Scheme for Teaching & Examination											
B. Tech. - IV (Mechanical) Seventh Semester											
Sr. No.	Course	Code	Teaching Scheme			Exam Scheme				Total Marks	Credits
						Theory		Tuto.	Pract.		
			L	T	P	Hrs.	Marks	Marks	Marks		
1	Machine Design-II	ME 401	3	1	2	2	100	25	50	175	5
2	Energy Systems	ME 403	3	0	0	2	100	-	-	100	3
3	Production Technology-I	ME 405	3	0	2	2	100	-	50	150	4
4	CAD-CAM	ME 407	3	0	2	2	100	-	50	150	4
5	Project Preliminaries	ME 409	0	0	4	-	-	-	50	50	2
6	Seminar	ME 411	0	0	2	-	-	-	50	50	1
7	Deptt. Elective-I*		3	0	0	2	100	-	-	100	3
	TOTAL		15	1	12		500	25	250	775	22
Total contact Hrs. per week (28) Total Credits =22 Total Marks = 775											

LIST OF DEPARTMENTAL ELECTIVES

B. Tech.. IV (M) 7th Semester, ELECTIVE – I*

1. ME 413 : Advanced Tribology
2. ME 415 : Advanced Refrigeration and Air-conditioning
3. ME 417 : Analysis of Solar Thermal Systems
4. ME 419 : Production Management
5. PR 420 : Design and Management of S.S. Enterprises
6. ME 421 : Design of Alternative Energy Systems
7. ME 423 : Computational Fluid Flow & Heat Transfer
8. ME 425 : Analysis and Synthesis of Mechanisms
9. ME 427 : Design of Machine Tools
10. ME 429 : Biomechanical Engineering
11. ME 420 : Optimization Techniques
12. ME 431 : Automobile Engineering

B. Tech. (MECHANICAL) Semester – 7	L	T	P	C
ME 401 MACHINE DESIGN -II	3	1	2	5

CO1	Apply design procedures to various gear drives.
CO2	Analyse the gear boxes for various industrial applications.
CO3	Design various types of mechanical brakes and clutches .
CO4	Illustrate the working of journal and antifriction bearings, and its selection and design.
CO5	Design belt drives, pulley, flywheel and power lifting devices
CO6	Apply the design concepts to miscelleneous machine components.

- **DESIGN OF POWER TRANSMISSIN ELEMENTS (08 Hours)**
  Design of belt drives, selection of flat and V- belts, design of pulleys and flywheels. Design of gear drives – spur, helical, bevel and worm gear drives. Design of single and multistage speed reducers. Rating of gears as per I.S. and AGMA standards.

- **DESIGN OF GEAR BOXES (08 Hours)**
  Types of gear boxes, design of machine tool gear boxes using preferred numbers.

- Design of clutches and brakes, types of clutches, design of single & multiple plate clutches, cone Clutch and centrifugal clutch. Design of block brake, pivoted shoe brake, long shoe brake, internal shoe brake. Simple and differential band brake. **(08 Hours)**

- **DESIGN OF BEARINGS (06 Hours)**
  Design of hydrodynamic journal bearings. Classification, material selection, Sommerfeld number and use of charts for the estimation of minimum film thickness, temperature rise, flow quantity etc. Design of pressure fed and self contained bearings. Rolling contact bearings. Classification and selection, factors affecting bearing life, bearing assembly and lubrication.

- **LOAD LIFTING DEVICES (06 Hours)**
  Selection of steel wire rope for hoists and cranes, crane hooks, design of hook block, sheaves and rope winding drums.

- **INTRODUCTION TO PRESSURE VESSELS (06 Hours)**
  Thin and thick cylinder, classification of pressure vessels, loads, stresses and types of failures.

- **STATISTICAL CONSIDERATIONS IN MACHINE DESIGN (03 Hours)**
  Statistical analysis of tolerances, reliability, statistical factor of safety, MTBF, Reliability of systems in series and parallel.

(Total Lecture Hours: 45 +Tutorial Hrs: 15)

PRACTICALS

1. Design and drawing of speed reducer (08 Hours)
2. Design and drawing of clutch of any of the following (04 Hours)
   a. Plate clutch
   b. Centrifugal clutch
   c. Multiplate clutch
3. Design and drawing of the any of the brake from following (04 Hours)
   a. Ext. Expanding brake
   b. Int. Expanding brake
   c. Differential band brake
4. Design of hook block & drawing (04 Hours)
5. Selection and mounting of rolling element bearing (04 Hours)
6. Design of gear box with its kinematic arrangement (04 Hours)
7. Design of bevel gear (02 Hours)

BOOKS RECOMMENDED

1. Bhandari V. B., “Design of Machine Elements”, Tata McGraw Hill, 1994.
2. Shigley Joseph, “Mechanical Engineering Design”, McGraw Hill, 1989.
3. Patel R.C., ”Machine Design”, C. Jamnadas & Co., 1992.
4. Karwa Rajendra, “A Text Book of Machine Design”, Laxmi Publication, 2006.
5. P.S. G. Design Data book (PSG College of Engg. & Tech.), DPV Printers, Coimbatore, 2000.

B. Tech. (MECHANICAL) Semester – 7	L	T	P	C
ME 403 ENERGY SYSTEMS	**3**	**0**	**0**	**3**

CO1	Understand the working of thermal power plant
CO2	Compare the steam generators based on different parameters
CO3	Illustrate the velocity diagram of impulse and reaction steam turbines
CO4	Analyse the performance of impulse and reaction steam turbines
CO5	Summarize the different non-conventional energy systems
CO6	Develop the solar water heating and air heating systems

- **INTRODUCTION** **(05 Hours)**
  Sources of energy, Convectional and Non conventional energy systems. Types of power plants: like combined cycle and cogeneration plants, Thermal power stations.

- **STEAM GENERATION** **(10 Hours)**
  Types of steam generators like natural circulation and forced circulation. Heat recovery steam generators (HRSG) with LP and HP evaporators, economizers, super heaters and air preheaters. High pressure boilers such as La Mont, Loeffler, Benson, Schmidt, Velox Boiler. Performance of boilers.

- **STEAM TURBINES** **(10 Hours)**
  Classification and general constructional features, Compounding of turbines. Steam nozzles, Flow through nozzles, Nozzle efficiency.
  (a) Impulse steam turbine: Velocity diagrams, Forces on blades, Blade efficiency, Gross stage efficiency, Efficiency of multi stage turbine, Blade height calculation, Carry over factor, Reheat factor
  (b) Impulse reaction turbine: Degree of reaction, Parson's reaction turbine, Height of blade, Stage efficiency, Carry over factor.

- **INTRODUCTION TO NON CONVENTIONAL ENERGY** **(20 Hours)**
  Present status of energy scenario
  (a) Solar: Solar time and solar angle, Solar radiation, Solar heating system, Principals and overview of developments in Solar water heating systems principles of solar photovoltaic, solar photovoltaic system
  (b) Wind: Wind energy resource, Efficiency of wind turbine, Principle of wind turbine, Wind turbine and application.
  (c) Biomass: Bio-energy sources, Combustion of biomass, Thermal pyrolysis and gasification.
  (d) Introductions to tidal, wave, OTEC, etc.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Wakil M. M., "Power Plant Technology", McGraw Hill, 1985.
2. Church E.F., "Steam Turbines", McGraw Hill, 1950.
3. Sukhatme S. P., "Solar Energy", Tata McGraw Hill, New Delhi, 1994.
4. Rai G. D., "An Introduction to Power Plant Technology", Khanna Publishers, Delhi, 1996.
5. Rao S. and Parulekar B. B., "Energy Technology", Khanna Publishers, New Delhi, 1999.
6. Mittal K.M., "Non-Conventional Energy Systems: Principles, Progress & Prospects", Wheeler Publishing, New Delhi, 1997.

B. Tech. (MECHANICAL) Semester – 7	L	T	P	C
ME 405 PRODUCTION TECHNOLOGY – I	3	0	2	4

CO1	Explain the tool nomenclature, tool materials, cutting forces and heat distribution during machining.
CO2	Analyze tool life, tool wear and failure analysis of cutting tools.
CO3	Determine the optimum value of parameters by using economics of machining.
CO4	Explain various types of thread and gear manufacturing processes.
CO5	Explain various unconventional machining processes, their capabilities and limitations.
CO6	Apply the knowledge of kinematics of machine tools, machine tool controls and tool layout for automats.

- **MECHANICS OF METAL CUTTING** **(10 Hours)**
  Tool materials, single point cutting tool, chip formation, determination of shear angle, shear stress and strain, force relations, tool wear and tool life, temperature in machining, surface roughness, economics of machining, cost estimation.

- **THREAD AND GEAR MANUFACTURING PROCESSES** **(05 Hours)**
  Thread manufacturing by casting, thread chasing, thread rolling, thread milling and thread grinding.
  Gear cutting by milling, broaching, planning, shaping, hobbing and rolling.

- **UNCONVENTIONAL MACHINING PROCESSES** **(15 Hours)**
  Ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), abrasive WAJM (AWJM), Electrochemical machining (ECM), Electric discharge machining (EDM), Ion beam machining (IBM), Electron beam machining (EBM)**.** Process principle**,** process equipment, process characteristics and parameters, applications of the process.

- **INTRODUCTION TO KINEMATICS** **(10 Hours)**
  Machine tools like lathe machine, milling machine, hobbing machine, shaping machine, etc.

- **MACHINE TOOL CONTROL AND HYDRAULIC CIRCUITS**. **(02 Hours)**
  Mechanical control, single spindle bar automatic lathe and multi tooling.
  Hydraulic controllers - hydraulic integral controller and hydraulic proportional controller.

- **INTRODUCTION TO AUTOMATS, TOOL LAYOUT FOR AUTOMATS**. **(03 Hours)**
  Classification of automatic machines, tool layout for automatic screw machines and bar stock feeding.

(Total Lecture Hours: 45)

PRACTICALS

1. To measure the tool-chip interface temperature in drilling operation under various cutting speeds and to plot temperature vs. speed curve for given tool-work material.
2. To determine shear plane angle under various cutting conditions.
3. To prepare operational sheet for a given component estimate production cost per piece for batch production.
4. To obtain power consumption at various cutting conditions during turning operation.
5. To grind a single point cutting tool and measure the tool angle.
6. To measure torque and thrust in drilling operation under various cutting conditions.
7. To study the hydraulic circuits: (a) linear circuit, (b) regenerative circuit.

BOOKS RECOMMENDED

1. Ghosh A. and Mallik A. K., "Manufacturing Science", East West Press, New Delhi, 2010.
2. Mehta N. K., “Machine Tool Design”, Tata McGraw Hill, 1992.
3. Sharma P. C., "A Textbook of Production Engineering", S. Chand & Company, New Delhi, 2006.
4. Pandey P. C., Shan H. S., “Modern Machining Processes”, Tata McGraw Hill, 2007.

5. HMT, “Production Technology”, Tata McGraw Hill, 2017.
6. Sinha B. P., “Mechanical Estimating and Costing”, Tata McGraw Hill, 1995.

B. Tech. (MECHANICAL) Semester – 7	L	T	P	C
ME 407 CAD-CAM	3	0	2	4

CO1	Explain the fundamental principles of CAD and learn drafting commands to generate part drawing
CO2	Demonstrate modelling of parametric curves, surface quality criteria and procedure of FEA
CO3	Apply transformation concept to find geometry position and 3D modeling
CO4	Develop an understanding of the fundamental principles of CAM and learn NC & CNC programming techniques and APT language to generate the tool paths and tool motion
CO5	Describe the concept of computer aided process planning and flexible manufacturing systems and their types.
CO6	Develop the NC/CNC part program for a given part drawing for machining centre.

(A) COMPUTER AIDED DESIGN (CAD)

- **PRINCIPLES OF COMPUTER AIDED DESIGN** **(03 Hours)**
  Computer configuration for CAD applications, Computer peripherals for CAD.

- **FUNDAMENTALS OF COMPUTER GRAPHICS** **(12 Hours)**
  Two dimensional transformation, three dimensional transformation and projections.

- **PLANE CURVES AND SPACE CURVES** **(04 Hours)**
  Surface description and generation. Hidden line algorithms for wire frame modeling. Solid modeling.

- Introduction to Computer Aided Drafting and Analysis Softwares such Auto CAD, PRO ENGINEER, ANSYS, etc. CAD System utilization and application. **(04 Hours)**

(B) COMPUTER AIDED MANUFACTURING (CAM)

- **INTRODUCTION** **(02 Hours)**
  Numerical control of machine tools, nomenclature, types, features, MCU.

- **TRANSDUCERS** **(16 Hours)**
  Tooling for N.C. Machines, ISO G & M Codes, N.C. part programming, tool setting, cutter compensation, parametric programming, APT language structure, APT Geometry, motion commands, post processor commands, repetitive programming, compilation and control commands.

- **INTRODUCTION TO COMPUTER AIDED PROCESS PLANNING** **(02 Hours)**
- **INTRODUCTION TO FLEXIBLE MANUFACTURING SYSTEMS** **(02 Hours)**

(Total Lecture Hours: 45)

PRACTICALS

1. Drafting practice using drafting package for drawing option.
2. Drafting practice using drafting package for modify option.
3. Drafting practice using drafting package for dimensional approach.
4. Programming practice for a given problem.
5. Programming practice for graphic application.
6. Practice for data exchange from draft package.
7. Drafting of design component
8. Demonstration of 3D modeling using CAD Packages.
9. Demonstration of stress analysis using FEA package.

BOOKS RECOMMENDED

1. Rogers David F. and Alan Adams J., “Mathematical Elements for Computer Graphics”, McGraw Hill, 1990.

2. Kundra T. K., Rao P. N. and Tewari M. K., “Numerical Control and Computer Aided Manufacturing”, Tata McGraw Hill, 1990.
3. Groover M.P., “Automation, Production Systems & Computer Integrated Manufacturing.”, Prentice Hall, 1989.
4. Krishnamoorthy C.S. and Rajeev S., “Computer Aided Design”, Narosa Publishing House, 1991.
5. Groover M.P. and Zimmers E.W., “Computer Aided Design and Manufacturing”, Prentice Hall India, 1997.
6. Elanchezhian C, Selwyn Sunder T and Shanmuga Sundar G., “Computer Aided Manufacturing”, Laxmi Publications, New Delhi, 2006.
7. Sinha S. K., “CNC Programming”, Galgotia Publications, 2004.
8. Rao P N., “CAD/CAM Principles and Applications”, Tata McGraw Hill, 2006.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 413 ADVANCED TRIBOLOGY	**3**	**0**	**0**	**3**

CO1	Introduction of basics & priniciples of Tribology.
CO2	Understand the concept about friction and wear in engineering apllications.
CO3	Analyze the concept of hydrodynamic, hydrostatic, hydrostatic squeeze lubrications, hydrodynamic and thrust Bearings.
CO4	Analyze the fundamentals of rolling element bearings to solves the stresses, torque and friction.
CO5	Explain the basics of measurements of surface roughness and topography.
CO6	Explain and Measurements of wear and friction.

- **SURFACES, FRICTION AND WEAR (10 Hours)**
  Topography of Surfaces, Surface features, Surface interaction, Theory of friction, Sliding and rolling Friction, Friction properties of metallic and non-metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistant materials, Surface treatment, Surface modifications, Surface coatings.

- **LUBRICATION THEORY (08 Hours)**
  Lubricants and their physical properties, lubricant standards, Lubrication regimes in hydrodynamic lubrication, Reynolds equation, Thermal, inertia and turbulent effects, Elasto-hydrodynamic (EHD), Magneto hydrodynamic lubrication, Hydro static lubrication, Gas lubrication, Solid lubrication.

- **DESIGN OF FLUID FILM BEARINGS (10 Hours)**
  Design and performance analysis of thrust and journal bearings, Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings , hydrostatic bearing design.

- **ROLLING ELEMENT BEARINGS (10 Hours)**
  Geometry and kinematics, Materials and manufacturing processes, Contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, Bearing life capacity and variable loads, ISO standards, Oil films and their effects, Rolling bearings failures.

- **TRIBO MEASUREMENT AND INSTRUMENTATION (07 Hours)**
  Surface topography measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, Bearing vibration measurement.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Cameron A., “Basic Lubrication Theory”, Ellis Horwood Ltd., UK, 1981
2. Halling J. (Editor), “Principles of Tribology “, Macmillian, 2017.
3. Williams J.A., “Engineering Tribology”, Oxford Univ. Press, 1994.
4. Neale, M.J., “Tribology Hand Book”, Butterworth Heinemann, 1995.
5. Stolarski T.A., “Tribology in Machine Design”, Industrial Press, 1990.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 415 ADVANCED REFRIGERATION & AIR CONDITIONING	3	0	0	3

CO1	Describe the properties of recent eco friendly refrigerants and evaluate performance of the actual vapour compression refrigeration system
CO2	Evaluate the performance of compound vapour compression refrigeration systems for various applications
CO3	Evaluate the performance of vapour absorption system for large cooling load application
CO4	Explain working principles of non-conventional refrigeration systems and evaluate the performance of steam jet refrigeration system.
CO5	Compute cooling/heating loads for designing air conditioning systems for residential and commercial building.
CO6	Design the air duct systems for large commercial buildings

- **COMPOUND VAPOUR COMPRESSION REFRIGERATION SYSTEMS (10 Hours)**
  Two stage compression with water intercooler, Liquid subcooler and flash chamber, Three stage compression with multiple expansion valves and flash intercoolers, Recent developments in refrigerants, Methods of defrosting, Expansion devices.

- **ANALYSIS OF VAPOUR ABSORPTION SYSTEM (06 Hours)**
  Temperature concentration and enthalpy concentration diagrams, Enthalpy balance for various components of aqua ammonia systems.

- **STEAM JET REFRIGERATION SYSTEMS (06 Hours)**
  Introduction, Analysis of steam jet refrigeration system, Performance of the steam jet system.

- **NON CONVENTIONAL REFRIGERATION SYSTEMS (06 Hours)**
  Thermo electric refrigeration system, Vortex tube refrigeration, Pulse tube refrigeration, Adiabatic demagnetization.

- **COMFORT AIR-CONDITIONING SYSTEMS (05 Hours)**
  Requirements of comfort airconditioning, Thermodynamics of human body, Comfort charts, Effective temperature, Ventilation standards.

- **DESIGN OF AIRCONDITIONING SYSTEMS (05 Hours)**
  Review of cooling coil load calculations, Bypass factor, Effective sensible heat factor, Design consideration for cooling coils, de-humidifiers and air washers, central air conditioning and unitary air conditioning systems, factory air conditioning.

- **DUCT DESIGN (07 Hours)**
  Fluid flow and pressure losses, Duct design, Duct arrangement system, Noise and noise control.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Stoeaker W. F., “Refrigeration and Air Conditioning”, McGraw Hill, 2004.
2. Dossat R.J., “Principles of Refrigeration”, John Wiley & Sons, 2000.
3. Arora C. P., “Refrigeration and Air Conditioning”, Tata McGraw Hill, 2007.
4. Arora S.C. and Domkundwar S., “A Course in Refrigeration and Air Conditioning”, Dhanpat Rai & Sons, 2006.
5. Thrakeld J. L., “Thermal Environmental Engineering”, Prentice Hall, 2002.
6. Ananthanarayanan P. N., “Basic Refrigeration and Air Conditioning”, Tata McGraw Hill, 2005.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 417 ANALYSIS OF SOLAR THERMAL SYSTEMS	3	0	0	3

CO1	Explain to solar thermal collector.
CO2	Describe various types of solar thermal collector.
CO3	Understand basics of solar heaters
CO4	Describe various types of solar heaters.
CO5	Analyze the cabinet drier and cooker.
CO6	Analyze the concentrating collectors.

- **FLAT PLATE COLLECTORS** **(12 Hours)**
  Radiation transmission through covers, Absorption, Transmittance – Absorption product, Basic energy equation of collector, Temperature distribution, collector efficiency – factors, Collector heat removal factor, Collector overall efficiency, Collector – performance.

- **SOLAR AIR HEATER** **(10 Hours)**
  Basic energy equation, Collector efficiency factors, Collector heat removal factor, Air heater efficiency, Performance of air heaters.

- **ANALYSIS OF CABINET DRIER AND COOKER** **(10 Hours)**
  Basic energy balance, Performance analysis of cooker, Cooking period, various types of driers and cookers.

- **CONCENTRATING COLLECTORS** **(13 Hours)**
  Concentration principles, Thermodynamic limit of concentration, Theory of cylindrical and parabolic collectors, Collector heat removal factor, Collector efficiency, Collector performance, Introduction to CPC.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Sukhatme S. P., “Solar Energy Principles of Thermal Collection and Storage”, Tata McGraw Hill, New Delhi, 1996.
2. Daffie, J. A and Beckman, W. A., “Solar Engineering of Thermal Processes”, John Wiley & Sons, New York, 1991.
3. Kreith F. and Kreider J. F., “Hand Book of Solar Energy”, McGraw Hill, New York, 1980.
4. Tiwari G. N. and Suneja, “Solar Thermal Engineering Systems”, Narosa Publishing House, New Delhi, 1997.
5. A. Mani, “Solar Radiation Data for India”, Allied Publishers, New Delhi, 1981.
6. Channiwala. S. A., “Solar Energy Data Book”, SVNIT, Surat, 2000.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 419 PRODUCTION MANAGEMENT	**3**	**0**	**0**	**3**

CO1	Develop an understanding of how the production management and production planning and control functions have strategic importance and can provide a competitive advantage.
CO2	Develop Material Requirement Planning (MRP) structure, explain the framework of capacity planning, agregate planning and manufacturing / operations strategy.
CO3	Apply sequencing models for achieving the cost and profit maximisation.
CO4	Apply replacement models to modernise the system.
CO5	Explain process planning and manpower planning for effective utilisation of resources.
CO6	Describe the concept of advanced production management strategies such as TQM, JIT, ERP, TPM, lean & agile manufacturing, Toyota productions system, etc.

- **INTRODUCTION (02 Hours)**
  Functions & scope of production management department, production management framework, types of production, classification of production system – job shop batch, continuous, cellular and mass production, organization structure for production function.
- **PRODUCTION PLANNING & CONTROL (06 Hours)**
  Objectives, production planning & production control, functions of PPC, production procedure, manufacturing methods and PPC, organization for PPC, Principles of sound production control system.
- **PROCESS PLANNING (03 Hours)**
  Framework for process engineering, process machine & equipment selection, machine requirements, machine output, manpower planning, line balancing, application of break-even point in the choice of machines or process, organization of the process planning department, operation planning, operation sheet (Process sheet)
- **PRODUCTION CONTROL (05 Hours)**
  Loading, Gantt chart, sequencing, scheduling; sequencing problems such as n jobs and 2 machines, n jobs and 3 machines (Johnsons Algorithm), n jobs and m machines; Assignment model – n jobs and n machines, scheduling – principles, scheduling strategies, finite loading, index method, scheduling and loading guidelines, dispatching, progressing.
- **CAPACITY PLANNING (05 Hours)**
  Measurement of capacity, measures of capacity, estimating future capacity needs, factors influencing effective capacity, factors favouring over capacity and under capacity, aggregate planning, aggregate planning guidelines, Master Production Schedule (MPS)
- **MATERIAL REQUIREMENT PLANNING (MRP) (05 Hours)**
  Objectives, MRP system & outputs, MRP logic, management information from MRP, lot sizing considerations, Manufacturing Resource Planning (MRP-II), capacity requirement planning.
- **REPLACEMENT MODELS (03 Hours)**
  Reasons & factors necessary for replacement of equipments, methods used in replacement such as total life average method, MAPI method etc., replacement models such as replacement of equipment / machine which deteriorate with time and items that fail completely are expensive to be replaced.
- **ADVANCED PRODUCTION MANAGEMENT (14 Hours)**
  Industrial engineering techniques such as Total Quality Management (TQM), Just-in-time (JIT) manufacturing, Business Process Reengineering (BPR), Group Technology, Theory of Constraints (TOC), Enterprise Resource Planning (ERP), Flexible Manufacturing System (FMS), Total Productive Maintenance (TPM), Lean & Agile manufacturing, Manufacturing Excellence, Toyota Production System (TPS) etc.
- **OPERATIONS STRATEGY (02 Hours)**
  Operations strategy model, external & internal conditions influencing strategy, SWOT (strengths – weaknesses – opportunities – Threats) analysis, components of production strategy, framework for manufacturing / operations strategy, interfaces between operations & marketing function.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Mahajan M., “Industrial Engineering and Production Management”, Dhanpat Rai & Sons, New Delhi, 2000.
2. Telsang M., “Industrial Engineering and Production Management”, S.Chand & Co., New Delhi, 2005.
3. Paneerselvam R., “Production and Operations Management”, Prentice Hall India, 2005.
4. Mukhopadhyay S.K., “Production Planning and Control – Text and Cases”, Prentice Hall India, 2004.
5. Bedi Kanishka, “Production Operations Management”, Oxford University Press, New Delhi, 2007.
6. Khanna R.B., “Production and Operations Management”, Prentice Hall India, 2007.
7. Jhamb L.C., “Production (Operations) Management”, Everest Publishing House, Pune, 2002.
8. Paneerselvam R., “Production and Operations Management”, Prentice Hall India, 2005.
9. Karajewski Lee J. and Ritzman L. P., “Operations Management”, Pearson Education, Delhi, 2002.

B. Tech. (PRODUCTION) Semester 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
PR 420 DESIGN AND MANAGEMENT OF SMALL SCALE ENTERPRISE	**3**	**0**	**0**	**3**

CO1	Describe basic concepts of entrepreneurship.
CO2	Analysis of different types of entrepreneurships.
CO3	Analysis of various types of problems related to entrepreneurship.
CO4	Basics of entrepreneurship managements.
CO5	Analysis of various aspects of modern management techniques.
CO6	Describe the various aspects of project planning.

- **CONCEPTS OF ENTREPRENEURSHIP (10 Hours)**
  Scope of entrepreneurship, Definitions of entrepreneurship and entrepreneur, Characteristics of an entrepreneur, Entrepreneurial development models and theories, Entrepreneurs Vs Managers
  Classification of entrepreneurs, Major types of entrepreneurship – Techno entrepreneurship, Women entrepreneurship, Social entrepreneurship, Intrapreneurship (Corporate entrepreneurship, Rural entrepreneurship, Family business etc., Problems for small scale enterprises and industrial sickness
  Entrepreneurial tests, Entrepreneurial environment – Political, Legal, Technical, Natural, Economic, Socio-cultural, etc.
- **ENTREPRENEURSHIP AND MANAGEMENT (05 Hours)**
  Introduction to management, Features of management, Nature of management, Principles of management, Fundamentals of planning, Types of business organizations.
- **FUNCTIONAL MANAGEMENT AREA IN ENTREPRENEURSHIP (16 Hours)**
  Core concepts of marketing, Marketing mix (4p), Segmentation – targeting – positioning, marketing research, Marketing information system, Concept of International marketing, Difference between domestic marketing & International marketing, Buying behavior, Introduction to operations management, Types of operation systems, Types of layouts, Material handling, Purchasing & store System, Inventory management, Location problem, Roles & functions of Personnel manager, Recruitment, Selection, Training, Industrial dispute, Collective bargaining, Goal of financial management, Key activities in financial management, Organization of financial management, Financial institutions, Financial instruments, Sources of finance, Ratio analysis, Capital budgeting, Working capital management.
- **MODERN MANAGEMENT ASPECTS (02 Hours)**
  Introduction to ERP, e – CRM, SCM, RE – Engineering, WTO, IPR, etc.
- **SUPPORT AND SOURCES OF INFORMATION FOR ENTREPRENEURSHIP (02 Hours)**
  State level institutions, Central level institutions and other agencies
- **PROJECT PLANNING (10 Hours)**
  Product development – Stages in product development, Feasibility analysis – technical, economic, financial etc., Project report, Project appraisal, Setting up an industrial unit – procedure and formalities in setting up an industrial unit.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Charantimath P. M., “Entrepreneurial Development Small Business Enterprises”, Pearson Education, 2006.
2. Desai Vasant, “Dynamics of Entrepreneurial Development and Management”, Himalaya Publishing House, India, 2001.
3. Banga T. R. and Shrama S.C., “Industrial Organisation and Engineering Economics”, Khanna Publishers, 1995.
4. Keller Kotler P., Koshi and Jha, “Marketing Management – A South Asian Perspective”, Pearson, 2007.
5. Prasad L.M., “Principles and Practice of Management”, S. Chand & Co., 1994.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 421 DESIGN OF ALTERNATIVE ENERGY SYSTEMS	**3**	**0**	**0**	**3**

CO1	Provide overview of energy systems that may replace fossil fuel systems
CO2	Develop design and modelling skills applicable to energy systems
CO3	Develop knowledge in designing of wind machines, solar energy system, biomass system, etc.
CO4	Design and analyze solar PV system
CO5	Analyze solar cooling system and its application
CO6	Understand economic and social aspects of applying alternate energy systems

- **DESIGN OF WIND MACHINES** **(08 Hours)**
  Basic theory, design concept, design of duten type wind machine, Designing three bladed propeller type – wind machine, site selection.

- **DESIGN OF SOLAR COOLING SYSTEM** **(08 Hours)**
  Absorption principles, acqua – ammonia, Li – Br – H_2O system, determination of collection area for a given cooling application.

- **DESIGN OF BIOMASS ENERGY SYSTEMS** **(08 Hours)**
  Alcohol fermentation, anaerobic digestion design of bio gas plant based on total cost minimization, factors influencing biogas plant performance.

- **GASIFIER** **(08 Hours)**
  Gasifier engine based gen – sets, decentralized electricity – generation, biomass gasifier, its principles, chemical reactions, design concepts of biomass gasifier, performance.

- **SOLAR PHOTO – VOLTAIC SYSTEMS** **(07 Hours)**
  Theory of solar cells, design concept of PV system, concept of PV diesel hybrid system.

- **THERMIONIC GENERATORS AND FUEL CELLS** **(06 Hours)**
  Electricity generation potential, principles and design of thermionic generators & fuel cells.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Peter Auer, “Advances in Energy Technologies”, Academic Press, 1977.
2. Twidell J. W. and Weir A. D., “Renewable Energy Resources”, ELBS, 1986.
3. Sukhatme S. P., “Solar Energy Principles of Thermal Collection and Storage”, Tata McGraw Hill, New Delhi, 1996.
4. Kreith and Kreider, “Hand Book of Solar Energy” McGraw Hill, New York, 1980.
5. Duffie J. A. and Beckman W. A., “Solar Engineering of Thermal Processes”, John Wiley & Sons, New York, 1991.
6. Channiwala S. A., “Solar Energy Data Book”, SVNIT, Surat, 2000.

B. Tech. (MECHANICAL) Semester -7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 423 COMPUTATIONAL FLUID FLOW & HEAT TRANSFER	3	0	0	3

CO1	Understand the concepts of mathematical modeling for fluid flow and associated transport processes
CO2	Classify various discretization methods and errors associated with numerical solution
CO3	Establish discrete algebraic equations using finite difference method
CO4	Apply finite volume method for numerical modeling of fluid flow
CO5	Develop solution of two-dimensional incompressible viscous flow problems using stream function vorticity formulation
CO6	Solve Navier-Stokes equations for incompressible flows using semi-explicit and semiimplicit algorithms

- **REVIEW OF GOVERNING EQUATIONS CONNECTIVE FLUID FLOW AND HEAT TRANSFER**
  Conservation of mass, Newton's second law of motion, Expanded forms of Navier-Stokes equations, Conservation of energy principle, Special forms of the Navier-Stokes equations, Classification of second order partial differential equations, Initial and boundary conditions, Governing equations in generalized coordinates.
  (08 Hours)

- **FINITE DIFFERENCE, DISCRETIZATION, CONSISTENCY, STABILITY AND FUNDAMENTAL OF FLUID FLOW MODELING**
  Elementary finite difference quotients, Basic aspects of finite difference equations, Errors and stability analysis, Some nontrivial problems with discretised equations, Applications to heat conduction and convection.
  (08 Hours)

- **SOLUTIONS OF VISCOUS INCOMPRESSIBLE FLOWS BY STREAM FUNCTION, VORTICITY FORMULATION**
  Two dimensional incompressible viscous flow, Incorporation of upwind scheme, Estimation of discretization error, Application to curvilinear geometries, Derivation of surface pressure and drag.
  (08 Hours)

- **SOLUTION OF NAVIER-STOKES EQUATIONS FOR INCOMPRESSIBLE FLOWS USING MAC AND SIMPLE ALGORITHMS**
  Staggered grid, Solution of the unsteady Navier-Stokes equations, Solutions of energy equation, Formulation of the flow problems, Simple algorithm. **(08 Hours)**

- **INTRODUCTION TO FINITE VOLUME METHOD** **(06 Hours)**
  Integral approach, discretisation & higher order schemes, Application to complex geometry.

- **INTRODUCTION TO FINITE ELEMENT METHOD** **(07 Hours)**
  Stiffness matrix, Isoparametric elements, Formulation of finite elements for flow and heat transfer problems.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Anderson D.A., Tannehill J.C. and Pletcher R.H., "Computational Fluid Mechanics and Heat Transfer", Hemisphere Publishing Co., New York, 2004.
2. Patankar S.V., "Numerical Heat Transfer and Flow", McGraw Hill, New York, 2002.
3. Ferziger J. H. and Peric M., "Computational Methods in Fluid Dynamics", Springer, New York, 2003.
4. Muralidhar K. and Sunderrarajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2005.
5. Chung T. J., "Computational Fluid Dynamics", Cambridge University Press, London, 2005.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 425 ANALYSIS AND SYNTHESIS OF MECHANISMS	3	0	0	3

CO1	Describe the mechanisms for achieving different types of motions.
CO2	Explain of different types of motions.
CO3	Understand of kinematics involved in plane mechanisms.
CO4	Describe the different theorems for studying of mechanisms.
CO5	Analysis of curvature theory.
CO6	Apply the basics understanding and solve the problems of kinematic synthesis for plane mechanisms.

- **INTRODUCTION TO MECHANISMS (05 Hours)**
  Geometry of motion, plane and space mechanisms, terminology, definitions, and assumptions. relative motion, degree of freedom, kinematic inversions, mechanical advantage.

- **KINEMATIC ANALYSIS OF PLANE MECHANISMS (15 Hours)**
  Position and displacement analysis – position of a point, graphical and complex – algebra method for displacement. Rotational and Translation displacement. Velocity analysis – relative motion, linear and angular velocity, relative velocity, instantaneous centres, Aronhold Kennedy theorem of three centres, angular velocity ratio, Freudenstein's theorem. Velocity analysis- analytical method, graphical method. Acceleration analysis linear and angular acceleration, acceleration difference, relative acceleration and Coriolis acceleration. Acceleration analysis by analytical and graphical methods. Computer – aided kinematic analysis.

- **CURVATURE THEORY (10 Hours)**
  Fixed and moving centroids, velocity and acceleration, inflection points and inflection circle. Euler Savary equation, Bobillier's theorem, cubic of stationery curvature.

- **KINEMATIC SYNTHESIS OF PLANE MECHANISMS (15 Hours)**
  Type, number and dimensional synthesis, function generation and path generation, Chebychev's spacing three, four and five point synthesis. Burmeseter point theory, synthesis by analytical and graphical methods. Computer aided synthesis.

(Total Lecture Hours : 45)

BOOKS RECOMMENDED

1. Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw Hill, 1995.
2. Sandor G.N. and Erdman A.G., "Mechanism Design – Analysis and Synthesis", Prentice Hall India, 1984.
3. Ghosh A. and Mallik A.K., "Theory of Mechanisms and Machines", East West Press, 1998.
4. Hall A. S., "Kinematics and Linkage Design", Prentice Hall India, 1966.
5. Hartenberg R.S. and Donavit J., "Kinematic Synthesis of Linkages", McGraw Hill, 1964.
6. Duffy J., "Analysis of Mechanisms and Robot Manipulators", Edward Arnold Publishers, 1980.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 427 DESIGN OF MACHINE TOOLS	**3**	**0**	**0**	**3**

CO1	Apply design procedures to speed and feed boxes..
CO2	Analyze the kinematics of machine tools.
CO3	Design of kinematics involves in machine tool.
CO4	Illustrate the working of journal and antifriction bearings, and its selection and design.
CO5	Design spindle, column, table and ways.
CO6	Analyze the control systems for the machine tools.

- **INTRODUCTION** **(03 Hours)**
  General requirements to machine tools, Machine tool design recommendations, Classification of motions to shape surface, Machine tool drives for rectilinear motion, Periodic motion, Reversing motion etc.

- **KINEMATICS OF MACHINE TOOLS** **(05 Hours)**
  Kinematics or gearing diagram of lathe, Drilling machine, Milling machine etc. Machine tool drive, Principles specification of machine tool.

- **DESIGN OF KINEMATICS** **(05 Hours)**
  Methods to determine transmission ratios for drives, Mechanical transmission and its elements, hydraulic transmission and its elements.

- **SPEED AND FEED BOXES** **(08 Hours)**
  General requirement, Design of gear trains, Speed boxes types, Speed changing devices, Feed boxes, Characteristics of feed mechanism, types of rapid traverse mechanisms, variable devices.

- **SPINDLE DESIGN AND SPINDLE BEARINGS** **(08 Hours)**
  Main requirement, Materials and details of spindle design, Spindle Bearings, bearings, Types of bearings and their selections, Bearing materials BED.

- **COLUMNS, TABLES AND WAYS** **(08 Hours)**
  Materials, Typical constructions and design, Basic design procedure of machine tool structure, Design of columns, function and types of guide ways, Design criteria and calculation of slide ways.

- **MACHINE TOOLS CONTROL SYSTEMS** **(08 Hours)**
  Requirement of control system Selection and construction of control systems, Mechanical control system, Predilection control, Remote control, safety devices.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Mehta N.K., “Machine Tool Design”, Tata McGraw Hill, 1984.
2. Basu S.K. and Pal D.K., “Design of Machine Tools”, Oxford & IBH, 1983.
3. Acherkan N., “Machine Tool Design”, Mir Publishers, Moscow, 1968.
4. Koenigsberger K., “Design Principles of Metal Cutting Machine Tools”, Pergaman Press, 1964.
5. Sen G.C. and Bhattacharya A., “Principles of Machine Tool”, New Central Book Agency, 1971.
6. Tobias S.A., “Machine Tool Vibration”, Blackie Oxford, London, 1965.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 429 BIOMECHANICAL ENGINEERING	**3**	**0**	**0**	**3**

CO1	Understand the basics of biomechanics.
CO2	Analyze the kinetics and kinematics concepts involved for human motions.
CO3	Understand the biomechanics of human skeletal.
CO4	Describe the linear and angular kinematics of human movement.
CO5	Understand of human movement in fluid medium.
CO6	Discuss about biomaterials and their applications.

- **BIOMECHANICS (04 Hours)**
  Introduction, Basics of biomechanical / biomechanics of solids and perspective, Problem solving approach.

- **KINETICS AND KINEMATIC CONCEPTS FOR ANALYSING HUMAN MOTION (06 Hours)**
  Introduction, Standard reference terminology, Forms of motion, Joint movement terminology, Qualitative analysis of human movement, Tools for measuring kinematic quantities, Basic concepts related to kinetics, Mechanical load on human body, Tools for measuring kinetic quantities.

- **THE BIOMECHANICS OF HUMAN SKELETAL (08 Hours)**
  Introduction, Composition and structure of bone tissue, Bone growth and development, Bone response to stress, Osteoporosis, Joint architecture Joint stability, Joint flexibility, Technique for joint flexibility, Behavioral properties of musculotendinous unit, Structural organization of skeletal muscle, Skeletal muscle function, Factors affecting muscular force generation, Muscle strength, Power and endurance.

- **BIOMECHANICS OF HUMAN UPPER EXTREMITY AND LOWER EXTREMITY (10 Hours)**
  Introduction, Structure of Shoulder, elbow, hip, ankle, foot, spine, wrist. Joints of the hand and knee, loads on shoulder, elbow, hip, knee, ankle, foot and spine. Movements of shoulder, elbow, wrist, hand, hip, knee, ankle, foot and spine, Complex loads on shoulder, muscles of spine.

- **LINEAR AND ANGULAR KINEMATICS AND KINETIC OF HUMAN MOVEMENT (08 Hours)**
  Introduction, Linear kinematic quantities, Kinematic of projectile motion Factors influencing projectile trajectory, Analyzing projectile motion, Observing the angular kinematics of human movement, Measuring angles, Angular kinematics relationships, Relation between linear and angular motions, Newton's laws, Mechanical behavior of bodies in contact, Work, power and energy relationships, Resistance to angular acceleration, Angular momentum, Angular analogues of Newton's laws of motion, Centripetal force.

- **HUMAN MOVEMENT IN A FLUID MEDIUM (03 Hours)**
  Introduction, The nature of fluid, Buoyancy, Drag, Lift force, Propulsion in a fluid medium.

- **BIOMATERIAL, BIOMECHANICAL AND IT'S APPLICATION (06 Hours)**
  Introduction, Biological material, Man-made material, Current avenues of biomaterial research, Static load considerations, Cyclic loading consideration, Composite materials-the impetus for more flexible prostheses

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Fung Y. C., Perrone N. and Anliker M., "Biomechanics: It's Foundation and Objectives", Prentice Hall, 1972.
2. Hughes William, "Aspects of Biophysics", John Wiley & Sons, 1979.
3. Berger S. A., Goldsmith W. and Lewis E. R., "Introduction to Bioengineering", Oxford University Press, 2008.
4. Susan J. Hall, "Basic Biomechanics", McGraw Hill, 2006.
5. Tompkins J., "Biomedical Digital Signal Processing", Prentice Hall, 1993.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 420 OPTIMIZATION TECHNIQUES	**3**	**0**	**0**	**3**

CO1	Develop the Linear Programming (LP) models to solve the engineering and management problems.
CO2	Analyze the assignment models for engineering problems to get optimal solutions.
CO3	Discuss different transportation models to get the optimal solutions.
CO4	Construct the networks for optimizing the project duration and cost.
CO5	Solve the game problems for the given pay-off matrix to get the optimum mix of strategies.
CO6	Select statistical quality control tools for designing of products and process controls.

- **INTRODUCTION** **(15 Hours)**
  Single and Multivariable optimization methods, constrained optimization methods, Kuhn-Tucker conditions – Necessary & sufficiency theorems.

- **LINEAR PROGRAMMING** **(10 Hours)**
  Traveling salesman problem and Transshipment problems – post optimization analysis.

- **INTEGER PROGRAMMING** **(06 Hours)**
  All integer, mixed integer and zero-one programming.

- **GEOMETRIC PROGRAMMING** **(09 Hours)**
  Concept – degree of difficulty – solution of unconstrained & Network Analysis – CPM – PERT.

- **DYNAMIC PROGRAMMING**. **(05 Hours)**

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Deb K., “Optimization for Engineering Design”, Prentice Hall India, 1995.
2. Rao S.S., “Optimization Theory and Application”, Wiley Easter, 1984.
3. Reklaitis G.V., Ravindram A., Ragsdell K.M. “Engineering Optimization – Methods & Application”, Wiley, 1983.
4. Verma A. P., “Operations Research”, S. K. Kataria & Sons, 2007
5. Vora N. D., “Quantitative Techniques in Management”, Tata McGraw Hill, 2006.

B. Tech. (MECHANICAL) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
ME 431 AUTOMOBILE ENGINEERING	3	0	0	3

CO1	Explain construction and working of elements of transmission system of an automobile.
CO2	Select suitable type of steering system for an automobile.
CO3	Compare suspension systems and braking systems used in automobiles along with their constituent components.
CO4	Illustrate working of different types of electrical systems used in automobiles.
CO5	Evaluate vehicle performance and dynamics based on estimated traction forces and resistances.
CO6	Determine suitability of different types of engines and power sources for modern vehicles.

- **POWER PLANT** **(03 Hours)**
  Constructional features of different types of engines used in automobiles.

- **VEHICLE PERFORMANCE** **(05 Hours)**
  Resistance to motion of vehicle, air rolling and gradient resistances. power requirement for acceleration and gradability, selection of suitable rear axle and gear ratios.

- **DRIVE MECHANISMS** **(05 Hours)**
  Torque, thrust, propeller shaft, joints (universal) differential, axles, materials, bearing loads, rear wheel drive, front wheel drive, all wheel drive.

- **SUSPENSION** **(05 Hours)**
  Types, springs, materials, shackles and mounting, independent suspension system, torsion bar, shock absorber – types, construction and working, vibration and riding comforts.

- **BRAKES** **(05 Hours)**
  Types, response time and distances, braking efficiency, weight transfer during braking, shoe and disc brakes. Brakes power ratio, hydraulic and power brakes, layout and details of component, power, brakes, Anti Braking System (ABS).

- **FRONT AXLE AND STEERING SYSTEMS** **(06 Hours)**
  Axle parts and materials, load and stress, steering, heads axle bearing wheel alignment, steering geometry layout of system, steering system for independent suspension and front wheel drive, wheel wobble, power steering, etc.

- **CLUTCH** **(06 Hours)**
  Types and necessity, description and working, torque damper, pedal pressure, centrifugal automatic, vacuum hydraulic operated clutch, fluid transmission – advantages and disadvantages.

- **GEAR BOX** **(06 Hours)**
  Necessity, Sliding mesh, constant mesh, synchromech, epicyclic, overdrives, electrics transmission – advantages and disadvantages.

- **ELECTRICAL & ELECTRONICS EQUIPMENT** **(04 Hours)**
  Battery, permanent magnet & electromagnet starting motors, alternator and regulators, contact point ignition system, Electronic ignition systems, driver information & control devices power modulus.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Crause, W.H., “Automobile Mechanics”, Tata McGraw Hill, New Delhi, 2007.
2. Heinz Heisler, “Vehicle and Engine Technology”, Arnold, London, 1999.
3. Banga T.R. and Singh Nathu, “Automobile Engineering”, Khanna Publishers, Delhi, 2001.

4. Srinivasan S., “Automotive Engines”, Tata McGraw Hill, New Delhi, 2001.
5. Narang G.B.S., “Automobile Engineering”, Khanna Publishers, New Delhi, 2002.
6. Sharma R. P. , “Course in Automobile Engineering”, Dhanpat Rai and Sons, New Delhi, 1998.

Scheme for Teaching & Examination											
B. Tech. - IV (Mechanical) Eighth Semester											
Sr. No.	Course	Code	Teaching Scheme			Exam Scheme				Total Marks	Credits
						Theory		Tuto.	Pract.		
			L	T	P	Hrs.	Marks	Marks	Marks		
1	Elements of Gas Turbine	ME 402	3	1	0	2	100	25	-	125	4
2	Industrial Management Techniques	ME 404	3	1	0	2	100	25	-	125	4
3	Production Technology -II	ME 406	3	0	2	2	100	-	50	150	4
4	Instrumentation & Control	ME 408	3	0	0	-	100	-	-	100	3
5	Project	ME 410	0	0	8	-	-	-	200	200	4
6	Deptt. Elective-II*		3	0	0	2	100	-	-	100	3
	TOTAL		15	2	10		500	50	250	800	22
Total contact Hrs. per week (27) Total Credits =22 Total Marks = 800											

LIST OF DEPARTMENTAL ELECTIVES

B. Tech. IV (M) 8th Semester, ELECTIVE –II*

1. ME 414 : Maintenance Engineering
2. ME 416 : Design of Heat Exchangers
3. ME 418 : Design of Material Handling Equipments
4. ME 422 : Cryogenics
5. ME 424 : Robotics
6. ME 426 : Total Quality Management
7. ME 428 : Advanced Mechanical Vibrations
8. ME 432 : Design of Pressure Vessels
9. ME 434 : Fluid Power Engineering
10. ME 436 : Fuzzy Logic Applications in Mechanical Engineering
11. ME 438 : Heat Treatment & Surface Coating Processes
12. ME 442 : Mechanical Cost Estimation

B. Tech. (MECHANICAL) Semester – 8	L	T	P	C
ME 402 ELEMENTS OF GAS TURBINES	**3**	**1**	**0**	**4**

CO1	Describe different cycle arrangements of gas turbines and their applications
CO2	Analyse ideal and actual cycle.
CO3	Recognize the principles of design, construction and operation of the major components of the gas turbine engine.
CO4	Predict the effect of compressibility and flow behaviour within the gas turbine components.
CO5	Solve 1-D design problems based on 1-D duct with variable area, friction and heat transfer.
CO6	Estimate the position and effect of normal shock within the 1-D compressible flow duct.

- **INTRODUCTION TO COMPRESSIBLE FLOW (04 Hours)**
  Thermodynamics of compressible flow, Perfect Gas, General effect of compressibility on fluid flow, Stagnation conditions.

- **1-D STEADY ISENTROPIC FLOW IN VARIABLE AREA PASSAGES (06 Hours)**
  Introduction, Governing equation, Isentropic process, Effect of area change in flow properties, chocking, Flow through nozzles, Flow through diffuser, Use of gas table, sums.

- **FLOW IN CONSTANT AREA DUCT WITH FRICTION (04 Hours)**
  Governing equation, Fanno line & its characteristic, Chocking

- **FLOW IN CONSTANT AREA DUCT WITH HEAT TRANSFER (04 Hours)**
  Governing equation, Rayleigh line its characteristic, Flow with maximum heat transfer

- **FLOW WITH NORMAL SHOCK (05 Hours)**
  Development of shockwaves, Strength of a shock waves, Governing equations (R.-h. equation), Pandtl-Mayer relations.

- **BASIC CYCLE & APPLICATION OF GAS TURBINE PLANT (05 Hours)**
  Brayton cycle, Basic & actual cycle analysis, Methods to improve the performance of basic cycle, General overview for applications of Gas turbine plant.

- **MAJOR COMPONENTS & SUPPORTING SYSTEMS OF GAS TURBINE PLANT COMPRESSOR**
  Centrifugal & axial flow compressor, Components & their functions, Velocity triangle, Performance, Slip factor, Prewhirl, Choking, Surging & stalling, Degree of reaction. **(06 Hours)**

- **COMBUSTION CHAMBER (06 Hours)**
  Types, Design requirements, Arrangement of combustion chamber, Losses & efficiency.

- **TURBINE (05 Hours)**
  Types, Materials for turbine blades & blade cooling, Air, Lubrication, Starting & Power transmission systems.

(Total lecture Hours: 45 +Tutorial Hrs:15)

BOOKS RECOMMENDED

1. Yahya S.M., “Fundamentals of Compressible Flow”, New Age International, 2003.
2. Radhakrishnan T., “Gas Dynamics”, Prentice Hall India, 2003.
3. Boyce Meherwan P., “Gas Turbine Engineering Hand Book, Gulf Publication, 2003.
4. Cohen Henry and Rogers G. F. C., “Gas Turbine Theory”, Addison Wesley Longman, 1996.
5. Ganesan V., “Gas Turbine”, Tata McGraw Hill, 2003.

B. Tech. (MECHANICAL) Semester – 8	L	T	P	C
ME 404 INDUSTRIAL MANAGEMENT TECHNIQUES	3	1	0	4

CO1	Develop the Linear Programming (LP) models to solve the engineering and management problems.
CO2	Analyze the assignment models for engineering problems to get optimal solutions.
CO3	Discuss different transportation models to get the optimal soltuions.
CO4	Construct the networks for optimizing the project duration and cost.
CO5	Solve the game problems for the given pay-off matrix to get the optimum mix of strategies.
CO6	Select statistical quality control tools for designing of products and process controls.

- **INTRODUCTION** **(08 Hours)**
  Linear programming, formulation, graphical method, Simplex method, difficulties in Simplex method, duality.

- **ASSIGNMENT & TRANSPORTATION MODELS** **(08 Hours)**

- **SEQUENCING PROBLEMS** **(03 Hours)**
  Flow shop & job shop problems, methods of solution.

- **PROJECT MANAGEMENT WITH CPM, PERT** **(08 Hours)**

- **THEORY OF GAMES** **(04 Hours)**
  Two person zero sum games, Dominance rule, Application of LP to game problems.

- **STATISTICAL QUALITY CONTROL** **(06 Hours)**
  Control charts for variables, fraction defectives, proportion defectives control & specification limits, percentage defectives, Relative Precision Index (RPI).

- **ACCEPTANCE SAMPLING** **(06 Hours)**
  Operating characteristic curves, single, double, multiple and sequential sampling plans, AOQ, AOQL.

- **PATENTS AND COPYRIGHTS** **(02 Hours)**
  Patents laws GATT, TRIPS, TRIMS, IPR etc in Global Perspective, Patents – Invention, Modification, Product and Process patents copyright.

(Total Lecture Hours: 45 +Tutorial Hrs :15)

BOOKS RECOMMENDED

1. Sharma S. D., “Operations Research”, Kedarnath Ramnath & Co., 1996.
2. Vohra N.D., “Quantitative Techniques in Management”, Tata McGraw Hill, 1990.
3. Dave N. R. and Manglani A. K., “Operation Research”, Acharya Publications, 1992.
4. Gupta R.C., “Statistical Quality Control”, Khanna Publishers, 1994.
5. Narayanan, “Patent Law”, Calcutta Eastern Law House, 1998.
6. Gopalkrishnan N. S., “Intellectual Property”, NLSIU, India, 1994.

B. Tech. (MECHANICAL) Semester – 8	L	T	P	C
ME 406 PRODUCTION TECHNOLOGY – II	3	0	2	4

CO1	Understand the terms related to metrology and techniques to measure length, angle, taper, screw thread and gear, and surface roughness
CO2	Explain the limit gauges for checking internal and external features
CO3	Illustrate mechanism of metal forming processes
CO4	Analyze bulk deformation processes such as forging, rolling, wire drawing and extrusion
CO5	Design cutting tools and form tools
CO6	Design blanking and piercing dies

- **METROLOGY** **(20 Hours)**

  Introduction to Metrology
  Measurement of length and angle
  Gear and thread measurement
  Surface roughness measurement
  Limit, Fit, Tolerance and Tolerance analysis, Limit gauges
  Optical Measuring instruments, Computers in Metrology.

- **MECHANICAL WORKING OF METALS** **(15 Hours)**

  Introduction to plastic deformation and yield criteria
  Mechanics of forming processes
  Cold and hot forming processes
  Analysis of forging, rolling, drawing, and extrusion.

- **TOOL DESIGN** **(10 Hours)**

  Design of single point cutting tools and form tools
  Design of multipoint cutting tools (Drill, Milling cutter, Broach)
  Design of blanking and piercing dies.

(Total contact hours: 45)

PRACTICALS

1. To calibrate given passometer.
2. To find angle of V-block, taper, and radius of circular arc.
3. To calibrate given gear tooth vernier.
4. To find the pitch of the given screw threads.
5. To find the angle of taper using sine bar.
6. To draw stress-strain behavior for model material.
7. To measure the force required in extrusion.
8. To find flow stress of the given material and to plot a graph of forging ratio vs flow stress.

BOOKS RECOMMENDED

1. Jain, R. K., “Engineering Metrology”, Khanna Publishers, 1997.
2. Ghosh A. and Mallik A. K., “Manufacturing Science” East West Press New Delhi, 1991.
3. Spliter David (Contributor, Editor), “Fundamentals of Tool Design”, Society of Manufacturing Engineers (SME), Michigan, 2003.
4. Donaldson Cyril, Lecain George H and Goold V C, “Tool Design”, Tata McGraw Hill, New Delhi, 2005.

5. Pacquin, J.R and Crowley, R. E., “Die Design Fundamentals”, Industrial Press, 1986.

B. Tech. (MECHANICAL) Semester – 8	L	T	P	C
ME 408 INSTRUMENTATION & CONTROL	3	0	0	3

CO1	Categorize different types of control system and model a complicated system into a more simplified form using transfer function concept.
CO2	Identify the needs of different types of controllers to ascertain the required dynamic response from the system.
CO3	Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and explain the nature of stability of the system
CO4	Analyse instruments characteristics using method of least square and performance characteristics of instruments
CO5	Analyse the function of various transducers and sensors
CO6	Elaborate the knowledge about data acquisition and data processing

- **FUNDAMENTALS OF CONTROL SYSTEM (07 Hours)**
  Basic concepts of control system, Classification, Transfer function, Block diagram and Signal flow graph.

- **COMPONENTS AND TYPES OF CONTROLLERS (08 Hours)**
  Control system components, Derivative, proportional and Integral controllers and their combinations, Relative merits and drawbacks, Hydraulic and pneumatic control systems, Industrial applications of control systems.

- **TIME RESPONSE AND STABILITY ANALYSIS (07 Hours)**
  Response characteristic of control systems, Laplace transformation, Stability criteria, Root Locus and Routh stability Criterion.

- **INSTRUMENT CHARACTERISTICS (07 Hours)**
  Method of least square, Generalized performance characteristics of instruments, First and Second order instruments, Response of a general form of instrument to step and linear input.

- **SENSORS & TRANSDUCERS (08 Hours)**
  Introduction, Mechanical detector – transducer elements, Classification of transducers, Transducer actuating mechanism. Resistance transducers, Variable inductance transducers, Mutual inductance transducer, Capacitive transducer, Piezo electric transducer LVDT, Hal effect transducers, Thermoelectric transducers, Photoelectric transducer, Photoemisive cell, Strain gauges, Types of strain gauges.

- **DATA ACQUISITION & PROCESSING (08 Hours)**
  Data transmission, Display devices and records, Signal conditioning, D to A and A to D convectors, Data storage, Introduction of LabVIEW software & programming exercising for USB data acquisition.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Holman J. P. and Gajda W. J., “Experimental Methods for Engineers”, Tata McGraw Hill, New Delhi, 2003.
2. Doebalin E.O., “Measurement System – Application and Design”, McGraw Hill, New York, 2004.
3. Beckworth T.G. and Buck W.L., “Mechanical Measurements”, Addison Wesely, 2002.
4. Donald. P.E., “Industrial Instrumentation”, CBS Publisher, New Delhi, 2004.
5. Nagrath I.J. and Gopal M., “Control Systems Engineering”, Wiley Eastern, New Delhi, 2006.
6. Ogata K., “Modern Control Engineering”, Prentice Hall India, 2003.
7. Dransfield Peter, “Engineering Systems and Automatic Control”, Prentice Hall India, 1974.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 414 MAINTENANCE ENGINEERING	**3**	**0**	**0**	**3**

CO1	Explain the importance of reliability and maintainability in plants and their important components.
CO2	Discuss the technologies and works related to maintenance and reliability.
CO3	Analyze the maintenance planning and control strategies.
CO4	Apply the maintenance techniques on different types of problems and solve them.
CO5	Explain the lubrication mechanism and their governing equations.
CO6	Discuss the total productive maintenance.

- **INTRODUCTION TO RELIABILITY & MAINTAINABILITY (06 Hours)**
  Introduction to reliability maintainability and availability, reliability and total life cycle, reliability and quality factors affecting reliability, probability of survival, failure rate, meantime between failures (MTTF).

  Concept of maintainability, meantime to repair (MTTR) design consideration, factors affecting maintainability, design & Installation factors, specifications, reliability, maintainability and availability relationship, plant efficiency, reliability survey.

- **INTRODUCTION TO MAINTENANCE JOBS & TECHNOLOGY (06 Hours)**
  Assembling & Dismantling, inspection & adjustment, lubrication, various basic methods of repairing, Maintenance – characteristics of item/system, routine Maintenance, fixed time maintenance, breakdown maintenance, shutdown maintenance, maintenance work load, maintenance budget, documentation & recording system.

- **MAINTENANCE PLANNING & CONTROL (06 Hours)**
  Objectives of planning maintenance, maintenance philosophies, maintenance organization, Basics of planned maintenance systems, plannability, control system, manpower planning, maintenance audit, human factors, fault tree analysis, computer aided maintenance.

- **TYPES OF EQUIPMENTS (06 Hours)**
  Automobiles, earthmoving equipments, agricultural and farm equipments, chemical process equipment, M/c. Tool, SPM, NC-CNC machines, hydraulic system, pneumatic system, rolling equipments, Mining & metallurgical equipments, pharmaceutical & medico equipments.

- **LUBRICATION THEORY & PRACTICE (05 Hours)**
  Importance in maintenance, purpose, classification, characteristics, additives, selection & testing

- **DIAGNOSTIC MAINTENANCE (06 Hours)**
  Introduction to maintenance techniques preventive maintenance, Predictive maintenance, condition monitoring, signature analysis, online / off line maintenance, non-destructive test, wear particles & oil analysis, thermography, ferrography, SME (Scanning Electro Microscope) importance of vibration & noise control in maintenance.

- **INTRODUCTION TO TPM (TOTAL PRODUCTIVE MAINTENANCE) (04 Hours)**
  Types of losses, measures to control losses, basics of TPM, organization structure, cost estimation, safety measures, work permit etc.

- **CASE- STUDIES (04 Hours)**
  (i) Repairing of 3 – Jaw / 4- Jaw Chuck
  (ii) Crack repairing in cast iron body
  (iii) Repairing of water-mono-block pumpset.
  (iv) Repairing of Tail-stock of a Lathe machines
  (v) Repairing of crack on lathe bed guide

- **MAINTENANCE MATERIALS (02 Hours)**
  Tools, seals, O' Ring, bushes, gaskets, welding rods, bearings, piston rings, liners, lubricants, oil, grease etc.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Kelly Anthony, “Maintenance Planning and Control”, East West Press, New Delhi, 2000.
2. Garg H.P. , “Industrial Maintenance”, S. Chand & Co., 2007.
3. Rao J.S. and Gupta K. “Theory and Practice of Mechanical Vibrations”, Wiley Eastern, 1987.
4. Srinath L.S., “Reliability Engineering”, East West Press, New Delhi, 2000.
5. Srivastava Sushil Kumar, “Industrial Maintenance Management”, S. Chand & Co., 2005.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 416 DESIGN OF HEAT EXCHANGERS	**3**	**0**	**0**	**3**

CO1	Summarize the different types of heat exchanger used in application.
CO2	Estimate the performance of shell and tube type heat exchanger.
CO3	Analyze the performance of tube finned heat exchanger.
CO4	Evaluate the performance of plate finned heat exchanger.
CO5	Calculation of pressure drop in compact heat exchanger.
CO6	Design the heat exchnager for the radiation furnace.

- **INTRODUCTION** **(05 Hours)**
  Heat exchanger types, constructional details of different heat exchangers, selection of heat exchanger.

- **DESIGN OF DOUBLE – PIPE EXCHANGERS** **(09 Hours)**
  Tube – Side heat transfer and pressure loss calculations, annular heat transfer and pressure loss calculations.

- **SHELL AND TUBE HEAT EXCHANGERS** **(09 Hours)**
  Approximate sizing of shell & tube heat exchangers, shell – side and tube – side calculations. design procedure for plain and finned tubes.

- **DESIGN OF COMPACT HEAT EXCHANGERS AND REGENERATORS** **(09 Hours)**
  Types of regenerator matrix. design of coils. design of automobile radiator.

- **DESIGN OF RADIATION FURNACES** **(09 Hours)**
  Well stirred model and longitudinal model.

- **FOULING MECHANISMS** **(04 Hours)**
  Growth and its effect, methods for minimizing fouling.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Shah R. K., “Fundamentals of Heat Exchangers Design”, John Wiley & Sons, 2003.
2. Kakakc S. and Liu H., “Heat Exchangers, Selection, Rating and Thermal Design”, CRC Press, Boston, 2012.
3. Kays and London, ”Compact Heat Exchangers” McGraw Hill, New York, 1998.
4. Saunders E.A.D., “Heat Exchangers - Selection, Design and Construction”, Longman Scientific & Technical, 1998.
5. Kern D.O., “Process Heat Transfer”, Tata McGraw Hill, 2000.
6. Heat Exchangers Design Handbook, Vol. 1 to 5, VDI, 1983.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 418 DESIGN OF MATERIAL HANDLING EQUIPMENTS	**3**	**0**	**0**	**3**

CO1	Understand the various aspects of material handling systems.
CO2	Understand the application of material handling systems.
CO3	Describe the design of Hoists.
CO4	Analysis and design of conveyors.
CO5	Understand the various types of conveyors.
CO6	Study of different types of Elevators.

- **INTRODUCTION** **(02 Hours)**
  Types of material handling equipments, Selection and applications.

- **DESIGN OF HOISTS** **(15 Hours)**
  Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, Pulley systems, Sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks, Crane grabs, Lifting magnets, Grabbing attachments, Design of arresting gear, Brakes: shoe, Band and cone types.

- **DRIVES OF HOISTING GEAR** **(09 Hours)**
  Hand and power drives, Traveling gear, Rail traveling mechanism, Cantilever and monorail cranes, Slewing, Jib and luffing gear, Cogwheel drive, Selecting the motor ratings.

- **CONVEYORS** **(09 Hours)**
  Types, Description, Design and applications of Belt Conveyors, Apron Conveyors and Escalators pneumatic conveyors, Screw conveyors and vibratory conveyors.

- **ELEVATORS** **(10 Hours)**
  Bucket elevators: design, Loading and bucket arrangements, Cage elevators, Shaft way, Guides, counter weights, Hoisting machine, Safety devices, Design of form lift trucks.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. ASME, “Materials Handling Handbook”, Wiley InterScience, 1985.
2. Spivakovsy A.O. and Dyachkov, V.K., “Conveying Machines”, MIR Publishers, 1985.
3. Alexandrov M., “Materials Handling Equipments”, MIR Publishers, 1981.
4. Chary, S. N, “Production and Operations Management”, Tata McGraw Hill, New Delhi, 2004.
5. Design Data (PSG College of Engg. & Tech.), DPV Printers, Coimbatore, 2000.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 422 CRYOGENICS	3	0	0	3

CO1	Select a suitable cryogen and material for development of ceryogenic system for different applications
CO2	Design and analyze gas liquefaction system and cryogenic refrigeration systems including cryocoolers.
CO3	Select proper cryogenic insulating material and designing of cryogenic insulation.
CO4	Analyse and design gas purification and separation system using cryogenics
CO5	Select and design storage, handling, and transfer systems for cryogens
CO6	Design vacuum system for cryogenic application.

- **INTRODUCTION** **(03 Hours)**
  Introduction and application**.**

- **CRYOGENICS FLUIDS** **(04 Hours)**
  Properties of air, Oxygen, Nitrogen, Hydrogen, Helium and its isotopes.

- **CRYOGENICS REFRIGERATION SYSTEMS** **(04 Hours)**
  Recuperative & regenerative cycles, Joule Thomson cycle ; Gifford , Mcmohan cycle, Stirling cycle, Pulse Tube refrigeration, Magneto caloric refrigeration, Vuilleumier refrigerator.

- **GAS LIQUIFACTION SYSTEMS** **(04 Hours)**
  Ideal systems, Linde, Linde dual pressure system, Claude, Heylandt, Kapitza systems, Cascade cycle.

- **CRYOGENIC INSULATION** **(03 Hours)**
  Vacuum insulation, Multilayer insulation (MLI), Methods of measuring effective thermal conductivity of MLI, Liquid & vapour shield, Evacuated porous insulation, Gas filled powders and fibrous materials, Solid foams.

- **CRYOGENIC INSTRUMENTATION** **(03 Hours)**
  Peculiarities of cryogenic strain measurement, Pressure, Flow, Density, Temperature and liquid level measurement for cryogenic application.

- **PURIFICATION AND SEPARATION OF GASES** **(04 Hours)**
  Liquefied natural gas: Principles of gas separation: Separation by condensation & flashing, Separation by distillation. Air separation system: Linde single column system. Linde double, Column systems etc, Liquefaction of Natural Gas.

- **STORAGE & HANDLING SYSTEMS** **(03 Hours)**
  Dewar vessel design, Piping, Support systems, Vessel safety devices and storage systems, Industrial storage systems.

- **TRANSFER SYSTEMS** **(04 Hours)**
  Transfer from storage, Un-insulated transfer lines, Insulated lines, Transfer system components.

- **PROPERTIES AND SELECTION OF MATERIALS** **(05 Hours)**
  Study of material properties & their selection for cryogenic application.

- **VACUUM SYSTEMS, CRYO PUMPING**. **(03 Hours)**

- **EQUIPMENTS FOR LOW TEMPERATURE SYSTEMS** **(05 Hours)**
  Heat exchangers, Compressors, Expanders.

(Total Lecture Hours : 45)

BOOKS RECOMMENDED

1. Hastlden, C., “Cryogenic Fundamentals”, Academic Press, 2001.
2. Barron R., “Cryogenic Systems”, Plenum Press, 2001.
3. Walker, “Cryocoolers”, Plenum Press, 2000.
4. Mikulin, Y., “Theory and Design of Cryogenic Systems”, MIR Publishers, 2002.
5. Barron, R. F., “Cryogenics Systems”, Oxford Press, USA, 2002.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 424 ROBOTICS	**3**	**0**	**0**	**3**

CO1	Explain the basics of robotic systems.
CO2	Apply the concept of robot arm kinematics.
CO3	Analyse statics and dynamics of robots.
CO4	Evaluate the manipulator trajectories and robot end effectors.
CO5	Decide the control of robot manipulators.
CO6	Illustrate robot programming, sensing and vision.

- **INTRODUCTION** **(04 Hours)**
  Background – Historical development – Robot arm kinematics & dynamics – Manipulator trajectory planning & motion control – Robot sensing – Robot programming language – Machine intelligence.

- **ROBOT ARM KINEMATICS** **(07 Hours)**
  Introduction – The direct kinematics problem –Inverse kinematics solution.

- **ROBOT ARM DYNAMICS** **(07 Hours)**
  Introduction – Lagrange-Euler formulation – Newton-Euler formulation – Generalized D'Alembert equations of motion.

- **PLANNING OF MANIPULATOR TRAJECTORIES** **(05 Hours)**
  Introduction – General considerations in trajectory planning – Joint interpolated trajectories – Planning of manipulation of Cartesian path trajectories.

- **CONTROL OF ROBOT MANIPULATORS** **(06 Hours)**
  Introduction – Control of puma robot arm – Computed torque technique – Near minimum time control – Variable structure control – Nonlinear decoupled feedback control – Resolved motion control – Adaptive control.

- **ROBOT END EFFECTORS** **(05 Hours)**
  Types of end effectors – Mechanical grippers – Types of grippers – Tools as end effectors – Robot-End effecter Interface – Gripper selection & design.

- **SENSORS IN ROBOTICS** **(05 Hours)**
  Introduction – Transducers & sensors – Sensors in robotics – Range sensing – Proximity sensors – Touch sensors – Tactile sensors – Force & torque sensor – Misc. sensors & sensor based system.

- **LOW LEVEL VISION** **(04 Hours)**
  Introduction – Image acquisition – Illumination technique – Imaging geometry – Relationship between pixels – Preprocessing.

- **ROBOT PROGRAMMING LANGUAGES** **(02 Hours)**
  Introduction – Characteristics of robot level languages – Characteristics of task level languages.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Fu K. S., "Robotics", Mc-Graw Hill, 2003.
2. Craig J.J., "Introduction to Robotics", Pearson Education, 2006.
3. Rivin E.I., "Mechanical Design of Robots", McGraw Hill, 2002.
4. Schilling R.J., "Fundamentals of Robotics", Prentice Hall India, 2002.
5. Groover, Weiss, Nagel and Odrey, "Industrial Robotics", McGraw Hill, 1988

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 426 TOTAL QUALITY MANAGEMENT	**3**	**0**	**0**	**3**

CO1	Identify the concepts and philosophies of Total Quality Management.
CO2	Classify tools and techniques of Total Quality Management.
CO3	Explain the concept and methodology of Six Sigma.
CO4	Analyse the quality and performance improvement techniques.
CO5	Measure the Costs of Quality (COQ).
CO6	Develop the quality improvement techniques in the manufacturing organizations.

- **INTRODUCTION (03 Hours)**
  Quality concepts & Quality management philosophies – Evolution of quality management, Definitions of quality, quality and profitability, quality and business results, TQM linkages with productivity- factors affecting quality & productivity, Quality – productivity determinant model, Traditional versus modern quality management, principles of Total Quality (TQ).

- **TOTAL QUALITY MANAGEMENT (04 Hours)**
  Concepts and features of TQM, TQM versus traditional management practices, elements of TQM, Models of TQM such as Oakland model, an integrated model of TQM, The building Blocks model, TQMEX model etc, Implementation of TQM – Strategic framework for implementing TQM, Roadblocks in TQM implementation.

- **PHILOSOPHIES OF QUALITY GURUS LIKE DEMING (04 Hours)**
  Deming 14 points, Juran – Juran quality trilogy, Taguchi, Ishikawa, Shigeo Shingo, Imami etc.

- **STRATEGIC QUALITY PLANNING (03 Hours)**
  Vision, Mission, SWOT analysis. Seven tools of quality such as Pareto analysis, Cause – and – effect diagram, Histogram etc.

- **SEVEN NEW MANAGEMENT TOOLS (03 Hours)**
  Why-why diagram, Prioritization matrix, Affinity diagram, Matrix dia etc.

- **QUALITY COSTS (02 Hours)**
  Costs of quality (COQ), Juran's model of optimum quality costs, Analysis of COQ for improvement.
  .

- **QUALITY CIRCLES (02 Hours)**
  Philosophy, Structure, implementation & operation, Brainstorming – field of application, Types of Brainstorming, 5 – M checklists.

- **TOTAL ORGANIZATIONAL INVOLVEMENT (02 Hours)**
  Total employees involvement (TEI), Effective communications, Training & mentoring, Recognition & reward, Feedback & performance appraisal competencies required for different managerial roles, Techniques of TEI, Reward, Techniques of zero defects programme.

- **TOTAL PRODUCTIVE MAINTENANCE (02 Hours)**
  Features of TPM, Causes of machine failures, Types of maintenance, Overall equipment effectiveness (OEE)

- **QUALITY FUNCTION DEPLOYMENT (03 Hours)**
  Voice of Customer (VOC), House of Quality, QFD methodology.

- **5 - S OF HOUSEKEEPING (03 Hours)**
  Seiri, Seiton, Seiso, Seiketsu and Shjitsuke, Audit of 5 - S (Auditor's checklist and Display of 5 - S status).

- **KAIZEN PDCA CYCLE (03 Hours)**
  Kaizen versus innovation, The seven wastes, Techniques of Kaizen, Kaizen implementation

- **POKA YOKE** **(01 Hours)**
  Techniques, Pillars and working principles of Poka yoke

- **SIX SIGMA** **(05 Hours)**
  Methodology of Six Sigma – DMAIC, Statistics associated with Six Sigma, Determination of First – time yield (FTY) of process, Z value, Defects per unit (DPU), Defects per million opportunities (DPMO) and Calculating of sigma value of the process.

- **PROCESS CAPABILITY ANALYSIS** **(01 Hours)**
  Process capability index, Upper and lower capability indices, The CpK index, Capability ratio, Taguchi capability index etc.

- **QUALITY CERTIFICATION** **(02 Hours)**
  ISO 9000 series and QS 9000 series certification, ISO 9000 series of standards, ISO 9001 requirements Implementation, Documentation, Internal Audits, Registration.

- **FAILURE MODE & EFFECT ANALYSIS (FMEA) – DESIGN & PROCESS FMEA** **(01 Hours)**

- **CASE STUDIES** **(01 Hours)**

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Mukharjee P.N., “Total Quality Management”, Prentice Hall India, 2006.
2. Bhat Shridharan K. “Total Quality Management- Text and Cases”, Himalaya Publication, Mumbai, 2006.
3. Ramasamy Subbaraj, “Total Quality Management”, Tata McGraw Hill, New Delhi, 2005.
4. Bedi Kanshka, “Quality Management”, Oxford University Press, New Delhi, 2007.
5. Lakhe R.R. and Mohanty R. P., “Handbook of Total Quality Management” Jaico Publishing House, Mumbai, 2005.
6. Sreenivasan N.S. and Narayana V., “Total Quality Management with Six Sigma – A Practical Guide to be a World Class Company”, Quality Circle Forum of India, Hyderabad, 2003.
7. Evans J.R. and Lindsay W.M., “The Management and Control of Quality, Thomson Learning, 2006.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 428 ADVANCED MECHANICAL VIBRATIONS	**3**	**0**	**0**	**3**

CO1	Understand different methods to obtain the equation of motions of vibratory body.
CO2	Analysis of single degree freedom vibratory body.
CO3	Understand the two and multiple degree freedom system.
CO4	Analysis of vibration in continuous systems.
CO5	Understand the various techniques to control vibration.
CO6	Understand the application of industrial vibration.

- **REVIEW OF FUNDAMENTALS (03 Hours)**
  Undamped & Damped free vibration of single degree of freedom systems. Equations of motions. Energy method, Free vibration with viscous damping.

- **FORCED VIBRATION OF SINGLE DEGREE OF FREEDOM SYSTEM (05 Hours)**
  Forced vibration with constant harmonic excitation, Steady state vibrations, Forced vibration with reciprocating & rotary unbalance, vibration isolation & transmissibility frequency response curves.

- **TWO DEGREES OF FREEDOM SYSTEM (08 Hours)**
  Normal modes & natural frequencies, Torsional system. Generalized co-ordinates and co-ordinate coupling, Vibration absorbers, Lagrange's equation.

- **MULTI DEGREE OF FREEDOM SYSTEM (12 Hours)**
  Equations of motion in terms of influence coefficients flexibility coefficients, Maxwell's reciprocal Theorem, mass & stiffness matrix, Matrix methods, Torsional Vibrations of multi rotor systems. Stodola method, Holzer's method, Forced vibration of multi-rotor system, Dynamics of rotors.

- **VIBRATION OF CONTINUOUS SYSTEMS (12 Hours)**
  Longitudinal vibration of bar, Torsional vibration of shaft.

- **INDUSTRIAL APPLICATIONS (05 Hours)**
  Vibration isolation, shock isolation, Practical aspects of vibration isolation. Uses of vibration in cleaning, conveying, machining, condition monitoring. Vibration measuring instruments, etc.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Rao S.S., "Mechanical Vibrations", Addison Wesley, 1995.
2. Grover G. K., "Mechanical Vibrations", Nem Chand & Bros., Roorkee, 1996.
3. Kelley Graham S., "Fundamental of Mechanical Vibrations", McGraw Hill International, 1993.
4. Thomson W.I., "Theory of Vibration with Application", Prentice Hall, 1975.
5. Anderson R.A., "Fundamentals of Vibration", Amerind Publishing Co., 1972.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 432 DESIGN OF PRESSURE VESSELS	**3**	**0**	**0**	**3**

CO1	Describe the factors influencing the design of pressure vessels
CO2	Discuss the different stresses in pressure vessels
CO3	Design of pressure vessels as per ASME and IS codes
CO4	Select the heads, covers nozzles, openings and support of pressure vessels
CO5	Analyze the buckling load and discontinuity stresses of pressure vessels
CO6	Estimate the various head losses in pipes

- **FACTORS INFLUENCING THE DESIGN OF VESSELS (08 Hours)**
  Classification of pressure vessels, material selection, loads & types of failures.

- **STRESSES IN PRESSURE VESSELS (15 Hours)**
  Stresses in circular ring, cylinder & sphere, membrane stresses in vessels under internal pressure, thick cylinders, multilayered cylinders, stress consideration in the selection of flat plate & conical closure, elliptical, torispherical, hemispherical heads, autofretage of thick cylinders, thermal stresses & their significance, fatigue of pressure vessels.

- **DESIGN OF PRESSURE VESSELS (08 Hours)**
  Design as per ASME & IS codes, externally pressurized vessels, tall vertical vessels, support for vertical & horizontal vessels, nozzle & flanges. Discontinuity stresses in pressure vessels.

- **BASIC CONCEPTS (08 Hours)**
  Flow through pipes, Fanno & Reynolds flow, pressure drop in isothermal & non-isothermal flows.

- **HEAD LOSSES (06 Hours)**
  Loss due to contraction & expansion, loss due to fittings, equipmental length, distribution & mixing losses.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Joshi M.V. and Mahajan V.V., “Process Equipment Design”, McMillan, India, 1996.
2. Harvey J.F., “Pressure Vessels Design”, Van Nostrand Co., 1974.
3. Singh K.P. & Soler A. L., “Mechanical Design of Heat Exchangers”, Arcturus Publishers, New Jersey, 1984.
4. Moss Demis R., “Pressure Vessel Design Manual”, Gulf Publishing Co., Houston, 1987.
5. “Handbook of Piping Design”, CRC Press, 1992.
6. IS 2825: 1969, Code for Unfired Pressure Vessels.
7. “ASHRAE Handbook : Fundamentals”, ASHRAE, 1985.
8. ASME Code, Section 8th, Divison -I, Division-II.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 434 FLUID POWER ENGINEERING	3	0	0	3

CO1	Explain the fluid power system, their classifications and important elements of the fluid power system.
CO2	Illustrate the hydraulic power circuit by using symbols.
CO3	Discuss the different types of pumps, reservoirs, filters, pressure regulators in the power circuits.
CO4	Explain the methodology to control the temperature and pressure in the hydraulic power circuit.
CO5	Discuss the techniques to control the discharge and leakage of fluid.
CO6	Select the suitable hydraulic elements and develop the power circuits.

- **INTRODUCTION** **(03 Hours)**
  Fluid power types, Systems and their applications, Desirable Properties of hydraulic & pneumatic fluids, Selection of fluids, Components of FPS.
- **HYDRAULIC SYMBOLS** **(03 Hours)**
  Circuit elements, Fluid pumps and motors, Hydraulic valves, Types of controls, Reservoirs for fluids, Miscellaneous units, Composite symbols.
- **FLUID POWER PUMPS** **(04 Hours)**
  Classification, Reciprocating, Rotary, Centrifugal, Working principle, Performance characteristics curves, Selection. Design considerations.
- **FLUID RESERVOIRS** **(03 Hours)**
  Types, Function, Settling tank etc.
- **PRESSURE ACCUMULATORS** **(05 Hours)**
  Types, Selection & Design considerations.
- **FILTERS AND STRAINERS** **(04 Hours)**
  Filter types, Circuits, Rating, Pressure drop in filters, Operation and maintenance.
- **FLUID TEMPERATURE CONTROL** **(04 Hours)**
  Types of heat exchangers used for oil cooling, Design considerations for fluid temperature control.
- **CONTROL VALVES** **(04 Hours)**
  Pressure control valves, Flow –control valves, Directional control valves.
- **FLUID SEALS** **(03 Hours)**
  Types, Materials for seals, Seal lubrication.
- **ELECTRICAL DEVICES FOR HYDRAULIC CIRCUITS** **(04 Hours)**
  Solenoids, Torque motors, Safety considerations.
- **FLUID POWER ACTUATORS** **(04 Hours)**
  Linear hydraulic actuators, Gear motors, Vane motors, Piston motors, Hydraulic motor performance.
- **INDUSTRIAL HYDRAULIC AND PNEUMATIC CIRCUITS** **(04 Hours)**

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Esposito Anthony, “Fluid Power with Applications”, Prentice Hall, 2003.

2. Cundiff John S., “Fluid Power Circuits and Controls: Fundamentals and Applications”, Lavoisier Publication, 2001.
3. Parr Andrew, “Hydraulics and Pneumatics”, Jaico Publishing House, 1999.
4. Kokernak Robert P., “Fluid Power Technology”, Prentice Hall, 1998
5. Rohner Peter, “Industrial Hydraulic Control”, Prentice Hall, 1987.
6. Pippenger J.J., “Industrial Hydraulics”, McGraw Hill, 1979.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 436 FUZZY LOGIC APPLICATIONS IN MECHANICAL ENGINEERING	3	0	0	3

CO1	Discuss the basics of fuzzification vs defuzzification.
CO2	Illustrate the different relations in fuzzy sets.
CO3	Discuss the different algorithms for the fuzzy system.
CO4	Select the suitable algorithm and simulate the system.
CO5	Explain the defuzzification methods
CO6	Develop a fuzzy logic controller and predict the outcome.

- **INTRODUCTION (10 Hours)**
  The case for imprecision, chance versus fuzziness, fuzzy sets and membership, utility of fuzzy systems, limitations of fuzzy systems.
  Classical sets: operations on classical sets, properties of classical (crisp) sets, mapping of classical sets to functions.
  Fuzzy sets: fuzzy set operations, properties of fuzzy sets, non-interactive fuzzy sets, alternative fuzzy set operations.

- **CLASSICAL RELATIONS AND FUZZY RELATIONS (09 Hours)**
  Crisp relations: cardinality of crisp relations, operations of crisp relations, properties of crisp relations. Fuzzy relations: cardinality of fuzzy relations, operations of fuzzy relations, properties of fuzzy relations.
  Classification by equivalence relations: crisp & fuzzy relations, Cluster analysis. Cluster validity, c-mean clustering, Similarity relations from clustering.

- **AUTOMATED METHODS FOR FUZZY SYSTEMS & FUZZY SYSTEMS SIMULATION (08 Hours)**
  Definitions, batch least square algorithm, recursive least square algorithm, gradient method, clustering method.
  Fuzzy relational equations, nonlinear simulation using fuzzy systems, fuzzy associative memories (FAMs).

- **DECISION MAKING WITH FUZZY INFORMATION (08 Hours)**
  Fuzzy synthetic evaluation, fuzzy ordering: non-transitive ranking, multi-objective decision making, fuzzy Bayesian decision method, decision making under fuzzy states and fuzzy actions, examples.

- **APPLICATIONS (10 Hours)**
  Applications in areas of: Production shop scheduling, group technology, robot control, preventing unwanted temperature fluctuations in air-conditioning systems, efficient and stable control of car-engines, improved efficiency and optimized function of industrial control applications, automatic motor-control for vacuum cleaners with recognition of surface condition and degree of soiling, single button control for washing-machines, flight aid for helicopters, controlling of machinery speed and temperature for steel-works, control for improved fuel-consumption for automobiles, elevator control for improved sensitiveness and efficiency, improved safety for nuclear reactors, etc.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Timothy J.R., "Fuzzy Logic with Engineering Applications", John Wiley & Sons, 2004
2. Zimmermann H.J., “Fuzzy Set Theory and its Applications”, Kluwer Academic Publishers, Norwell, 1996.
3. Terano T., Asai K., and Sugeno M., “Fuzzy Systems Theory and its Applications”, Academic Press, San Diego, 1992.
4. Klir G.J. and Yuan B., “Fuzzy Sets and Fuzzy Logic”, Prentice Hall India, 1997.
5. Rao R.V., “Decision Making in the Manufacturing Environment using Graph Theory and Fuzzy Multiple Attribute Decision Making Methods”, Springer-Verlag, London, 2007.
6. Nie J. and Linkens D., “Fuzzy Neural Control: Principles, Algorithms and Applications”, Prentice Hall India, 1998.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 438 HEAT TREATMENT AND SURFACE COATING PROCESSES	**3**	**0**	**0**	**3**

CO1	Determine phase transformation mechanism during different heat treatment processes.
CO2	Analyze the significance of various phases achieved through heat treatment of steel.
CO3	Distinguish heat treatment processes adopted for various ferrous and non-ferrous metals.
CO4	Describe the importance of various surface hardening methods.
CO5	Describe the importance of surface engineering and heat treatment.
CO6	Summarize concepts of various surface coating techniques.

- **HEAT TREATMENT PROCESSES (08 Hours)**
  Heat treatment for improvement of properties, Equilibrium diagrams, Principles of heat treatment of steels. Various heat treatment processes.

- **HEAT TREATMENT OF STEEL (07 Hours)**
  Plain carbon steels, Alloy steels, Structural and Tool steels and Cast Irons.

- **HEAT TREATMENT OF NONFERROUS METALS AND ALLOYS (08 Hours)**
  Heat treatment of Aluminium and its alloy, Magnesium alloys, Titanium alloys, Copper and its alloys

- **CHEMICAL HEAT TREATMENT OF STEELS (06 Hours)**
  Carburising, Cyaniding, Nitriding, Carbonitriding, Boroding

- **SURFACE HARDENING (07 Hours)**
  Flame and Induction Hardening, Electron Beam Hardening, Laser Hardening.

- **SURFACE TREATMENT/COATINGS FOR PREVENTION AGAINST FAILURE (09 Hours)**
  Mechanical surface treatment, Metallic coatings, Dipping, Spraying, Electrochemical deposition, Electroless deposition, Plasma techniques, Chemical Vapor deposition and Physical vapor deposition, Ion beam bond deposition techniques, Plastic Coatings, Polyurathene coatings ,Weld surfacing, Thermal Spraying, Cladding, etc.

(Total Lecture Hours : 45)

BOOKS RECOMMENDED

1. Rajan T.V, Sharma C.P and Sharma Ashok, “Heat Treatment Principles and Techniques”, Prentice Hall India, 1993.
2. Charlie R., “Heat Treatment for Ferrous Alloys”, Hemisphere Publishing Co., 1979.
3. “Metals Handbook: Heat treating, Cleaning and Finishing”, American Society for Metals, 1972.
4. Zakharov B., “Heat Treatment of Metals”, Peace Publication, Moscow, 1962.
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