	**-**	**04**	**-**	**250**	**300**	**17**
Clock Hours Per Week: 19									

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

SEMESTER – VII

Professional Elective – IV		
S. No	**Course Code**	**Title of the Course**
1	22MEE13	Automobile Engineering
2	22MEE14	Control System Theory
3	22MEE15	Mechanical Vibrations
4	22MEE16	Supply Chain Management

Professional Elective – V		
S. No	**Course Code**	**Title of the Course**
1	22MEE17	Renewable Energy Sources
2	22MEE18	Digital Manufacturing and Industry 4.0
3	22MEE19	Composite Materials and Testing
4	22MEE20	Principles of Industrial Engineering

Open Elective – II		
S. No	**Course Code**	**Title of the Course**
1	22CHO01	Fuel Cells and Batteries
2	22CSO01	Introduction to Web Technologies
3	22ITO02	Principles of Internet of Things
4	22EGO01	Technical Writing Skills

22MEC28

OPERATIONS RESEARCH

Instruction	3L	Hours per Week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Prerequisite: Knowledge on basics of mathematics

Course Objectives: This course aims to

1. Make the students come to know the formulation of LPP models.
2. Familiarize the students with the Algorithms of Graphical and Simplex Methods.
3. Make the students understand the Transportation and Assignment techniques.
4. Familiarize the students with the procedure of Project Management along with CPM and PERT techniques.
5. Make the students understand the concepts of sequencing and queuing theory.

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

1. Understand the concepts of linear programming problems and Solve
2. Solve the given transportation problem.
3. Develop optimum pair of operations and resources by using Assignment technique.
4. Analyze project management techniques like CPM and PERT to plan and execute projects successfully.
5. Apply sequencing and queuing theory concepts for industry applications.

CO-PO Articulation Matrix

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
CO 1	2	2	1	-	1	-	-	1	1	-	-	1	1	1	2
CO 2	2	1	1	-	1	-	-	1	-	-	-	1	1	-	2
CO 3	1	1	1	-	-	2	-	-	-	-	2	1	1	-	2
CO 4	3	-	-	-	-	-	-	1	-	-	-	2	1	-	3
CO 5	2	1	1	-	-	2	1	-	1	-	2	1	1	-	3

UNIT-I

Introduction: Definition and scope of operations research.

Linear programming: Introduction, formulation of linear programming problems, graphical method of solving LP problem, simplex method, degeneracy in simplex, duality in simplex.

UNIT-II

Transportation models: Finding an initial feasible solution - north west corner method, least cost method, Vogel's approximation method, finding the optimal solution, special cases in transportation problems - unbalanced transportation problem, degeneracy in transportation, profit maximization in transportation.

UNIT-III

Assignment techniques: Introduction, Hungarian technique of assignment techniques, unbalanced problems, problems with restrictions, maximization in assignment problems, travelling salesman problems.

UNIT-IV

Project management: Definition, procedure and objectives of project management, differences between PERT and CPM, rules for drawing network diagram, scheduling the activities, Fulkerson's rule, earliest and latest times, determination of ES and EF times in forward path, LS & LF times in backward path, determination of critical path, duration of the project, free float, independent float and total float, crashing of network.

UNIT-V

Sequencing models: Introduction, General assumptions, processing 'n'jobs through two machines, processing 'n' jobs through three machines.

Queuing theory: Introduction, Kendall's notation, single channel - Poisson arrivals - exponential service times.

Text Books:

1. Hamdy A. Taha, Operations Research-An Introduction, 10th edition, Pearson education India,2017.
2. S.D. Sharma, Operations Research, Kedarnath, Ramnath& Co., Meerut,2009.
3. V.K. Kapoor, Operations Research, S. Chand Publishers, New Delhi, 2004.

Suggested Reading:

1. R. PaneerSelvam, Operations Research, 2nd edition, PHI Learning Pvt. Ltd., New Delhi,2008.
2. Nita H. Shah, Ravi M. Gor, HardikSoni, Operations Research, PHI Learning Private Limited,2013.

22MEE13

AUTOMOBILE ENGINEERING

(Professional Elective-IV)

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

Prerequisite: Applied Thermodynamics

Course Objectives: This course aims to

1. Learn about the layout and arrangement of principal parts of an Automobile.
2. Understand the working of various engine support systems in an automobile.
3. Learn about different types of Suspension systems, Steering systems, Wheels and Tyres.
4. Understand different types of Automobile Power Trains and Braking systems.
5. Learn about the Pollution Control and Alternative Energy Sources for Automobiles.

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

1. Identify principal parts of an automobile and its layout.
2. Understand the various systems in automobile like engine cooling, lubrication, ignition, electricaland air conditioning systems.
3. Understand the various suspension and steering systems.
4. Analyze the functioning of drive train, transmission and braking systems.
5. Understand the importance of alternative power trains for pollution control.

CO-PO Articulation Matrix

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
CO 1	2	1	1	-	1	-	1	-	1	2	1	3	1	1	1
CO 2	2	1	1	-	1	-	1	-	1	2	1	3	2	3	2
CO 3	2	2	1	-	1	-	1	-	1	2	1	3	2	3	2
CO 4	2	2	1	-	1	-	1	-	1	2	1	3	2	3	1
CO 5	2	2	1	-	1	3	2	1	1	2	1	3	2	3	1

UNIT - I

Engine: Chassis layout - parts of the automobile body, Types of automobile chassis, Engine location, Engine components - cylinder block, cylinder head, crankcase, piston and piston rings, cylinder liners, firing order. Valve operating mechanism, Variable Valve Timing (VVT), Carburetion, Gasoline Direct Injection (GDI) engine, Multi-Point Fuel Injection (MPFI) system, Common Rail Direct Injection (CRDI) engine, Electronic Fuel Injection system, Turbocharger.

Maintenance: Trouble shooting and overhauling, engine tune up, warning lights.

UNIT - II

Lubricating System: Functions of lubricating system, Wet sump and Dry sump lubricating systems.

Cooling System: Characteristics of an effective cooling system, Components of a cooling system - water pump, radiator, thermostat control, anti-freezing compounds.

Ignition Systems: Components of an Ignition System, Battery and Electronic Ignition Systems.

Electrical Systems: Main electrical circuits, Generating & Starting circuit, Automobile Air-Conditioning system.

UNIT - III

Wheel and tyres: Tyre construction, Tyre specification, Tyre wear and causes.

Suspension systems: Objectives of a Suspension system, Independent suspension system, Rigid Axle suspension system, MacPherson Strut Suspension, Double Wishbone Suspension, Coil and Leaf springs, Torsion bar.

Steering Systems: Linkage arrangements and its components, Rack and Pinion Steering Gear Box, electronic power steering system, Steering geometry: caster, camber, King Pin Inclination, Toe in, Toe out, Wheel Balancing, Wheel Alignment.

UNIT – IV

Power Train: Single Plate Clutch, Manual Transmission (Synchromesh transmission), Automatic transmission**,** Torque converter, Propeller shaft, Universal coupling, Differential, Four-wheel drive system, All-wheel drive system.

Braking System: Disc and Drum Brakes, Description and operation of Hydraulic braking system, Hand brake linkage, Anti-lock Braking System (ABS), Electronic Brakeforce Distribution (EBD), An overview on Advanced Driver-Assistance System (ADAS).

UNIT – V

Pollution control: Emissions from Automobiles, Euro norms and Bharat Norms - Bharat Stage Emission Standards 6, Catalytic Converter, Selective Catalytic Reduction (SCR).

Alternative Power Trains: Electric Vehicle Technology, Hybrid Vehicle Technology, An introduction to Fuel Cell Electric Vehicles (FCEVs) and Flexible Fuel Vehicles (FFVs).

Text Books:

1. R. K. Rajput, A Textbook of Automobile Engineering, 2nd edition, Laxmi Publications Pvt Ltd, 2007
2. Kirpal Singh, Automobile Engineering, Vol I and II",12th edition, Standard Publishers, 2011
3. P.L. Kohli, Automotive Electrical Equipment, Tata McGraw Hill, 1985.

Suggested Reading:

1. S. Srinivasan, Automotive Mechanics, 2nd edition, Tata Mc Graw Hill, 2003
2. William H. Crouse, Donald L. Anglin, "Automotive Mechanics", 10th edition, Tata Mc GrawHill, 2007.

Online Resources :

1. https://archive.nptel.ac.in/courses/107/106/107106088/
2. https://nptel.ac.in/courses/107103084

22MEE14

CONTROL SYSTEMS THEORY

(Professional Elective-IV)

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

Prerequisite: Engineering Mathematics, basics electronics.

Course Objectives: This course aims to

1. To introduce students to the fundamental of feedback control system theory.
2. Use of analytical design methods in designing, analyzing various physical systems and to apply thegained knowledge in developing solutions for real world systems.
3. To develop the ability of formulating mathematical models and designing feedback controlsystems.
4. To provide students with necessary tools to analyze linear feedback control systems.

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

1. Students should be able apply major equations of linearized models and their transfer function
2. Student are learned to apply Final-value Theorem to determine the steady-state response
3. Students should be able to understand how to construct Bode and polar plots for transferfunctions
4. Students should be able to understand the applications of Nyquist criteria to find Gain and phasemargins.
5. Demonstrate the effect of damping on the plant using the DC position control system.

CO-PO Articulation Matrix

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
CO 1	3	3	1	1	-	1	1	-	-	-	-	1	3	2	2
CO 2	3	3	1	2	1	1	1	-	-	-	-	1	3	2	2
CO 3	3	3	3	3	2	1	1	-	-	-	-	1	3	2	2
CO 4	3	3	2	3	2	1	1	-	-	-	-	1	3	2	2
CO 5	3	2	3	2	2	1	1	-	-	-	-	1	3	2	2

Unit-I

Control Systems Classification: Open Loop & Closed Loop Systems. Mathematical models and Transfer functions from governing equations of mechanical, electrical, hydraulic, pneumatic, thermal systems. AC, DC servomotors & electro mechanical servo systems.

Unit-II

Block diagrams, Block diagram reduction. Signal flow graphs, Mason's gain formula. Transient response. Time domain specifications of 1^{st} and 2^{nd} order systems. Steady state error, Error coefficients, sensitivity and Performance indices.

Unit-III

Routh criteria, Root Locus method. Frequency Response: Bode, Polar plots. Correlation between transient and frequency response, Bandwidth, Experimental determination of transfer functions.

Unit-IV

Nyquist criteria. Gain and phase margins, Lead. Lag and Lead-lag compensator design, PID controller, linearization of Non linear systems.

Unit- V

State space representation: Concept of state, State variable, state models of linear time invariant systems, derivation of state model from transfer functions and differential equations. State transition matrix, solution of state equations by time domain method. Concept of controllability and observability.

Text Books:

1. Ogata, K., *"Modern Control Engineering"*, Prentice Hall, 2004
2. M. Gopal, *"Control Systems"*, Tata McGraw Hill, 2004.
3. Anand kumar.A "control systems", Prentice Hall of India,2014

Suggested Reading:

1. Norman S. Nise, *"Control Systems Engineering"*, John Wiley & Sons, Inc., 2001
2. B.C.Kuo,"AutomaticControlSystems",9thedition,JohnWiley,andson'sPublishers,2009
3. K.R. Varmah, 'Control Systems' McGraw Hill, June, 2010

22MEE15

MECHANICAL VIBRATIONS

(Professional Elective – IV)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Dynamics of machines. Engineering Mathematics.

Course Objectives: This Course aims to

1. To analyze free vibration, damped and undamped vibrations.
2. The principles of harmonically excited vibrations
3. The principle of damped and undamped vibrations of two degrees of freedom system
4. To develop the equations of motion for a continuous system in elongation, bending and torsion to findthe natural frequencies and mode shapes.
5. The working principles of vibration measurements

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

1. Apply Newton's law of motion and energy method to get governing differential equations of vibrating systems.
2. Analyze response of machine members in forced vibration with different excitation frequencies, Recommend suitable vibration parameters for isolation and compute critical speeds.
3. Analyze mode shape and decoupling of equation of motion for 2 degree of freedom systems.
4. Predict natural frequency and mode shape for all continuous systems.
5. Understand working principles of vibration measuring instruments.

CO-PO Articulation Matrix

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
CO 1	2	2	-	1	1	1	1	1	-	1	1	1	3	-	3
CO 2	3	2	1	1	1	-	-	1	1	-	1	1	3	-	3
CO 3	3	2	1	1	1	-	2	-	1	-	1	1	3	-	3
CO 4	3	2	-	1	1	-	-	1	1	-	1	1	3	-	3
CO 5	1	2	1	2	1	1	1	1	-	1	2	1	3	-	3

UNIT - I

Introduction: Fundamentals of vibrations analysis, classification of vibrating systems, damping systems.
Single Degree of Freedom Systems: Formulation of equation of motion–Energy method, Rayleigh method, principle of virtual work, principal of conservation energy.
Free vibration response: Undamped, damped (viscously damped, logarithmic decrement, coulomb damping) translational & torsional systems, case studies on formulation and response calculation.

UNIT - II

Forced vibration response: Response of undamped systems to harmonic excitations, response of damped systems to harmonic excitations, response of damped systems to rotating unbalance, magnification factor, displacement transmissibility, force transmissibility, relative motion, vibration control–whirling of shafts.

UNIT - III

Two Degree of Freedom Systems: Free and forced vibration response–Formulation of equation of motion (undamped, damped), Eigen values and Eigen vectors, modal matrix, normal modes, modes superposition, coordinate coupling, principal coordinates, decoupling of equations of motion, influence coefficients, semidefinite systems, self-excitation and stability analysis.

UNIT - IV

Vibrations of Continuous Systems: Vibrations of strings, bars and beams, formulation of equations of motion, characteristic equations, identification of nodes and mode shapes.

UNIT - V

Vibration Measurements and Applications: Vibration pickup, vibrometer, accelerometer, Piezoelectric transducers, electrodynamic transducers; Vibration exciters–mechanical and electro dynamicshakers; Frequency measuring instruments.

Text Books:

1. J.J. Thomson, –Theory of vibration with Application, 5/e, 2014.
2. S.S. Rao, –Mechanical vibration, 5/e, Pearson, 2011
3. G.S. Grover & Nigam, –Mechanical vibrations, 8/e, New Chand & Bros**,** 2018

Suggested Reading:

1. V.P. Singh, –Mechanical vibration, 3/e, Dhanpath Rai & Co., 2014.
2. S. Graham Kelley, –Mechanical vibration, Schaums Outline Series, TMH, 2011.

22MEE16

SUPPLY CHAIN MANAGEMENT

(Professional Elective-IV)

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

Prerequisite: Nil

Course Objectives: This course aims to
1. Bring awareness about transportation and warehouse management systems.
2. Design supply chain networks.
3. Familiarize the concept of demand and supply and integrating it with supply chain management.
4. Plan and manage inventories.
5. Determine pricing and revenue management.

Course Outcomes: Upon completion of this course, students will be able to
1. Understand fundamentals of supply chain and its key concepts.
2. Design an effective supply chain network.
3. Understand the essence of demand and supply and associated gaps.
4. Apply inventory management techniques.
5. Evaluate pricing and revenue management systems.

CO-PO Articulation Matrix

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
CO 1	3	3	3	3	3	2	2	-	3	3	3	3	1	-	1
CO 2	1	3	3	2	2	2	3	2	3	3	3	3	1	-	-
CO 3	3	3	3	3	3	2	3	-	3	3	3	3	1	-	-
CO 4	3	3	3	3	3	2	3	-	3	3	3	3	1	1	1
CO 5	1	3	3	2	2	3	3	2	3	3	3	3	-	-	1

UNIT-I

Concept of SCM: Supply Chain definition, stages of supply chain, objectives, drivers of SCM-facilities, inventory, transportation, information, sourcing and pricing. Decision phases in Supply chain, pull and push processes, achieving strategic fit, expanding strategic scope. Introduction to Logistics Management.

UNIT-II

Designing the Supply Chain Network: Role of distribution in supply chain and factors influencing its network design and decisions, Types of distribution networks – manufacturer storage with direct shipping, manufacturer storage with direct shipping and in transit merge, distributor storage with package carrier delivery, distributor storage with last mile delivery, manufacturer/distributor storage with customer pickup, retail storage with customer pick up. Framework for network design decisions-supply chain strategy, regional facility configuration, desirable sites and location choices, E-Business and Distribution network.

UNIT-III

Planning Supply and Demand: Planning demand & supply in a supply chain demand forecasting- moving averages, exponential smoothing, trend and seasonality, Risk management in forecasting. Aggregate planning, Master scheduling, Materials Requirement Planning, time phased order plan, critical ratio, product tree structures.

UNIT-IV

Planning & Managing Inventories in a Supply Chain: Inventory control, objectives of inventory management in supply chain, Deterministic inventory and probabilistic inventory control, Economic Order Quantity, quantity discounts, Reorder point. ABC analysis, FNSD analysis, VED analysis.

UNIT-V

Sourcing, Pricing, Coordination and IT in Supply chain : Sourcing decisions, key sourcing related processes, In-house or outsource, pricing & revenue management, differential pricing strategies, coordination in supply chain, bullwhip effect, information technology and supply chain, supply chain macroprocesses-CRM, ISCM, SRM, TMF

Text Books:

1. Sunil Chopra & Peter Meindl, Supply Chain Management – Strategy, Planning and Operation, Pearson Education, Inc., Upper Saddle River, New Jersey, 2003
2. N. J. Kumar &Mukesh Bhatia, Supply Chain Management, Neha publishers & Distributors, 2010.
3. Michael H. Hugos, Essentials of Supply Chain Management, 3rd edition, John Wiley & Sons, Inc,Hoboken, New Jersy, 2011.

Suggested Reading:

1. Martin Christopher, Logistics & Supply Chain Management, 5th edition, Financial Times Series,2010.
2. Dobler Donald. W, David.N.Burt, Purchasing & supply Management Text & Cases, McGraw- Hill,1996.
3. A.K. Chitale, R.C, Gupta, Materials Management-Text and Cases, Prentice-Hall of India PvtLimited, 2007.

22MEE17

RENEWABLE ENERGY SOURCES

(Professional Elective-V)

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

Prerequisites: Knowledge on Thermodynamics

Course Objectives: This course aims to
1. Need and importance of non-conventional energy resources
2. Extent of solar energy which can be utilized as energy resource
3. Concept of wind energy and its merits and demerits
4. Operating principles of geothermal energy and bio-energy
5. Merits and demerits of tidal energy, wave energy and OTEC

Course Outcomes: Upon completion of this course, students will be able to
1. Recognise the importance of renewable energy and solar geometry.
2. Select the solar collector based on the application.
3. Understand the working principles of wind power plants.
4. Understand the principles of geothermal and biogas plants.
5. Distinguish wave, tidal and OTEC energy.

CO-PO Articulation Matrix

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
CO 1	1	-	-	-	1	3	2	1	1	2	1	3	1	1	1
CO 2	1	1	1	1	2	2	2	1	1	2	1	3	2	3	2
CO 3	1	1	1	1	2	2	2	2	1	2	1	3	2	3	2
CO 4	1	1	1	1	2	2	2	1	1	2	1	3	2	3	1
CO 5	1	1	1	1	1	2	2	2	1	2	1	3	2	3	1

UNIT-I

Energy Sources: forms of energy, energy chain (route), Indian energy scenario, energy and environment, energy conservation and its importance, , classification of energy sources, classification of Renewable energy sources(RES), advantages and limitations of non renewable and renewable energy sources.

Solar Energy: Solar radiation, basic definitions: Irradiance, solar constant, insolation, radiosity, latitude, hour angle, declination, altitude angle, zenith angle, azimuth angle and radiation measuring instruments

UNIT-II

Solar thermal collectors: working, comparison, merits and demerits of flat plate and concentrating (focusing) collectors.

Applications of solar collectors: water heating, space heating, solar cookers, solar pond, solar thermal power plants based on central receiver, dish/stirling cycle and chimney, solar refrigeration.

Solar photovoltaics: materials, cells, space based solar power (SBSP), advantages and disadvantages. PV System applications stand alone and grid connected systems, various components of solar powered systems.

UNIT-III

Wind Energy: Sources of wind, merits and demerits of wind energy, site selection factors, classification of wind mills(turbines), working and comparison of horizontal axis, Savonius and Darries vertical axis windmills, power extracted from the wind, power duration and velocity duration characteristic curves, wind-solar and wind-diesel hybrid plants

UNIT-IV

Geothermal Energy: Layers in earth, resources of geothermal energy, hydrothermal, petrothermal and geopressure resources, advantages, disadvantages, applications and environmental effects of geothermal energy sources.

Biomass Energy: Resources, site selection factors, bio mass conversion processes: direct combustion,thermo chemical, bio chemical, working of KVIC, Janata, Deenbandu and Pragathi

design(spherical) biogas plants, operational problems, causes and remedies relating to a biogas plant.

UNIT V

Tidal power: Tidal systems, site selection for tidal power plant, operation of single basin and double basintidal plants, advantages and disadvantages of tidal power.

Wave energy - Differences between tides and waves, advantages and disadvantages of wave power,working principle of wave energy conversion devices.

Ocean thermal energy conversion (OTEC): OTEC power plants, location, open cycle and closed cycle OTEC plants, advantages, limitations and applications of OTEC, environmental impact of OTEC plants.

Text Books:

1. S. Hasan Sayeed and D.K. Sharma, Non Conventional Energy Resources, S.K. Kataria & Sons, NewDelhi, 2017.
2. Dr. R.K. Singal, Non Conventional Energy Resources, S.K. Kataria & Sons, New Delhi, 2005.
3. G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.

Suggested Reading:

1. K. M. Mittal, Non-Conventional Energy Systems, Wheeler Publishing Co. Ltd, New Delhi, 2003.
2. R.K.Rajput, Non-Conventional Energy Sources and utilisation, S.Chand,2016.

Online Resources:

1. https://nptel.ac.in/courses/103103206
2. https://archive.nptel.ac.in/courses/121/106/121106014/

22MEE18

DIGITAL MANUFACTURING AND INDUSTRY 4.0

(Professional Elective-V)

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

Prerequisite: Knowledge on basics of Manufacturing Processes.

Course Objectives: This course aims to

1. Make understand the concept and applications of Digital Manufacturing and Industry 4.0.
2. Relate different Additive manufacturing processes as a part of Digital Manufacturing
3. Make understand the concept of Virtual prototyping, digital design and Importance of reverse engineering inDigital Manufacturing
4. Make understand the concept of Industry 4.0 and allied technologies.
5. Provide an understanding on the challenges faced and relevant industrial applications of Industry 4.0

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

1. Understand the Basics and applications of Digital Manufacturing and Industry 4.0.
2. Understand the role of Additive Manufacturing, Virtual prototyping and Reverse Engineering processes and their adaptability to Digital Manufacturing.
3. Understand the concepts of digital manufacturing based product life cycle and its management.
4. Understand the concept of Industry 4.0 and allied technologies.
5. Understand the basics of Internet of things and cloud computing pertaining the fourth industrial revolution.

CO-PO Articulation Matrix

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	1	1	3	2	3	1	1	2	3	2	2	3	3
CO2	2	2	3	2	3	2	2	2	2	2	3	2	2	3	3
CO3	2	2	2	2	2	2	3	2	2	2	2	2	2	1	3
CO4	2	2	2	3	3	2	2	1	2	3	3	3	3	2	3
CO5	3	2	2	2	3	2	2	2	2	2	2	2	3	3	3

UNIT-I

Introduction to digital manufacturing: Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System, Impact on manufacturing careers, Advantages of digital manufacturing and design, Information sharing in the digital thread, Digital twins and Files format (STL, AMF, 3MF), Multiple organizations in the manufacturing process. Introduction of Industry 4.0 and 5.0. Case study on car manufacturing by Bosch.

UNIT-II

Additive Manufacturing Processes: Additive Manufacturing processes – Engineering polymers, metalsand ceramics. Stereolithography, Selective Laser Sintering, Fused Deposition Modeling, Layered object manufacturing. Electronic Materials, Bio-printing, Food Printing. Preprocessing and Post processing in AM

Virtual Prototyping & Reverse Engineering: Virtual Prototyping, Applications, Virtual Prototyping and Virtual Manufacturing. Reverse Engineering, Application of Reverse Engineering in Digital Manufacturing.

Self-Learning of Manufacturing System and Intelligent Manufacturing System.

UNIT-III:

Key Technology of Digital Manufacturing: Various Digital Technologies in Product Lifecycle, Digital Equipment and Digital Processing Technology, Technology of Digital Maintenance and Diagnosis.

Product life cycle management: Introduction, Types of Product Data, Product life cycle management (PLM) systems. Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

UNIT-IV:

Industry 4.0: Various Industrial Revolutions, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, automation, data exchanges, cloud, cyber-physical systems, mobile robots, Big Data, deep machine learning, Production Systems, IoT, Challenges of implementing Industry 4.0, Impact of implementing Industry 4.0 in various sectors, Applications domainsand the way forward. Basics of Industry 5.0 and its applications.

UNIT –V:

Internet of Things (IoT) - IoT design methods, physical devices and enabling technologies, Industrial Internet of Things (IIoT), Smart Manufacturing.

Cloud Computing and Manufacturing- Cloud models, cloud manufacturing examples, cloud based manufacturing, Cloud service and platforms for manufacturing.

Augmented Reality and Virtual Reality in Manufacturing.

Text Books: `

1 Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital ManufacturingScience, Springer-Verlag London Limited, 2012
2 Brent Stucker, David Rosen, and Ian Gibson, Additive Manufacturing Technologies, ISBN 978-1-4419-1120-9, Springer, 2010
3 Chee Kai Chua, Kah Fai Leong, 3D printing and additive manufacturing: principles and Application, 4th edition of rapid prototyping
4 Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things.

Suggested reading:

1 Lihui Wang and Andrew Yeh Ching Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009
2 Venuvinod, PK; Ma, W; Rapid prototyping – Laser based and other technologies, Kluwer,2004

22MEE19

COMPOSITE MATERIALS AND TESTING

(Professional Elective - V)

Instruction	3L	Periods per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Prerequisites: Strength of materials, Engineering materials.

Course Objectives: This Course aims to

1. Types of composite materials used in commercial composites.
2. Prediction of the properties of UD lamina based on the constituent materials.
3. Method of predicting failure in composite lamina using different theories.
4. Analysis of composite laminates based on classical lamination theory.
5. Fabrication and testing methods of composite materials.

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

1. Understand composite materials, classification, types of matrix and fibre materials.
2. Understand types of analyses, stress strain relationships for different materials and characterization of UD lamina.
3. Understand the variation of properties with orientation and failure theories of UD lamina.
4. Analyze the laminates for stresses and strains using CLT.
5. Summarize the various fabrication methods of composite materials and measurements of properties through tests.

CO-PO Articulation Matrix

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
CO 1	1	-	1	-	-	-	2	3	-	3	-	3	2	2	2
CO 2	3	3	2	1	1	-	-	3	-	3	-	3	2	2	2
CO 3	3	3	2	1	1	-	-	3	-	3	-	3	2	2	2
CO 4	3	3	2	1	1	2	-	3	-	3	-	3	2	2	2
CO 5	3	3	1	3	-	2	-	3	-	3	-	3	2	2	2

UNIT-I

Introduction: Introduction to composite materials, general characteristics, Fibres, Matrix materials, Interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites, Carbon fibre composites, nanocomposites, Advantages, Applications of composite materials, Military, civil, space, automotive and commercial applications.

UNIT-II

Basic Concepts and Characteristics: Stress strain relations for anisotropic, orthotropic and isotropic materials, Scales of analyses: micromechanics, macro mechanics, Elastic constants of UD lamina using MOM approach, thermal and moisture coefficients, Haplin-Tsai equations, load transfer mechanism from fibre to matrix, Restrictions on engineering constants.

UNIT-III

Elastic behaviour of UD Lamina: Transformation of stress, Strain and elastic parameters reduced and transformed stiffness matrix and compliance matrix, variation of lamina properties with orientation. Tensile and compressive strengths of UD fibre composites, Macromechanical failure theories, Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion and quadratic interaction (Tsai- Wu) criteria.

UNIT-IV

Elastic Behaviour of Laminate: Laminate Nomenclature, Kirchhoff's Hypothesis, CLT, Laminate strains and displacements - Laminate stresses & strains - Stress distributions through the thickness - Force and moment resultants - Laminate stiffness matrix: ABD Matrix-Classification of laminates and their effect on the ABD Matrix - Elastic couplings.

UNIT-V

Fabrication Processes: Hand lay-up, bag molding, autoclave processing, RTM, pultrusion, filament winding. Case studies on fabrication of composite parts/ boats/pressure vessels/automotive parts/ aerospace parts.

Testing: Fibre and matrix tests, gel time test for resins, curing cycle, tensile test, compressive test, in-plane shear test, inter-laminar shear test, flexural test.

Text Books:

1. R. M. Jones, "Mechanics of Composite Materials", Mc Graw Hill Co., 2006.
2. B. D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, "Analysis and performance of fiber composites", Wiley & Sons 3/e, 2013.
3. M. Balasubramanian, "Composite materials and processing", CRC press, 2014.

Suggested Reading:

1. Isaac M. Daniel and Ori Ishai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 1994.
2. Sanjay K. Mazumdar, "Composites manufacturing", CRC Press, 2002.

22MEE20

PRINCIPLES OF INDUSTRIAL ENGINEERING

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

Prerequisite: Nil

Course Objectives: This course aims to
1. Basic principles of industrial engineering along with work study techniques.
2. Concepts of plant location and layouts.
3. Significance of production planning & control.
4. Necessity of inventory control techniques.
5. Essence of quality engineering.

Course Outcomes: Upon completion of this course, students will be able to
1. Conceptualize the essence of industrial engineering techniques.
2. Select and design plant location and layouts.
3. Plan, execute and control production related issues.
4. Analyze and choose right inventory control techniques.
5. Plot control charts and apply quality control tools.

CO-PO Articulation Matrix

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	2	1	1	1	2	2	2	2	2	2	2
CO2	2	2	2	1	2	1	2	1	2	2	2	2	2	2	2
CO3	2	1	2	1	2	1	1	2	2	2	2	1	2	1	2
CO4	2	2	2	1	2	1	1	1	1	1	2	2	2	1	2
CO5	3	2	1	1	2	1	1	1	1	1	2	3	2	1	2

UNIT–I: Concepts of Industrial Engineering:

Productivity-concepts, Principles and Techniques, Production Vs Productivity, Productivity Improvement Methods. Work Study: Method Study and Work Measurement steps involved in method study and work measurement, Recording Techniques-FlowProcessCharts,multipleactivitychart,twohandedprocesschart, SIMOChart.Varioustechniquesofworkmeasurement-TimeStudy,WorkSampling, PMTS etc, Standard time computation.

UNIT–II: Plant Location and Layout:

Factors for Plant Locations, Types of production-Mass, batch, job. Types of plant layout - product, process and fixed position layouts, cellular layouts.

UNIT–III: Production Planning and Control:

ElementsofPPC-Planning,Routing,Scheduling,Dispatching.Production planning by line of Controls, Materials Requirement Planning (MRP), Manufacturing Resource Planning (MRP II).

UNIT–IV: Inventory Control:

ABC analysis, FSN analysis, VED Analysis, PSystem, Q System. Economic order quantity, Lead time, Buffer Stock,ASRS, Stores management.

UNIT–V: Quality Engineering:

Control Charts-X, R, P, C charts. OC Curve, Acceptance Sampling, Kaizen, JIT, ISO-9000, Quality Concepts by Deming, Juran, Philip Crosby. Taguchi ' loss function. Six Sigma, Zero defects.

Text Books:

1. SK Hajra Choudhury, Nirjhar Roy, AKHajra Choudhury 'Industrial Engineering & Management' Media Promoters & Pub. Pvt. Ltd.,
2. Banga and Sharma 'Industrial Engineering and Management' Khanna Publishers, 2008.
3. O.P.Khanna, Industrial Engineering and Management, Dhanpat Rai Pub.,
4. M.S.Mahajan Industrial Organization &Management, Nirali Prakashan Pub.

Suggested Readings:

1. K.K.Ahuja,Industrial Management, Khanna Publishers,5thEd.1993.
2. Production Systems-Planning Analysis And Control Riggs., Wiley Publishers, 1992.
3. ElwoodSBuff Rakesh K Sarin Modern Production Operations Management, John Wiley & Sons (Asia) Pte Ltd. 1983.

22CHO01 **FUEL CELL AND BATTERIES**

(Open Elective)

Instruction	3L Periods per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course helps the students to

1. Create awareness about alternate clean fuel available.
2. Evaluate the concepts and chemistry of fuel cell
3. Examine the details of fuel used in fuel cell technology
4. Explain the application of fuel cell in different sectors
5. Evaluate the fuel cell system balance plant and future opportunities

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

1. Apply know-how of thermodynamics, electrochemistry and principle of fuel cell
2. Understand the different types of fuel cell
3. Understand the components of hydrogen-based fuel cell
4. Explain the application of fuel cell in transport, stationary and portable sector
5. Understand the impact of this technology in a global and societal context

CO-PO Articulation Matrix

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	3	-	-	2	3	-	-	-	1	2	1	1	2
CO2	3	3	3	-	-	2	2	-	-	-	1	2	1	1	1
CO3	3	3	3	-	-	2	2	-	-	-	1	2	2	2	2
CO4	3	3	3	-	-	2	2	-	-	-	1	2	1	1	2
CO5	3	3	3	-	2	2	3	-	-	-	1	2	1	1	2

UNIT - I

Introduction: Electrochemical Systems and Fuel Cell, Fuel Cell Fundamentals and Basic Concepts, Fuel Cell Degradation, Fuel Cell Operation, Types Of Fuel Cell And Its Applications: Direct Carbon Fuel Cell, Solid Oxide Fuel Cell, Polymer Electrolyte Fuel Cell, Alkaline Fuel Cell, Phosphoric Acid Fuel Cell, Molten Carbonate Fuel Cell, Fuel Cell Thermodynamics - Heat, Work Potentials, Prediction of Reversible Voltage, Fuel Cell Efficiency.

UNIT – II

Fuels and Fuel Processing: Introduction, Feedstock for H_2 production: Natural gas, Liquefied petroleum gas, Liquid hydrocarbon Fuels: Gasoline and Diesel, Alcohols- Methanol and Ethanol, Ammonia, Biomass, Fuel processing for fuel cell applications: Desulfurization, fuel reforming, water gas shift reaction, Carbon monoxide Removal.

UNIT – III

Fundamental and Components of Portable Hydrogen Fuel Cell: Introduction, PEM Fuel cell Components and their properties: Membrane, Electrode, Gas diffusion layer, Bipolar plates, Stack design principles, system design, performance analysis, current/voltage, voltage efficiency and power density, ohmic resistance, direct methanol and other non-hydrogen fuel cells, biofuel cell

UNIT – IV

Application of Fuel Cell: Hydrogen fuel cell use in transport, stationary Fuel cell characterization: - in-situ and ex- situ characterization techniques, i-V curve, frequency response analyses; Fuel cell modelling and system integration: - 1D model - Analytical solution and CFD models.

UNIT – V:

Balance of plant and commercialization issues, Future Opportunities, obstacles and challenges associated in fuel cell systems, impact of this technology in a global and societal context

Text Books

1. Nigel M. Sammes ,Fuel Cell Technology, Reaching Towards Commercialization, SpringerLondon, 2006.
2. David A Berry, Dushyant Shekhawat, J.J. Spivey, Fuel Cells: Technologies for FuelProcessing, , Elsevier Science, 2011.

Suggested Readings

1. Shigenori Mitsushima, Viktor Hacker Fuel Cells and Hydrogen, From Fundamentals to Applied Research, Elsevier Science, 2018.

22CSO01

INTRODUCTION TO WEB TECHNOLOGIES

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge on a programming language.

Course Objectives: This course aims to

1. Acquire knowledge on HTML, Java Script and XML to develop client side web applications.
2. Learn developing web applications using Django.

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

1. Understand the technologies required for developing web application.
2. Identify and choose HTML tags, CSS and java scripts to develop well-structured and easily maintained web pages.
3. Design and Develop interactive and innovative web pages using various platforms/technologies like HTML, CSS, XML, JAVASCRIPT.
4. Create and deploy web applications in web server by using Django concepts.
5. Evaluate different web applications to implement optimal solutions for real time problems

CO-PO Articulation Matrix

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
CO 1	2	3	2	2	1	1	1	1	2	3	1	3	1	1	2
CO 2	2	3	2	2	1	1	1	1	2	3	1	3	1	1	1
CO 3	2	3	2	2	1	1	1	1	2	3	1	3	2	1	2
CO 4	2	3	2	2	1	1	1	1	2	3	1	3	1	1	1
CO 5	2	3	3	2	1	1	1	1	2	3	1	3	2	1	2

UNIT - I

Web Basics: WWW Browsers, Web Servers, URL, MIME, HTTPS.

Introduction HTML5: basic tags, Images, Tables, Lists, Forms, Layout, Graphics, span and div tags. Grid, Cascading Style Sheets.

UNIT – II

The Basics of Java script: Primitive operations and Expressions, Arrays, Functions, Pattern Matching Using Regular Expressions, Document Object Model, Element Access in JavaScript, Events and Event Handling, Handling Events from Body, Button, Text Box and Password Elements.

Dynamic Documents with Java Script: Positioning Elements, Moving Elements, float and clear.

UNIT - III

XML: Introduction, uses of XML, the Syntax of XML, XML Document Structure, Namespaces, XML schemas, displaying Raw XML Documents, displaying XML documents with CSS, JSON, XML vs JSON.

UNIT - IV

Django: Introduction, Models, Templates, supported data bases, URL configuration. Templates, Modifying and Improving the Templates, Creating a Form.

UNIT - V

Applications: Introduction to Ajax, Node.js and.

Bootstrap: Introduction to Bootstrap, bootstrap grid, bootstrap components.

Web Application Frameworks: React JS, JQuery.

Text Books:

1. HTML5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery), Dreamtech, 2017.
2. Adrian Holovaty and Jacob Kaplan-Moss" The Definitive Guide to Django Web Development Done Right", après-2009
3. P. J. Deitel - Deitel, H. M. Deitel - Deitel, "Internet & World Wide Web How To Program", 5th Edition, Prentice Hall, 2007.
4. Miguel Grinberg , "Flask Web Development", First edition-2014.

Suggested Reading:

1. Web Technologies, Uttam K Roy, Oxford University Press
2. Chris Bates, "Web Programming, building internet applications", 2nd edition, John Wiley & Sons, 2010.
3. JavaScript for Modern Web Development: Building a Web Application Using HTML, CSS, and JavaScript, by Alok Ranjan, Abhilasha Sinha, Ranjit Battwad, BPB, 2020.

Online Resources:

1. https://www.w3.org/standards/webdesign/
2. https://www.w3schools.com/angular/
3. https://www.w3schools.com/jquery/default.asp
4. https://www.tutorialspoint.com/flask/index.htm
5. https://www.tutorialspoint.com/web2py/index.htm
6. https://www.tutorialspoint.com/fuelphp/index.htm

22ITO02 PRINCIPLES OF INTERNET OF THINGS

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

Course Objectives:

1. To provide an overview of Internet of Things, building blocks of IoT and real-world applications.
2. To explore various IOT enabling technologies.
3. To facilitate students, understand Python scripts for IoT platform.
4. To identify steps in IOT design Methodology.
5. To introduce the Raspberry Pi device, its interfaces and Django Framework.

Course Outcomes: Upon completing this course, students will be able to

1. Comprehend the terminology, protocols and communication models of IoT.
2. Define the various IoT enabling technologies and differentiate between M2M and IoT.
3. Acquire the basics of Python Scripting Language used in developing IoT applications.
4. Describe the steps involved in IoT system design methodology.
5. Design simple IoT systems using Raspberry Pi board and interfacing sensors with Raspberry Pi.

CO-PO Articulation Matrix

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	1	-	1	-	-	-	-	1	1	1	1
CO2	1	2	2	1	-	2	1	-	-	1	-	-	1	1	2
CO3	2	2	2	2	1	2	2	1	1	1	1	1	2	-	2
CO4	2	1	2	2	1	-	2	1	-	1	2	2	1	1	1
CO5	1	2	2	1	-	2	1	-	1	1	-	-	2	1	2

UNIT-I

Introduction & Concepts: Introduction to Internet of Things- Definitions & Characteristics of IoT, Physical Design of IOT-Physical Layer, Network Layer, Transport Layer, Application Layer, Things in IoT, IoT Protocols, Logical Design of IOT-Nonfunctional Blocks, IoT Communication Models-Requestreponse,Publisher-Subscriber, Push-Pull, Exclusive Pair, IoT Communication APIs-REST API, Websocket API.

UNIT-II

IOT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, IOT Levels & Deployment Templates. Differences and similarities between IOT and M2M, Domain Specific IoT's – IoT applications for Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle.

UNIT-III

Introduction to Python: Motivation for using Python for designing IoT systems, Language features of Python, Data types- Numbers, Strings, Lists, Tuples, Dictionaries, Type Conversions, Data Structures: Control of flowif, for, while, range, break/continue, pass, functions, modules, packaging, file handling, data/time operations, classes, Exception handling.

UNIT-IV

IoT Platforms Design Methodology: Introduction, IoT Design Methodology Steps-Purpose and Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device and Component Integration, Application Development, Case Study on IoT System for Weather Monitoring.

UNIT-V

IoT Physical Devices and End Points: Basic building blocks of an IoT device, Raspberry Pi about the Raspberry Pi board, Raspberry Pi interfaces-Serial, SPI, I2C, Other IoT Devices pcDuino, BeagleBone Black, Cubieboard. Python Web Application Framework: Django Framework-Roles of Model, Template andView

Text Books:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things - A Hands-on Approach", Universities Press, 2015.
2. Matt Richardson & Shawn Wallace, "Getting Started with Raspberry Pi", O'Reilly (SPD), 2014.

Suggested Reading:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publications.

Web Resources:

1. The Internet of Things - Article https://dl.acm.org/citation.cfm?id=1862541
2. Internet of Things - Tutorial
3. http://archive.eurescom.eu/~pub/abouteurescoiem/message_2009_02/Eurescom_message_02_2009.pdf

22EGO01

TECHNICAL WRITING SKILLS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Language proficiency and the ability to simplify complex technical concepts for a diverse audience.

Course Objectives: This course aims to

1. Process of communication and channels of communication in general writing and technical writing in particular.
2. Learn Technical Writing including sentence structure and be able to understand and use technology specific words.
3. Write business letters and technical articles.
4. Write technical reports and technical proposals.
5. Learn to write agenda, record minutes of a meeting, draft memos. Understand how to make technical presentations.

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

1. Communicate effectively, without barriers and understand aspects of technical communication.
2. Differentiate between general writing and technical writing and write error free sentences using technology specific words.
3. Apply techniques of writing in business correspondence and in writing articles.
4. Draft technical reports and technical proposals.
5. Prepare agenda and minutes of a meeting and demonstrate effective technical presentation skills.

CO-PO-PSO Articulation Matrix

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
CO 1	-	2	1	1	-	1	1	2	3	3	2	3	-	1	1
CO 2	-	1	-	1	-	-	-	1	2	2	1	2	-	-	-
CO 3	-	2	-	2	-	1	1	1	2	3	2	2	-	-	1
CO 4	2	2	1	3	-	2	2	1	3	3	2	2	1	1	1
CO 5	1	1	1	1	-	1	1	1	3	3	2	2	1	-	1

Unit - I

Communication – Nature and process.

Channels of Communication – Downward, upward and horizontal communication. Barriers to communication.

Technical Communication – Definition, oral and written communication. Importance and need for Technical communication. Nature of Technical Communication. Aspects and forms of Technical communication. Technical communication Skills – Listening, Speaking, Reading & Writing.

Unit II

Technical Writing – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

Unit III

Business correspondence – Sales letters, letters of Quotation, Claim and Adjustment letters.

Technical Articles: Nature and significance, types. Journal articles and Conference papers, elements of technical articles.

Unit IV

Technical Reports: Types, significance, structure, style and writing of reports. Routine reports, Project reports.
Technical Proposals: Definition, types, characteristics, structure and significance.

Unit V

Mechanics of Meetings: Preparation of agenda, participation, chairing and writing minutes of a meeting. Memorandum. Seminars, workshops and conferences.
Technical Presentations: Defining purpose, audience and locale, organizing content, preparing an outline, use of Audio Visual Aids, nuances of delivery, importance of body language and voice dynamics.

Textbooks:

1. Meenakshi Raman & Sangeeta Sharma, "Technical Communications-Principles and Practice", Oxford University Press, Second Edition, 2012.
2. M Ashraf Rizvi, "Effective Technical Communication", Tata McGraw Hill Education Pvt Ltd, 2012.

Suggested Reading:

1. Kavita Tyagi & Padma Misra, "Basic Technical Communication", PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw Hill, 2003

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18_mg13/preview
2. https://www.technical-writing-training-and-certification.com/
3. https://academy.whatfix.com/technical-writing-skills

22MBC01

ENGINEERING ECONOMICS AND ACCOUNTANCY

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

Prerequisite: Nil

Course Objectives: This course aims to

1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in achieving a firm's Objective.

Course Outcomes: Upon completion of this Course, student will be able to

1. Apply fundamental knowledge of Managerial Economics concepts and tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decision based on any technique.

CO-PO Articulation Matrix

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	1	1	1	1	1	1	1	-	-	1	1	1
CO2	2	2	2	2	-	1	1	1	-	1	-	1	-	-	-
CO3	1	2	1	2	2	-	2	1	-	1	-	-	1	1	1
CO4	2	2	1	2	2	1	1	3	-	1	-	-	1	1	1
CO5	1	3	1	2	1	1	2	-	-	1	2	1	1	1	1

UNIT - I

Introduction to Managerial Economics: Introduction to Economics and its evolution - Managerial Economics - its Nature and Scope, Importance; Relationship with other Subjects. Its usefulness to Engineers; Basic concepts of Managerial economics - Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equimarginal Principle, Contribution, Negotiation Principle.

UNIT - II

Demand and Supply Analysis: Demand Analysis - Concept of Demand, Determinants, Law of demand - Assumptions and Exceptions; Elasticity of demand - Price, Income and Cross elasticity - simple numerical problems; Concept of Supply - Determinants of Supply, Law of Supply; Demand Forecasting - Methods.

UNIT - III

Production and Cost Analysis: Theory of Production - Production function - Isoquants and Isocosts, MRTS, Input-Output Relations; Laws of returns.

Cost Analysis: Cost concepts – Types of Costs, Cost-Output Relationship – Short Run and Long Run; Market structures – Types of Competition, Features of Perfect Competition, Price Output Determination under Perfect

Competition, Features of Monopoly Competition, Price Output Determination under Monopoly Competition Break-even Analysis – Concepts, Assumptions, Limitations, Numerical problems.

Unit - IV

Accountancy: Book-keeping, Principles and Significance of Double Entry Bookkeeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments.

Unit - V Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and sources of raising finance. Capital Budgeting, Methods: Traditional and Discounted Cash Flow Methods - Numerical problems.

Text Books:

1. Mehta P.L."Managerial Economics: Analysis, Problems and Cases", Sultan Chand & Son's Educational publishers, 2016.
2. Maheswari S.N. "Introduction to Accountancy", Vikas Publishing House, 12th Edition, 2018.

Suggested Readings:

1. Panday I.M. "Financial Management", 11th edition, Vikas Publishing House, 2016.
2. Varshney and K L Maheswari, Managerial Economics, Sultan Chand, 2014.
3. M. Kasi Reddy and S. Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of India Pvt Ltd, 2007.
4. A. R. Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2018.

22MEC32

PROJECT PART – I

Instruction	4	Hours per week
Duration of SEE	--	Hours
SEE	--	Marks
CIE	50	Marks
Credits	2	

Course Objective: The objective of Project Part -1 is to enable the student take up investigative study in the broad field of Engineering / Technology, either fully theoretical/practical or involving both theoretical and practical work tobe assigned by the Department on an individual basis or two/three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) towards R&D.

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

1. Identify a topic in advanced areas of Mechanical / Allied fields of Engineering.
2. Review literature to identify the gaps, define the objectives and scope of the work.
3. Generate innovative ideas for societal benefit and Nation building.
4. Develop prototypes/models, experimental setup and software systemsnecessary to meet the objectives.
5. Prepare a technical report and present before the departmental committee

The work shall include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for Presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental Committee

CO-PO Articulation Matrix

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
CO 1	3	1	1	1	1	1	3	1	3	3	1	3	3	2	3
CO 2	2	3	2	-	1	1	1	2	3	3	1	2	3	2	3
CO 3	3	2	1	1	2	3	3	1	3	3	1	3	3	2	3
CO 4	3	3	2	3	3	1	3	1	3	3	1	3	3	2	3
CO 5	3	3	1	1	1	-	-	2	2	3	1	2	3	2	3

Guidelines for the award of marks:

Evaluation by	Maximum Marks	Evaluation Criteria /Parameter
Supervisor	20	Project Status / Review
	5	Report
Departmental Committee	5	Relevance of the Topic
	5	PPT Preparation
	5	Presentation
	5	Question and Answers
	5	Report Preparation

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY

B.E. (MECHANICAL ENGINEERING)

SEMESTER – VIII

S. No.	Course Code	Title of the Course	Scheme of instruction			Scheme of examination			Credits
			Hours per week			Duration in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1		Open Elective - III	3	-	-	3	40	60	3
PRACTICALS									
2	22MEC33	Technical Seminar	-	-	2	-	50	-	1
3	22MEC34	Project Part - II	-	-	8	-	100	100	4
TOTAL			**3**	**-**	**10**	-	**190**	**160**	**8**
Clock Hours Per Week: 13									

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

Open Elective – III		
S. No	**Course Code**	**Title of the Course**
1	22EEO06	Waste Management
2	22ITO03	Introduction to Cloud Computing
3	22EGO02	Gender Sensitization
4	22CIO02	Fundamentals of Blockchain Technology

22EEO06

WASTE MANAGEMENT

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

Prerequisite: None.

Course Objectives: This course aims to
1. To Imbibe the concept of effective utilization of any scrap
2. To become familiar with the processes of all disciplines of engineering.
3. To learn the technique of connectivity from waste to utility.

Course Outcomes: Upon completion of this course, students will be able to
1. Categorize the waste based on the physical and chemical properties.
2. Explain the Hazardous Waste Management and Treatment process.
3. Illustrate the Environmental Risk Assessment, methods, mitigation and control.
4. Interpret the Biological Treatment of Solid and Hazardous Waste.
5. Identify the waste disposal options, describe the design and construction, Operation, Monitoring, Closure of Landfills.

CO-PO Articulation Matrix

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
CO 1	2	1	2	-	-	3	3	2	-	-	-	-	1	1	2
CO 2	2	1	2	-	-	3	3	2	-	-	-	-	1	1	2
CO 3	2	1	3	-	2	3	3	2	-	-	-	-	1	1	2
CO 4	2	3	3	-	1	3	3	2	-	-	-	-	-	-	2
CO 5	2	3	3	-	2	3	3	2	-	-	-	-	-	-	2

UNIT -I

Introduction to Waste Management and Municipal Solid Waste Management: Classification of waste: Agro based, Forest residue, Industrial waste, e-Waste, Municipal Solid Waste Management: Fundamentals Sources, composition, Generation rates, Collection of waste, Separation, Transfer and Transport of waste, Treatment and Disposal options.

UNIT -II

Hazardous Waste Management and Treatment: Hazardous Waste Identification and Classification, Hazardous Waste Management: Generation, Storage and collection, Transfer and transport, Processing, Disposal, Hazardous Waste Treatment: Physical and Chemical treatment, Thermal treatment, Biological treatment, Pollution Prevention and Waste Minimisation, Hazardous Wastes Management in India.

UNIT -III

Environmental Risk Assessment: Defining risk and environmental risk, Parameters for toxicity quantification, Types of exposure, Biomagnifications, Effects of exposure to toxic chemicals, Risk analysis and Risk matrix, Methods of risk assessment, Mitigation and control of the risk, Case studies.

UNIT -IV

Biological Treatment: Solid and Hazardous Waste Composting, Bioreactors, Anaerobic decomposition of solid waste, Principles of biodegradation of toxic waste, Inhibition, Co-Metabolism, Oxidative and Reductive processes, Slurry phase Bioreactor, In-situ-remediation.

UNIT -V:

Waste Disposal: Key Issues in Waste Disposal, Disposal Options and Selection Criteria: Disposal options, Selection criteria, Sanitary Landfill: Principle, Landfill processes, Landfill Gas Emission: Composition and properties, Hazards, Migration, Control, Leach ate Formation: Composition and properties. Leach ate migration, Control, Treatment, Environmental Effects of Landfill, Landfill Operation Issues, Design and construction, Operation, Monitoring, Closure of Landfills-Landfill Remediation, National and International Waste Management programs.

Text Books:

1. John Pichtel, Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D.Buckingham, P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, NewYork, 1994
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, NewYork, 1997.

Suggested Reading:

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by KantiL.Shah 1999, Prentice Hall.
2. Solid and Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers & Dist.

22ITO03 INTRODUCTION TO CLOUD COMPUTING

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

Course Objectives: This course aims to
1. To impart the basics of cloud computing for business management.
2. To illustrate and explore the benefits of cloud storage and its applications, usage by managers.
3. To enable students explore cloud computing driven real time systems.

Course Outcomes: Upon completing this course, students will be able to
1. Understand the characteristics and models in Cloud computing.
2. Asses Cloud services applications and the challenges associated with Cloud Computing.
3. Apply various cloud services and deployment models and virtualization techniques for business.
4. Analyze the concepts of cloud storage and demonstrate their use.
5. Evaluate various cloud programming models and apply them in virtual office management.

CO-PO Articulation Matrix

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
CO 1	2	2	3	1	1	-	-	-	1	1	1	1	2	1	2
CO 2	2	1	2	1	2	-	-	-	-	-	1	-	1	1	2
CO 3	2	1	2	2	1	-	-	-	-	-	-	-	1	1	1
CO 4	2	1	1	1	1	-	-	-	-	-	-	1	1	1	2
CO 5	2	1	1	1	1	-	-	-	-	-	-	1	2	2	2

UNIT-I

Cloud Computing Overview: Origins of Cloud computing – Cloud components - Essential characteristics – On-demand self-service, Broad network access, Location independent resource pooling , Rapid elasticity , Measured service, Comparing cloud providers with traditional IT service providers, Roots of cloud computing.

UNIT-II

Cloud Insights: Architectural influences – High-performance computing, Utility and Enterprise grid computing, Cloud scenarios – Benefits: scalability ,simplicity ,vendors ,security, Limitations – Sensitive information - Application development- security level of third party - security benefits, Regularity issues: Government policies.

UNIT-III

Cloud Architecture- Layers and Models: Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, Service providers, challenges and risks in cloud adoption.
Cloud deployment model: Public clouds – Private clouds – Community clouds - Hybrid clouds - Advantages of Cloud computing.

UNIT-IV

Cloud Simulators- CloudSim and GreenCloud : Introduction to Simulator, understanding CloudSim simulator, CloudSim Architecture(User code, CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim, Introduction to GreenCloud

UNIT-V

Introduction to VMWare Simulator: Basics of VMWare, advantages of VMware virtualization, using VMware workstation, creating virtual machines-understanding virtual machines, create a new virtual machine on local host, cloning virtual machines, virtualize a physical machine, starting and stopping a virtual machine.

Text Book:

1. Anthony T.Velte , Toby J. Velte Robert Elsenpeter, "Cloud computing a practical approach", TATA McGraw- Hill , New Delhi – 2010

Suggested Reading:

1. Michael Miller – Que, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Onlin", 2008
2. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, "Cloud computing for dummies", Wiley Publishing, Inc, 2010
3. Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, "Cloud Computing (Principles and Paradigms)", Inc. 2011

Web Resource:

1. https://nptel.ac.in/courses/106105167/1

22EGO02

GENDER SENSITIZATION

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: No specific prerequisite is required.

Course Objectives: This course will introduce the students to

1. Sensibility regarding issues of gender in contemporaryIndia.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

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

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways in which gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

CO-PO-PSO Articulation Matrix

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
CO 1	-	-	1	-	-	2	2	1	1	-	-	1	1	1	1
CO 2	-	-	1	-	-	2	2	1	1	-	-	1	-	1	1
CO 3	-	-	1	-	-	2	2	2	2	1	1	1	-	-	-
CO 4	-	-	1	-	-	3	2	2	2	1	1	1	-	1	1
CO 5	-	-	1	-	-	2	2	2	3	1	1	1	1	1	1

UNIT – I
Understanding Gender:
Gender: Why Should We Study It? (*Towards a World of Equals*: Unit -1)
Socialization: Making Women, Making Men (*Towards a World of Equals*: Unit -2)
Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste. Different Masculinities.

UNIT – II
Gender and Biology:
Missing Women: Sex Selection and Its Consequences (*Towards a World of Equals*: Unit -4)
Declining Sex Ratio. Demographic Consequences.
Gender Spectrum: Beyond the Binary (*Towards a World of Equals*: Unit -10)
Two or Many? Struggles with Discrimination.

UNIT – III
Gender and Labour:
Housework: the Invisible Labour (*Towards a World of Equals*: Unit -3)
"My Mother doesn't Work." "Share the Load."

Women's Work: Its Politics and Economics (*Towards a World of Equals*: Unit -7)
Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

UNIT-IV
Issues of Violence
Sexual Harassment: Say No! (*Towards a World of Equals*: Unit -6)
Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading:"*Chupulu".*
Domestic Violence: Speaking Out (*Towards a World of Equals*: Unit -8)
Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading:
New Forums for Justice.
Thinking about Sexual Violence (*Towards a World of Equals*: Unit -11)
Blaming the Victim-"I Fought for my Life…." - Additional Reading: The Caste Face of Violence.

UNIT – V
Gender: Co - Existence
Just Relationships: Being Together as Equals (*Towards a World of Equals*: Unit -12)
Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers.
Additional Reading: Rosa Parks-The Brave Heart.

Textbook:

1. A. Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed,
   Gogu Shyamala, Deepa Sreenivas and Susie Tharu"Towards a World of Equals: A Bilingual Textbook on Gender"**,** Telugu Akademi, Hyderabad, 2015.

Suggested Reading:

1. Menon, Nivedita. "Seeing like a Feminist", Zubaan-Penguin Books, New Delhi, 2012.
2. Abdulali Sohaila, "I Fought For My Life…and Won", Available online at:
   http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

Web Resources:

1. https://aifs.gov.au/publications/gender-equality-and-violence-against-women/introduction
2. https://theconversation.com/achieving-gender-equality-in-india

Note: Since it is an Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

22CIO02

FUNDAMENTALS OF BLOCKCHAIN TECHNOLOGY

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

Course Objectives: This course aims to
1. To provide an understanding of blockchain benefits and limitations
2. To familiarize with decentralisation and cryptography
3. To explore theoretical foundations of bitcoin
4. To equip with the knowledge of smart contracts
5. To analyse real-world case studies and applications of blockchain technology across various industries.

Course Outcomes: Upon completing this course, students will be able to
1. Explain the fundamental concepts and principles of blockchain technology.
2. Describe the decentralisation and cryptographic primitives.
3. Understand bitcoin and its limitations
4. Analyse smart contracts and Ethereum blockchain
5. Evaluate the potential applications and impact of blockchain technology in different sectors..

CO-PO Articulation Matrix

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
CO 1	3	3	3	3	1	-	-	-	-	-	-	3	1	-	-
CO 2	3	3	3	3	1	-	-	-	-	-	-	3	1	-	-
CO 3	3	3	3	3	2	-	-	-	-	-	-	3	-	-	-
CO 4	3	3	3	3	2	-	-	-	-	-	-	3	-	-	-
CO 5	3	3	3	3	3	-	-	-	-	-	-	3	1	1	1

UNIT-I

Introduction to Blockchain Technology

Blockchain 101: Distributed systems, History of blockchain, Introduction to blockchain, Types of lockchain, CAP theorem and blockchain, Benefits and limitations of blockchain.

UNIT-II

Decentralization and Cryptography:

Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Decentralized organizations. Cryptography and Technical Foundations: Cryptographic primitives, Asymmetric cryptography, Public and private keys.

UNIT-III

Bitcoin and Alternative Coins:

Bitcoin, Transactions, Blockchain, Bitcoin payments Alternative Coins. Theoretical foundations, Bitcoin limitations, Namecoin, Litecoin, Primecoin, Zcash.

UNIT-IV

Smart Contracts and Ethereum 101:

Smart Contracts: Definition, Ricardian contracts. Ethereum 101: Introduction, Ethereum blockchain, Elements of the Ethereum blockchain, Precompiled contracts

UNIT-V

Alternative Blockchains: Blockchain-Outside of Currencies: Internet of Things, Government, Health, Finance, Media. **Case studies and real-world projects showcasing blockchain technology in various industries**.

Text Books:

1. Imran Bashir, "Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained", Packt Publishing Ltd, Second Edition, 2018
2. Imran Bashir, "Mastering Blockchain - A technical reference guide to the inner workings of blockchain, from cryptography to DeFi and NFTs", Packt Publishing Ltd, Fourth Edition, 2023.

Suggested Readings:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction"
2. Daniel Drescher, " Blockchain Basics: A Non-Technical Introduction in 25 Steps", Apress, First Edition, 2017

Web Reference:

1. https://nptel.ac.in/courses/106/104/106104220/
2. https://nptel.ac.in/courses/106/105/106105184/

22MEC33

TECHNICAL SEMINAR

Instruction	2	Hours per week
Duration of SEE	--	Hours
SEE	--	Marks
CIE	50	Marks
Credits	1	

Course Objective: The goal of a seminar is to introduce students to critical reading, understanding,summarizing, explaining and preparing report on state of the art topics in a broad area of his/her specialization. Seminar topics may be chosen by the students with advice from the faculty members and the studentshall read further relevant articles in the domain.

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

1. Identify the recent advances in the field of engineering/technology.
2. Develop the skills and expertise in report writing.
3. Compile the content and prepare comprehensive report.
4. Demonstrate skills required for preparation of a technical report.
5. Present technical know-how and professional skills before the committee.

CO-PO Articulation Matrix

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
CO 1	2	1	1	1	2	2	2	1	1	3	1	2	1	1	2
CO 2	1	2	2	1	2	1	1	3	1	3	-	2	1	1	2
CO 3	2	1	1	1	2	1	1	2	2	2	-	2	1	-	1
CO 4	1	2	2	1	2	1	1	3	1	3	-	2	1	1	2
CO 5	1	1	1	2	2	1	1	1	2	2	1	2	2	1	2

The seminar must be clearly structured and the power point presentation shall include followingaspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and conclusions
5. References

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the noticeboard.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentationshould be for 20 minutes in PowerPoint, followed by question and answers sessionfor 10minutes.
3. Submit the detailed report of the seminar in spiral bound in a précised format assuggested by the department.

Seminars are to be scheduled from 3rd week to the last week of the semester and any change in schedule shall be discouraged. For the award of sessional marks students are judged by three (3) facultymembers and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.
Note: Topic of the seminar shall be preferably from any peer reviewed recent journal publications.

Guidelines for awarding marks		
Sl. No.	**Description**	**Max Marks**
1.	Contents and relevance	10
2.	Presentation skills	10
3.	Preparation of PPT slides	05
4.	Questions and answers	05
5.	Report in a prescribed format	20
Total Marks		**50**

22MEC34

PROJECT PART-II

Instruction	8	Hours per week
Duration of SEE	--	Hours
SEE	100	Marks
CIE	100	Marks
Credits	4	

Course Objectives: The objective of Project Part-2 is to enable the student extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance ofa Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a goodtraining for the student(s) in R&D work and technical leadership.

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

1. Summarize the literature review for the identified problem.
2. Identify methods and materials to carry out experiments/ develop code/simulation.
3. Integrate the methodology and engineering tools adopted for solving the problem.
4. Analyze and discuss the results to draw valid conclusions.
5. Exhibit knowledge, skill, attitude and technical knowhow in preparingreport as per format and presenting as a professional engineer.

CO-PO Articulation Matrix

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
CO 1	3	2	1	1	2	1	1	2	3	3	1	3	2	1	2
CO 2	3	3	3	2	2	1	1	2	3	3	1	2	2	1	2
CO 3	3	3	3	3	3	1	1	2	3	3	1	2	2	1	2
CO 4	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2
CO 5	3	3	3	2	2	1	2	3	3	3	3	2	2	1	2

The assignment to normally include:

1. In depth study of the topic assigned.
2. Review and finalization of the Approach to the Problem relating to the assigned topic.
3. Preparing an Action Plan for conducting the investigation, including teamwork.
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
5. Final development of product/process, testing, results, conclusions and future directions.
6. Preparing a paper for Conference presentation/ Publication in Journals, if possible.
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar presentation before Departmental Committee.

Guidelines for the award of marks in CIE:

Evaluation by	MaximumMarks	Evaluation Criteria / Parameter
Department Review Committee	10	Review 1
	15	Review 2
	25	Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Report Preparation
	10	Analytical / Programming / Experimental Skills

Guidelines for awarding marks in SEE:

Evaluation by	MaximumMarks	Evaluation Criteria / Parameter
External and Internal Examiners together	20	Power Point Presentation
	40	Thesis Evaluation
	20	Quality of the project • Innovations • Applications • Live research projects • Scope for future study • Application to society
	20	Viva-Voce

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Credits	21.5	19.5	25	20.5	25	23.5	17	08	160