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											

B. Tech. - IV (Production) Seventh Semester											
Sr. No.	**Course**	**Code**	**Teaching Scheme**			**Exam Scheme**				**Total Marks**	**Credits**
						Theory		**Tuto.**	**Pract.**		
			L	**T**	**P**	**Hrs.**	**Marks**	**Marks**	**Marks**		
1	Tool Design	PR 401	3	0	2	2	100	-	50	150	4
2	Metal Forming Technology	PR 403	3	0	2	2	100	-	50	150	4
3	Design of Machine Tool Elements	PR 405	3	0	2	2	100	-	50	150	4
4	Quantitative Techniques in Production Management	PR 407	3	1	0	2	100	25	-	125	4
5	Project Preliminaries	PR 409	0	0	4	-	-	-	50	50	2
6	Seminar	PR 411	0	0	2	-	-	-	50	50	1
7	**Industrial Training Report	PR 413	0	0	0	-	-	-	50	50	0
8	Deptt. Elective-I*		3	0	0	3	100	-	-	100	3
	TOTAL		15	1	12	-	500	25	300	825	22
Total contact Hrs. per week (28) Total Credits =22 Total Marks = 825											
** Audited subject to be evaluated by Professor (T &P) for award of NP or NF Grades											

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. IV (P) 7th Semester, ELECTIVE –I*

1. ME 413 : Advanced Tribology
2. PR 415 : Industrial Robotics
3. PR 417 : Theory of Plasticity
4. PR 419 : Heat Treatment & Surface Coating Processes
5. PR 421 : Hydraulic & Pneumatic controls
6. PR 423 : Materials Management
7. ME 431 : Automobile Engineering

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

- **DESIGN OF POWER TRANSMISSIN ELEMENTS** **(08 Hours)**
  Design o 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 g ears 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, c one 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. Cla ssification, material selection, S ommerfeld 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 selecti on, 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 PRESSU RE 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 facto r 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 b earing (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

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

- **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 turb ine, 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 bi omass, 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

- **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)**
  USM, AJM, WJM, AWJM, ECM, EDM, IBM, 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 temp. in drilling operation under various cutting speeds and to plot temp. vs. speed curve for given tool-work material.
2. To determine shear plane angle under various cu tting conditions.
3. To prepare operational sheet for a given component as shown in the sketch & to 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, 1998.
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, 1995.
5. HMT, “Production Technology”, Tata McGraw Hill, 1980.
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

(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. (PRODUCTION) Semester – 7	L	T	P	C
PR 401 TOOL DESIGN	3	0	2	4

- **DESIGN OF JIGS AND FIXTURES** **(15 Hours)**
  Basic principles of location, Locating methods and devices, Basic principles of clamping, Types of clamps.
  Types of drill jigs, General considerations in the design of drill jigs and material selection, Drill bushings, Methods of construction.
  Types of fixtures, Design of milling, boring, broaching, grinding and turning fixtures and material selection.

- **DESIGN OF PRESS TOOLS** **(20 Hours)**
  Press tool operations, Types of press, press tool material, General press information (e.g. tonnage, shut height, stroke etc.), Selection of press, Type of press tools, cutting action in punc h and die operations, Die clearance.
  Die design fundamentals: Blanking and piercing die construction, P ilots, Strippers, Blank layout, Bending die construction and design, Forming dies, Drawing operations, Variables affecting metal flow in drawing, Determining blank size, Drawing force calculation, Design of progressive dies, Development of strip -layout for progressive die.

- **DESIGN OF CUTTING TOOLS** **(10 Hours)**
  Design of single point cutting tools & form tools.
  Design of multipoint cutting tools, Drilling, Milling tools and broach tools.

(Total Lecture Hours: 45)

PRACTICAL

Design sheets –

1. Sketches of standard locators and hardwares.
2. Sketches of standard clamps.
3. Design of a jig for a given component.
4. Design of a fixture for a given component.
5. Design of blanking die for a given component.
6. Design of compound die for a given component.
7. Design of progressive die for a given component.
8. Design of a drawing die for a given comp onent.
9. Design of a broach for a given component.
10. Design of form tool for a given component.

BOOKS RECOMMENDED

1. Cyrll Donaldson, “Tool Design”, Tata McGraw Hill, New Delhi, 2005.
2. Spliter David (Contributor, Editor), “Fundamentals of Tool Design”, Societ y of Manufacturing Engineers (SME), Michigan, 2003.
3. Pacquin J. R. and Crowley R.E, “Die Design Fundamentals”, Industrial Press, 1986.
4. Suchy Ivana, “Handbook of Die Design”, McGraw Hill, USA, 2006.
5. Keyes K.A., “Press Working Stamping and Dies”, Society of Manufacturing Engineers (SME), Michigan, 1982.

B. Tech. (PRODUCTION) Semester – 7	L	T	P	C
PR 403 METAL FORMING TECHNOLOGY	3	0	2	4

- **INTRODUCTION** **(01 Hour)**

- **STRESS ANALYSIS** **(03 Hours)**
  Stress tensor, Mohr's circle for stress transformation.

- **STRAIN ANALYSIS** **(02 Hours)**
  Strain tensor, isotropic elasticity.

- **STRESS-STAIN RELATIONSHIP & YIELD CRITERIA** **(05 Hours)**
  Strain energy. Yield criteria - Tresca & Von-Mises Criterion. Effective stress & strain, flow rules or plastic stress-strain relationship. Work hardening, mechanical properties, determination of work hardening expression, strain rate & temperature.

- **SLIP LINE FIELD THEORY** **(05 Hours)**
  - Hencky-Prandtl Nets.
  - Properties of slip lines.
  - Construction of slip line Nets.
  - Continuity equations along slip lines and velocity discontinuity.
  - Velocity diagram or Holograph.

- **FORGING** **(05 Hours)**
  Classification, plane strain & axisymmetric strain in upsetting, forging load calculation for plane strain & axisymmetric forging. Uniform energy method. Forging defects. Open die & close die forging.

- **EXTRUSION** **(04 Hours)**
  Introduction, calculation of extrusion load using slab method, energy method & upper bound method. Defects in extrusion. Direct & indirect extrusion.

- **WIRE DRAWING** **(04 Hours)**
  Introduction, defects, maximum possible reduction. Wire drawing load calculation using slab method.

- **ROLLING** **(04 Hours)**
  Classification, types of mill, calculation of roll separating force, torque & power, angle of bite, maximum reduction in rolling, rolling defects, roll flattening, roll camber.

- **SHEET METAL FORMING** **(12 Hours)**
  - Bending of plates, bendability, spring back, bending force, bending moment for real material, stress & strain in bending.
  - Blanking, punching. Derivation & calculation of optimum clearance. Blanking force.
  - Deep drawing – Stress in deep drawing, drawability. Drawing load.
  - Unconventional forming - explosive, magnetic pulse forming, etc.
  - Friction & lubrication in forming.

(Total Lecture Hours: 45)

PRACTICALS

1. To construct a slip-line net for upsetting a w/p of width b = 3.6 h.
2. To draw the graph of pressure in terms of shear yield stress (k) vs. the distance from the centre of w/p.
3. To draw stress strain behavior for model material.
4. To find flow stress of the given material and to plot a graph of forging ratio vs. flow stress. Plot the bulge profile of the forged pieces, to find the radius of curvature of bulging of the forged pieces and to plot a graph of forging ratio vs. H_f / R_c.
5. To measure the bending force and to draw the graphs of bending force vs. b ending angle for 'V' bending of strip. Also draw strain distribution.
6. (a) To study behavior of rod under action of bending process for different diameter of the rod.
   (b) To plot the graph of moment vs. moment of inertia.

(c) Plot the graph of moment vs. radius of curvature.

7. To measure the force required in extrusion of model material by using a die having different diameter and to draw the graphs between extrusion force vs. extrusion ratio.
8. To study the rolling process and plot the graph for percentage reduction in area vs. power in rolling.

BOOKS RECOMMENDED

1. Hosford William F. and Caddell R. M., "Metal Forming Mechanics and Metallurgy", Prentice Hall, 1993.
2. Mielnik Edward M., "Metal Working Science and Engineering", McGraw Hill, 1991.
3. Dieter G. E., "Mechanical Metallurgy", McGraw Hill, 1988.
4. Rao P.N., "Manufacturing Technology", Tata McGraw Hill, 1990.
5. Wangoner Robert H. and Jean-Loup Chenot, "Fundamentals of Metal Forming", John Wiley & Sons, 1997.
6. Beddoes J. and Bibby M. J., "Principles of Metal Manufacturing Processes", Viva Books, 2000.
7. Ghosh A. and Mallik A. K., "Manufacturing Science", East -West Press, New Delhi, 1998.
8. Sharma P. C., "Production Engineering", S. Chand & Co., New Delhi, 2003.

B. Tech. (PRODUCTION) Semester – 7	L	T	P	C
PR 405 DESIGN OF MACHINE TOOL ELEMENTS	3	0	2	4

- **PRINCIPLES OF MACHINE TOOL DESIGN** **(09 Hours)**
  General Cutting Tool forces for various machining processes.

- **KINEMATICS OF MACHINE TOOLS** **(08 Hours)**
  Selection of speeds & feeds. Design of gear box. Step less drives.

- **DESIGN OF MACHINE TOOL STRUCTURES** **(08 Hours)**
  Principles, materials, static & dynamic stiffness. Shapes of machine tool structures. Design of beds, columns, housings, tables, ram etc.

- **DESIGN OF GUIDE WAYS & POWER SCREWS** **(08 Hours)**
  Design of different types of guide ways and power screws.

- **DESIGN OF SPINDLES** **(08 Hours)**
  Materials of spindles. Machine tool compliance. Anti friction bearings. Sliding bearings.

- **INTRODUCTION TO DYNAMICS OF MACHINE TOOLS** **(04 Hours)**

(Total Lecture Hours: 45)

PRACTICAL

1. Details of slide ways and guide ways
2. Design of machine structure elements
3. Design of spindle
4. Design of gear box
5. Design of roller/journal bearing
6. Design of hydro dynamic bearing
7. Design of hydro static bearing

BOOKS RECOMMENDED

1. Mehta N. K., "Machine Tool Design", Tata McGraw Hill, 2000.
2. Basu S. K. and Pal D. K., "Design of Machine Tools", Oxford and IBH, 2002.
3. Achertan, N., "Machine Tool Design", Mir Publishing, Moscow , 1999.
4. Koenigsberger F., "Design Principles of Metal Cutting Machine Tools", Pergamon Press, 1998.
5. Sen G. C. and Bhattacharyya A., "Principles of Machine Tools", New Central Book Agency, 1988.
6. Tobias, S. A., "Machine Tool Vibration", Blackie Oxford, London, 1965.

B. Tech. (PRODUCTION) Semester – 7	L	T	P	C
PR 407 QUANTITATIVE TECHNIQUES IN PRODUCTION MANAGMENT	3	1	0	4

- **INTRODUCTION** **(15 Hours)**
  Linear Programming problems and their Graphic Solution. Simplex Method – Duality – post optimality Analysis.

- **TRANSPORTATION AND TRANSSHIPMENT PROBLEMS** **(06 Hours)**
  Methods of solving transportation problems.

- **ASSIGNMENT PROBLEM** **(04 Hours)**
  The assignment problem and methods of solution. Application of Assignment problem to solve Travelling salesman problems.

- **INTEGER PROGRAMMING PROBLEMS** **(06 Hours)**
  All integer, Mixed integer and Zero-One programming and methods of solution.

- **SEQUENCING PROBLEMS** **(04 Hours)**
  Flow shop and Job shop problems, solution methods for solving various categories of sequencing problems.

- **QUEUING THEORY** **(04 Hours)**
  General structure of Queuing systems. Operating characteristics of Queuing systems, Analysis of M/M/1 model.

- **SIMULATION** **(06 Hours)**
  Process of Simulation, Monte Carlo simulation, Application of Simulation.

(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. Sharma J.K., “Mathematical Models in Operations Research”, Tata McGraw Hill, 1989.
4. Dave N. R. and Mangalani A. K., “Operations Research”, Acharya Publication, 1990.
5. Hajra Chaudhary S.K., “Production Management”, Media Promoters and Publishers, 1990.

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

- **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 effe cts, Elasto-hydrodynamic (EHD), Magneto hydrodynamic lubrication, Hydro static lubrication, Gas lubr ication, 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 stre ss 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, 1984.
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

- **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 refrigerant s, 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 R efrigeration, Pulse tube refrigeration, Adiabatic demagnetization.

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

- **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

- **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, va rious 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, collec tor 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, N ew York, 1991.
3. Kreith F. and Kreider J. F., "Hand B ook of Solar Energy", McGraw Hill, N ew 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

- **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 producti on 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 deptt., operation planning, operation sheet (Process sheet)

- **PRODUCTION CONTROL** **(05 Hours)**
  Loading, Gantt chart, Sequencing, Scheduling; sequencing problems such as n jobs a nd 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, Progre ssing.

- **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, Aggrega te planning guidelines, Master Production Schedule (MPS)

- **MATERIAL REQUIREMENT PLANNING** **(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 replaceme nt 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, Manufac turing Excellence, Toyota Production System (TPS) etc.

- **OPERATIONS STRATEGY** **(02 Hours)**
  Operations strategy model, external & internal conditions influencing strategy, SWOT (strengths – weaknesses – opportunities – Threats) analysis, Comp onents 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", Dhanp at 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

- **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

- **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 p v system, concept of p v diesel hybrid system .

- **THERMIONIC GENERATORS AND FUEL CELLS** **(06 Hours)**
  The 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

- **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

- **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. Burmese ter 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

- **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 P ress, 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, Londo n, 1965.

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

- **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.

- **THE 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

- **INTRODUCTION** **(15 Hours)**
  Single and Multivariable optimization methods, constrained optimizatio n 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

- **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 resistan ces. 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 wobb le, 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 mot ors, 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 Del hi, 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.

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

- **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 lubricants 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, UK, 1981
2. Halling J. (Editor), “Principles of Tribology “, Macmillian, 1984.
3. Williams J.A., “Engineering Tribology”, Oxford University 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. (PRODUCTION) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
PR 415 INDUSTRIAL ROBOTICS	3	0	0	3

- **INTRODUCTION** **(03 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 – The inverse kinematics solution.

- **ROBOT ARM DYNAMICS** **(07Hours)**
  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** **(06 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, Lee and Gonzalez, "Robotics", McGraw 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 M.P., "Industrial Robotics", McGraw Hill, 2001.

B. Tech. (PRODUCTION) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
PR 417 THOERY OF PLASTICITY	3	0	0	3

- **Stress Analysis** **(03 Hours)**
  Introduction, Definition of stress, Stress Tensor, Principal Stresses and Stress invariants, Mohr's Circle, Stress Deviator Tensor

- **Strain Analysis** **(03 Hours)**
  Introduction, Definition of Strain, Strain Tensor, Principal Strains, Strain Invariants, Strain Deviator Tensor.

- **Stress-Strain Relationships** **(03 Hours)**
  Introduction, Basic Stress- strain relationship. Equations of Elasticity, Elastic Strain Energ y Functions,

- **Yield Criteria** **(03 Hours)**
  Criteria for yielding – Tresca criterion, Von mises Criterion, Effective stress -strain.

- **Plastic Stress-Strain Relationships** **(05 Hours)**
  Stress – strain relation in plasticity, State of plastic stra in-strain rate, plastic Anisotropy, stress – stain relations for strain hardening metals, Saint Venant's theory of plastic flow, Prandtl- Reuss Theory of elastic plastic deformation

- **Slip-Line Field Theory** **(04 Hours)**
  Slip line theory, Hencky's theory of small plastic deformation plasticity conditions, Velocity Equations, Geometry of Slip-line, Numerical Solution of Boundary-value Problems, Geometrical Coinstruction of Slip-line fields, Upper and Lower Bounds, Slip Line Characteristics.

- **Elastoplastic Problems of Spheres and Cylinders** **(07 Hours)**
  Thin walled tube for combined loading, Experimental verification of Saint Venant's theory of plastic flow, Thick wall tube & spherical shell under internal pressure Considering ideally plastic m aterials. Rotating cylinders & Disks in plastic state Torsion & Bending. Two dimensional plastic flow problems for strain hardening materials

- **Elastoplastic Problems in Torsion** **(07 Hours)**
  Torsion Problems, Elasticity Solutions, Elastoplastic Tors ion of Perfect Plasticity, Elastoplastic Torsion with Strain Hardening, Bar with Rectangular Cross Section and Circular Cross Section.

- **Elastoplastic Problems in Bending** **(05 Hours)**
  Bending problems, Pure bending of beams, Theory of limit analysis

- **Theory of Metal Forming** **(05 Hours)**
  Instability in tension, Theory of metal forming, Two dimensional problem of steady motion, Non steady motion, Axial symmetry plastic anisotropy.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Hill R., "The Mathematical Theory of Plasticity", Oxford University Press, London, 1971.
2. Hoffman and Sachs G., "Introduction to the Theory of Plasticity for Engineers", McGraw Hill, 1953.
3. Mielnik Z.M., "Metalworking Science and Engineering", McGraw Hill, 1991.
4. Mendelson Alexander, "PLASTICITY: Theory and Application", The Macmillan Co, New York, 1968.

B. Tech. (PRODUCTION) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
PR 419 HEAT TREATMENT AND SURFACE COATING PROCESSES	3	0	0	3

- **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 st eels 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/C OATINGS FOR PREVENTION AG AINST F AILURE** **(09 Hours)**
  Mechanical surface treatment, Metallic coatings, Dipping, Spraying, Electrochemical deposition, Electroless deposition, Plasma techniques, Chemical Vapor deposition and P hysical vapor deposition, Ion beam bond deposition techniques, Plastic Coatings, Polyurathene coatings ,Weld surfacing, Thermal Spraying, Cladding

(Total Lecture Hours : 45)

BOOKS RECOMMENDED

1. Charlie R., "Heat Treatment for Ferrous Alloys", Hemisphere Publishing Co.,1979.
2. Zakharove, "Heat treatment of Metals", Peace Publication, Moscow, 1962.
3. Stan Grainger, "Engineering Coatings-Design and Application", Jaico Publishing House,1994.
4. Rajan T.V, Sharma C.P and Sharma Ashok , "Heat Treatment Principles and Techniques", Prentice Hall India, 1993.
5. "Metals Handbook: Heat treating, Cleaning and Finishing", American Society for Metals, 1972.

B. Tech. (PRODUCTION) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
PR 421 HYDRAULIC & PNEUMATIC CONTROLS	3	0	0	3

- **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, Gears 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 Application”, Prentice Hall, 2003.
2. Cundiff John S., “Fluid Power Circuits and Controls: Fundamentals and Aapplications”, Lavoisier Publication, 2001.
3. Andrew Parr, “Hydraulics and Pneumatics”, Jaico Publishing House, 1999.
4. Kokernak Robert P., “Fluid Power Technology”, Prentice Hall, 1998.
5. Norvelle Don, “Fluid Power Technology” , West Publishing Co., 1995
6. Peter Rohner, “Industrial Hydraulic Control”, Prentice Hall, 1987.

B. Tech. (PRODUCTION) Semester – 7 (DEPARTMENT ELECTIVE – I)	L	T	P	C
PR 423 MATERIALS MANAGEMENT	3	0	0	3

- **INTRODUCTION** **(02 Hours)**
  Materials Management, operating environment, manufacturing strategy, Supply chain, concepts, Integrated Materials, Management, Flow of materials in manufacturing.

- **PRODUCTION PLANNING SYSTEM** **(04 Hours)**
  Manufacturing planning and control system, Master Production schedule, Purchasing and Production Activity Control, Manufacturing Resource Planning (MRP II), Master scheduling – Developing a Master Production schedule, Rough – cut capacity planning, Master schedule Decisions.

- **MATERIALS REQUIREMENTS PLANNING** **(05 Hours)**
  Inputs to MRP system such as MPS, inventory records, Bills of material, MRP process, Capacity Requirements Planning.

- **PRODUCTION ACTIVITY CONTROL** **(02 Hours)**
  Scheduling, load leveling, scheduling, bottlenecks, production reporting.

- **PURCHASING** **(03 Hours)**
  Establishing specifications, Functional specification description, Selecting suppliers, Placement of Purchase order, Price determination, Impact of MRP on purchasing, organizational implications of supply chain Management, Purchasing cycle, Life cycle costing (LCC)

- **SOURCING THE RIGHT MATERIAL** **(02 Hours)**
  The importance of suppliers, Identification of key characteristics of development of sup plier Directory, Supplier selection, Supplier performance monitoring, planning for a reliable supplier.

- **INVENTORY FUNDAMENTALS** **(08 Hours)**
  Supply and demand pattern, objectives of inventory management, inventory costs, Financial statements of inventory, ABC inventory control, Ideal & Real inventory management systems. Independent demand ordering systems, determining safety stock, normal distribution, determining the safety stock & order point, determining service levels, Two – bin system & Perpetual inventory record system, Periodic Review System, Distribution inventory.

- **INVENTORY CONTROL UNDER RISK AND UNCERTAINTY** **(08 Hours)**
  A profit approach to risk analysis, A profit approach under uncertainty, A cost approach under risk or uncertainty, calculation of average costs, Economic Safety stock levels, The stockout cost, Minimum cost determination, Safety stocks and Service levels.

- **PHYSICAL INVENTORY & WAREHOUSE MANAGEMENT** **(05 Hours)**
  Warehouse activities, cube utilization & accessibility, stock location, order picking & assembly, Physical Control & security, inventory record accuracy, causes of inventory record errors, measuring inventory record accuracy, Auditing inventory records. Physical Distribution System, Total – cost concept, Interfaces, Transportation, Transportation cost elements, warehousing & transportation costs, Market boundaries, Packaging, Material handling, Multi-ware house systems.

- **SUPPLY CHAIN MANAGEMENT** **(04 Hours)**
  Integrated supply chains, Managing the customer & supplier interface, Supplier selection and Certification, Outsourcing, Measures of supply-chain performance.

- **INTRODUCTION TO 'SAP' SOFTWARE** **(02 Hours)**

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Tony Arnold J. R. and Chapman Stephen N., “Introduction to Materials Management”, Pearson Education, Delhi, 2005.
2. Chatterjee S., “Applied Materials Management”, Response Books, New Delhi, 2004.
3. Mishra Rajendra, “Materials Management”, Excel Books, New Delhi , 2007.
4. Krajewski Lee J. and Ritzman L. P., “Operations Management – Strategy and Analysis”, Pearson Education, Delhi, 2002.
5. Bedi Kanishka, “Production and Operations Management”, Oxford Uni versity Press, New Delhi. 2007.
6. Wild Ray “Operations Management – Text and CD- ROM”, Thomson Learning, London, 2003.
7. Monks J.G., “Operations Management”, Tata McGraw Hill, New Delhi, 2005.

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

- **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 poin t 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. Heisler Heinz, “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											

B. Tech. - IV (Production) Eighth Semester											
Sr. No.	Course	Code	Teaching Scheme			Exam Scheme				Total Marks	Credits
						Theory		Tuto.	Pract.		
			L	T	P	Hrs.	Marks	Marks	Marks		
1	Welding Technology	PR 402	3	1	0	2	100	25	-	125	4
2	Production Planning & Operations Management	PR 404	3	0	0	2	100	-	-	100	3
3	Computer Aided Manufacturing	PR 406	3	1	2	2	100	25	50	175	5
4	Modern Machining Methods	PR 408	3	1	0	-	100	25	-	125	4
5	Project	PR 410	0	0	8				200	200	4
6	Deptt. Elective-II*		3	0	0	2	100	-	-	100	3
	TOTAL		15	3	10		500	75	250	825	23
Total contact Hrs. per week (28) Total Credits =23 Total Marks = 825											

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. IV (P) 8th Semester, ELECTIVE –II*

1. PR 420 : Design and Management of Small Scale Enterprise
2. PR 414 : Industrial Maintenance & Safety Engineering
3. ME 426 : Total Quality Management
4. ME 442 : Mechanical Cost Estimation
5. ME 420 : Optimization Techniques
6. PR 416 : Rapid Prototyping and Tooling

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

- **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 VARIABL E 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 FRIC TION** **(04 Hours)**
  Governing equation, Fanno line & its characteristic, Chocking

- **FLOW IN CONSTANT AREA DUCT WITH HEAT TRANSFER** **(04 Hours)**
  Governing equation, Rayleigh line its characte ristic, 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

- **INTRODUCTION** **(08 Hours)**
  Linear programming, formulation, graphical method, Simplex method, difficulties in S implex 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 et c 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

- **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

- **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 Syste ms, 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 tr ansducer, 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. (PRODUCTION) Semester – 8	L	T	P	C
PR 402 WELDING TECHNOLOGY	3	1	0	4

- **INTRODUCTION** **(05 Hours)**
  Classification & overview of welding & Allied joining processes, Advance welding processes, such as Laser Beam Welding, Electron Beam Welding, Ultrasonic Welding etc., classification of electrodes, Coding of electrodes, Electrode efficiency.

- **PHYSICAL & METALLURGICAL ASPECTS OF WELDING** **(10 Hours)**
  Emission and Ionization of electric arc, arc structure, arc characteristics & Power, arc stability, arc blow, Thermal aspects of welding. Metallurgical effects of welding , weld metal solidification, Iron-carbon diagram, Time Temperature Transformation Curve, Continuous Cooling Transformation Curve.

- **WELD JOINT DESIGN** **(06 Hours)**
  Weld design for static loading-arc welded joints-stress calculation for welds-design for different types of loading-weld design for fatigue loading-fatigue strength of weld joint-life of joint under fatigue.

- **WELD SYMBOLS** **(03 Hours)**
  Basic symbols, Need fro representing weld.

- **ESTIMATION OF WELDING COST** **(02 Hours)**
  Factors, costing procedures, cost components.

- **WELDING DEFECTS** **(03 Hours)**
  Cracks, distribution, inclusions, porosity, blow holes, po or fusion etc., causes and remedies

- **WELD INSPECTION & TESTING** **(10 Hours)**
  Destructive test: Tensile, bend, impact, nickbreak, hardness, etch ing etc.
  Nondestructive test: Visual inspection, leak test, stethoscopic test, X -ray and gamma ray radiography, magnetic particle test, liquid dye penetration, ultrasonic etc.

- **RESIDUAL WELDING STRESSES** **(04 Hours)**
  Concept, types of residual stresses, control of residual stresses and measurement of residual stresses, causes of residual stress-measurement and calculation of residual stresses-residual stresses in different joints-methods of relieve stress-distortion types-distortion measurement-distortion control & correction of distorted weld metals.

- **SAFETY IN WELDING** **(02 Hours)**
  Personal protective equipments, physical hazards, radiation, neat, toxic hazards, noise, fire.

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

BOOKS RECOMMENDED

1. Little R.L., "Welding Technology", Tata McGraw Hill, New Delhi, 1994.
2. Ghosh A. and Mallik A.K., "Manufacturing Science", East West Press, 1985.
3. Davies A.C., "The Science and Practice of Welding", Cambridge University, New York, 1989.
4. Balchin N.C., "Health and Safety in Welding and Allied Processes", Jaico Publishing House, Mumbai, 1989.
5. Rao P. N., "Manufacturing Technology", Tata McGraw Hill , 1990.
6. Mukharjee P. C., "Fundamental of Metal Casting Technology", Tata McGr ew Hill, 1970.
7. Jeffus Larry “Welding Principles and Applications” Delmar Publishers, 1999.

B. Tech. (PRODUCTION) Semester – 8	L	T	P	C
PR 404 PRODUCTION PLANNING & OPERATION S MANAGEMENT	3	0	0	3

- **INTRODUCTION** **(02 Hours)**
  Operations management, transformation process, classification of production syst ems, organization structure for production function; Decision – making areas in operations management.

- **PRODUCTION PLANNING & CONTROL** **(04 Hours)**
  Functions of PPC, Production planning & production control,, Routing, Scheduling, Gantt Chart , Dispatching, etc., Production Procedure, Organization for PPC, manpower planning. Production control – loading sequencing & scheduling, sequencing problems – Assignment model, Gantt chart.

- **DEMAND FORECASTING** **(06 Hours)**
  Quantitative forecasting techniques such as time series analysis, method of least squares, simple moving & weighted moving average regression & correlation; exponential smoothing met hod, economic indicators method, qualitative forecasting techniques such as collective opinion method, Delphi technique etc. measures of forecast accuracy, selecting a forecasting method, costs and accuracy of forecasts .

- **REPLACEMENT** **(02 Hours)**
  Reasons & factors necessary for replacement of equipments, replacement of an equipment which deteriorates over time, replacement of items that fail completely.

- **INVENTORY MANAGEMENT** **(07 Hours)**
  Materials management, types of inventories, inventory costs, inventory management systems, inventory management models such as basic EOQ model, EOQ with price break, EOQ with shortages, production lot size model; safety stock, ABC analysis.

- **MATERIALS REQUIREMENT PLANNING** **(05 Hours)**
  Objectives, MRP terminology, MRP system - inputs and outputs, MRP logic, Manufacturi ng resource planning.

- **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 planni ng, Aggregate planning guidelines, Master Production Schedule (MPS)

- **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.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Telsang I. N., “Industrial Engineering and Production Management”, S. Chand & Co., New Delhi, 2004.
2. Mohanty R. P. and Deshmukh S. G., “Advanced Operations Management”, Pearson Education, Delhi , 2004.
3. Bedi Kanshka, “Production and Operations Management”, Oxford University Press, New Delhi, 2007.
4. Khanna R. B., “Production and Operations Management”, Prentice Hall India, 2007.
5. Krajewski Lee J. and Ritzman Larry P., ‘Operations Management”, Pearson Education, Delhi, 2005.
6. J.G. Monks, “Operations Management – Theory and Problems”, McGraw Hill, New York, 2004.
7. Adams E.E. and Ebert R. T., “Production and Operations Management – Concepts Models and Behaviour”, Prentice Hall India, 2005.

B. Tech. (PRODUCTION) Semester – 8	L	T	P	C
PR 406 COMPUTER AIDED MANUFACTURING	3	1	2	5

- **INTRODUCTION** **(06 Hours)**
  Fundamentals of Manufacturing, Automation and C. I. M., Production operations and automation strategies.

- **NUMERICAL CONTROL (N.C.) MACHINES** **(12 Hours)**
  N.C. Production systems. Introduction to N.C, N.C. Machine tools. Machine control units. Tooling for N.C. machines. N.C. part programming, Cutter compensation, Parametric programming, Direct Numerical Control Computer Numerical Control.

- **COMPUTER AUTOMATED PART PROGRAMMING** **(10 Hours)**
  Adaptive control, APT language structure, APT Geometry, Motion commands, Post processor commands, Repetitive programming, Compilation and Control commands.

- **AUTOMATED GUIDED VEHICLE AND STORAGE RETRIEVAL SYSTEMS.** **(02 Hours)**

- **COMPUTER AIDED PROCESS PLANNING** **(04 Hours)**
  Types, route cards, inputs to the process plan.

- **SHOP FLOOR CONTROL & AUTOMATIC IDENTIFICATION TECHNIQUES.** **(04 Hours)**

- **FLEXIBLE MANUFACTURING SYSTEMS** **(07 Hours)**
  Introduction, Sequencing & scheduling in FMS. Group technology. Production flow analysis.

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

PRACTICALS

1. Demonstration of CNC milling machine with user interface and calculation of coordinates of g iven geometry in absolute & incremental mode of cutter path.
2. Write the CNC Milling part programming for a given geometry using linear and circular interpolation,
3. Write the CNC Milling part programming for a drilling of holes using pack drilling cycle and repeat loop feature.
4. Write the CNC Milling part programming for a given geometry using subroutine.
5. Write the CNC Milling part programming for a given geometry using mirror commands.
6. Write the CNC Milling part programming for a given geometry using tool rad ius compensation.
7. Demonstration and study of CNC lathe machine with sample programming.
8. Write the CNC Lathe machine part programming for given geometry using Rou gh and finish facing cycle.
9. Write the CNC Lathe machine part programming for given geometry usi ng Rough and finish turning cycle.

BOOKS RECOMMENDED

1. Groover Mikell P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall India, 1991.
2. Groover Mikell P. and Emory Zimmers W., "CAD/CAM: Computer Aided Design and Manufacturing", Prentice Hall India, 1991.
3. Kundra T. K., Rao P. N. and Tewari N. K., "Numerical Control & Computer Aided Manufacturing", Tata McGraw Hill, 1990.
4. Elanchezhian C, Sunder Selwyn T and Shanmuga Sundar G, “Computer Aided Manufacturing”, Laxmi Publications, New Delhi, 2006.
5. Sinha S. K., “CNC Programming”, Galgotia Publicatio ns, 2004.
6. Rao P N., “CAD/CAM: Principles and Applications”, Tata McGraw Hill, 2006.

B. Tech. (PRODUCTION) Semester – 8	L	T	P	C
PR 408 MODERN MACHINING METHODS	3	1	0	4

- **INTRODUCTION** **(03 Hours)**
  Trends in modern manufacturing and an overview of modern machining methods

- **MECHANICAL METHODS** **(09 Hours)**
  Introduction, principle, process description, process capabilities, limitations, and applications of Ultrasonic Machining (USM), Abrasive Jet Machining (AJM), and Abrasive Water Jet Machining (AWJM) processes

- **ELECTROCHEMICAL & CHEMICAL METHODS** **(12 Hours)**
  Fundamental principle, process description, process capabilities, limitations, and applications of Electrochemical Machining (ECM), Electrochemical Grinding (ECG), Electrochemical deburring, Electrochemical honing and Chemical Machining (CM) processes

- **THERMAL METAL REMOVAL METHODS** **(12 Hours)**
  Fundamental principle, process description, process capabilities, limitations, and applications of Electrical Discharge Machining (EDM), Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma Arc Machining (PAM), Plasma Arc welding (PAW), and Hot Machining (HM) processes.

- **HYBRID MACHINING METHODS** **(04 Hours)**
  Concept, classification, process capabilities, and applications,

- **MICROMACHINING** **(05 Hours)**
  Introduction to micro machining; micro-turning, micro-milling, micro-drilling, micro EDM, micro- WEDM, micro ECM, etc.

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

BOOKS RECOMMENDED

1. Jain V.K., “Advanced Machining Process”, Allied Publishers, New Delhi, 2002.
2. Mishra P. K., “Non-conventional machining”, Narosa Publishing House, New Delhi, 1997.
3. Boothroyd G. and Knight W.A., “Fundamentals of Machining and Machine Tools”, Marcel Dekker, New York, 2005.
4. Benedict G.F., “Non-traditional Manufacturing Processes”, Marcel Dekker, New York, 1987.
5. Pandey P.C. and Shan H.S., “Modern Machining Processes”, Tata McGraw Hill, New Delhi, 1980
6. Groover M.P., “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, Wiley, New York, 2006.
7. Basting D., “Excimer Laser Technology – Laser Sources, Optics, Systems and applications”, Lambeda Physik, Germany, 2001.
8. Wright P.K. and Trent E.M., “Metal Cutting” , Elsevier, New York, 2000.

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

- **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

- **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, 1998.
3. Kays and London, ”Compact Heat Exchangers” McGraw Hill, New York, 1964.
4. Saunders E.A.D., “Heat Exchangers - Selection, Design and Construction”, Longman Scientific & Technical, 1998.
5. Keran D.O., “Process Heat Transfer”, Tata McGraw Hill, 1997.
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

- **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 e levators, 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

- **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

- **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 – The 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

- **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, the Taguch i 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 Manag ement- 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., "Handb ook 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

- **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

- **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 ver tical & 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

- **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 temperatu re 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 ENG INEERING	3	0	0	3

- **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 associativ e 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

- **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 F AILURE** **(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.
5. Grainger Stan, “Engineering Coatings-Design and Application”, Jaico Publishing House, 1994.

B. Tech. (MECHANICAL) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 442 MECHANICAL COST ESTIMATION	3	0	0	3

- **IMPORTANCE OF ESTIMATING (08 Hours)**
  Objectives of estimating –constituents of estimate, mechanical estimating – costing and cost estimation ,functions of estimation organization and prerequisites of estimation, estimating such as design and drafting period, time & motion studies, time allowances etc. estimation of material, labour cost, production estimate sheet., advantages & elements of costing, classification of cost elements.

- **METHODS OF DEPRECIATION (08 Hours)**
  Depreciation – types of depreciation such as physical, functional & accidental depreciation, methods of calculations depreciation such as straight line, diminishing balance, sinking fund methods etc., meth ods of allocation overloads.

- **ANALYSIS OF OVERHEAD EXPENSES (05 Hours)**
  Factory expenses, depreciation, administration expenses, selling and distribution expenses (overheads), allocation of overhead expenses etc.

- **ESTIMATION AND COSTING OF MACHINING OPERATIONS (10 Hours)**
  Length of cut, feed, depth of cut, RPM, cutting speed, concept of unit time, cycle time and total time , calculation of machining time for turning, shaping and milling operations.

- **ESTIMATION AND COSTING FOR METAL FORMING AND FABRICATION PROCESSES (10 Hours)**
  Welding, estimation of welding cost, gas cutting, electric welding, estimation of forging cost, forging operations, losses in forging, hot metal forming. Estimation and costing of rough casting, forged parts , welded jobs and sheet metal work.

- **BUDGET AND BUDGETARY CONTROL (04 Hours)**
  Setting up the budgets, budget limitations, essentials of budgeting, budgetary control, objectives, & benefits of budgetary control, requirements of effective budgeting, budgetary control system etc.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Sharma S. K., Sharma Sarita and Sharma Tushar, “Industrial Engineering and Operations Management”, S.K. Kataria and Sons, New Delhi, 2007.
2. Mahajan M.S., “Industrial Engineering and Production Management”, Dhanpat Rai and Sons, Delhi, 2007.
3. Sinha B. P., “Mechanical Estimation and Costing”, Tata McGraw Hill, 1995.
4. Banga T. R. and Sharma S. C., “Mechanical Estimating”, Khanna Publishers, 1996.
5. Saha G. H., “Elements of Estimating and Costing”, S.K. Kataria and Sons, 2000.

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

- **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.
- **TUTORIALS**
  Tutorials will be given on real life cases, market survey and analysis to develop students in real life environment in additions to the theoretical concepts

(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 Organization and Engineering Economics", Khanna Publishers, 1995.
4. Kotler P., Keller, Koshi and Jha, "Marketing Management – A South Asian Perspective", Pearson, 2007.
5. Prasad L.M., "Principles and Practice of Management", S. Chand & Sons, 1994.

B. Tech. (PRODUCTION) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
PR 414 INDUSTRIAL MAINTENANCE & SAFETY ENGINEERING	3	0	0	3

- **INTRODUCTION** **(04 Hours)**
  Introduction to maintenance concepts, maintenance systems, maintenance management.
- **CONDITION BASED MAINTENANCE** **(06 Hours)**
- **QUANTITATIVE TECHNIQUES IN MAINTENANCE RESOURCES** **(07 Hours)**
  Replacement strategies, PERT, CPM, Operations Research in maintenance.
- **CONCEPT OF SAFETY AND SAFETY PSYCHOLOGY, STATISTICS OF SAFETY** **(04 Hours)**
- **APPRAISAL** **(04 Hours)**
  Analysis, Inspection, Investigation and Control Techniques.
- **LIGHT, COLOUR, VENTILATION AND TEMPERATURE** **(03 Hours)**
- **SAFETY IN ENGINEERING INDUSTRIES** **(04 Hours)**
- **SAFETY IN TEXTILE INDUSTRIES** **(04 Hours)**
- **SAFETY IN CHEMICAL INDUSTRIES** **(04 Hours)**
- **SAFETY IN OTHER INDUSTRIES** **(05 Hours)**

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Morrow L. C. C., “Maintenance Engineering Handbook”, McGraw Hill, USA , 1997.
2. Kelly Anthony A., “Maintenance Planning and Control”, Prentice Hall, USA , 1984.
3. Gupta A.K., “Reliability Engineering and Terotechnology”, Mcmillan India Limited, 1996.
4. Gupta A.K. and Sharma J. K., “Management Systems”, Mcmillan India Ltd., 1997.
5. National Productivity Council, “Maintenance Management”, New Delhi, 1998.

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

- **INTRODUCTION** **(03 Hours)**
  Quality concepts & Quality management philosophies – Evolution of quality management, Definitions of quality, quality and profitability, quality and business results, T QM 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 TQ M, 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. S even 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 compete ncies 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 equipme nt 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 c alculating of sigma value of the process.

- **PROCESS CAPABILITY ANALYSIS** **(01 Hours)**
  Process capability index, upper and lower capability indices, The CpK index, capability ratio, the 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. (PRODUCTION) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 442 MECHANICAL COST ESTIMATION	3	0	0	3

- **IMPORTANCE OF ESTIMATING (08 Hours)**
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2. Mahajan M.S., “Industrial Engineering and Production Management ”, Dhanpat Rai and Sons, Delhi, 2007.
3. Sinha B. P., “Mechanical Estimation and Costing”, Tata McGraw Hill, 1995 .
4. Banga T. R. and Sharma S. C. “Mechanical Estimating”, Khanna Publishers, 1996 .
5. Saha G. H., “Elements of Estimating and Costing”, S.K. Kataria and Sons, 2000.

B. Tech. (PRODUCTION) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
ME 420 OPTIMIZATION TECHNIQUES	3	0	0	3

- **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. K. Deb., "Optimization for Engineering Design", Prentice Hall India, 1995.
2. S.S. Rao, "Optimization Theory and Applications", Wiley Eastern, 1984.
3. Reklaitis G.V., Ravindram A. and Ragsdell K.M. "Engineering Optimization – Methods and 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. (PRODUCTION) Semester – 8 (DEPARTMENT ELECTIVE – II)	L	T	P	C
PR 416 RAPID PROTOTYPING AND TOOLING	3	0	0	3

- **INTRODUCTION** **(06 Hours)**
  Basic concept - Overview of existing technologies of prototyping and tooling - Need for speedy design to market operations, introduction to rapid prototyping and tooling .

- **ACCELERATED PRODUCT DEVELOPMENT** **(08 Hours)**
  Applications of CAD, techniques, procedures, product slicing, software, applications.

- **STEREO LITHOGRAPHY SYSTEMS** **(06 Hours)**
  Principle, Process parameters, Process details, Machine details, Applications.

- **LASER SINTERING SYSTEMS** **(06 Hours)**
  Principle, Process parameters, Process details, Machine details, Applications.

- **FUSION DEPOSITION MODELING** **(06 Hours)**
  Principle, Process parameters, Process details, Machine details, Applications.

- **LAMINATED OBJECT MANUFACTURING** **(06 Hours)**
  Principle, Process parameters, process details, Machine details, Applications.

- **RAPID TOOLING** **(07 Hours)**
  Direct and indirect methods, techniques such as vacuum casting, DMLS, etc.

(Total Lecture Hours: 45)

BOOKS RECOMMENDED

1. Pham D.T. and Dimov S.S, “Rapid Manufacturing”, Springer-Verlag, London, 2001.
2. Ghosh A., “Rapid Prototyping: A Brief Introduction”, East West Press, 2003
3. Cooper K. G., “Rapid Prototyping Technology: Selection and Application”, CRC Press, 2001.
4. Wohlers T., “Wohlers Report 2007”, Wohlers Associates, USA, 2007.
5. Kai C.C., Leong K.F., and Lim C.S., “Rapid Prototyping: Principles and Applications”, World Scientific, 2003.