DEPARTMENT OF MECHANICAL ENGINEERING

LIST OF COURSES OFFERED FOR MINOR PROGRAM (R20)

Course code	Course Title	Contact hours/week				Credits
		L	T	P	Total	
20MEM1	Introduction to Thermal Sciences	3	1	0	4	4
20MEM2	Elements of Manufacturing Processes	4	0	0	4	4
20MEM3	Fundamentals of Mechanical Engineering Design	3	1	0	4	4
20MEM4	Engineering Materials	4	0	0	4	4
20MEM5	Fundamentals of Operations Research	3	1	0	4	4
20MEM6	Computer Aided Manufacturing	4	0	0	4	4

	MINOR'S	**L**	**T**	**P**	**Cr.**
B.Tech. (Sem.)	**20MEXX-INTRODUCTION TO THERMAL SCIENCES**	3	1	0	4

Pre-requisites: Engineering Physics

Course Educational Objective:

The objective of the course is to provide the fundamentals of thermal science concepts.

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

CO1: Classify the thermodynamic systems, properties and cycles (**Remembering – L1**).

CO2: Compare and contrast the working of different thermodynamic cycles. (**Understanding –L2**)

CO3: Comprehends the characteristic features of internal combustion engine and its subsystems (**Understanding –L2**).

CO4: Describe the function of steam and gas turbine power plant system. (**Understanding –L2**)

CO5: Apply the principles of heat transfer for cooling of electronic components (**Applying –L3**)

UNIT - I

BASIC CONCEPTS OF THERMODYNAMICS: Introduction- Macroscopic and Microscopic approaches-System, Properties of System, State, Path, Process and cycles, path and Point Functions. Thermodynamic Equilibrium, Law s of Thermodynamics

UNIT - II

THERMODYNAMIC CYCLES: Introduction, Carnot cycle, Basic Rankine Cycle, Diesel Cycle, Brayton Cycle, Bell-Coleman cycle.

UNIT – III

INTERNAL COMBUSTION ENGINES: Classification of IC Engines, Basic Engine Components- Working principles of 2-Stroke and 4-Stroke engines, Applications of I.C Engines.

ENGINE SYSTEMS: Introduction, Need of Fuel supply system, ignition system, lubrication and cooling systems, supercharging and turbo charging of IC engines.

UNIT - IV

STEAM TURBINE POWER PLANT COMPONENTS: Introduction, steam turbine power plant Components, Methods to improve efficiency of steam power cycle.

GAS TURBINE POWER PLANT COMPONENTS: Introduction, Gas turbine plant and Its Components, Classification of Gas Turbine plants and its applications.

UNIT - V

HEAT TRANSFER: Basic Modes of Heat Transfer- Basic laws of Heat transfer- - Steady and unsteady state heat Transfer, Applications of heat transfer.

ELECTRONIC COOLING SYSTEM: Introduction, Need of electronic cooling, Air and liquid cooling systems, cooling of printed circuit boards (PCBs).

TEXT BOOK:

 1. P.K.Nag, Engineering Thermodynamics‖- McGraw-Hill. 5th Edition, 2013.

 2. R.K.Rajput, Thermal Engineering, Laxmi publications, 5th Edition, 2005.

REFERENCE BOOKS:

1. Arora &Domkundwar, A course in Power Plant Engineering- DhanpatRai&Company 5th Revised Reprint Edition, 2004.

2. R.C.Sachdeva - Fundamentals of Engineering Heat and Mass Transfer —New Age Science Publishers, 3nd Edition, 2009.

	MINOR'S	**L**	**T**	**P**	**Cr.**
B.Tech. (XXX Sem.)	**20ME - ELEMENTS OF MANUFACTURING PROCESSES**	4	0	0	4

Pre-Requisites   : Nil

Course Educational Objective:

To introduce students to the wide range of materials and processes, which are currently used in manufacturing industry. The course will enable the students to identify the processes characteristics, select the main operator parameters, the tool geometry and materials, and determine forces and power required to select the main and auxiliary equipment.

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

CO 1: Illustrate the casting processes, advantages, and limitations. **(Understanding–L2)**

CO 2: Describe the various welding techniques and explain gas welding and arc welding. **(Understanding – L2)**

CO 3: Summarize various lathes, milling machines and drilling machines with their operations and working principles. **(Understanding – L2)**

CO 4: Categorise the various boring, shaper, slotter, planer, broaching with their operations and working principles and their importance in manufacturing system. **(Understanding – L2)**

CO 5: Understand the nature of plastic deformation and identify the types of metal forming processes. **(Remembering – L1)**

UNIT –I

CASTING PROCESSES: Introduction to Foundry - Steps involved in casting, advantages, limitations and applications of casting process, Pattern types, Allowances for pattern, Pattern materials.

TYPES OF CASTING: Sand castings, Pressure die casting, Permanent mould casting, Centrifugal casting, Precision investment casting, Shell Moulding, Continuous Casting-Squeeze casting, Defects in Castings, Casting of non-ferrous materials.

UNIT-II

BASIC JOINING PROCESSES: Types of welding-Gas welding, Arc welding, shielded metal arc welding, GTAW, GMAW, SAW, Resistance welding (spot, seam, projection, flash types), Thermit welding, Flame cutting - Use of Oxyacetylene, Arc cutting, Soldering, Brazing and Braze welding and their application.

WELDMENTS TESTING: Inspection of welds – Destructive and Non-Destructive testing methods, Defects in welding, Causes and Remedies, Effect of Gases in welding.

UNIT-III

LATHE AND MILLING MACHINES: Lathe, Principle, specifications, Types of lathes-Special purpose lathes, work holding devices, Types of milling machines-Schematic diagrams, operations, milling cutters, mounting of cutters.

DRILLING, BORINGMACHINE: Schematic diagram, Working, Specifications, Advantages and disadvantages of Drilling machine, Boring Machine: types- operations.

UNIT-IV

SHAPER, SLOTTER, PLANER: Schematic diagram, Working, Advantages and disadvantages of Shaper, Planer, Slotting.

GRINDING, BROACHING: Grinding and allied finishing process, and Broaching Machine.

UNIT-V

EXTRUSION AND DRAWING PROCESSES: Classification of Extrusion processes-tool, equipment, and principle of these processes, influence on friction, defects and analysis-rod/wire drawing-tool, equipment and principle of processes defects-Tube drawing and sinking processes.

TEXT BOOKS:

1. P.N. Rao , Manufacturing Technology – Vol I & II, TMH, 5 th Edition, 2018.
2. Richard W Heine, Philp Rosenthal& Karl R.Loper, Principles of metal casting, TMH Edition, 2017.

REFERENCES

1. S. Kalpakjain, S.R.Schmid, Manufacturing Engineering and Technology, Pearson Edu., 7 th Edition, 2014.
2. R.K. Jain, Production Technology /Khanna Publishers, 19 th Edition, 2020.
3. Lindberg, Process and materials of manufacturing, PE, 4th Edition, 2015.
4. Sarma P C, Production Technology, S Chand & Company Ltd, 8 th Edition, 2014.
5. B.S. Raghuvamsi, Workshop Technology, Dhanapatirai and co. 12 th Edition, 2013.

	MINOR'S	**L**	**T**	**P**	**Cr.**
B.Tech. (Sem.)	**20MEXX- FUNDAMENTALS OF MECHANICAL ENGINEERING DESIGN**	3	1	0	4

Pre-Requisites:

Course Educational Objective:

The main objective of this course is to familiarize the steps involved in the design process of various machine elements.

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

CO1: Comprehend the basic concepts in design of various machine elements. (**Understanding-L2**)

CO2: Apply free body diagram concepts to analyze rigid bodies in static conditions. (**Apply-L3**)

CO3: Interpret the different stresses induced in machine elements under static loading. (**Understanding-L2**)

CO4: Estimate the design parameters of shafts subjected to combined loading. (**Analyzing-L4**)

CO5: Describe the characteristic features of the flexible drives and gears. (**Understanding-L2**)

UNIT- I

INTRODUCTION – Design philosophy – Introduction - Basic concept of machine design – Types of design - Types of design based on methods - Factors to be considered in machine design – Problems. Engineering Materials – Introduction – Ferrous, non-ferrous materials – Non metals, Mechanical properties of common engineering materials. Design and manufacturing – Introduction – Types of limits, fits - Preferred numbers - Common manufacturing processes.

UNIT - II

SYSTEM OF FORCES: Introduction, Basic terminology in Mechanics, laws of Mechanics, characteristics of force, system of forces-types, Resolution and Composition of forces, Resultant of coplanar concurrent force system, Resultant of coplanar non-concurrent force system-moment of a force and couple.

EQUILIBRIUM OF SYSTEM OF FORCES: Free Body Diagram, Lami's theorem, Equilibrium of a rigid body subjected to coplanar concurrent forces and non-concurrent forces, Equilibrium of connected bodies.

UNIT – III

SIMPLE STRESSES: Introduction – load, stress, strain, types of stress and strain, stress-strain diagram, factor of safety, types of modulus, poison's ratio, relation between different types of modulus, stresses due to axial loads.

BENDING AND TORSIONAL STRESSES: Bending stress in straight beams, bending equation, Torsion, torsional shear stress, torsion equation, Theories of failure, problems.

UNIT – IV

ANALYSIS OF COMBINED STRESSES: State of plane stress at a point in stressed body, Normal and Tangential stresses on inclined planes - Principal stresses and their planes - Plane of maximum shear - Mohr's circle of stresses**.**

SHAFT DESIGN-Introduction, materials used for shafts, manufacturing of shafts, types of shafts, stresses in shafts.

UNIT - V

BELT AND ROPE DRIVES: Introduction **-** Selection of belt drive- Types of belt drives materials- Velocity ratio- Slip -Creep - Tensions for flat belt drive& V-belt drive -Angle of contact Centrifugal tension- Maximum tension – Rope drives.

GEARS: Introduction, Terminology**,** Types, Law of gearing- Profile for gears- Involute action-Path of contact, Arc of contact, Contact ratio- Velocity of sliding –Interference and Undercutting.

TEXT BOOKS

1. 1.S.S. Bhavikatti, Engineering Mechanics, 4thedition, New Age International (P) Ltd, 2012.
2. Sadhu Singh, ―Strength of Materials‖, Khanna Publishers, 10thEdition, 2013.
3. 3.Rattan S.S, ―Theory of Machines‖, 3rd Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2011.
4. Bhandari V.B, Design of Machine Elements, 3rdEdition, Tata McGraw Hill 2010.

REFERENCES

1. Manoj K Harbola, Engineering Mechanics, 2nd edition, CEng age Learning, 2012.
2. S.Ramamrutham, ―Strength of Materials‖, 14thEdition, DhanpatRai& Sons, 2011.
3. Sadhu Singh ―Theory of Machines‖, 3rd Edition, Pearson Education, 1997.
4. Shigley J.E and Mischke C. R., Mechanical Engineering Design, 6thEdition, Tata McGraw-Hill,
   2003.

			MINOR'S	L	T	P	Cr.
B.Tech. (IV Sem.)			**20MEXX- ENGINEERING MATERIALS**	4	0	0	4

Pre-Requisites   **:** Applied Mathematics, Engineering Physics, Engineering Chemistry.

Course Educational Objective:

       The objective of this course is to acquire knowledge on properties and applications of metals, non-metals and alloys, understand the concept of equilibrium diagrams; demonstrate the concept of heat treatment process.

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

CO1: Comprehend the properties of the metals, alloys and crystallization mechanism. (**Understanding-L2**)

CO2: Construct equilibrium diagrams and draw the conclusions. (**Applying– L3**)

CO3: Distinguish various ferrous metals and alloys. (**Understanding – L2**)

CO4: Identify change in properties of materials with heat treatment principles. (**Understanding-L2**)

CO5: Describe the properties and applications of non-metallic and composite materials. (**Understanding-L2**)

UNIT-I

ENGINEERING MATERIALS: Introduction, classification of engineering materials and their mechanical properties. Bonds in solids: Ionic bond, covalent bond and metallic bond. Mechanism of crystallization of metals, grain and grain boundaries, Effect of grain boundaries on the properties of metals and alloys – Determination of grain size.

CONSTITUTION OF ALLOYS: Necessity of alloying, Solid Solutions-Interstitial Solid Solution and Substitution Solid Solution, Hume Rothery rules.

UNIT-II

EQUILIBRIUM DIAGRAMS: Experimental methods of construction of equilibrium diagrams, Classification of equilibrium diagrams- isomorphous, eutectic, partial eutectic equilibrium diagrams. Equilibrium cooling and heating of alloys, lever rule, coring. Study of Cu-Ni and Bi-Cd equilibrium diagrams.

UNIT-III

FERROUS METALS AND ALLOYS: Study of Iron-Iron carbide equilibrium diagram. Transformations in the solid state – allotropy, eutectic, eutectoid, peritectoid reactions.

STEEL: Classification of steels, structure, properties and applications of plain carbon steels, low carbon steel, medium carbon steel and high carbon steel.

CAST IRONS: Structure, properties and applications of white cast iron, malleable cast iron, grey cast iron, spheroidal graphite cast iron.

NON FERROUUS MATERIALS: Properties and applications of aluminium and copper.

UNIT-IV

HEAT TREATMENT OF ALLOYS: Annealing, normalizing and hardening. Construction of TTT diagram for eutectoid steel. Hardenability-determination of harden ability by jominy end quench test. Surface hardening methods and age hardening treatment and applications.

UNIT-V:

NON-METALLIC MATERIALS: Introduction and classification of non metallic materials. Classification of Polymers on basis of Thermal behaviour (Thermoplastics & Thermosetting). Properties and applications of polymers.

COMPOSITES: Introduction of composite, Characteristics of composites, Constituents of composite, Types and applications of composites.

TEXT BOOKS

1. V.D.Kotgire, S.V.Kotgire, Material Science and Metallurgy, Everest Publishing House, 24thEdition, 2008.
2. Sidney H. Avener, Introduction to Physical Metallurgy, Tata McGraw-Hill, 3rdEdition, 2011.

REFERENCES

1. Richard A.Flinn, Paul K.Trojan, Engineering Materials and Their Applications, Jaico Publishing House, 4thEdition, 1999.
2. William and callister, Materials Science and engineering, Wiley India private Ltd., 2011.
3. U.C Jindal and Atish Mozumber, Material since and metallurgy, Pearson education- 2012.

	MINOR'S	L	T	P	Cr.
B.Tech. (XX Sem.)	**FUNDAMENTALS OF OPERATIONS RESEARCH**	3	1	0	4

Prerequisite Subject: Applied Mathematics.

Course Educational Objective:

The objective of this course is to introduce the concepts of formulating an engineering problem into a mathematical model to develop an optimal solution.

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

CO 1: Apply linear programming approach for optimizing the objectives of industrial oriented problems. **(Applying -L3)**

CO 2: Formulate and solve Transportation Models and assignment Models. **(Applying -L3)**

CO 3: Implement the strategies in competitive situations and to sequence the jobs to be processed on machines. **(Applying -L3)**

CO 4: Identify the replacement period of the equipment and analyze the waiting situations in an organization. **(Analyzing–L4)**

CO 5: Determine the optimum inventory level and resolve the complex problem into domains with dynamic programming approach. **(Applying -L3)**

UNIT - I

INTRODUCTION: Introduction to Operations Research, Development, Definition, Characteristics and Phases – Types of models – Operations Research models – applications.

LINEAR PROGRAMMING: Linear Programming Problem Formulation, Graphical solution, Simplex method, artificial variables techniques, Two–phase method, Big-M method.

UNIT - II

TRANSPORTATION PROBLEM: Formulation, Optimal solution, unbalanced transportation problem, Degeneracy.

ASSIGNMENT PROBLEM: Introduction, optimal solution, Variants of Assignment Problem-Travelling Salesman problem.

UNIT - III

GAME THEORY: Introduction, Minimax (maximin) Criterion and optimal strategy, Solution of games with saddle points, rectangular games without saddle points, 2 X 2 games – dominance principle – mX2 and 2 X n games, mxn games.

JOB SEQUENCING – Introduction – Flow –Shop sequencing – n jobs through two machines – n jobs through three machines – Job shop sequencing – two jobs through 'm' machines-graphical model.

UNIT – IV

THEORY OF REPLACEMENT: Introduction, Replacement of Equipment that Deteriorates Gradually, Replacement of Equipment that fails suddenly, Group Replacement.

WAITING LINES: Single Channel – Poisson arrivals – exponential service times – with infinite population and finite population models.

UNIT – V

INVENTORY MODELS: Introduction, terminology, EOQ, deterministic models — Instantaneous production, finite production, continuous demand, no set up cost, shortages are not allowed – purchase inventory models with one price break and multiple price breaks.

DYNAMIC PROGRAMMING: Introduction, Bellman's Principle of optimality, Applications of dynamic programming, capital budgeting problem, shortest path problem, linear programming problem.

TEXTBOOKS

1. S.D Sharma, ―Operation Research‖, Kedar Nath and RamNath - Meerut , 2008
2. Operations Research / N.V.S. Raju / SMS, 2009

REFERENCES

1. Singiresu S Rao, Engineering Optimization: Theory and Practice, A Wiley-IntersciencePublication, 4th edition,2009.
2. Hiller &Libermann, Introduction to O.R (TMH), 9TH EDITION, 2009.
3. Kantiswarup. P.K.Gupta, Man Mohan, Operations Research, Sultan Chand& Sons, EducationalPublications, New Delhi, 14th Edition, 2008.
4. A.M.Natarajan, P.Balasubramani, A. Tamilarasi, Operations Research, Pearson Education, 2nd edition, 2014.
5. Taha, Introduction to Operations Research, PHI, 9th edition, 2010.

	MINOR'S	L	T	P	Cr.
B.Tech.(Sem)	20MEXX -COMPUTER AIDED MANUFACTURING	4	0	0	4

Pre-Requisites : Understanding of preliminaries of design and manufacturing

Course Educational Objective:

The objective of this course is to introduce the students to the standard terminologies, conventions, processes, operations, design, and operational characteristics of computer aided manufacturing.

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

CO 1: Comprehend the fundamentals of computer aided manufacturing and recognize the importance of computers in manufacturing. (**Understanding - L2**).

CO 2: Interpret the principles of CNC technology and hardware. (**Understanding - L2**)

CO 3: Develop CNC programs for manufacturing of different geometries on milling and lathe machines. (**Applying - L3**).

CO 4: Apply principles of group technology for parts classification and coding. (**Applying - L3**).

CO 5: Describe the layouts of Flexible Manufacturing Systems for industrial applications. (**Understanding - L2**)

UNIT-I

COMPUTER AIDED MANUFACTURING: Meaning of manufacturing, Nature & Type of manufacturing system, Evolution, Process for product realization, CAM fundamentals, Objectives &scope, Benefits of CAM, Role of management in CAM.

COMPUTE INTEGRATED MANUFACTURING: Concepts of Computer Integrated Manufacturing, Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel to understand basic functions.

UNIT-II

NC/CNC MACHINE TOOLS: NC and CNC Technology: Fundamentals, Types, Classification, Specification and components, control loops, Construction Details, Controllers, drives, feedback devices,

CNC HARDWARE: Introduction, re circulating ball screw, anti-friction slides, step/servo motors. Axis designation, NC/CNC tooling.

UNIT-III

INTRODUCTION TO PROGRAMMING: Fundamentals of Part programming, Types of formats, applications.

NC PROGRAMMING FOR DIFFERENT OPERATIONS: Part Programming for drilling, lathe and milling machine operations, subroutines, do loops, canned Cycles, parametric sub routines.

UNIT-IV

GROUP TECHNOLOGY: Introduction, part families, part classification and coding systems: OPITZ, PFA, FFA, Cell design, rank order clustering, composite part concepts, Benefits of group technology.

COMPUTER AIDED PROCESS PLANNING: Introduction, Approaches to Process Planning, Different CAPP system, application and benefits.

UNIT-V

FLEXIBLE MANUFACTURING SYSTEM: Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of flexibility and FMS, FMS lay out and advantages.

AUTOMATED MATERIAL HANDLING SYSTEM: Introduction, Types and Application, Automated Storage and Retrieval System, Automated Guided Vehicles, Cellular manufacturing, Tool Management, Tool supply system, Tool Monitoring System, Flexible Fixturing, Flexible Assembly Systems.

TEXT BOOKS

1. Computer Aided Manufacturing by Tien Chien Chang, Pearson Education, 3rd edition, 2006
2. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover, Pearson Education, 5th edition, 2019

REFERENCES

1. Computer Aided Manufacturing- Rao, Tewari, Kundra, McGraw Hill, 3rd edition, 2017
2. Computer integrated manufacturing -S. Kant Vajpayee – Prentice Hall of India, 3rd edition, 2013
3. CAD/CAM, Principles and Applications –P N Rao, McGraw Hill, 2nd edition, 2010