With effect from the academic year 2022-23

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instruction as per R20 Curriculum

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	20MEC16	Dynamics of Machines	3	--	--	3	40	60	3
2	20MEC17	Applied Thermodynamics and HeatTransfer	3	--	--	3	40	60	3
3	20MEC18	Design of Machine Elements	3	1	--	3	40	60	4
4	20MEC19	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	20MEC20	Dynamics and Vibrations Lab	--	--	2	3	50	50	1
8	20MEC21	Applied Thermodynamics and HeatTransfer Lab	--	--	2	3	50	50	1
9	20MEC22	CAD/CAM Lab	--	--	2	3	50	50	1
Industrial/Rural Internship			3-4 weeks / 175 hours						2
TOTAL			**18**	**01**	**06**	--	**390**	**510**	**22+2**

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

CIE - Continuous Internal Evaluation SEE – Semester End Examination

Professional Elective – II(3/3)		
S.No.	**Subject Code**	**Name of the Subject**
1	20MEE05	Refrigeration and Air Conditioning
2	20MEE06	Robotic Engineering
3	20MEE07	Research Methodology and Innovation
4	20MEE08	Product Design and Process Planning

With effect from the Academic year 2022-23

Open Elective-1 (3/3)		
S. No.	**Subject Code**	**Name of the Subject**
1	20ITO01	Object Oriented Programming Using JAVA
2	20CSO09	Fundamentals of Database Management Systems
3	20 EEO03	Energy auditing
4	20BT O01	Biology for Engineers
5	20MTO04B	Numerical Methods

With effect from the Academic year 2022-23

20ME C16

DYNAMICS OF MACHINES

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

Objectives:

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 freedom systems.
5. To understand the modes of vibrations, Two degree of Freedom and Torsional Vibrations

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

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

UNIT- I

Force analysis: Dynamic force analysis of single slider crank mechanism, concept of dynamically equivalent link and correction couple.

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 and punching presses.

UNIT- II

Gyroscope: Principle of gyroscope, roll, yaw and pitch motions, gyroscopic effect in a two-wheeler, car, 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 in line and radial engines.

UNIT - IV

Vibrations: Vibrations of single degree freedom system (axial, transverse and torsional). Natural frequency of 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. Matrix iteration method, Jacobi's method.

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. A. 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

20ME C17

APPLIED THERMODYNAMICS AND HEAT TRANSFER

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

Objectives: To understand

1. The working principle of single stage 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 principles of conductive and convective heat transfer.
5. The principles of heat exchanger, concepts of radiation, phase change heat transfer.

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

1. Estimate the power required and efficiency of reciprocating air compressor using the principles of thermodynamics.
2. Understand the working principle of I.C engines and evaluate the performance of I.C. engines.
3. Understand the concepts of normal, abnormal combustion and the functioning of engine systems like cooling, lubrication and ignition.
4. Estimate the heat transfer through composite slabs, composite cylinders and understand the dimensionless numbers used in convection.
5. Understand the basic principles of heat exchangers, radiation, boiling and condensation.

UNIT – I

Reciprocating Air Compressors: Classification of compressors, advantages of reciprocating compressors over rotary 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, methods to control the abnormal combustion, octane and cetane number, types of combustion chambers, cooling systems, lubrication systems, battery and magneto ignition systems of IC engines, working principle of simple carburetor and fuel injector.

UNIT - IV

Modes of Heat Transfer: Conduction-General 3-D conduction equation in cartesian and cylindrical coordinates, one dimensional steady state conduction through slabs, hollow cylinders without heat

generation, critical radius of insulation for cylinders.

Convection: Basic concepts of free and forced convection, dimensionless numbers and their physical significance, simple problems on free and forced convection.

UNIT - V

Radiation: Concept of black-body Laws of radiation – Planck's Law, Wien's displacement law, Stefan Boltzmann Law, Kirchoff's Law.

Heat Exchangers: Classification, concept of LMTD, effectiveness, simple problems.

Boiling and Condensation: Basic concepts of boiling and condensation**,** pool boiling curve.

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
3. J.P. Holman, Heat Transfer, McGraw Hill Publication, New Delhi,

Data Book:

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

Suggested Reading:

1. R.K. Rajput., Thermal Engineering, Laxmi Publishers, New Delhi, 2014
2. Ozisik, Heat Transfer, TMH, 2004

With Effect from academic year 2022-2023

20ME C18

DESIGN OF MACHINE ELEMENTS

(Use of data book is permitted)

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

Objectives:

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.

Outcomes: At the end of the course, students are 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.

UNIT – I

Introduction: Materials used in machine components and their specifications to Indian standards. Codes and standards 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 Marine type of couplings.
Design of Belt Drive Systems: selection of belts and design of pulleys.

UNIT – IV

Design of Riveted Joints: Types of riveted joints, efficiency of the joint. Design of joints subjected to direct 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, bolt of 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, 34th edition, S Chand publications, 2018.

Suggested Reading:

1 Robert L. Norton, Machine Design: An Integrated Approach, 2nd edition, 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 Books:**

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

With Effect from the Academic Year 2022 – 23

20ME C19

CAD/CAM

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

Objectives:

1. To teach the basic design process and the importance and types of geometric modelling techniques
2. To teach the theory for modelling of surface and solid modelling techniques
3. To impart the basic skill in writing CNC part programming
4. To teach basic configurations of robot Manipulator
5. To teach concepts of part classification coding, computer aided process planning, automated inspection methods

Outcomes: At the end of the course, the students are 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 to model engineering components using solid modelling techniques.
3. Distinguish various NC systems and write the CNC part program for simple components .
4. Demonstrate the fundamentals knowledge of robotics
5. Understand the elements of a modern manufacturing environment

UNIT-I

Introduction: Introduction to CAD, Product cycle, Design Process, Design criteria, Alternative solutions, Hardware integration and networking, Data Exchange Formats (IGES, STEP).

Geometric Transformations: Introduction, Translation, Rotation, Scaling, Reflection Transformations, Homogenous Representation, Concatenated Transformation, Transformations about fixed point.

UNIT-II

Wire frame Modeling: Wire frame entities and their definition, interpolation and approximation curves. parametric and non-parametric representation- line, circle and helix curves, properties of splines, synthetic curves: parametric representation of cubic spline, Bezier and B-spline curves, continuity, properties and characteristics, Introduction to non-uniform rational B-splines.

Surface Modeling: Surface representation 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 modelling, Assembly modelling and mating conditions.

UNIT-III

Numerical Control of Machine Tools: Features and elements of NC, Types of NC systems: PTP, straight Cut and Contouring. definition of axes, definition of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual part programming and computer aided part programming for simple components (APT).

UNIT-IV

CNC: Introduction to CNC, Typical configurations, Machining centres

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, sensors in robotics, programming methods. Robot industrial applications: material handling, processing and assembly and inspection.

UNIT-V

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

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

Text books:

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

Suggested Reading:

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

With Effect from the Academic Year 2022 – 23

20ME E05

REFRIGERATION AND AIR CONDITIONING

(Professional Elective-II)

(Use of data book is permitted)

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

Objectives:

1. Acquire the basic knowledge about refrigeration, its applications for aircrafts.
2. Demonstrate basic knowledge of vapor compression refrigeration system, cascade and compound refrigeration.
3. Understand various types of refrigeration systems – absorption, steam-jet and non-conventional.
4. Acquire the basic knowledge of various psychrometric processes and comfort air conditioning.
5. Acquire knowledge in estimating air conditioning loads.

Outcomes: At the end of the 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.

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 Airconditioning 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 J.W. Jones, 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 Air-conditioning Data Book, New Age International Publishers, 2010.

20ME E06

ROBOTIC ENGINEERING

(Professional Elective-III)

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

Objectives:

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 and orientation.
5. Robot vision for image acquisition and processing and plan for various tasks and various Languagesand Programming methods of robot.

Outcomes: At the end of the course, the students are 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 ofa robot for various tasks
4. Recommend sensors and controllers for finding position and orientation to take corrective action basedon feedback
5. Design an intelligent robot using machine vision and sensors to perform an assigned task.

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.

With Effect from the Academic Year 2022 – 23

20MEE07

RESEARCH METHODOLOGY AND INNOVATION

(Professional Elective-II)

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

Objectives:

1. To make the students to formulate the research problem
2. To identify various sources for literature review and data collection.
3. To prepare the research design
4. To equip the students with good methods to analyze the collected data
5. To enable students use creative thinking and innovative skills for problem solving

Outcomes: At the end of the course, students are 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 in research

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 hypothesis-testing research studies, Basic Principles of Experimental Design, Steps in Sample design

UNIT – IV

Data Collection and Analysis: Collection of primary data-Observation, Interview and Questionnaire methods, Secondary data, Measures of central tendency, Measures of dispersion, Measures of asymmetry, Important parametric tests-z, t, F, Chi-Square, 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. JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.

NPTEL Reference:

1. Prof. Soumitro Banerjee, Research Methodology, IISER Kolkata - https://archive.nptel.ac.in/courses/127/106/127106227/
2. Prof. B. K. Chakravarthy, Design, Technology and Innovation, IIT Bombay - https://archive.nptel.ac.in/courses/107/101/107101088/

With Effect from the Academic Year 2022 – 23

20ME E08

PRODUCT DESIGN AND PROCESS PLANNING

(Professional Elective-II)

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

Objectives:

1. The essence of innovation in product development.
2. The Human Machine Interactions (ergonomics).
3. The various Intellectual Property Rights.
4. The interaction between Design, Manufacturing, Quality and Marketing.
5. The awareness about overall view of Process Planning.

Outcomes: At the end of the 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 indeveloping 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 productdevelopment.

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 lawsof 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, estimation of machining time in various cutting operations, 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, McGrawHill Publication,

12.

With Effect from the Academic Year 2022 – 23

20ITO01

OBJECT ORIENTED PROGRAMMING USING JAVA

(Open Elective-I)

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

Course Objectives:

1. To familiarize with fundamentals of object-oriented programming paradigm.
2. To impart the knowledge of string handling, interfaces, packages and inner classes.
3. To acquaint with Exception handling mechanisms and Multithreading.
4. To gain knowledge on collection framework, stream classes.
5. To familiarize web application environment using Servlets and JSP

Course Outcomes:

Upon completing this course, students will be able to:

1. To understand fundamentals of object-oriented programming paradigm.
2. To apply knowledge of string handling, interfaces, packages and inner classes.
3. To implement Exception handling mechanisms and Multithreading.
4. To demonstrate knowledge on collection framework, stream classes.
5. To develop web applications using Servlets and JSP. \\

UNIT-I

OOP concepts: Data abstraction, encapsulation, inheritance, benefits of inheritance, polymorphism, classes and objects, Procedural and object oriented programming paradigms.

Introduction to Java: Java's Magic: The Byte code, The Java Buzzwords, Simple Java Programs, Java Primitive Types, Arrays: How to create and define arrays, Basic Operators, Control statements.

Introducing Classes: Declaring objects, methods, Constructors, this keyword, Method Overloading and Constructor Overloading, Objects as parameters, Returning objects, Use of static and final keywords.

UNIT-II

Inheritance: super and subclasses, Member access rules ,super keyword**,** Method overriding, Dynamic method dispatch , Abstract classes, using final with inheritance , Introduction to Object class.

Packages: Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages.

Interfaces : Defining and implementing interfaces, Nested Interfaces. **Strings Handling:** String & StringBuffer classes, StringTokenizer class and Wrapper classes and conversion between Objects and primitives.

Inner classes in Java: Types of inner classes, Creating static / non-static inner classes, Local and anonymous inner classes.

UNIT-III

Exception Handling in Java: what are Exceptions? Exception types**,** Usage of try, catch, throw, throws and finally clauses, writing your own exception classes. **Multi-threading in Java:** The java Thread Model, How to create threads, Thread class in java, Thread priorities, Thread synchronization.

Generics: What are Generics? Generic classes, bounded types, Generic methods and interfaces.

UNIT-IV

Collections Framework: Overview of Collection Framework, Commonly used Collection classes – Array List, Linked List, Hash Set, Linked Hash Set, Tree Set, Collection Interfaces –Collection, List, Set, Sorted Set, Accessing a collection via an Iteration, Storing user-defined classes in collections, Map Interfaces and Classes, using a comparator. Legacy classes – Vector, Hash table, The Enumeration interface.

Input/Output : How to read user input (from keyboard) using scanner class, Stream classes, Input Stream, Output Stream, File Input Stream, File Output Stream, Reader and Writer, File Reader, File Writer classes. File class.

UNIT-V

Java Servlets: Overview of Java Servlet API, Servlet Implementation, Servlet Configuration, Servlet Exceptions, Servlet Life cycle, Request and Response methods, Approaches to Session tracking, Servlet Context, Servlet Collaboration.

JSP Basics: Introduction to JSP, Directives, Scripting Elements, Standard Actions.

Databases: Connect servlet to MySQL, Connect JSP to MySQL.

Text Books:

1. Herbert Schildt, "Java: The Complete Reference", 8th Edition, Tata McGraw Hill Publications, 2011.
2. Kathy Sierra, Bryan Basham, Bert Bates, ―Head First Servlets and JSP‖, 2nd Edition, O'Reilly Media, Inc, 2008.

Suggested Reading:

1. E Balagurusamy "Programming with JAVA", 6th Edition, Tata McGraw-Hill Publishing company Ltd, 2019.
2. Sachin Malhotra & Saurabh Choudhary, "Programming in Java", 2nd Edition, Oxford University Press, 2014.
3. C. Thomas Wu, "An introduction to Object-oriented programming with Java", 4th Edition, Tata McGraw-Hill Publishing company Ltd., 2010.
4. Kathy Sierra, Bert Bates, "Head First Java: A Brain-Friendly Guide", 2nd Edition, O'Reilly,2005

Web Resources:

1. https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html.
2. http://nptel.ac.in/courses/106106147/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computerscience/6-092- introduction-to-programming-in-java-january-iap-2010/lecture-notes/

With Effect from the Academic Year 2022 – 23

20CSO09

FUNDAMENTALS OF DATABASE MANAGEMENT SYSTEMS

(Open Elective-I)

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

Course Objectives: The objectives of this course are,

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

Course Outcomes: On Successful completion of this course, student will be able to,

1. Classify the difference between FMS and DBMS; describe the roles of different users and the structure of the DBMS. Design the database logically using ER modeling
2. Outline the schema of the relational database and key constraints. Develop queries using DDL, DML and DCL of SQL.
3. Identify the inference rules for functional dependencies and apply the principles of normal forms to decompose the relations in a database.
4. Summarize the concepts of dense, sparse, ISAM and B+ tree indexing and get familiar with states and properties of transactions.
5. Interpret the locking, time stamp, graph and validation-based protocols for concurrency control.
6. Summarize log-based recovery techniques to increase the robustness of the database, identify to resolve the deadlocks in the transactions.

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. Index Definition in SQL.

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, Recoverability.

UNIT - V

Concurrency Control: Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols.
Deadlocks Handling: Deadlock Prevention, Deadlock Detection and Recovery.
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", Sixth Edition, McGraw-Hill International Edition, 2011.
2. Date CJ, Kannan A, Swamynathan S, "An Introduction to Database Systems", Eight Edition, Pearson Education, 2006.

Suggested Reading:

1. Raghu Ramakrishnan, JohnnesGehrke, "Database Management Systems", Third Edition, McGraw Hill, 2003.
2. RamezElmasri, Durvasul VLN Somayazulu, Shamkant B Navathe, Shyam K Gupta, "Fundamentals of Database Systems", Fourth Edition, Pearson Education, 2006.

20EEO03

ENERGY AUDITING

(Open Elective-I)

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

Prerequisites: Students should have prior knowledge on different Electrical Energy Generation systems, measuring instruments and basics of power systems

Course objectives:

1. To know the concept of Energy auditing
2. To understand the formulation of efficiency for various engineering systems
3. To explore the different ways to design various technologies for efficient engineering systems.

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

1. Know the current energy scenario and various energy sources
2. Understand the concepts of energy auditing.
3. Evaluate the performance of existing engineering systems
4. Explore the methods of improving energy efficiency in different engineering systems
5. Design different energy efficient appliances.

UNIT-I

Basics of Energy and its various forms: Overview of Engineering, elements Solar energy, electricity generation methods using solar energy, PV cell, elements of wind energy, electricity generation using wind energy, elements of Bio energy, Bio mass energy conservation, elements of Geothermal energy, sources of Geo thermal energy, sources of Chemical energy, fuel cells, Energy Scenario in India

UNIT-II

Energy Auditing-I: Introduction, Need for energy audit, types of energy audit: Preliminary audit, General/mini Audit, Investment-grade/ Comprehensive audit. Major energy consuming equipment and systems, Energy audit team, energy Auditing methodology: preliminary and detailed. Process flow diagram, Energy Audit report format

UNIT-III

Energy Auditing-II: For buildings: Energy Auditing Instruments, Energy Efficiency, Energy Auditing for buildings- stages in programs, surveying, measurements, and model analysis. Energy audit form of commercial buildings such as Hotel, checklist for Energy saving measures.

UNIT –IV

Energy Efficient Technologies-I: Energy Efficient Technology in Mechanical Engineering: Heating, ventilation, and air-conditioning; Evaporative coolers, Air conditioners -types such as Portable; Central AC, Window AC and Split AC

Energy Efficient Technology in Electrical Engineering: Electricity billing, Power Factor Improvement-Regenerated Energy in Lifts and Escalators

UNIT-V

Energy Efficient Technologies-II: Energy Efficient Technology in Civil Engineering: Green building-features- concept of Embodied energy -Building design-Green construction-Net Zero Energy Building - **Energy Efficient Technology in Chemical Engineering**: Green chemistry, - Battery Managementsystems – concept and salient features -topologies

Text Books:

1. Umesh Rathore, 'energy management', Kataria publications, 2nd ediiton, 2014.
2. G.Hari hara Iyer : Green Building – Fundamentals , Notion Press .com2022
3. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland University of Technology.

Suggested reading:

1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)
2. Guide books for National Certification Examination for Energy Manager / Energy AuditorsBook-1, General Aspects

With Effect from the Academic Year 2022 – 23

20BTO01

BIOLOGY FOR ENGINEERS

(Open Elective-I)

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

Prerequisites: The school level basic knowledge in Fundamental science is required.

Course Objectives: The objectives of this course are

1. Understand the milestones reached by human in the field of biology.
2. Understand the human body and its parts.
3. Understand the human anatomy and medical devices.
4. Understand types of advanced therapies.
5. Understand the treatment of toxic pollutants in the environment.
6. Understand genome sequencing and NGS.

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

1. Appraise the values of Biology in classical and modern time
2. Develop modern instruments related to skeletal, nervous, and circulatory system
3. Apply concept of respiratory, excretory, and assisted reproductive process for developing related instruments
4. Illustrate the modern interdisciplinary tools related to medical biotechnology and bioremediation
5. Summarize the basic knowledge about nucleic acids, proteins and their sequencing

UNIT-I

Introduction to Biology: Classical Vs Modern Biology; Importance of Biological Science and Historical developments; Origin of Life, Urey Miller Experiment, Spontaneous Generation Theory; Three Domains of Life; Principle and Applications of Microscope (Light and Electron Microscope), Prokaryotic and Eukaryotic Cell- Structure and their differences.

UNIT-II

Human Anatomy and Functions-I: Human organ systems and their functions; Skeletal System-Bones, Tendon, Ligaments, principle and applications in knee replacement; Nervous System - Structure of Brain, Spinal Cord, Neuron, Neurotransmitters, Synapse, Alzheimer's - a case study, principle and applications of Imaging Techniques (CT & MRI scans); Circulatory System - Heart structure and functions, principle and applications of cardiac devices (Stent and Pacemaker), Artificial heart, blood components and typing, haemocytometer.

UNIT-III

Human Anatomy and Functions-II: Respiratory Systems - Lung structure and function, principle and applications of Peak Flow Meter, ECMO (Extra Corporeal Membrane Oxygenation); Excretory Systems-Kidney structure and function, principle and applications of Dialysis; Prenatal diagnosis; Assisted reproductive techniques- IVF, Surrogacy.

UNIT-IV

Medical Biotechnology and Bioremediation: Cells of Immune System, Etiology of cancer, Cancer treatment (Radiation Therapy); Stem Cells and its Clinical applications; Scaffolds and 3D printing of organs; Bio sensors and their applications; Parts of bioreactor and its types; Bioremediation.

UNIT - V

Bioinformatics: Nucleic acid composition, Genetic Code, Amino acid, Polypeptide, Levels of protein structure, Homolog, Ortholog and Paralog, Phylogenetics, Genome Sequencing, Human Genome Project, Next generation sequencing.

Text Books:

1. Champbell, N.A., Reece, J.B., Urry, Lisa, Cain, M,L., Wasserman, S.A., Minorsky, P.V., Jackson, R.B., "Biology: A global approach", Pearson Education Ltd, Edition 11, 2017.
2. Shier, David, Butler, Jackie, Lewis, Ricki., "Hole's Human Anatomy & Physiology"., McGraw Hill 2012.

Suggested Reading:

1. Bernard R. Glick, T. L. Delovitch, Cheryl L. Patten, "Medical Biotechnology", ASM Press, 2014.

With Effect from the Academic Year 2022 – 23

20MTO04B

NUMERICAL METHODS

(Open Elective-I)

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

Course Objectives:

1. Solve algebraic and transcendental equations.
2. Solve simultaneous equations when the number of unknown increases by iterative methods
3. Learn interpolation and extrapolation techniques to fit the numerical tabulated data.
4. Solve numerical integration to get approximate solution of given date using Simpson's 1/3 rd, 3/8th Weddle's rules
5. Solve ODE using Taylor, Picard's , Euler's, modified Euler's , Rungekutta methods.

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

1. Apply numerical methods to find roots of algebraic and transcendental equations.
2. Derive the solutions when system of equations has more than two unknowns and learn to reduce the instability of equations.
3. Apply interpolation and extrapolation techniques to fit the numerical tabulated data.
4. Find numerical integration by using Simpson's 1/3 rd, 3/8thand Weddle's rules
5. Apply numerical methods to Solve ODE using Taylor, Picard's , Euler's, modified Euler's, Rungakutta methods.

UNIT-I:

SOLUTIONS OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS

Bisection Method, Regulae Falsi Method (method of false position); Newton Raphson Method, Approximate solution of equations by Horner's method.

UNIT-II:

SOLUTIONS OF SIMULTANEOUS EQUATIONS

Gauss elimination method, Jacobi's Iteration Method, Gauss Seidel Iteration Method, Solutions of Non-Linear simultaneous equations by Newton Raphson method.

UNIT III:

FINITE DIFFERENCES AND INTERPOLATION

Finite difference operators, Newton's forward and backward interpolation formulas, Interpolation for unequal intervals, Lagrange's interpolation, Newton's divided difference formulas , inverse interpolation.

UNIT IV:

NUMERICAL DIFFERENTIATION AND INTEGRATION

Numerical derivatives using Newton's forward difference formula, Numerical derivatives using Newton's backward interpolation formulas, Numerical integration: Simpson's 1/3rd, 3/8th rules. Weddle's rule.

UNIT V:
NUMERICAL SOLUTIONS FOR DIFFENTIAL EQUATIONS
Solution of differential equation: Picard's method, Taylor's method, Euler's method, modified Euler's method, Rungakutta fourth order method.

Text Books:

1. S. S. Shastry Introductory methods of Numerical Analysis, PHI Learning PVT LTD 2012
2. B.S. Grewal, Numerical Methods in Engineering & Science with Programs in C, C++ & MATLAB", Khanna Publishers, 19th Edition, 2013.

Suggested Reading:

1. R.K. Jain and S.R.K. Iyengar," Numerical methods for Scientific and Engineering Computation", New Age.
2. N.M. Kapoor, "Fundamentals of Mathematical Statistics", Pitambar Publications.

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20MEC20

DYNAMICS AND VIBRATIONS LAB

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

Objectives:

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

Outcomes: At the end of the course, the students are 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

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, 2nd edition, Oxford University Press, 2007

With Effect from the Academic Year 2022 – 23

20ME C21

APPLIED THERMODYNAMICS AND HEAT TRANSFER LAB

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

Objectives:

1. To demonstrate basic knowledge related to performance of petrol and diesel engines.
2. To understand the importance of heat balance sheet in IC engine.
3. To evaluate the performance of multi-stage reciprocating air compressor.
4. To demonstrate knowledge in evaluating thermal conductivity and heat transfer coefficient under natural and forced convection phenomena.
5. To understand the basic concepts of radiation heat transfer and evaluation of overall heat transfer coefficient in a heat exchanger.

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

1. Evaluate the performance of petrol and diesel engines.
2. Estimate the conversion of heat supplied by the fuel to various other forms of energy in an I.C engine.
3. Determine the performance of multi stage reciprocating air compressor.
4. Estimate the thermal conductivity of a material and the value of convection heat transfer coefficient under natural/forced convection.
5. Determine the Stefan - Boltzmann constant, emissivity of grey plate and overall heat transfer coefficient of heat exchanger.

List of the Experiments:

Applied Thermodynamics

1. Determination of Valve timing diagram and Port timing diagram of IC engine.
2. Determination of Performance characteristics of a multi-cylinder petrol engine.
3. To conduct Morse test on multi cylinder petrol engine.
4. To conduct performance test on a variable compression ratio petrol engine.
5. To conduct performance test on single cylinder diesel engine
6. To conduct heat balance test on single cylinder diesel engine.
7. To determine volumetric efficiency, isothermal efficiency of multi -stage reciprocating air compressor.
8. Determination of Fuel properties like Flash point, Fire point, Viscosity and Calorific value of fuel.

Heat Transfer

9. Determination of thermal conductivity of composite wall.
10. Determination of convective heat transfer coefficient under Natural and Forced convection phenomenausing pin-fin apparatus.
11. Determination of Emissivity of a given plate.
12. Determination of the value of Stefan-Boltzmann constant.
13. Determination of Heat transfer coefficient in parallel and counter flow heat exchanger.
14. Evaluate the performance parameters and pollution levels of an alternative fuel on a four stroke single cylinder diesel engine.

Note: Students should perform a minimum of 10 experiments including experiment 14 which is compulsory.

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

Suggested Reading:

1. R.K. Rajput., Thermal Engineering, Laxmi Publishers, New Delhi, 2014
2. D.S. Kumar, Heat Transfer, S K Kataria Publishers, 2015

With Effect from the Academic Year 2022 – 23

20ME C22

CAD/CAM LAB

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

Objectives:

1. To teach the basic design process and the importance and types of geometric modeling techniques
2. To teach Assembly modelling by applying suitable assembly constraints
3. To generate orthographic views of components and assemblies.
4. To demonstrate the Indication of size, form, and positional tolerances on the drawing sheets
5. To demonstrate the working of CNC machines and write part programs for different operations

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

1. Make use of appropriate features to generate 3D model using CAD software
2. Apply constraints to assemble the components
3. Demonstrate the knowledge splines and 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

List of the Exercises:

1. Introduction and Working with Splines
2. Surface Modeling
3. Part modeling of simple parts using various features
4. Assembly of simple machine components (couplings)
5. Implementation of Geometric Transformations and Bezier curves using MATLAB
6. Contouring on CNC Milling Machine
7. Rectangular Pocketing and Circular Pocketing on CNC Milling Machine
8. Step Turning on CNC Lathe Machine and Taper Turning on CNC Lathe Machine
9. Multiple Turning on CNC Lathe Machine
10. Generation of STL files , Part orientation, support and Tool path generation using any RP software
11. Demonstration of FDM technology using 3D printer.
12. Develop a product using 3D Printing / generate CNC toolpath for its component it

Note: Student should complete a minimum of 10 exercises including exercise number14 which is compulsory.

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

With effect from the academic year 2022-23

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instruction as per R20 Curriculum

B.E. (MECHANICAL ENGINEERING)

SEMESTER – VI

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	20MEC23	Metrology and Instrumentation	3	--	--	3	40	60	3
2	20MEC24	Machine Design	3	--	--	3	40	60	3
3	20MEC25	Thermal Turbo Machines	3	--	--	3	40	60	3
4	20MEC26	Finite Element Analysis	3	1	--	3	40	60	4
5		Professional Elective - III	3	--	--	3	40	60	3
PRACTICALS									
6	20MEC27	Metrology and Instrumentation Lab	--	--	2	3	50	50	1
7	20MEC28	Machine Drawing Lab	--	--	2	3	50	50	1
8	20MEC29	Production Drawing Lab	--	--	2	3	50	50	1
9	20MEC30	Thermal Engineering Lab	--	--	2	3	50	50	1
10	20MEC31	Finite Element Analysis Lab	--	--	2	3	50	50	1
11	20EGCO3	Employability Skills Lab	--	--	2	3	50	50	1
TOTAL			**15**	**01**	**12**	--	**500**	**600**	**22**

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

Professional Elective – III (3/3)		
S.No.	**Subject Code**	**Name of the Subject**
1	20MEE09	Computational Fluid Dynamics
2	20MEE10	Additive Manufacturing
3	20MEE11	Operations Research
4	20MEE12	Industrial Safety and Maintenance

With effect from the academic year 2022-23

20MEC23

METROLOGY AND INSTRUMENTATION

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

Objectives:

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

Outcomes: At the end of the course, 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.

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 plan 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

With Effect from the Academic Year 2022 – 23

20ME C24

MACHINE DESIGN

(Use of design data handbook is permitted)

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

Objectives:

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.

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

1. Understand the design procedure of helical, leaf springs under static and fluctuating loads.
2. Design the spur, helical and bevel 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.

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 fluctuating loads.

Leaf Springs: modeling of leaf springs, stresses and deflection, 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, Helical and Bevel 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: journal bearing and thrust bearings.

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 C-clamp and crane Hook.

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

Text Books:

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

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.Balaveera Reddy., Design Data Hand book for Mechanical Engineers, 3rd edition, CBS Publisher, 2018
2. PSG College, Design Data book,2012

With Effect from the Academic Year 2022 – 23

20MEC25

THERMAL TURBO MACHINES

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

Objectives:

1. To acquire basic knowledge of functioning of nozzles and diffusers.
2. To understand the design of ducts with frictional flow.
3. To know the working principles of various rotary compressors.
4. To understand the working of steam turbines.
5. To acquire basic knowledge in the functioning of gas turbines.

Outcomes: At the end of the course, the 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.

UNIT-I

Introduction to Compressible Flows: Speed of propagation of pressure waves, Mach number, Acoustic velocity and Mach cone, compressibility factor for compressible and incompressible flows, pressure field due to a moving source of disturbance, one dimensional compressible flow. Isentropic flow with variable area, Static and Stagnation properties, Mach number variation, Area ratio as function of Mach number, flow through different types of nozzles and diffusers Flow with Normal Shocks, governing equations.

UNIT-II

Flow in Constant Area Ducts with Friction-Fanno Flow: Variation of flow properties, variation of Mach number with duct length, isothermal flow with friction, Prandtl – Meyer relation, Rankine-Hugoniot equations and Stagnation pressure ratio across shock.

UNIT-III

Rotodynamic Compressors: Introduction to Turbomachines, classification and applications. Comparison of 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.

With Effect from the Academic Year 2022 – 23

20MEC26

FINITE ELEMENT ANALYSIS

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

Objectives:
1. Equip the students with the Finite Element Analysis fundamentals and formulations.
2. Enable the students to formulate the axial, truss, beam and circular shaft problems.
3. Enable the students to formulate 2D problems with special cases.
4. Enable the students to formulate quadrilateral element, use of numerical integration, Gaussian quadrature and one dimensional dynamic problems.
5. Enable the students to understand the convergence requirements, heat transfer, formulate 3D problems and perform engineering simulations using Finite Element Analysis software (ANSYS)

Outcomes: At the end of the course, the students are able to
1. Understand FE method for solving field problems using energy formulations.
2. Analyze bars, trusses, beams and circular shafts 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 isoparametric element for static analysis and 3 D elements.
5. Solve heat transfer problems and apply finite element analysis software for engineering solutions.

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

Analysis of beams: 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, analysis of circular shaft subjected to torsion.

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 with triangular elements.

UNIT - IV

Quadrilateral elements and Numerical Integration: Two dimensional four noded isoparametric elements, Numerical integration and Gauss quadrature.

Dynamic Analysis: Formulation of finite element model, element mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and beam.

UNIT - V

Heat transfer analysis: Steady state heat transfer analysis, one dimensional analysis of a fin and two dimensional analysis of thin plate, formulation of time dependent field problems, applications to one dimensional heat flow in a rod.

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 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.

With Effect from the Academic Year 2022 – 23

20MEE09

COMPUTATIONAL FLUID DYNAMICS

(Professional Elective-III)

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

Objectives:

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.

Outcomes: At the end of the course, the students are 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

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.

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.

With Effect from the Academic Year 2022 – 23

20MEE10

ADDITIVE MANUFACTURING

(Professional Elective-II)

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

Objectives:

1. To introduce students the basics of additive manufacturing, its advantages and limitations and concept of mass customization.
2. To familiarize students with different additive manufacturing techniques.
3. To teach students about STL file issues and familiarize them with various RP softwares.
4. To demonstrate various post processing techniques and rapid tooling concept.
5. To demonstrate the applications of rapid prototyping in various fields

Outcomes:

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,

UNIT-I

Overview: Traditional Manufacturing Vs Additive Manufacturing, Mass Customization, Reverse Engineering, fundamental fabrication process, AM Process chain, Classification of AM process, Advantages and Limitations of AM.

UNIT-II

AM Technologies: Vat Photopolymerization: Stereolithography (SL), Materials, SL resin curing process, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.

Extrusion-Based AM Processes: Fused Deposition Modeling (FDM), Principles, Materials, and Plotting and path control, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.

Sheet Lamination AM Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Selective Laser Melting(SLM), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM) Process

UNIT-III

Pre-processing in AM: STL 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 Softwares: Features of various AM software's like Magics, Mimics, Solid Viewrt, 3 D Rhino,

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.

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 , LOM tools , EOS direct tool Process

AM Applications: Applications in Design Industry, Analysis and Planning, Application in Aerospace, Automobile Sectors, 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. K. Venuvinod and Weiyin Ma, Rapid Prototyping: Laser-based and Other Technologies, Springer, 2004.

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.

With Effect from the Academic Year 2022 – 23

20MEE11

OPERATIONS RESEARCH

(Professional Elective-III)

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

Objectives:

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

Outcomes: At the end of the 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.

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.

With Effect from the Academic Year 2022 – 23

20MEE12

INDUTRIAL SAFETY AND MAINTENANCE

(Professional Elective-III)

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

Objectives: The students will be able to understand

1. Causes for industrial accidents and preventive steps to be taken.
2. Fundamental concepts of Maintenance Engineering.
3. About wear and corrosion along with preventive steps to be taken
4. The basic concepts and importance of fault tracing.
5. The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

Outcomes: At the end of the course, the 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.

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.

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 Readings:

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

With Effect from the Academic Year 2022 – 23

20ME C27

METROLOGY AND INSTRUMENTATION LAB

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

Objectives:

1. To choose the proper measuring instrument for the precise measurement of length, height and diameter.
2. To classify the different measuring instruments used for the angular measurement.
3. To develop gear & screw thread parameters using optical projector and tool maker's microscope.
4. To analyze the limits, fits and tolerances for selection and design of gauges.
5. To determine the working principles in the measurement of Flatness, Roundness and Surface roughness.

Outcomes: At the end of the 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.

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 and 3D scanner.
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 .

With Effect from the Academic Year 2022 – 23

20MEC28

MACHINE DRAWING LAB

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

Objectives: Students will learn

1. The importance of machine drawing in industries
2. The usage of solid modeling software
3. Various drawing and feature commands
4. Orthographic and isometric views
5. The assembly of various industrial components

Outcomes: Students are able to

1. Understand the importance and need of machine drawing in industries.
2. Model different machine components using CAD software.
3. Draw a detailed dra
4. wing of a component to facilitate its manufacture.
5. Analyze aspects of orthographic views in the preparation of the part/assembly drawings.
6. Identify the sequence of steps to assemble the machine/system components

List of Experiments/Exercises:

1. Introduction to machine drawing: importance and need in industries of automobile, aero and manufacturing, classifications of drawings.
2. Study of various commands/ tool bars using solid modelling package (solid works).
3. Part modelling of a components using feature commands Extrude Boss, Extrude Cut, Fillet, Chamfer with mass properties
4. Part modelling using feature commands Revolve, Rib with mass properties
5. Part modelling of a components using feature commands loft, sweep with mass properties
6. Drawing the view from the front, top and left of the objects.
7. Drawing the sectional views of a components
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 Piston of a petrol engine assembly model from parts and views of the assembly
11. Creation of Lathe tail-stock assembly model from parts and views of the assembly
12. Creation of Revolving centre assembly model from parts and views of the assembly

Note : Students should prepare a minimum of 10 drawings

Suggested Reading:

1. K.L. Narayana, P. Kannaiah, K. Venkata Reddy, Machine drawing Published by New Age International (P) Limited, 5th edition, 2018.
2. N. D. Bhatt, V. M. Panchal Machine drawing [including computer aided drafting first-angle projection method], Charotar publishing house, 50th edition, 2016.

With Effect from the Academic Year 2022 – 23

20ME C29

PRODUCTION DRAWING LAB

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

Objectives: Students will learn to

1. Construct production drawings to enable produce the components in the shop floor and assemble them to meet the final functional requirements.
2. Create drawings for visualization using any modelling packages Solid works, CATIA etc.
3. Choose the Fits, Limits and Tolerances of parts for manufacturing and assembly.
4. Use the Conventions like surface finish, roughness, concentricity
5. Prepare Bill of materials for assembly and process sheet in manufacturing industry.

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

1. Interpret the working drawing/ industrial blueprint of various components.
2. Identify the different parts of the object with dimensional tolerances
3. Create the various part drawings using solid modelling package
4. Use the various functions of modelling soft ware: annotations, sheet making etc.
5. Prepare Bill of materials for assembly and process sheet in manufacturing industry.

List of Exercises/Experiments:

1. Introduction to production drawing: importance and need in industries
2. Conventional representation of Materials and machine components
3. Study of the terms used in the limit system and types of fits
4. To learn the need of geometrical tolerances, form and positional tolerances
5. Understanding surface roughness and its indication
6. Study the importance of process sheet preparation

Study the following assembly drawings and draw the component drawings with suitable tolerances and fits, surface roughness, bill of materials etc., Prepare the process sheet using any one of the modelling software tools: solid works/solid edge/CATIA/ProE/Auto CAD-MDT/Nx.

7. Stuffing box
8. I.C engine connecting rod
9. Revolving centre
10. Square tool post
11. Universal coupling
12. Steam Engine Cross Head
13. Drill Jig (Plate Type)
14. Non Return Valve
15. Blow off Cock

Note : Students should prepare a minimum of 6 drawings

Suggested Reading:

1. K. Venkata Reddy, K.L. Narayana, P. Kannaiah, Production drawing, 4th edition, New Age International (P) Limited, 2018,.
2. P.Narasimha Reddy, T.A. Janardhan Reddy and C. Srinivas Rao, Production Drawing Practice, Hi-Tech Publishers, 2001.

With Effect from the Academic Year 2022 – 23

20MEC30

THERMAL ENGINEERING LAB

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

Objectives:

1. To demonstrate knowledge in evaluating thermal conductivity of a metal rod and critical heat flux of a material.
2. To know about the phase change heat transfer and performance of cross flow heat exchanger.
3. To understand the working of principle of axial flow fan and centrifugal blower.
4. To evaluate the COP of Refrigeration tutor and AC tutor.
5. To determine the pressure distribution in nozzle; drag and lift coefficients for contoured bodies.

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

1. Determine thermal conductivity of a metal rod and critical heat flux of a copper wire.
2. Estimate the convective heat transfer coefficients for phase change heat transfer and effectiveness of cross flow heat exchanger.
3. Determine the overall efficiency of centrifugal/axial-flow compressor.
4. Study of COP of refrigeration/air conditioning tutor.
5. Determine the - pressure distribution in a nozzle/cylinder/aero-foil; lift and drag forces for different geometrical profiles.

List of the Experiments

1. Study of Thermal conductivity of metal rod.
2. Determination of critical heat flux for copper wire in water.
3. Evaluate the convective heat transfer coefficient of dropwise and filmwise condensation.
4. Evaluate the effectiveness of cross flow heat exchanger.
5. Determination of overall efficiency of centrifugal blower
6. Study of overall efficiency of axial flow fan
7. Study of COP of refrigerating tutor
8. Study of COP of air conditioning tutor
9. Determination of pressure distribution for convergent and divergent nozzle
10. Determination of pressure distribution for a cylinder
11. Determination of pressure distribution for an aerofoil.
12. Determination of lift and drag coefficient for different contours
13. Determination of Sensible and Latent heat loads for a class room and validating the data with RAC software.

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

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.K. Rajput, Heat Transfer, Laxmi Publication, 2014

With Effect from the Academic Year 2022 – 23

20MEC31

FINITE ELEMENT ANALYSIS LAB

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

Objectives:

1. Trusses , Bars of constant cross section area, tapered cross section area and stepped bar.
2. Beams -Simply supported, cantilever, beams with UDL, and beams with varying load etc.
3. Stress analysis of a rectangular plate with a circular hole, axisymmetric problems.
4. Buckling analysis and Dynamic Analysis.
5. Steady state and Transient heat transfer analysis.

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

1. Apply basics of Theory of Elasticity to continuum problems.
2. Analyze finite elements like 1D, 2D and 3D structures for 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 software.

List of Exercises:

1. Analysis of plane truss & special truss with various cross sections and materials.
2. 2D & 3D beam analysis with different sections, different materials for different loads
3. Static analysis of plate with a hole.
4. Plane stress, plane strain and axisymmetric loading on the in plane members.
5. Static analysis of connecting rod with tetrahedron and brick elements.
6. Static analysis of flat and curved shell due to internal pressure.
7. Buckling analysis of plates, shells and beams to estimate BF and modes.
8. Modal analysis of beams, plates and shells for natural frequencies and mode shapes.
9. Harmonic analysis of a shaft and transient analysis of plate.
10. Steady state heat transfer analysis of chimney and transient analysis of casting.
11. Non linear analysis of cantilever beam.
12. Coupled field analysis.
13. Static/Buckling/Modal/Harmonic/Transient/Non-Linear/ heat transfer analysis of a selected component.

Note:

1. Students should complete a minimum of 10 exercises including exercise number 13 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.

Code : 20EGCO3

EMPLOYABILITY SKILLS
(BE/BTech V & VI semester - Common to all Branches)

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

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 mange time effectively and deal with stress.
4. Mak**e** 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.

UNIT 1

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 2

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 3

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management-

Corporate Culture – Grooming and etiquette-Statement of Purpose (SOP).

UNIT 4

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

UNIT 5

Interview Skills: Cover Letter andRésumé 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.

Suggested Reading:

1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005
2. Dr. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006
3. Edgar Thorpe and ShowickThorpe , "Objective English", 2nd edition, Pearson Education, 2007
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010
5. Gulati and Sarvesh, " Corporate Soft Skills", New Delhi: Rupa and Co. , 2006
6. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004
7. A Modern Approach to Verbal & Non-Verbal Reasoning by R S Aggarwal, 2018
8. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989