B.Tech. Mechanical Engineering, Third Year [6th Semester]

Sr. No.	Course No.	Subject	L	T	P	Hours	Credits
1.	ME-321	Industrial Engineering	3	0	0	3	3
2.	ME-322	Machine Design-II	3	0	0	3	3
3.	ME-323	Machining Science	3	0	0	3	3
4.	ME-324	Computer Aided Manufacturing	3	0	0	3	3
5.	ME-325	Heat Transfer	3	1	0	4	4
6.	ME-320	Open Elective-II	3	0	0	3	3
7.	ME-323(P)	Production Lab-IV	0	0	2	2	1
8.	ME-324(P)	Production Lab-V	0	0	2	2	1
9.	ME-325(P)	Thermal Lab-III	0	0	2	2	1
					Total =	**25**	**22**

Open Elective - II [ME-320]

a) Entrepreneurship
b) Condition Monitoring
c) Energy Conservation and Maintenance
d) Product Design and Value Engineering
e) Production and operation management

ME-321 **INDUSTRIAL ENGINEERING**

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Concept of Industrial Engineering; Functions and role of I.E.; Role of Industrial Engineering in the plant; Concept of Productivity, Productivity measures and productivity index, Principles and types of Organization
2. **INVENTORY CONTROL**: Introduction; importance; Functions and types of inventories; Inventory costs, zero inventory, economic long size, ABC analysis; Inventory classification and analysis.
3. **QUALITY AND RELIABILITY**: Introduction and definition of quality, Evolution of Quality: Inspection, Quality Control, Customer-Orientation: Internal & External Customer Concept, Life cycle approach to quality cost- Prevention; Appraisal and Failure costs. Seven QC tools (Histogram, Check sheets, Ishikawa diagrams, Tareto, Scatter diagrams, Control charts). Reliability evaluation, Maintainability, and availability concepts
4. **BREAK EVEN ANALYSIS**: Concept of Break-Even analysis; Assumptions in Break-Even analysis, Important terms and Definitions; Calculations of Break-Even Points, Advantages, Limitations, and Application of Break-Even analysis
5. **DEPRICIATION**: Concept of Depreciation, Purpose of Calculating Depreciation; Types of Depreciation; Methods of Calculating Depreciation.
6. **WORK STUDY**: Concept of Work Study, Advantages; Techniques of Work Study, Scope & Procedure of Method Study; Elements of Method Design; Flow Process Chart, Flow Diagram; String Diagram, Multiple Activity Charts; Work Sampling; Objectives of Work Measurement, Basic Procedure of Time Study.
7. **VALUE ANALYSIS**: Concept & Objectives of Value Engineering/Analysis; Value Engineering; Function Analysis System Techniques; Factors to be Considered for Value Determination; Value Analysis procedure.

BOOKS RECOMMENDED:

1. Production Planning and Control - Samuel Eilon
2. Production and Operations Management - Adam Ebert
3. Industrial Engineering - O.P. Khanna
4. Production Management - Buffa
5. Production Planning & Inventory Control Narsimhan
6. Fundamentals of Quality Control - Mitra
7. Product Design and Development Ulrich, K.T. and Eppinger

ME- 322

MACHINE DESIGN-II

L	T	P/D	Cr
3	0	0	3

1. **SPUR GEARS**: Nomenclature, involute gears, Lewis equation and Lewis form factors, working stress in gear teeth, dynamic loads on gear teeth, design of spur gears for wear

2. **BEVEL GEARS**: Straight bevel gears – nomenclature, virtual number of teeth, endurance load, dynamic load, wear load –AGMA standards, design of gears whose axis are intersecting at right angle.

3. **WORM GEARS**: Nomenclature, Lewis equation for strength design, design of worm gears-given approximate centre to centre distance, dynamic load, endurance load, wear load, AGMA- Power reducing equations, efficiency of worm gears, check for wear load and heat dissipation.

4. **HELICAL GEARS**: Nomenclature - virtual number of teeth, helix angle, free width, velocity factors, strength design, limiting endurance, beam strength load, dynamic loading, wear loads

5. **JOURNAL BEARINGS**: Introduction to lubrication, hydrodymamic bearings, Sommerfeld number ,l/d ratio clearance ratio, minimum film thickness, design procedure, bearing materials

6. **BALL AND ROLLER BEARINGS**: Types, static and dynamic load capacity, bearing life, selection of bearings for steady and variable loading.

7. **DESIGN OF MULTISPEED GEAR BOX**: Use of preferred numbers, design with speed diagrams for gear boxes.

8. **CASE STUDY**

BOOKS RECOMMENDED:

1. Design of m/c Elements	V.B. Bhandari
2. Machine Design	Patel, Sikh and Pandya
3. Machine Design	Pandya & Shah
4. Machine Design	Sharma & Aggarwal
5. Machine Design	Shigley
6. Machine Design	Kulkarni
7. Machine Design	Sadhu Singh
8. Machine Design	R.K.Jain

HANDBOOK:
Design Data Book PSG College of Technology Coimbatore Use of this hand book permitted in the examination.

ME-323

MACHINING SCIENCE

L	T	P/D	Cr
3	0	0	3

1. **MATERIALS AND GEOMETRY OF CUTTING TOOLS**: Introduction, Desirable Properties of Tool Materials, Characteristics of Cutting Tool Materials, Cutting tool geometry, Chip flow direction, Tool angles specification systems, Cutting parameters and Tool geometry, Indexable inserts, chip breakers, Tools of unusual geometry.
2. **MECHANICS OF METAL CUTTING**: Merchant's circle diagram- determination of cutting and thrust forces; Coefficient of friction; shear plane angle, Velocity and force relationship, shear stress and strain and strain rate in orthogonal cutting, stress distribution along rake face, theories of Lee and Shaffer's, Oxley's, etc. Cutting force measuring techniques i.e dynamometer.
3. **THERMAL ASPECTS IN MACHINING AND CUTTING FLUID**: Regions of heat generation; Heat In the Primary Shear Zone, Heat at the Tool/work Interface, Heat Flow at the Tool Clearance Face, Average shear plane temperature; Average chip-tool interface temperature; method of tool temperature measurement, temperature distribution in tool, Cutting Fluid: Types and composition of cutting fluids, selection of cutting fluid.
4. **TOOL WEAR, TOOL LIFE AND MACHINABILITY**: Tool wear mechanisms, Types of tool damage during cutting, Wear and chipping characteristics of different tool materials, Tool wear equations, tool failure criteria, Tool life equations, Effect of process parameters on Tool life, Tool life testing, Machinability, Surface finish and surface integrity.
5. **ABRASIVE MACHINING PROCESSES**: Introduction, Classification of grinding processes and Mechanics of Centreless grinding, Gear grinding, surface grinding and cylindrical grinding processes, Mechanics of wheel wear, Effect of grinding parameters on grinding wheel performance, creep feed grinding, Honning and lapping and machining with controlled contact tool.
6. **ECONOMICS OF MACHINING PROCESSES**: Introduction, Cost of single pass turning operation, Optimization of cutting speed for minimum cost in turning, Maximum rate of production and Maximum profit rate in turning; Effect of feed on cutting speed for minimum cost in turning, Restriction on optimum cutting conditions, Economics of facing operations, Economics of Interrupted cutting, optimization of multistage Batch Machining.

BOOKS RECOMMENDED:

1.Fundametal of Metal cutting and Machine tools	B.L.Juneja
2.Engineering Metrology	R.K.Jain.
3.Manufacturing Engineering and Technology	Kalpakjian;Person Pub.
4.Manufacturing Engineering and Technology	Groover;TMH Pub.
5.ASM Hand Books on Machining	
6.Metal Cutting	Trent
7. Metal cutting theory and practice	Bhattacharya

ME-324

COMPUTER AIDED MANUFACTURING

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Historical background, role of computers in manufacturing, automation, Types of automation, Automation strategies, fundamentals of NC, Need of NC machine tool, Elements of NC machine tools, Axes of NC machines, NC machine tools, tooling for NC machines, Steps in NC manufacturing, advantages of NC system, applications of NC systems, economic of NC manufacturing, machining centers.
2. **COMPUTER NUMERICAL CONTROL**: Principle of operation of CNC features of CNC systems, development in CNC systems, adaptive control, direct numerical control (DNC), standard communication interfaces, programmable logic controllers (PLCs), communication networks, configuration of CNC system.
3. **CNC PART PROGRAMMING**: Introduction, Manual part programming: structure and format of part program NC programming codes, programming for two axis control system, programming for three axis control system, Computer aided CNC part programming: Need of Computer aided part programming, computer aided Part Programming languages: Automatically programmed tools programming (APT) and Compact-II, CAD/CAM-Based part programming.
4. **GROUP TECHNOLOGY AND CELLULAR MANUFACTURING**: Introduction to industrial robotics, Introduction, Group technology: Part families, parts classification and coding, production flow analysis, machine cell design, Computer aided process planning (CAPP): Types of process planning system, Advantages of CAPP.
5. **COMPUTER AIDED QUALITY CONTROL (CAQC)**: Use of computers in QC, Computer aided inspection (CAI): contact inspection methods, non contact inspection, in process gauging, online inspection and quality control, Machine Vision system, Computer aided testing (CAT).
6. **FLEXIBLE MANUFACTURING SYSTEM**: Introduction to FMS (building blocks of FMS), different types of flexibilities in FMS, type of FMS, Machining system of FMS, Tool management systems, work piece handling system, FMS Control, Lay out considerations in FMS Advantages of FMS. Introduction to computer integrated manufacturing systems (CIMS), the future automated factory; trends in manufacturing, human factors in future automated factory, the social impact.

BOOKS RECOMMENDED:

1. Automation: Production Systems & CAM	Groover, Eaglewood
2. An introduction to Automated Process Planning	Chand & Wysk , T.K.Kundra
3. System approach to Computer Integrated Design and Manufacturing	Nanua Singh
4. FMS	R.Maleki
5. CNC Machines	Pabla, BS & Adinathan
6. CAD/CAM	Suresh Dalela & PK Jain.

ME-325

HEAT TRANSFER

L	T	P/D	Cr
3	1	0	4

1. **INTRODUCTION**: Basic Concepts and Modes of heat transfer; Relationship to thermodynamics.

2. **CONDUCTION**: Mechanism; Fourier's general conduction equation in 3-D; 1-D steady state conduction with heat generation: composite plane wall and cylinders, thermal resistance network, critical thickness of insulation; extended surface heat transfer. 2-D steady state conduction: solution for simple boundary conditions, Unsteady heat conduction: lumped parameter system, semi-infinite wall with convection boundary condition, Use of Heisler charts

3. **CONVECTION**: Mechanism, forced convection, basic concepts of hydrodynamic and thermal boundary layers, similarity conditions of heat transfer processes, equations of motion and energy, application of dimensional analysis, Laminar boundary layer analysis on flat plate, Fully-developed heat transfer through smooth pipes, Relation between fluid friction and heat transfer, forced convection empirical correlations, Free convection: laminar free convection on a vertical flat plate; empirical correlations, Boiling and condensation: mechanism, laminar film condensation on a vertical plate, empirical correlation

4. **RADIATION**: Thermal radiation, monochromatic and total emissive power absorptivity, reflectivity and transmissivity, black, grey and real surfaces, Planck's distribution- law, Wien's displacement law, Stefan -Boltzmann's law, Kirchhoff's law, heat transfer by radiation between black surface and grey surfaces, heat transfer in the presence of re-radiating surface, electrical network method of solving radiation problems, radiation shields, shape factors

5. **HEAT EXCHANGERS**: Basic type of heat exchangers, fouling factor, overall heat transfer co-efficient, logarithmic mean temperature difference, effectiveness –NTU, Methods of design of single and multiple pass heat exchangers.

RECOMMENDED BOOKS:

1. Heat Transfer – A practical Approach — Yunus A. Cengel
3. Fundamental of Heat and Mass Transfer — Incropera & Dewitt
4. Heat Transfer — J.P.Holman
5. Heat and Mass Transfer — Eckert & Drake
6. Heat and Mass Transfer — R.K. Sachdeva

Open Elective-II [ME-320]

ME – 320 (a) ENTREPRENEURSHIP

L	T	P/D	Cr
3	0	0	3

1. **THE ENTREPRENEURIAL DEVELOPMENT PERSPECTIVE**: Concept of Entrepreneurship Development, Entrepreneur Vs. Intrapreneur, Entrepreneur Vs. Entrepreneurship, Attributes and characteristics of a successful Entrepreneur, Role of Entrepreneur in India economy and developing economics with reference to self-Employment Development, Entrepreneurship Culture.
2. **CREATING ENTREPRENEURIAL VENTURE**: Business Planning Process, Environmental Analysis – Search and Scanning, Indentifying problems and opportunities, Defining Business Idea, Basic Government Procedures to be complied with.
3. **PROJECT MANAGEMENT**: Technical, Financial, Marketing, Personnel and Management Feasibility study, Estimating the Financial requirements – Schemes offered by various commercial banks and financial institutions.
4. **ENTREPRENEURSHIP DEVELOPMENT AND GOVERNMENT**: Entrepreneurship developments – Introduction to various incentives, subsidies and grants – Export Oriented Units – Fiscal and Tax concessions available.
5. **ROLE OF VARIOUS AGENCIES IN THE ENTREPRENEURSHIP DEVELOPMENT**: District Industries Centres (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB).
6. **CAUSES OF ENTREPRENEUR FAILURE**: The FOUR Entrepreneurial Pitfalls (Peter Drucker)
7. **WOMEN ENTREPRENEURS**: Reasons for Low/No Women Entrepreneurs, Role, Problems and Prospects.
8. **CASE STUDIES**: Case studies of Successful Entrepreneurial Ventures, Failed Entrepreneurial Ventures and Turnaround Ventures.

BOOKS RECOMMENDED:

1. Entrepreneurship : New Venture Creation — David H. Holt
2. Entrepreneurship — Hisrich Peters
3. The Culture of Entrepreneurship — Brigitte Berger
4. Project management — K. Nagarajan
5. Dynamics of Entrepreneurship Development — Vasant Desai
6. Entrepreneurship Development — P.C. Shejwalker
7. Thought Leaders — Shrinivas Pandit
8. Entrepreneurship, 3rd Edition — Steven Brandt
9. Business Gurus Speak — S. N. Chary
10. The Entrepreneurial Connection — Gurmit Narula

ME – 320 (b) **CONDITION MONITORING**

L	T	P/D	Cr
3	0	0	3

1. Importance of machine health monitoring and fault diagnosis of plant, Classification of Maintenance Activities: Breakdown, Preventive and Predictive Maintenance, Condition Monitoring maintenance strategies.

2. Fault identification/detection; visual inspection; crack detection techniques like magnetic crack detection, dye penetrant, radiography; oil analysis; wear particle analysis; Ferrography; strain gauge technology, ultra sonic crack detection, themography.

3. Condition monitoring methods; sensors required for various applications viz. electrical fluid, mechanical; wear debris analysis; vibration of mechanical components; on line and off line techniques.

4. Noise analysis; fluid borne, structural borne, air borne noise measurement and its analysis.

5. Signal processing; signature analysis and their significance; machine signatures; spectrum analysis; time series analysis.

6. Expert systems and real time process analysis; microcomputer interfacing; data acquisition, expert system skills, Classification of Maintenance Activities: Breakdown, Preventive and Predicitive Maintenance, Condition Monitoring.

BOOKS RECOMMENDED:

Mechanical Faults Diagnostics and Condition Monitoring R. A. Colacott
John Wiley & Sons, 1997.

1. Handbook of Condition Monitoring B.K.N. Rao, Elsevier Science Publisher
.
2. Engineering Condition Monitoring, Practice, Methods and Applications, Barron, R., Addison Wesley Longman, 1996
3. Condition Monitoring for Engineering Services Armstrong, J.H. & & Taylor P.
4. Maintenance Engineering and Management Mishra R.C. & Pathak K.

ME – 320 (c) ENERGY CONSERVATION AND MAINTENANCE

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Concept of energy management, energy demand and supply, economic analysis; Duties and responsibility of energy managers.

2. **ENERGY CONSERVATION**: Basic concepts, Energy conservation in household, transportation, agricultural, service and industrial sectors, Lighting, HVAC systems.

3. **ENERGY AUDIT**: Definition, need, and types of energy audit; Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements; Fuel & energy substitution; Energy audit instruments; Energy Conservation Act; Duties and responsibilities of energy managers and auditors.

4. **MATERIAL AND ENERGY BALANCE**: Facility as an energy system; Methods for preparing process flow; material and energy balance diagrams.

5. **ENERGY ACTION PLANNING**: Key elements; Force field analysis; Energy policy purpose, perspective, contents, formulation, ratification; Organizing the management: location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability; Motivation of employees: Information system-designing barriers, strategies; Marketing and communicating: Training and planning.

6. **ENERGY CONSERVATION IN INDUSTRIES:** Centrifugal pumps: Energy consumption & saving potentials; Design consideration minimizing over design; Case studies Fans & Blowers: Specification, safety margin, choice of fans-controls, design considerations. Air compressor & compressed air systems: Selection of compressed air layout, Design consideration. Refrigeration & Air conditioning: Heat load estimation, methods of minimizing heat loads, optimum selections of equipments; Case studies, Energy conservation in cooling towers & spray ponds; Case studies.

7. **THERMAL ENERGY MANAGEMENT**: Energy conservation in boilers, steam turbines and industrial heating systems; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pumps; Building Energy Management.

RECOMMENDED BOOKS:

1. Energy Management Principles — C B Smith
2. Energy Auditing and Conservation; Methods, Measurements, Management & Case Study — Hamies
3. Energy Management and Conservation — D Patrick & S W Fardo
4. Heating and Cooling of Buildings: Design for Efficiency — J.Krieder & A.Rabi
5. Principles of Energy Conservation — Archie, W Culp
6. P. Energy Management — O'Callaghan

ME – 320 (d) PRODUCT DESIGN & VALUE ENGINEERING

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Introduction to Product Design, Design by Evolution and Innovation, Essential factors of product design, Production consumption cycle, Flow and value addition in Production consumption cycle.

2. **FUNCTIONAL & AESTHETICS CONSIDERATION**: Basic design considerations, Role of Aesthetics in product design, Basic concept and elements of Visual design, Functional design practice.

3. **MANUFACTURING CONSIDERATION**: Producibility Requirements in the design of machine components, Forging design, Pressed component design, Design for machining, Ease of location and Clamping, Some additional aspects of production design, Design of powder metallurgical parts, Redesigning on basis of production consideration.

4. **VALUE ENGINEERING**: Concept of value, cost and price, customer and value, philosophy and objectives of value analysis, types of value, areas of application of value engineering, limitations of value analysis, difference between value engineering and cost reduction techniques; Tool of technology in value analysis, method & engineering, cause and effect diagram, SWOT analysis, break even analysis, systems approach; Job plan for value analysis approach: Information phase, Function Phase, Creation Phase, Evaluation Phase, Recommendation Phase, Implementation Phase, Audit Phase; Value Engineering Cell, value manual, composition of cell, Cost cutting, various cost cutting techniques; Case studies in value engineering and analysis from manufacturing and service industries.

BOOKS RECOMMENDED:

1. Product Design and Development — Kail T. Ulrich & Steven D. Eppinger
2. Product Design and Engineering — A.K. Chitale & Gupta
3. Product Design and Process Engineering — Niebel & Draper
4. Design of Systems and Devices — Middendorf Marcel Dekker
5. Value Engineering SAVE — Mudge
6. Techniques of Value Analysis and Value Engineering — Miles Lawerence
7. Value Engineering in Manufacturing — ASME
8. Value Engineering Theory — Parker, D.E.

ME- 320(e) PRODUCTION AND OPERATION MANAGEMENT

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION :** Functional subsystems of Organizations; definition, Systems of Production System; Flow Shop; Job Shop; Batch Manufacturing; The Project, Productivity, Strategic Management; Corporate Strategies; Generic Competitive & Functional Strategies, GDP and its Impact, World class Manufacturing.
2. **FACILITY LOCATION:** Introduction; Factors influencing plant location, Single Facility Location Problems; Model of Multifacility Location Problem; method of Transformation; Model of Determine X-Coordinates of New Facilities, Model of Determine Y – Coordinate, Minimax Location Problem, Gravity Location Problem, Euclidean-Distance Location Problem, Covering Problem; Total Covering Problem; Multiple objective Partial Covering Problem, Model of Warehouse Location Problem; Descriptive Model; Working Mathematical Model.
3. **PLANT LAYOUT AND MATERIAL HANDLING:** Concept and Classification of Layout, Advantages and Limitations of Process & Product Layout and Technology Layout, Layout Design Procedure; Systematic Layout Design Procedure; Computerized Relative Allocation of Facilities Technique (CRAFT); CRAFT Procedure and Application; Automated Layout Design Program (ALDEP); Computerized Relationship Layout Planning (CORELAP); Application of CORELAP, Algorithms and Models for Group Technology; Rank Order Clustering Algorithm(ROC); Bond Energy Algorithm; Mathematical Model for Machine-Component Cell Formation, Materials Handling Systems; Unit Load Concept; Material Handling Principles; Classification of Material Handling Equipments.
4. **LINE BALANCING:** Concept of Mass Production System; Objective of Assembly Line Balancing; Generalized Algorithm; Rank Positional Weight Method; The COMSOAL Algorithm; Model for Assembly Line Balancing; Integer Programming Model for Minimize Number of Work Station; Model to Minimize Balancing Delay, Stochastic Assembly Line Balancing.
5. **AGGREGATE PLANNING AND MASTER PRODUCTION SCHEDULING:** Concept of Aggregate Planning; Nature and Strategies of Aggregate Planning; Aggregate Planning Methods, Master Production Plan/Schedule; Cut-and-Fit Methods
6. **PROJECT MANAGEMENT:** Introduction and Phases of Project Management; Guidelines and Rules for Network Construction; Critical Path Method (CPM); Gantt Chart/Time Chart; Project Evaluation and Review Technique (PERT), General Guidelines for Crashing Network; Crashing of project Network with Costs Trade-Off, Project Scheduling with Constrained Resources; Resources Levelling Techniques; Resources Allocation Technique, Graphical Evaluation and Review Technique (GERT), Project Management Softwares; InstaPlan III; Yojana.

BOOKS RECOMMENDED:

1. Operations Management - Mc Gregor D
2. Operations Management - Russell & Taylor
3. Operations Management - Jaseph G. Monk
4. Introduction to Work Study - I.L.O.
5. Production and Operations Management - Adam Ebert
6. Production Management - Buffa
7. Industrial and Systems Engineering - Turner, Prentice Hall Pub.