SCHEME OF EXAMINATION

B. TECH. (3rd SEMESTER) PRODUCTION AND INDUSTRIAL ENGINEERING

S. No.	Course No	Subjects	Teaching Schedule (Hours)				Credits	Duration of Exams. (Hours)
			L	T	P/D	Total		
1	PI-201	Thermodynamics	3	1	-	4	3.5	3
2.	PI-203	Strength of Materials	3	1	-	4	3.5	3
3.	PI-205	Machine Drawing	-	-	4	4	2.0	4
4.	PI-207	Production Technology-I	3	1	-	4	3.5	3
5.	PI-209	Material science	3	1	-	3	3.5	3
6.	PI-211	Kinematics of Machines	3	1	-	4	3.5	3
7.	MAT-201	Mathematics-III	3	1	-	4	3.5	3
8.	PI-213	Strength of Materials (Practical)	-	-	2	2	1.0	3
9.	PI-215	Production Technology-I (Practical)	-	-	2	2	1.0	3
10.	PI-217	Thermodynamics (Practical)	-	-	2	2	1.0	3
		Total	18	06	10	34	26.0	

SCHEME OF EXAMINATION

B. TECH. (4th SEMESTER) PRODUCTION AND INDUSTRIAL ENGINEERING

S. No.	Course No	Subjects	Teaching Schedule (Hours)				Credits	Duration of Exams. (Hours)
			L	T	P/D	Total		
1	PI-202	Dynamics of Machines	3	1	-	4	3.5	3
2.	PI-204	Fluid mechanics and Hydraulic Machines	3	1	-	4	3.5	3
3.	PI-206	Production Technology-II	3	1	-	4	3.5	3
4.	ECE-216	Digital electronics and microprocessor architecture	2	1	-	3	2.5	3
5.	PI-208	Metrology	3	1	-	4	3.5	3
6.	PI-210	Operations Research	3	1	-	4	3.5	3
7.	HUT-211	Organizational Behavior	2	1	-	3	2.5	3
8.	PI-212	Kinematics and Dynamics of Machines (Practical)	-	-	2	2	1.0	3
9.	PI-214	Fluid mechanics and Hydraulic Machines (Practical)	-	-	2	2	1.0	3
10.	PI-216	Production Technology-II (Practical)	-	-	3	3	1.5	3
11.	PI-218	Metrology (Practical)	-	-	2	2	1.0	3
		Total	19	07	09	35	27	-

SCHEME OF EXAMINATION

B. TECH. (5th SEMESTER) PRODUCTION AND INDUSTRIAL ENGINEERING

S. No.	Course No	Subjects	Teaching Schedule (Hours)				Credits	Duration of Exams. (Hours)
			L	T	P/D	Total		
1	PI-301	Machine design	3	-	6	9	6.0	4
2.	PI-303	Thermal Engineering	3	1	-	4	3.5	3
3.	PI-305	Work Study and Ergonomics	3	1	-	4	3.5	3
4.	PI-307	Production Technology-III	3	1	-	4	3.5	3
5.	PI-309	Production planning and control	3	1	-	4	3.5	3
6.	PI-311	Heat Transfer	3	1	-	4	3.5	3
7.	PI-313	Work study and Ergonomics(Practical)	-	-	2	2	1.0	3
8.	PI-315	Thermal Engineering (Practical)	-	-	2	2	1.0	3
9	PI-317	Heat transfer (Practical)	-	-	2	2	1.0	3
10.	PI-319	Vocational Training (Viva –Voce)	-	-	-	-	3.0	-
		Total	18	5	12	35	29.5	

SCHEME OF EXAMINATION

B. TECH. (6th SEMESTER) PRODUCTION AND INDUSTRIAL ENGINEERING

S. No.	Course No	Subjects	Teaching Schedule (Hours)				Credits	Duration of Exams. (Hours)
			L	T	P/D	Total		
1	ET-324	Control System	3	1	-	4	3.5	3
2.	PI-302	Plant Layout and Material Handling	3	1	-	4	3.5	3
3.	PI-304	Quality Control and reliability	3	1	-	4	3.5	3
4.	PI-306	Tool Engineering	3	1	-	4	3.5	3
5.	PI-308	CAD/CAM	3	1	-	4	3.5	3
6.	PI-310	Non-conventional manufacturing processes	3	1	-	4	3.5	3
7.	HUT-311	Business Management	3	1	-	4	3.5	
8.	ET-326	Control System (Practical)	-	-	2	2	1.0	3
8.	PI-312	CAD/CAM(Practical)	-	-	3	3	1.5	3
9.	PI-314	Seminar-I	-	-	2	2	1.0	3
		Total	21	7	07	35	28.0	

SCHEME OF EXAMINATION

B. TECH. (7th SEMESTER) PRODUCTION AND INDUSTRIAL ENGINEERING

S. No.	Course No	Subjects	Teaching Schedule (Hours)				Credits	Duration of Exams. (Hours)
			L	T	P/D	Total		
1	PI-401	Engineering Economy	3	1	-	4	3.5	3
2.	PI-403	Measurements & Instrumentation	3	1	-	4	3.5	3
3.	PI-405	Entrepreneurship Development	3	1	-	4	3.5	3
4.	PI-407	Product Design and Development	3	1	-	4	3.5	3
5.	PI-	Elective I *	3	1	-	4	3.5	3
6.		Open Elective I**	3	1	-	4	3.5	3
7.	PI-409	Measurements & Instrumentation (Practical)	-	-	2	3	1.5	3
8.	PI-411	Project-I	-	-	6	6	9.0	3
9.	PI-413	Practical Training Report	-	-	-	-	3.5	3
10.	PI-415	Seminar-II	-	-	2	2	1.0	3
		Total	18	06	10	34	36.0	

* Elective I will be offered from the list of Elective-I

** Open Electives I will be offered from the list of Open Electives.

SCHEME OF EXAMINATION

B. TECH. (8th SEMESTER) PRODUCTION AND INDUSTRIAL ENGINEERING

S. No.	Course No	Subjects	Teaching Schedule (Hours)				Credits	Duration of Exams. (Hours)
			L	T	P/D	Total		
1	PI-402	Productivity Engg. & Management	3	1	-	4	3.5	3
2.	PI-404	Value Engineering	3	1	-	4	3.5	3
3.	PI-406	Maintenance Engineering	3	1	-	4	3.5	3
4.	PI-	Elective II*	3	1	-	4	3.5	3
5.		Open Elective II **	3	1	-	4	3.5	3
6.	PI-408	Project-II	-	-	6	6	9.0	3
7.	PI-410	Comprehensive Viva-Voce	-	-	-	-	3.0	3
8.	PI-412	General Fitness and Professional Aptitude (Viva-Voice)	-	-	-	-	3.5	3
9.		Total	15	5	6	26	33.0	

* Elective II will be offered from the list of Elective-II

**Open Electives II will be offered from the list of Open Electives

LIST OF ELECTIVE-I (Anyone in 7th Semester)

Sl No.	Course No	Name of Elective Subject	Offered as Open Elective To Other Branches
1.	PI-421	Computer Integrated Manufacturing	NO
2.	PI-423	Supply Chain Management & Logistics	YES
3.	PI-425	Industrial Robotics	YES
4.	PI-427	Experimental Design	NO
5.	PI-429	Automobile Engineering	NO
6.	PI-431	Marketing and Financial Management	YES
7.	PI-433	Soft Computing	YES
8.	PI-435	Industrial Engineering & Organization	YES (Not for Mech& PI students)

LIST OF ELECTIVE-II (Anyone in 8th Semester)

Sl No.	Course No	Name of Elective Subject	Offered as Open Elective To Other Branches
1.	PI-422	Total Quality Management	YES
2.	PI-424	Flexible Manufacturing System	NO
3.	PI-426	Management Information System	YES
4.	PI-428	Enterprise Resource Planning	YES
5.	PI-430	Modeling and Simulation	NO
6.	PI-432	Materials Management	NO
7.	PI-434	Energy Management	YES

B.TECH. Ist/IInd SEMESTER
(COMMON TO ALL BRANCHES)
MET-103 MANUFACTURING PROCESSES

L	T	P/D	Cr
3	1	-	3.5

Casting
Patterns, Materials, Types of allowances, Sand casting: types & properties of molding sand: Various molding methods: Core and its types. Permanent mould castings.Co2 casting centrifugal castings. Die castings: shell molding. Plaster molding. Investment castings.Casting defects.remedies.

(6 hrs)

Primary Metal Working Processes
Hot and cold forging.Hot cold rolling. Wire drawing and extension processes.

(4 hrs)

Metal Shearing and Forming
Introduction to shearing.notching. lancing. bending drawing. Stretching. Embossing and coining operations. Process and their types Die and punch operations.

(6 hrs)

Metal Machining Processes
Lathe – parts and accessories. Specifications, Turning tools, various operations on lathe (turning, taper turning thread cutting drilling boring knurling).

(6 hrs)

Welding and Allied Processes
Classification of gas welding. Resistance welding and its types, thermit welding. Electric are welding – metal are welding carbon are welding. Submerged are welding. TIG MHG.Welding defects and remedies. Soldering and brazing.

(8 hrs)

Special Welding Processes
Electro stag welding.Atomic hydrogen welding.Plasnet are welding. Ultrasonic welding.Laser welding.

(6 hrs)

Plastics Processing:
Plastics: Their types and manufacturing properties. Compression molding and Injection molding.

(4 hrs)

Reference Books:

1. DeGarmo, E. P., Black, J.T., and Kohser, R.A., “Materials and Processes in Manufacturing”, Prentice-Hall of India.
2. Kalpakjian, S., and Schmid, S.R., “Manufacturing Engineering and Technology”, Pearson Education.
3. Groover, M.P., “Fundamentals of Modern Manufacturing”, John Wiley & Sons.
4. Manufacturing Processes by Bageman
5. Manufacturing Materials and Processes by Lindherg
6. Principles of Manufacturing Materials by Camphell
7. Workshop Technology by Hazara, ChowdharyVol.I& II
8. Workshop Technology Vol. I& II by Raghuwanshi

B. TECH. (2nd SEMESTER)
(Common to All Branches)
MET-104 ENGINEERING GRAPHICS-II

L	T	P/D	Cr
-	-	6	3.0

Curves
Conics.Cycloid.Epicycloid.Hypocycloid. Involute. Evolute.Spiral.

(2 weeks)

Inter-Section
Interpenctration of simple solids i.e. prism with prism.Cylinder with cylinder.Cylinder with prism, cone-with cylinder and cone with prism (AXIS of solids horizontal or vertical only).

(2 $\frac{1}{2}$ weeks)

Development
Development or right and oblique prism.Cylinder.Cone and pyramids.Sectioned solids.Practical Problems.

(2 $\frac{1}{2}$ weeks)

Isometric Projections
Isometric scale.Isometric projections of simple solids and their combinations.

(2 weeks)

Engineering Graphics Standards
Projections.Sectioning.Conventional representation.Dimensioning. Basis of tolerancing and surface finish symbols. BIS. ISO. DIN.

(1 week)

Fasteners
Screw. Threads and threaded fasteners. Rivets and riveted joints.Welds and welded joints.

(2 weeks)

Machine Drawing
Free hand drawing of simple machine parts i.e. cotter joint, knuckle joint and shaft couplings, pipe fittings and pipe joints.

(2 weeks)

Reference Books:

1. Engineering Drawing by N.D. Bhatt
2. Machine Drawing by N.D. Bhatt
3. Machine Drawing by N. Sidheshwar
4. Engineering Drawing by P.S. Gill
5. Machine Drawing by P.S. Gill
6. Fundamentals of Engineering Drawing by Luzadder& Duff (PIII)

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-201 THERMODYNAMICS

L	T	P/D	Cr
3	1	-	3.5

Fundamental concepts

Definition of thermodynamics, Thermodynamic state and system, Boundary, Surroundings, Universe, Thermodynamic systems: Closed, Open, Isolated, Adiabatic, Homogeneous and Heterogeneous; Macroscopic and Microscopic approaches, Properties of system: Extensive and Intensive; Energy, Heat, Work Thermodynamic equilibrium: Mechanical, Thermal and Chemical, Thermodynamic processes, Quasi-static Process, Reversible and Irreversible Processes, Zeroth law of thermodynamics. **(7 hrs)**

First law of thermodynamics

Law of conservation of energy, Internal energy, First law of thermodynamics (Joule's experiment), Application of first law of thermodynamics to Non-flow system viz. constant volume, constant pressure and constant internal energy process. Reversible adiabatic and reversible polytrophic processes, etc. First law of thermodynamics applied to steady flow processes viz. water turbine, steam or gas turbine, pump, boiler, compressor, condenser, evaporator and nozzles, etc. Application of steady flow energy equation to transient flow processes, Perpetual motion machine of the first kind, Enthalpy. **(7 hrs)**

Second law of thermodynamics

Limitation of first law of thermodynamics, Thermal reservoir, Heat source and heat sink, Heat engines, Refrigerator and heat pump, Statements of second law of thermodynamics: Clausius statement, Kelvin-Plank statement, Equivalence of Clausius statement to the Kelvin-Plank statement, Perpetual motion machine of the second kind. Carnot heat engine, Caroot theorem. Thermodynamic temperature, scale Engine operating between more than two reservoirs, Corollaries of the second law of thermodynamics, Entropy, Characteristics of Entropy, Temperature-Entropy diagram, Entropy changes for closed and open systems, Clausius inequality, Third law of thermodynamics. **(7 hrs)**

Availability and Irreversibility

Available and unavailable energy, Availability of work reservoir and heat reservoir, Availability in non-flow and steady flow systems. Helmholtz and Gibbs functions, Irreversibility in a closed system **(4 hrs)**

Thermodynamic relations

Maxwell relations, Specific heat relations, Entropy equations (first and second Tds equations), Relations between internal energy and enthalpy, Clausius-Claperyon equation for evaporation of liquids, Kirchoff's equation **(4 hrs)**

Ideal gas mixtures

Mass fraction, Mole fraction, Volume fraction, Partial pressure, Gibbs Dalton law, Partial pressure ratio, Gas constant and. specific heats of a gas mixture, Entropy change of a gas mixture **(4 hrs)**

Properties of steam

Formation of steam and related terms, Thermodynamic properties of steam and steam table, Internal latent heat, Internal energy of steam, Entropy of water, Entropy of wet steam, Entropy of evaporation and superheated steam. T-S diagrams, Mollier diagram, Expansion of steam: Hyperbolic, Reversible adiabatic and Throttling processes. Dryness fraction of steam, Measurement of dryness fraction: Bicket calorimeter, Throttling calorimeter, Separating and throttling calorimeter **(7 hrs)**

Reference Books:

1. Engineering Thermodynamics by P.K. Nag, Tata McGraw-Hill

2. Engineering Thermodynamics by C.P. Arora, Tata McGraw-Hill

3. Fundamentals of Classical Thermodynamics by Gordon J. Van Wylen, Wiley Eastern Limited

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-203 STRENGTH OF MATERIALS

L	T	P/D	Cr
3	1	-	3.5

1. **Simple Stresses and Strains**
   Concept of stress and strain, Normal and shear stresses, Hooke's law, Modulus of elasticity, modulus of rigidity, stress-strain diagram, elongation due to self weight, column of uniform strength, composite sections, statically indeterminate systems, temperature stresses, strain analysis , Poisson's ratio, Volumetric strain, factor of safety, tensile test diagram, elastic constants, relation between elastic constants. **(5 hrs)**

2. **Compound Stresses and Strains**
   Stresses on an inclined plane, principal stresses and principal planes, Mohr's stress circle, three coplanar stresses, ellipse of stress, strain analysis, principal strains. **(4 hrs)**

3. **Strain Energies and Theory of Failures**
   Strain energy, resilience, strain energy in 3-D system, shear strain energy, shear strain energy in 3-D system, stresses due to various types of loading, Different theories of failure, significance, graphical representation. **(4 hrs)**

4. **Bending Moment and Shear Force Diagrams**
   Types of supports and beams, shear force, bending moment, relation between load, shear force and bending moment, shear force and bending moment diagrams for various types of loading and supports, maximum bending moment and point of contraflexure. **(4 hrs)**

5. **Stresses in Beams**
   Stresses due to simple bending, moment of inertia, beams with uniform bending strength, composite or flitched beams, shear stress distribution, variation of shear stress in beams of various sections. **(5 hrs)**

6. **Slope and Deflection**
   Beam differential equation, slope and deflection at a point, double integration method, Macaulay's method, moment-area method, Castigliano's theorem. **(5 hrs)**

7. **Torsion**
   Derivation of torsion equation and its assumptions, applications of the equation to the hollow and solid circular shafts, torsional rigidity, combined torsion and bending of circular shafts, close-coiled-helical springs. **(4 hrs)**

8. **Thin cylinders and spheres**
   Thin cylinders subjected to internal pressure, circumferential and longitudinal stresses and strains, maximum shear stress, increase in diameter and volume of vessel, Thin spherical shells subjected to internal pressure, wire winding of thin cylinders. **(5 hrs)**

9. **Columns and struts**
   Columns under axial load, concept of instability and buckling, slenderness ratio, various end conditions, Euler's theory for initially straight columns, assumptions and limitations,

empirical formulae. **(4 hrs)**

Reference Books:

1. G H Ryder, *"Strength of Materials",* ELBS.
2. S S Rattan, "Strength of Materials", Tata McGraw Hill, India.
3. Beer P F and Johnston (Jr) E R, *"Mechanics of Materials",* SI Version, Tata McGraw Hill, India.
4. Sadhu Singh "Strength of Materials", Khanna Publishers.
5. Popov E P, *"Engineering Mechanics of Solids",* SI Version, Prentice Hall of India, New Delhi.
6. Timoshenko S P and Young D H, *"Elements of Strength of Materials",* East West Press, New Delhi.

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-205 MACHINE DRAWING

L	T	P/D	Cr
-	-	4	2

Introduction

Introduction of unit assembly drawing, Practice in drawing details and assembly of simple units.

(1 week)

Jigs and Fixtures

Preparation of assembly and details working drawing of simple jigs and fixtures viz. tail stock, tool head of shaper etc.

(2 weeks)

Valves

Gate valves, globe valves, non return valve, foot valve, blow-off valve, feed check valve, water tap, non-return valves.

(2 weeks)

Simple Steam and I.C. Engine Parts

Pistons, piston rod, cross head, stuffing box and glands, connecting rods, piston and connecting rod for I.C. engine.

(2 weeks)

Gears

Gear terminology, profile of involutes gear teeth, method of drawing involutes profile for spur and rack and pinion gears, I.S. convention representation of assembly of spur gears, helical gears, Bevel gears, Worm and worm wheel.

(2 weeks)

Pulleys

Flat belt, V-belt, rope pulleys, fast and loose pulley

(1 week)

Pipe Joints

Common types of joints, for wrought, C.I. and M.S. water and steam pipes.

(1 week)

Bearing

Simple solid, bushed, pedestal, footstep bearings, I.S. conventional representation of ball and roller bearings, bracket and hangers of different types and bracket bearings, Plumber block etc.

(2 weeks)

Limits, Fits and Tolerances

Symbols, I.S. limits, fits and tolerances, Dimensioning with tolerances-indicating various types of fits on detail and assembly drawings of simple jigs and fixtures.

(1 week)

Note: *Drawings should be in first angle method of projection.*

Reference Books:

1. Machine Drawing- N.D. Bhatt, Charotar Pubs.
2. Machine Drawing- Sidheshwar, Tata McGraw-Hill
3. A text book of Machine drawing**-** Laxminarayan&Mathur, Jain Brothers
4. A text book of Machine drawing**-** R.B. Gupta, SatyaPrakasham Tech. Pub.

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-207 PRODUCTION TECHNOLOGY- I

L	T	P/D	Cr
3	1	-	3.5

1. Milling

Introduction, Milling machines types, milling cutters, milling operations, dividing head and indexing types, Up milling down milling, milling operations, special set-ups. **(6hrs)**

2. Hole Making Operations

Introduction, Drilling, reaming, boring, tapping, other hole making operations **(3hrs)**

3. Reciprocating Machine Tools

Construction and working of shaper, planer and slotter, quick-return mechanism, job holding devices **(3hrs)**

4. Theory of Machining:

(a) Metal Cutting

Concept of generatrix and directrix; Classification of machining processes: Orthogonal and oblique, machining, single point and multi-point machining; Tool geometry: Single point cutting tool geometry, specifications in different standards, selection of tool angles; Cutting tool materials, different types of cutting tools, Chip formation: Mechanism, chip types, chip control; Mechanics of single point orthogonal machining: Merchant's circle, force, velocity, shear angle, and power consumption relations **(11hrs)**

(b) Cutting Tool Wear and Life:

Wear Mechanism, wear criterion, Taylor's tool life equation, flank wear, crater wear, variable affecting tool life, machinability and its measures **(4 hrs)**

(c) Thermal aspects of machining:

Cutting temperature and factors affecting it, measurement, cutting fluids and its types, selection of cutting fluids **(3hrs)**

(d) Analysis of Machining processes

Mechanics of machining of turning, boring, shaping and planning, milling (Slab and face milling), drilling, machining time calculations of above operations **(6hrs)**

(e) Economics of metal machining:

Elements of machining cost, machining economics and optimization for single pass turning operation. **(3hrs)**

Suggested Books:

1. DeGarmo, E. P., Black, J.T., and Kohser, R.A., "Materials and Processes in Manufacturing", Prentice-Hall of India.
2. Kalpakjian, S., and Schmid, S.R., "Manufacturing Engineering and Technology", Pearson Education.
3. Groover, M.P., "Fundamentals of Modern Manufacturing", John Wiley & Sons.
4. Lindberg, R.A., "Processes and Materials of Manufacture", Prentice-Hall of India
5. Boothroyed, G. et al., Fundamentals of Metal Cutting and Machine Tools, McGraw Hill.
5. Rao,P.N., "Manufacturing Technology", (Vol. 2), Tata McGraw-Hill
6. Ghosh, A. and Mallik, M., "Manufacturing Science", E.W. Press
7. Lal, G.K., "Introduction to Machining Science", New Age International Publishers.
9. Production Engineering Science- Pandey and Sing

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-209 MATERIAL SCIENCE

L	T	P/D	Cr
3	1	-	3.5

Plastic Deformation

Types of defects in crystals- point, line and surface defects, deformation by slip, slip planes, twinning, mechanical and annealing twins, dislocation- edge and screw dislocation, critical resolved shear stress, dislocation loop, energy of dislocation, force on dislocation, stress field around dislocation, dislocation motion, perfect, extended and sessile dislocation, jogs, dislocation density, Frank Read source, dislocation pile-up, interaction between dislocation and vacancies. **(6 hrs)**

Work Hardening

Work hardening of single crystal and polycrystalline materials, mechanism of work hardening, work softening, Bauschinger's effect, grain boundaries, its effect on crystal and on strength, grain size, low angle grain boundaries, polygonization, solid solution hardening, yield point phenomenon, strain aging, dispersion of second phase particles, preferred orientation, recovery and its mechanisms, recrystallization - mechanisms and laws, grain growth, hot working and cold working and their effects on mechanical properties.

(6 hrs)

Fracture and Creep

Introduction, types fracture, theoretical cohesive strength of metals, Griffith's theory of brittle fracture and its modification, stages in development of ductile fracture, methods of fracture protection, creep test, creep curve, creep curve equations, creep curve at constant temperature, stress- rupture test, effects of metallurgical variables on creep, creep mechanisms. (**6 hrs**)

Fatigue of Metals

Introduction, factors to cause fatigue failure, stress cycles, S-N curve, fatigue test, theories of fatigue-Orowan theory, fatigue limit theory, Wood's theory and dislocation movement theory, effect of stress concentration on fatigue, size effects, corrosion fatigue, fretting, low temperature and high temperature fatigue.

(6 hrs)

Phase Diagrams

Introduction, plotting of binary diagram, equilibrium cooling of an alloy, solid solutions, eutectic, eutectoid and peritectic systems, Iron-Iron carbide (Iron carbon) equilibrium diagram- various phases present, various reactions involved, critical points, explanation of Iron carbon diagram; phase rule.

(4 hrs)

Heat Treatment

TTT diagram, pearlite transformation and bainite transformation, continuous cooling and TTT diagram- transformation of austenite, factors affecting critical cooling rate, heat treatment processes- annealing, normalizing, spheroidizing, hardening and tempering, austempering, martempering, precipitation hardening, case hardening- carburising, nitriding, cyaniding, flame hardening, induction hardening.

(6 hrs)

Ceramics and Powder Metallurgy

Classification of ceramic materials, ceramic and non- ceramic materials, mechanical and magnetic properties of ceramics, classification and properties of composite materials, whiskers and whisker composites, various methods of preparations of raw powders, blending, compacting, sintering, finishing operations-sizing, impregnation, infiltration, advantages and disadvantages, typical applications of powder metallurgy.

(6 hrs)

Reference Books :

1. Material Science and Engineering- V. Raghavan, Prentice Hall
2. Materials Science and Engineering An Introduction- W.D. Callister, John Wiley
3. Mechanical Behaviour of Materials - McClontock& Argon, Addison-Wesley
4. Mechanical Behaviour of Materials- Courtney, McGraw-Hill
5. Mechanical Metallurgy-Dieter

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-211 KINEMATICS OF MACHINES

L	T	P/D	Cr
3	1	-	3.5

1. Mechanism and machines:
Kinematics, introduction to analysis and synthesis of mechanisms, links, Kinematics' pairs, Degree of freedom, Dynamitic chain mechanism, Machine, Four-bar chain, Inversions, Single and double slider crank chain, Quick return mechanisms (**6 hrs**)

2. Velocity Analysis:
Velocity determination: Relative velocity methods, Instantaneous center method, Acceleration determination, Kennedy's theorem (**3 hrs**)

3. Acceleration Analysis:
Centripetal and tangential accelerations, Acceleration determination by graphical method using velocity polygons, Corioli's component of acceleration, Klein's and other constructions. (**3 hrs**)

4. Computer-aided analysis and synthesis of mechanism:
Analytical methods to find velocity and acceleration of four-link mechanism, slider crank mechanism, freundenstein's equation, Coordinate angular displacements of input and output links (Path generation, function generation), Least square technique, Rigid body guidance. (**4 hrs**)

5. Lower pairs:
Pantograph, straight-line motion mechanisms (Paucellier, Hart, Scott Russel, Grasshopper, Watt, Kempe's, Tchybishev, Parallel linkages) Indicator mechanisms (Simplex, Crosby, Thomson, etc) Automobile steering gears (Davis and Ackermann), Hooks joint (universal coupling), Double hooks joints. (**6 hrs**)

6. Friction:
Types of friction, Laws of dry friction, Motion along inclined plane Screw threads, Wedge, Pivots and collars, Plate and cone clutches, Antifriction bearings, friction circle and friction axis, bearings and lubrication, Power loss in bearings (**6 hrs**)

7. Cams:
Types of cams and followers, various motions of the follower, Construction of cam profiles, Analysis for velocities and accelerations of tangent and circular arc cams with roller and flat-faced followers. (**6 hrs**)

8. Belts, Ropes and Chains:
Open and crossed belt drives, velocity ratio, slip, material for belts, crowning of pulleys, law of belting, types of pulleys, length of belts, ratio of belt tensions, centrifugal tension, power transmitted by belts and ropes, initial tension, creep, chain drive, chain length, classification of chains. (**6 hrs**)

Books Recommended:

1. Theory of Machines- S.S.Rattan, Tata McGraw Hill
2. Theory of Mechanism and Machines - JagdishLal, Metropolitan Book Co.
3. Mechanism Synthesis and Analysis- A.H. Soni, McGraw-Hill
4. Mechanism- J.S. Beggs, McGraw-Hill
5. Mechanics of Machines- P. Black, Pergamon Press
6. Theory of Machines - .L. Ballaney, Khanna Publisher

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
Mathematics-III MAT – 201

L	T	P/D	Cr
3	1	-	3.5

PART-A– FINITE DIFFERENCES AND DIFFERENCE EQUATIONS

Finite Differences
Finite differences, Difference operators, Newton's forward and backward interpolation formulae, Bessel's formulae and Stirling's formulae, Lagrange's interpolation formula for unequal interals, Numerical differtiation, Numerical integration: Newton-cote's quadrature formula (Trapezoidal rule, Simpson's 1/3 and 3/8 rule), Gaussian quadrature formula.

(9 hrs)

Difference Equations
Formation of difference equations, Solution of homogenous and non- homogenous with constant coefficients linear difference equations.

(4 hrs)

PART-B NUMERICAL METHODS WITH PROGRAMMING

Numerical Solution of algebraic and transcendental Equations
Bisection method, Regula-Falsi method, Newton Raphson method, Secant method.

(4 hrs)

Solution of Linear Simultaneous Equations
Gauss elemination method, Gauss-Jordan method, Crout'striangularisation method, Jacobi's iteration method, Gauss-Seidalinteration method.

(5 hrs)

Numerical solution of ordinary differential equations
Picard's method, Euler's method, Runga-Kutta method, Milne's predictor-corrector method, Adams-Bashforth method.

(6 hrs)

PART – C

Statistical Methods
Method of Least Square and curve fitting, Correlation, Coefficient of correlation, Rank correlation, Regression and lines of Regression, Binomial distribution, Poisson distribution and Normal distribution with their properties and application. (**8 hrs)**

Operational Research
Linear programming problems formulation, solving linear programming problems using
i) Graphical Methods ii) Simplex Method iii) Dual Simplex Method **(5hrs)**

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-213 STRENGTH OF MATERIALS (PRACTICAL)

L	T	P/D	Cr
-	-	2	1

List of Experiments:

1. To study the universal impact testing m/c and to find the impact strength of the given specimen.
2. To study the pendulum type impact testing m/c and to find the impact strength of given specimen.
3. To study Vicker cum Brinell hardness testing m/c.
4. To study Rockwell hardness testing m/c and to find the Rockwell hardness of given specimen.
5. To study the Erichson cupping m/c and to find the Erichson value of given sheet metal specimen.
6. To study the Brinell hardness testing m/c and to find the Brinell hardness of given specimen.
7. To study the fatigue testing m/c.
8. To study the universal testing machine (UTM) and to perform tensile test on it.
9. To perform compression test on UTM for a given specimen.
10. To perform shear test on UTM for a given specimen.
11. To determine the value of modulus of elasticity of a given specimen using extensometer on UTM.
12. To perform bending test on UTM for a given specimen.
13. To study the torsion testing machine and to find the modulus of rigidity, torsional strength and modulus of rupture in torsion for a given specimen.
14. To study the strut-testing machine and to determine the value of Euler's crippling load for different end conditions.
15. To measure the hardness of a given specimen with the help of SHORE-SLEROSCOPE.
16. To study the spring testing machine and to find the stiffness of given spring.

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-215 PRODUCTION TECHNOLOGY - I (PRACTICAL)

L	T	P/D	Cr
-	-	2	1

List of Experiments:

1. Measurement of tool angles of single and multi- point tools (Milling and Drills) using gauges.
2. Prepare a job on a lathe having various operations viz. drilling, boring, taper turning, thread cutting, knurling, etc.
3. Prepare a V-groove on shaper
4. Introduction to various grinding wheels and demonstration on the cylindrical and surface grinder.
5. Introduction to tool and cutter grinder and various dynamometer.
6. Introduction and demonstration of measurement of tool tip temp measurement.
7. Prepare a wooden pattern of the given item considering allowances etc.
8. Prepare a mould and do casting of the pattern (Sl. No.3) prepared above.
9. Study of electrical wiring, material tools used, safety precautions, various circuits, its installation, inspection, earthing, distribution boxes and switches.
10. Study and exercise on household, staircase and godown wiring.
11. Practice welding by electric arc welding in flat, horizontal and vertical position.

B. TECH. (3rd SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-217 THERMODYNAMICS (PRACTICAL)

L	T	P/D	Cr
-	-	2	1

List of Experiments:

1. Study of 2 stroke petrol and diesel engine models.
2. Study of 4-stroke petrol/diesel engine model.
3. Study of boilers.
4. Study of Babcock- Wilcox boiler.
5. Study of Locomotive boiler.
6. Study of Lancashire boiler.
7. To study the Red wood viscometer and measure the viscosity of fluid.
8. To measure the flash point of the given fuel.
9. To study the Nestler boiler.
10. To study various parts of the vertical steam engine.
11. To study the Ruston Diesel engine and make a trial on it.

B. TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-202 DYNAMICS OF MACHINES

L	T	P/D	Cr
3	1	-	3.5

1. Static Forces in Mechanisms:
Static force analysis, Static equilibrium, free body diagram, Analysis of static forces in mechanism. (**2 hrs**)

2. Dynamic Forces in Mechanisms:
D'Alembert's principal, Equivalent offset inertia force, Dynamics of reciprocating parts, Piston effort, Crank effort, Equivalent dynamical systems, and Inertia force in reciprocating engines by graphical and analytical method. (**4 hrs**)

3. Flywheels:
Turning moment and crank effort diagrams for single cylinder and multi-cylinder engines, coefficient of fluctuation of energy, coefficient of fluctuation of speed, flywheel and its function. (**3 hrs**)

4. Gears:
Types of gears, gear terminology, condition for correct gearing, cycloidal and involutes profiles of gear teeth, pressure angle, path of contact, arc of contact, interference, undercutting, minimum number of teeth, number of pairs of teeth in contact, helical, spiral, worm and worm gear, bevel gear. (**6 hrs**)

5. Gear Trains:
Gear trains: simple, compound, reverted, and epicyclic, Solution of gear trains, sun and planet gear, bevel epicyclic gear, compound epicyclic gear, pre- selective gear box, differential of automobile, torque in gear trains. (**4 hrs**)

6. Brakes and Dynamometers:
Types of brakes, friction brakes, external shoe brakes, band brakes, band and block brakes, internal expanding shoe brake, dynamometers: absorption, transmission, and torsional. (**4 hrs**)

7. Governors:
Types of governors: Watt, Porter, Proell, spring loaded centrifugal, Inertia, Sensitiveness, Stability, Isochronism's, Hunting, Effort and power of governor, controlling force. (**4 hrs**)

8. Gyroscopic Motion:
Gyroscope, Gyroscopic couple and its effect on aircraft, naval ships during steering, pitching and rolling, Stability of an automobile(2-wheelers & 4-wheelers). (**4 hrs**)

9. Balancing:
Static and dynamic balancing of rotating parts, balancing of I.C. engines, balancing of multi-cylinder engine: V-engines and radial engines, balancing of machines. (**4 hrs**)

10. Mechanical Vibrations:
Introduction, linear, longitudinal, torsional, single degree of freedom vibrations without and with damping, forced vibrations, transmissibility, vibration measuring instruments (**5 hrs**)

Books Recommended:

1. Theory of Machines- S.S.Rattan, Tata McGraw Hill
2. Theory of Mechanism and Machines- JagdishLal, Metropolitan Book Co.
3. Mechanism Synthesis and Analysis- A.H. Soni, McGraw-Hill
4. Mechanism- J.S. Beggs, McGraw-Hill
5. Mechanics of Machines- P. Black, Pergamon Press
6. Theory of Machines- P.L. Ballaney, Khanna Publisher

B. TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-204 FLUID MECHANICS AND HYDRAULIC MACHINES

L	T	P/D	Cr
3	1	-	3.5

Fluid Statics

Fluid, properties of fluid, fluid pressure, Pascal's law, general equation of fluid statics, pressure head of a fluid, simple and differential manometers, mechanical gauges.

(4 hrs)

Fluid Kinematics

Langrangianand Eulerian methods, types of flow, velocity and acceleration, continuity equation (cartesian co-ordinates), stream function, velocity potential function, flow nets, types of motion: linear translation, linear deformation, angular deformation and rotation.

(5 hrs)

Fluid Dynamics

Euler's equation, Bernoulli's equation, energy equation, practical applications of Bernoulli's equation in venturimeter, orfice meter and pitot tube. Reynold's experiments.

(5 hrs)

Principles of Hydraulic Machines

Impact of jet on stationary and moving flat and curved plates, forces on series of vanes, radial vanes.

(4 hrs)

Hydraulic Turbines

Introduction, development of hydraulic turbines, classification of turbines.Turbines: Pelton, Francis, Propeller, Kaplan; working and essential components of these turbines.

(6 hrs)

Hydraulic Pumps

Centrifugal pumps: working and its various components, classification, losses and efficiencies. Reciprocating pumps: working and its various components, classification, comparison with centrifugal pumps, air-vessels. Other hydraulic pumps: propeller pump, jet pump, air lift pump, gear pump, screw pump, vane pump, submersible pump.

(8 hrs)

Hydraulic Systems

Hydraulic valves: check or non-return valve, relief valve, speed control valve, pressure compensating valve, direction control valve. Hydraulic filters, tanks used in hydraulic systems, hydraulic piping, hydraulic fluids. Hydraulic accumulator, hydraulic intensifier, hydraulic lift, hydraulic crane, hydraulic coupling, torque converter, hydraulic ram.

(8 hrs)

Reference Books:

1. Fluid Mechanics and Hydraulic Machines-By S.S. Rattan, Khanna Publishers.
2. Fluid Mechanics and Fluid Power Engineering-By D.S. Kumar, Katson Publishers.
3. Fluid Mechanics and Machinery-By D. Rama Durgaiah, New Age International Publishers
4. Introduction to Fluid Mechanics and Machinery-By Som and Biswas, TMH

B. TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-206 PRODUCTION TECHNOLOGY-II

L	T	P/D	Cr
3	1	-	3.5

1.Grinding
Operations and applications of surface, cylindrical, centre less and internal grinding processes, dressing, truing and balancing of grinding wheels, grading and selection of grinding wheels, Mechanics of grinding, machining time calculation **(7hrs)**

2.Finishing and Super Finishing Processes
Principles and applications of honing, super finishing, lapping, polishing, buffing, peening, and burnishing. **(4hrs)**

3. Press Working of Sheet Metal
Introduction, classification of presses, shearing action, cutting forces, clearance and its effect, shear, angular clearance, stripper, center line of pressure and its mathematical calculation. Die materials, Die types, construction details of die set, auxiliary equipment, safety devices. **(9 hrs)**

4.Capstan,Turret And Automatic Lathe
Limitations of a center lathe, Introduction to Capstan and Turret lathe, Universal Bar equipment, tool layout for simple parts. Automatic lathe: Introduction, classification, tooling layout **(7hrs)**

5.Theory and Analysis of Metal Forming Process
Plastic deformation and yield criteria, relationship between tensile and shear yield stresses, Friction conditions in metal working, Analysis of forming processes: Rolling, forging, wire drawing, extrusion, temperature and lubrication aspect in metal forming, forming defects **(10hrs)**

6.Thread Manufacturing:
Introduction, Methods: casting, thread cutting, Thread Rolling, Die Threading, Thread Milling, Thread Grinding and Tapping, calculation of blank size **(3hrs)**

Suggested Books:

1. DeGarmo, E. P., Black, J.T., and Kohser, R.A., "Materials and Processes in Manufacturing", Prentice-Hall of India.
2. Kalpakjian, S., and Schmid, S.R., "Manufacturing Engineering and Technology", Pearson Education.
3. Groover, M.P., "Fundamentals of Modern Manufacturing", John Wiley & Sons.
4. Lindberg, R.A., "Processes and Materials of Manufacture", Prentice-Hall of India
5. Boothroyed, G. et al., Fundamentals of Metal Cutting and Machine Tools, McGraw Hill.
5. Rao,P.N., "Manufacturing Technology", Tata McGraw-Hill
6. Manufacturing Science - Ghosh and Mallik, E.W. Press
7. Production Engineering Science- Pandey and Singh
8. Avitzur, B., Metal Forming: Processes and Analysis, Mc-Graw Hill.
9. Rowe, G.W., Elements of Metal working theory, Edward Arnold.
10. Donaldson, Tool Design, TMH.

B.TECH. 4TH SEMESTER
PRODUCTION AND INDUSTRIAL ENGINEERING
ECE-216 Digital Electronics and Microprocessor Architecture

L	T	Total	Cr
2	1	3	2.5

UNIT-1

Binary number, Number base conversions, Octal and Hexadecimal numbers, complements, signed binary number, Binary codes. Simplification of Boolean functions by Karnaugh Map and Quine MeCluskey method **(5hrs)**

UNIT-II

Combinational Circuit, Adders, subtractors, code converters, Binary adder & subtractor. Decimal adder, Magnitude comparator, decoder and Encoder, Multiplexers, Synchronous Sequential Circuits, Flip flop excitation tables. Design of Shift register,

(5hrs)

UNIT –III

Introduction to memory devices, SRAM, DRAM, ROM, EPROM,Flash EPROM, EPROM, Address Decoder. PLA, PAL, FPGA, CPLD. Cell structures and functional description of all these devices. **(5hrs)**

UNIT-IV

Introduction to microprocessors, applications. Intel's 8085 Architecture, Instruction set, Basic programming, Meomory interfacing with 8085. Intel's 8255,8251. Parallel and serial I/O interfacing case-studies using 8255 and 8251. **(10hrs)**

Reference Books:

1. Digital Design by M. Morris Mano
2. Digital Electronics by R.P. Jain
3. Principles of Computer Hardware by Alan Clements
4. Microprocessor Architecture, Programming and Applications with 8085 by Ramesh Gaonkar

B. TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-208 METROLOGY

L	T	P	Cr.
3	1	-	3.5

Introduction

Meaning of Metrology, Objectives of Metrology, Necessity and Importance of Metrology, Precision Measurement –Its need.Limits, Fits and Tolerance, Classification of Measuring Instruments, Classification of Methods of Measurements.

(6 hrs)

Principles of Measuring Instruments

Definitions, Classification of Measuring Equipments, Principles of Mechanical Measuring Instruments, Principles of Optical Instruments -Reflection, Refraction, Lenses, Interference, Optical prisms & Optical projectors, Priciples of Electrivcal Measuring Instruments, Principles of Pneumatic Measuring Instruments.

(4 hrs)

Linear Measurements

Calipers, Vernier Calipers, Vernier Height Gauge, Vernier Depth Gauge, Micrometers - Description of micrometer, types of micrometers, Advantages and Limitations of commonly used Precision Instruments.

(4 hrs)

Angular and Taper Measurements

Angular Measurements, Introduction, Instruments for Angular Measurement -Protractors, Sine bars, Sine table, Sine center, Angle gauges, Spririt level & Clinometers, Taper Measurement - Gauges for Tapers, Taper Measuring Instruments.

(4 hrs)

Screw Thread Measurements

Introduction, Classification of Threads, Elements of Screw Threads, Specifications of screw Thread, Measuring Elements of a Screw thread, External Screw Thread Measurements, Internal Screw Thread Measurements, Screw Thread Gauges.

(4 hrs)

Gear Measurements

Introduction, Types of Gears, Methods of making Gears, Forms of Gear Teeth, Involutes curve, Gear Tooth Terminology, Measurement of Tooth thickness, Measurement of Tooth Profile, Measurement of pitch.

(4 hrs)

Measurement of Circularity

Circularity, Roundness and Circularity, Measurement of Circularity-Devices Used, V-block and dial indicator, Precision measuring instruments, Measurement of Roundness of Machined Shafts.

(4 hrs)

Comparators

The Comparator, Desirable Features of a Comparator, Use of Comparators, Types of Comparators, Mechanical Comparators -Dial Indicator, Optical Comparators, Electrical and Electronic Comparators, Pneumatic Comparators, Limit Gauges, Toolmaker's Microscope.

(4 hrs)

Measurement of Surface Finish

Methods of Measuring Surface Finish.

(3 hrs)

General Instruments

Profile Projector, Combination set, Surface Plate, Miscellaneous Gauges.

(3 hrs)

Reference Books:

1. Metrology and Instrumentation by O.P.Khanna (DhanpatRai Publications)
2. A Text Book of Metrology by M. Mahajan (DhanpatRai Publications)

B. TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-210 OPERATIONS RESEARCH

L	T	P	Cr.
3	1	-	3.5

Introduction

Development of operations Research, characteristics and scope of operations research in management, Models in operations research, Model formulation, Types of mathematical models, limitations of operations Research. (**4 hrs**)

Linear programming:

L.P. models, simplex method, the algebra of simplex method. (Minimization and Minimization problems). The big M method, post optimality analysis, essence of duality theory, application of sensitivity analysis. (10**hrs**)

Transportation and Assignment

Introduction to Model, matrix terminology, formulation and solution of Transportation model (least cost method, Vogel's Approximation method), least time transportation problem, assignment problems. (6 hrs)

Decision Analysis

Steps in decision theory approach, Decision making environment, Decision making under certainty and uncertainty, Decision making under conditions of risk, Decision trees, Advantages and limitations of decision tree solutions, post-optimality analysis. (**8 hrs**)

Simulation

Introduction, applications of simulation, advantages and limitations of simulation technique, generation of random numbers, Time-flow mechanism, simulation languages. (**4 hrs**)

Queuing Theory

Introduction, Applications of queuing theory, Waiting time and idle time costs, single channel queuing theory and multi channel queuing theory with Poisson arrivals and exponential services, Numerical on single channel and multi channel queuing theory. (**6 hrs**)

Game Theory

Theory of games, competitive games, Rules and Terminology in game Theory, Rules for game theory- saddle point, dominance , mixed strategy (2 x 2 games), mixed strategy (2x n games or m x 2 games), mixed strategy (3 x 3 games), two person zero sum games, n –person zero sum games. (**4 hrs**)

Books Recommended:

1. Introduction to Operation Research by Hiller and Lieberman, Mc Graw-Hill.
2. Operations Research by P.K. Gupta and D.S. Hira
3. Linear Programming by N.P. Loomba
4. OR- Mahahan
5. OR- Taha
6. OR- Hillier and Libberman

(Common to all branches, 3rd and 4th Semesters of B.Tech.)

HUT-211 ORGANISATIONAL BEHAVIOUR

L	T	P/D	Cr
2	1	-	2.5

UNIT-I INTRODUCTION

Concept of OrganisationalBehaviour, Nature of OrganisationalBehaviour, OrganisationalBehaviour and other similar fields of study – Psychology, Sociology, Anthropology, Political Science. Approaches to OrganisationalBehaviour. Challenges and opportunities for Organizational Behaviour

UNIT-II UNDERSTANDING AND MANAGING INDIVIDUAL BEHAVIOUR

Concept of Behaviour, Process of Behaviour, Foundations of Individual Behaviour. Values, Attitudes and Job Satisfaction: Importance of values, Types of values. Concept of Attitudes, Theories of Attitude Formation. Factors in Attitude Formation.Attitude Management.Measuring Job Satisfaction, the effect of Job Satisfaction on Employee Performance.

UNIT-III UNDERSTANDING PERSONALITY AND PERCEPTION

Personality

What is Personality? Personality Theories, Determinants of Personality, Personality Traits affecting Behaviour.

Perception

Concept of Perception, Perceptual Process, Factors influencing Perception.

Learning

Concept of Learning, Components of Learning Process, Factors affecting Learning.

UNIT-IV UNDERSTANDING AND MANAGING GROUP BEHAVIOUR

Group Dynamics

Concept of Group Dynamics, Concept of Group, Formal and Informal Groups, Group Behaviour.

Communication

Concept of Communication, The Communication Process, Barriers in Communication, Essentials of Effective Communication

Leadership

Meaning of Leadership, Leadership Theories-Charismatic Leadership Theory, Trait Theory, Behavioural Theory.

UNIT-V UNDERSTANDING AND MANAGING ORGANISATIONAL SYSTEM

Design of Organisation Structure

Concept of OrganisationStructure, forms of Organisation Structure, Contingent Factors in Organisational Design.

Organisational Culture
What is Organisational Culture? What do Cultures Do? Creating and Sustaining Culture.

Work Stress
What is Stress? Course of Stress, Effects of Stress, Managing Stress.

Organisational Change
Nature of Organisational Change, Factors of Organisational Change, Planned Change, Process of Planned Change, Resistance to Change, Overcoming Resistance to Change.

UNIT-VI UNDERSTANDING THE CONCEPT AND THEORIES OF MOTIVATION

Motivation
Concept of Motivation, Motivation and Behaviour, Theories of Motivation-Maslow's Need Hierarchy Theory, Harzberg's Motivation-Hygiene Theory, McGrejor's Theory X and Theory Y.

Reference Books:

1. OrganisationalBehaviour – Stephen P. Robbins (Pearson Education)
2. OrganisationalBehaviour- Fred Luthans (MacGraw Hill, New York)
3. OrganisationalBehaviour – Jit S. Chandan (Vikas Publishing House Pvt. Ltd.)
4. OrganisationalBehaviour – L.M. Prasad (Sultan Chand & Sons, New Delhi)
5. Human Relations &OrganisationalBehaviour- R.S. Dwivedi (Oxford, IBH)
6. Personnel Management – C.B. Mamoria(Himalayan Publications, New Delhi)

B.TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-212 KINEMATICS AND DYNAMICS OF MACHINES (PRACTICAL)

L	T	P/D	Cr
-	-	2	1

List of Experiments :

1. To détermine expérimentally the ratio of the cutting time to idle time (i.e. cutting time to idle time (i.e. cutting stroke to idle stroke) of the crank & slotted lever (QRM) and compre the results to theoritical values. Plot the following :
   (a) ϕ v/s X (displacement of slider).
   (b) ϕ v/ s velocity
   (c) ϕ v/s Acceleration and to compare the values of velocities.
   (d) {Take angles ϕ =45^0, 90^0, 135^0, 225^0, 270^0 & 335^0, ϖ =1 rad/s}

2. To determine the value of coefficient of friction between the screw and nut of the jack, while :
   (a) Raising the load
   (b) Lowering the load

3. To draw experimentally a curve of the follower displacement v/s cam angle. Differentitate the above curve to get velocity and acceleration plot and compare the values with those obtained analytically.
4. To determine the coefficient of friction between belt and pulley and plot a graph between $\log_{10} T_1/ T_2$ v/s ϕ.
5. To determine the displacement, velocities & accelerations of the driven shaft of Hooke's joint for a constant speed of the driver shaft.
   (a) To determine experimentally, the moment of inertia of a flywheel and axle and compare with theoretical values.
   (b) To determine the frictional torque between flywheel axle and ball bearing.

6. To fine critical speed experimentally and to compare the whirling speed of a shaft with the theoretical values.
7. To fine experimentally the gyroscopic couple on motorized gyroscope and compare with applied couple.
8. To perform the experimental of balancing of rotating parts and find the unbalanced couples and force.
9. Study of centrifugal governor, automoblile transmission unit and epicyclical gear train.
10. To determine Corioli's component of acceleration of the given mechanical system.

B. TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-214 FLUID MECHANICS AND HYDRAULIC MACHINES (PRACTICAL)

L	T	P/D	Cr
-	-	2	1.0

List of Experiments

1. To determine metacentric height of the ship model.
2. To verify the Bernoulli's theorem.
3. To determine coefficient of discharge for an Orificemeter.
4. To determine coefficient of discharge of a venturimeter.
5. To determine the various hydraulic coefficients of an Orifice (C_d ,C_c ,C_v).
6. To determine coefficient of discharge for an Orifice under variable head.
7. To calibrate a given notch.
8. To determine coefficient of discharge for a mouth piece.
9. To determine the Darcy Weisbach Coefficient of friction for flow through commercial pipes.
10. To determine critical Reynolds' numbers for flow through commercial pipes.
11. To study development of boundary layer over a flat plate.
12. To measure the pressure distribution around a cylinder placed in the air stream and to calculate the coefficient of drag therefrom.
13. To study the momentum characteristics of a given jet.

B. TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 216 PRODUCTION TECHNOLOGY – II (PRACTICAL)

L	T	P/D	Cr
-	-	2	1.0

List of Experiments:

1. Practices of slab milling on milling machine.
2. To cut gear teeth on milling machine using dividing head.
3. Introduction to gear hobbing and practice on it.
4. Introduction and demonstration on Die-sinking EDM.
5. Introduction and demonstration of Wire-EDM.
6. To carryout welding using submerged arc welding.
7. To carryout welding using MIG welding set.
8. Introduction to weldments testing/inspection techniques and carryout its inspection/ testing.
9. Introduction to sand, mould testing equipments, moisture testing etc.
10. Introduction, demonstration and practice on CIM system

B. TECH. (4th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-218 METROLOGY (PRACTICAL)

L	T	P/D	Cr
-	-	2	1

List of Experiments

1. To measure the angle of a taper rod using sine bar and slip gauges.
2. To measure the straightness of machine tool surface by sensitive spirit level.
3. To measure the angle and width of a V- groove
4. To measure the gear tooth thickness by using gear tooth vernier caliper.
5. To measure the elements of screw thread using tool makers microscope.
6. To measure the elements of screw thread using profile projector
7. To study the CNC Machine.

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-301 MACHINE DESIGN

L	T	P/D	Cr
3	-	6	6.0

Concepts of Design:
Design methodology, Design criterion based on fracture, deformation and elastic stability, design stress, factor of safety Selection of Engineering Materials
(4 hrs)

Design for Strength:
Stress concentration, causes and mitigation, Endurance limit, Notch sensitivity, Factors affecting endurance limit, Design for finite and infinite life .soderberg and Goodman diagram.
(4hrs)

Design of Joints:
Riveted joints for boiler shell according to I.B.R., riveted structural joint and riveted joint with eccentric loading. Types of welded joints, strength of welds under axial load, welds under eccentric loading. Designation of various types of bolts and nuts. Design of bolted joints, bolts of uniform strength. Bolted joints with eccentric loads. (5 Hours)

Design of Shaft, Keys and Couplings:

Design of shafts subjected to pure torsion, pure bending load. Combined bending and torsion, combined torsion, bending and axial loads. Design of keys, Types of shaft couplings. Design of sleeve or muff coupling, flange coupling and bush type flexible couplings.
(5 hrs)

Design of Mechanical Springs:

Introduction, Helical springs: stress analysis, deflection analysis, spring materials, styles of ends. Design against static and fluctuating loads: Design of leaf springs. (6 hrs)

Design of Gears:

Introduction: spur gear, helical gear. Calculation of load carrying capacity, design of spur and helical gears for dynamic and wear loads, bearings reactions. (6 hrs)

Design of Belts, Clutches and Brakes:
Introduction: Types of belts, design of flat and Vee belts. Design of single and multi plates clutches, design of cone clutch. Design of shoe, band, band and block brakes
(6 hrs)

Design of Bearings:
Introduction, Classification of bearings, selection of bearings, sliding contact bearings. types, materials, lubricants, properties of lubricants, hydrodynamic lubrication and design of hydrodynamic journal bearing: Rolling contact bearings: types, selection of rolling contact bearings and comparison of rolling and sliding contact bearing.
(6 hrs)

Books Recommended:

1. Design of Machine Elements- Bhandari,Tata McGraw-Hill
2. Machine design- Sharma and Aggarwal. Kaston Publication
3. Machine Design- Maleev and Hartmann, CBS Publication
4. Machine Design-An Integrated Approach- Robert L. Norton, Prentice-Hall
5. Fundamentals of Machine Component Design-R.C.Juvinall, John Wiley & Sons
6. PSG Design data book-PSG Publication,Coimbtore.

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-303 THERMAL ENGINEERING

L	T	P/D	Cr
3	1	-	3.5

Basic laws of thermodynamics

Thermodynamic system, thermodynamic properties, thermodynamic equilibrium, quasi-static state, Zeroth law of thermodynamics, work and heat, First law of thermodynamics for a closed system, non-flow process, steady flow energy equation, Second law of thermodynamics, Kelvin-Planck and Claussius statement, Reversible and Irreversible processes, Concept of entropy, limitations of laws of thermodynamics (5 hrs)

Steam Boilers

Introduction, Classification of boilers, Fire tube and water tube boilers, Babcock-Wilcox Boilers, Brief description of boiler mountings and accessories, Natural draught and artificial draught (3hrs)

Steam Nozzle

Function, Shapes of nozzles for different Mach Number, Steady flow energy equation, Continuity equation, Nozzle efficiency, Critical pressure ratio (3 hrs)

Steam Turbine

Introduction, Classification of steam turbines, Impulse turbine, working principle, compounding, Description of velocity diagram, Impulse reaction turbine, working principle, degree of reaction, Parson's turbine, Governing of turbines (4 hrs)

Internal Combustion Engine

Introduction, Classification, cycle of operation in four stroke and two stroke I.C. engine, Valve timings (2hrs)

Air Standard Cycles

Assumptions made in air standard cycles, Otto cycle, Diesel cycle,Brayton cycle, Dual cycle, Comparison between these cycles, Air standard efficiency, specific work output, work ration and mean effective pressure (with simple numerical problems), Deviation of actual cycle from ideal cycle (2 hrs)

Combustion in I.C. Engine

SI engine: Ignition limits, stages of combustion, abnormal combustion, detonation, pre-ignition, Octane rating

CI engine: stages of combustion, delay period, variables affecting delay period, knock, Cetane rating (3 hrs)

Carburetion, Fuel injection and Ignition systems

Multi point fuel injection systems, Fuel injection in CI engine, ignition system, its types, ignition timing, spark plug (3 hrs)

Lubrication and cooling

Functions of lubricating system, properties and rating of lubricating oils, necessity of engine cooling, Cooling systems, Coolants (2 hrs)

Engine Performance

Simple description of Performance parameters, Indicated power, brake power, mechanical efficiency, brake mean effective pressure, indicated mean effective pressure, torque, brake specific fuel consumption, indicated specific fuel consumption, thermal efficiency, heat balance, performance curves (2 hrs)

Air Pollution and Control

Sources and classification of air pollutants, Effect on human health, methods of emission controls (1 hr)

Refrigeration & Air –conditioning

Introduction, Carnot refrigeration and heat pump, units of refrigeration, COP of refrigerator, and heat pump, vapour refrigeration system (1 hr)

Air Refrigeration

Basic principle of operation of air refrigeration, Bell Coleman Air refrigerator , Simple Vapour Compression Refrigeration System (1 hr)

Simple vapour compression refrigeration system, different compression processes, limitation of vapour compression refrigeration system if used on reversed Carnot cycle, representation of theoretical and actual cycle on T-S and p-H charts, effects of operating conditions on the performance of the system (2 hrs)

Introduction to air conditioning systems

Difference in air conditioning and refrigeration, Psychrometric properties of moist air (wet bulb, dry bulb, dew point temperature, relative and specific humidity) (1 hr)

Psychrometry

Psychrometric charts, mixing of two air streams, sensible heating and cooling, latent heating and cooling, humidification and de-humidification, cooling with de-humidification, cooling with adiabatic humidification (2 hrs)

Air conditioning system

Classification, factors affecting air-conditioning systems, winter and summer air-conditioning systems, unitary and central air-conditioning systems, Room sensible heat factor, Effective room sensible heat factor (3 hrs)

Recommended books

Thermal Engineering by Ballaney, Khanna Publisher
Steam and gas Turbine by R.Yadav, CPH
Internal Combustion Engines by Mathur& Sharma, DhanpatRai& Sons
Internal Combustion Engine by Ganesan, TMH
Refrigeration and Air Conditioning by C.P.Arora, TMH
Refrigeration & Air Conditioning by Arora&Domkundwar, DhanpatRai& Sons

B. TECH. (5TH SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-305 WORK STUDY AND ERGONOMICS

L	T	P/D	Cr
3	1	-	3.5

Productivity

Concept and Definition, Difference Between Production and Productivity, Reasons for Low Productivity, Factors Influencing Productivity, Productivity Measures, Measurement Models, Methods/ Techniques to Improve Productivity, Work-Study and Productivity, Work Content.

(5hrs)

Introduction to Work-Study

Importance, Human Considerations in Work-Study Relationship of Work-Study Man With Management, Supervisor & Workers.

(3 hrs)

Method-Study

Definition, Objectives, Step-by-Step Procedure, Questioning Techniques, Charts And Diagrams For Recording Data. Outline Process Charts, Flow Process Charts, Multiple Activity Charts, Two Handed Process Chart, String Diagram, Travel Chart, Cycle Graph, Chrono-Cycle Graph, Therbligs, Micro Motion Study and Film Analysis, SIMO Chart, Principles Of Motion Economy. Development and Installation of New Methods.

(10 hrs)

Work-Measurement

Definition, Various Techniques Of Work-Measurement Work-Sampling, Stop-Watch Time Study & Its Procedure, Job Selection, Equipment and Forms Used For Time Study, Rating, Methods of Rating, Allowances And Their Types, Work Sampling, Normal Time, Standard Time, Numerical Problems, Predetermined –Motion Time Analysis and Its Types, Work Factor, Method Time Measurement.

(10 hrs)

Ergonomics

Introduction, History of Development, Objectives, Man-Machine System and Its Components. Design of Man –Machine Systems, Introduction to Structure of The Body- Features of The Human Body, Stress And Strain, Metabolism, Measure Of Physiological Functions- Workload And Energy Consumption, Biomechanics, Types Of

Movements of Body Members, Strength And Endurance, Speed Of Movements. Applied Anthropometry – Types, Use, Principles In Application, Design of Work Surfaces And Seat Design. Visual Displays For Static Information, Visual Displays of Dynamic Information, Auditory, Tactual And Olfactory Displays And Controls. Effect of Vibration, Noise, Temperature and Illumination on Performance.

(12 hrs)

Reference Books:

1. Barnes Ralph M., "*Motion & Time study: Design and Measurement of Work*", Wiley Text Books,2001.
2. Marvin E, Mundel& David L, "*Motion & Time Study: Improving Productivity*", Pearson Education, 2000.
3. Benjamin E Niebel and FreivaldsAndris, "*Methods Standards & Work Design*", McGraw Hill, 1997.
4. International Labour organization, "*Work-study*", Oxford and IBH publishing company Pvt. Ltd., N.Delhi, 2001.
5. Sanders Mark S and McCormick Ernert J, "*Human Factors in Engineering and Design*", McGraw-Hill Inc., 1993.
6. Sharma S K and Sharma Savita, "*Work study and Ergonomics"*, S K Kataria& Sons., Delhi, 2004.

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-307 PRODUCTION TECHNOLOGY-III

L	T	P/D	Cr
3	1	-	3.5

1.Powder Metallurgy
Theory of powder metallurgy, manufacture of metal powders, sintering, secondary operations, properties of finished parts, design considerations and applications. (**5hrs)**

2.Gear Manufacturing and Broaching
Classification of gear production methods, gear forming, gear generation: gear hobbing, gear shaping, production of helical, spur, and bevel gears, gear finishing methods: shaving, burnishing, grinding, lapping, honing, Broaching: Broach, cutting action of broach, broaching operations, broaching machines, mechanics of broaching and machining time calculation (**5hrs)**

3. Composite Materials and Their Processing:
Introduction, Types of Composites materials, Agglomerated Materials, Reinforced materials, Laminates, Surface Coated Materials, Production of Composite Structures, Fabrication of particulate composite Structures, Fabrication of reinforced Composite, Fabrication of Laminates, Machining, Cutting and Joining of Composites. (**5 hrs)**

4.Theory of Welding
Thermal effects in welding, structure in weld and heat affected zone, distortion and residual stresses, weldability or joinability, weld quality, welding of Cast Iron, Stainless Steel, Aluminium, non-destructive examiniation of weldments/materials/castings: Magnetic particle test, Liquid penetrant test, Electromagnetic methods, Radiography, Holography, Ultrasonic methods; gas and arc cutting, **(12hrs)**

5.Foundry and casting
sand testing, solidification phenomenon, melting furnaces; Cooling and solidification of castings, cooling curves, nucleation and dendrite formation, gating system : Pouring time, choke area, sprue, pouring basin, sprue base well, Gating ratios, in-gate design, Slag trap systems : runner extension, whirl gate, Riser Design: Caine's method, Modulus method, Naval research laboratory method, feeding distances, chills, grouping castings, feeding aids, **(13hrs)**

Suggested books

1. Sharma P C, " *Production Engineering*", S Chand & Company,1997.
2. Heine, R.W., Loper, C.R. and Rosenhal, P.C., Principles of Metal Casting, TMH.
3. Flinn, R.A., Fundamentals of Metal Casting, Addison-Wesley.
4. P.N. Rao, Manufacturing Technology, TMH
5. Pandey and Singh, Production Engineering Sciences
6. Ghosh&Mallik, Manufacturing Science, Affiliated East West Press.
7. DeGarmo, E. P., Black, J.T., and Kohser, R.A., "Materials andProcesses in Manufacturing", Prentice-Hall of India.
8. Kalpakjian, S., and Schmid, S.R., "Manufacturing Engineering andTechnology", Pearson Education.
9. Groover, M.P., "Fundamentals of Modern Manufacturing", JohnWiley& Sons.

10. Malhotra, "*Handbook on Non-destructive Testing of Concrete*", Publisher: CRC Press, 2002.
11. Mix, Paul E, "*Introduction To Nondestructive Testing: A Training Guide*", John Wiley and Sons Ltd, 1999.
12. Blitz and Jack, "*Electrical and Magnetic Methods of Nondestructive Testing*", Institute of Physics Publishing, 2001.
13. Henrique L M, "*Non Destructive Testing and Evaluation for Manufacturing and Construction*", Hemisphere Publishers, New York, 2001.
14. Kuo, S., "Welding Metallurgy", John Wiley & Sons 2003
15. Dieter, G.E., "Mechanical Metallurgy", McGraw-Hill 1988

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-309 PRODUCTION PLANNING AND CONTROL

L	T	P/D	Cr
3	1	-	3.5

General

Introduction, functions of production planning and control, objectives of PPC, importance of PPC, preplanning, production planning, production control, other components of PPC, simplification and standardization, time and motion study.

(4 hrs)

Manufacturing System

Production system, Job production, Batch production, continuous production, size of plants, type of industry.

(3 hrs)

Introduction to MRP and JIT

Introduction, MRP concept , inputs to MRP , working of MRP, MRP outputs, MRP calculations, lot sizing in MRP, MRP-II, concept of JIT manufacturing system, characteristics, goal and elements of JIT, push and pull production system.

(4 hrs)

Supply chain management

Introduction and overview of SCM, concept of supply chain, value creation in supply chain, value chain models, supply chain activities, SCM business process integration, strategic consideration for supply chain, distribution, logistics engineering, inbound and out bound logistics.

(4 hrs)

Sales forecasting

.
Introduction, definition, objectives and importance of forecasting, need for forecasting, types of forecasting, process of sales forecasting, factors affecting forecasting, criteria for a good sale, forecasting techniques: casual and time series analysis, moving average, exponential smoothing. Trend and seasonality.
(6 hrs)

Inventory Control

Definition, classification, objectives of inventory control, functions, economic order quantity, deterministic and probabilistic inventory models. Numerical on inventory control. Inventory carrying costs, factors affecting inventory costs. V.E.D. analysis, S-D-E analysis, F-S-N analysis H-M-L analysis and ABC analysis. Safety stocks, their objectives safety stocks and service levels.

(8 hrs)

Project scheduling with CPM and PERT

Introduction, objectives and applications of network analysis, basic concept in networks, difference between CPM and PERT, network conventions, numbering of events (Fulkerson's rule), determination of critical path, optimizing through CPM, PERT, resources allocation.

(8 hrs)

Loading and Scheduling

Introduction, Scheduling Procedure, Master Schedule, its objectives, Order scheduling, Loading by scheduled period, Dispatching, Job card, Job order. Commercial Loading & Scheduling Devices.

(5 hrs)

Reference Books:

1. Production Planning and control: Samuel Eilon
2. Production Planning and Control: K.C. Aggarwal & K.C. Jain
3. Industrial Engg. & Operation Management by S.K. Sharma & Savita Sharma.
4. Production Planning and Control: King J.R.
5. Production Planning and Control: Sharma, Hari Rraghu Rama.
6. Production Planning and Control: Narasimhan Seetha-rama L.

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-311 HEAT TRANSFER

L	T	P/D	Cr
3	1	-	3.5

Definition of heat; Modes of Heat Transfer; Basic Laws of heat transfer; Electrical Analogy of heat conduction; Conduction through composite walls; Overall heat transfer coefficient.

(5 hrs)

Conduction

The General Conduction equation in Cartesian, cylindrical and spherical coordinates; steady one dimensional heat conduction without internal heat generation: the plane slab; the cylindrical shell; the spherical shell; Critical thickness of insulation; Variable thermal conductivity, Steady one dimensional heat conduction with uniform internal heat generation: the plane slab; cylindrical and spherical systems. Fins of uniform cross-section: Governing equation; Temperature distribution and heat dissipation rate; Efficiency and effectiveness of fins.

(12 hrs)

Convection

Free and forced convection; Newton's law of cooling; convective heat transfer Coefficient; Nusselt number; Dimensional analysis of free and forced convection; Analytical solution to forced convection problems: the concept of boundary layer; hydrodynamic and thermal boundary layer; Momentum and Energy equations for boundary layer. Exact solution for laminar flow over an isothermal plate using similarity transformation.The integral approach; integral momentum and energy equations; solution of forced convection over a flat plate using the integral method.Analysis of free convection; governing equations for velocity and temperature fields.Relation between fluid friction and heat transfer, Reynolds analogy. Dimensionless numbers: Reynolds, Prandtl, Nusselt, Grashoff and Stanton Numbers and their significance, Heat transfer with change of phase; Nusselt theory of laminar film Condensation.

(13 hrs)

Radiation

Theories of thermal radiation; Absorption, reflection and transmission; Monochromatic and total emissive power; Black body concept; Planck's distribution law; Stefan Boltzman law; Wien's displacement law; Lambert's cosine law; Kirchoff's law; Shape factor; Heat Transfer between black surfaces.

(5 hrs)

Heat Exchangers

Introduction; classification of heat exchangers; Logarithmic mean temperature Difference; Area calculation for parallel and counterflow heat exchangers; Effectiveness of heat exchangers; NTU method of heat exchanger design. Applications of heat exchangers.

(**5 hrs**)

Reference Books :

1. A Text Book on Heat transfer - S.P. Sukhatme, University Press
2. Heat Transfer Holman, McGraw-Hill
3. Heat & Mass Transfer. D.S. Kumar, S.K. Katariya

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-313 WORK STUDY AND ERGONOMICS (PRACTICAL)

L	T	P/D	Cr
-	-	2	1.0

List of Experiments

1. Draw a flow process chart with time estimates for a simple welding process.
2. Draw a two handed process chart for a simple process of a job preparation on a lathe.
3. To study various Rating Factor systems and find standard time for making small sand mould
4. Method to improve the assembly and dis-assembly of a Bolt, a nut and three washers
5. Methods Improvement – Assembling pins on cardboard
6. Rating Practice – Films.
7. Work sampling exercises
8. Stop watch time study on drilling machine, lathe machine and CNC machine
9. Calibration of an individual using Tread Mill as a loading-device.
10. Measurement of anthropometric data and analysis of data.
11. Audiometric examination a through pure tone audiogram of a subject using portable audiometer
12. To measure the respiratory parameter of an individual.
13. To study the effect of ergonomically poor designed control panel on the error rate.

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-315 THERMAL ENGINEERING (PRACTICAL)

L	T	P/D	Cr
-	-	2	1.0

List of Experiments

1. Study of Babcock-Wilcox boiler, Locomotive boiler, Lancashire boiler
2. Study ofNestler boiler.
3. To make a trial on boiler to calculate equivalent evaporation and efficiency
4. Study of 2-strike petrol and diesel engine
5. Study of 4-stroke petrol and diesel engine
6. To make a trial on 4-stroke diesel / petrol engine to calculate Brake power specific fuel consumption and draw its characteristic curves.
7. To conduct Morse test to find out indicated power of multi cylinder petrol engine.
8. Study and performance of basic vapour compression refrigeration cycle.
9. To evaluate performance of refrigeration system.
10. Study of compressor.

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-317 HEAT TRANSFER (PRACTICAL)

L	T	P/D	Cr
-	-	2	1

List of Experiments:

1. Determination of thermal conductivity of a metal rod.
2. Determination of thermal conductivity of an insulating powder.
3. Determination of thermal conductivity of a liquid using Guard-plate method.
4. Determination of thermal resistance of a composite wall
5. Temperature distribution of a pin fin in free-convection.
6. Temperature distribution of a pin fin in forced-convection
7. Forced convection heat transfer from a cylindrical surface
8. Determination of Effectiveness of a Heat Exchanger
9. Determination of Stefan-Boltzman constant
10. Performance of Solar still
11. Determination of critical heat flux
12. Performance of solar water heater
13. Measurement of solar radiation using solar integrator.

B.TECH. (5th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 319 VOCATIONAL TRAINING REPORT

L	T	P/D	Cr
-	-	-	3.0

The students are required to undergo an Industrial training of about 6 weeks duration in Public Sector undertakings, (HMT, BHEL, IOC etc.) and private sectors of repute like MUL, Hero-Honda Ltd. etc. during summer vacations at the end of 4th semester.

The training report will be submitted by the students along with the certificate indicating the duration of training and the nature of Project-done.

The students will be assessed through a viva-voce.

B.TECH. (6th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
ET-324 CONTROL SYSTEM

L	T	P/D	Cr
3	1	-	3.5

Introduction to Control Systems:

Concept of control, control system terminology, classification of Control Systems, comparison of open loop and closed loop structures, characteristics of control system error criteria.Mathematical and state variable models of the system: Mechanical systems, electrical systems, electromechanical, liquid level(with interaction) pressure, thermal.

Fluidic devices and their applications.
Differential equations of physical systems, transfer function of linear systems, block diagram models, and signal flow graph.

D.C. & A.C. Servomotors, Synchros.Feed back Control System Characteristics:-
Time domain and frequency domain responses and characteristics, steady state error, concept of stability.

Analysis of Linear Feedback Systems:-
R-H stability criterion, Nyquist criterion, Bode plot, Root locus and Liapunov's criterion.

Introduction to design of Feedback Control Systems:-
Approaches to system design, phase lead, phase lag design using Bode-diagram.
Controllability, observability. Basic control action(ON-OFF, P/I/D) realization of control actions.

Suggested Books:-

1. Nagrath and Gopal "Control System Engineering" TMH
2. Ogata K," Modern Control Engineering" PHI
3. Kuo BC,"Automatic Control Systm" PHI
4. Dorf RC and Bishop RH,"Modern Control System" Addison-Wesley Publisher
5. Perkins WR,Guz JB Jr. "Engineering of Dynamic systems"

B.TECH. (6th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 302 PLANT LAYOUT AND MATERIAL HANDLING

L	T	P/D	Cr
3	1	-	3.5

1. General:
Concepts and factors governing plant location, Site Selection, Rural v/s Urban plant sites, Analysis of location alternatives, Introduction of plant layout, Principles and objectives of effective layout, Advantages of good layout, Types of plant layout, their features, applications and comparison.

2. Planning the Layout:
Factors influencing plant layout:- Material, Machinery, Man, Movement, Waiting, Service, Change, and Building factors, Workstation design, Plant layout procedure, Factory building, Types of factory building, Building equipments, common problems in plant layout, Tools and techniques of layout planning:- Operation process chart, Flow process chart, Flow diagram, String diagram, Travel Chart, Evaluating alternate layouts – various methods, Computer Aided Layout Design.

3. Line Balancing:
Introduction, Objectives of Line Balancing, Constraints in Line Balancing problems, Preventive measures to achieve a balanced production line, Types of Line Balancing; (a) Assembly Line Balancing (b) Fabrication Line Balancing, heuristic and other methods of Line Balancing. Simple numerical problems of Line Balancing.

4. Material Handling:
Objectives of material handling, Functions and principles of material handling, Methods of material handling, Types of material handling systems, Basic features of material handling, Various material handling considerations including combined handling, Space for movements.

5. Material Handling Equipment:
Introduction, Types of material handling equipment, Selection and maintenance of material handling equipment, characteristics of material handling equipment such as Conveyers, Cranes, Hoist, Mobile equipment etc., Economical and Technical considerations of handling equipment.

References and Text Books:

1. Plant Layout and Design - by Moore McGraw Hill
2. Plant Layout and Material Handling - by Apple & Ronald -
3. Plant Layout - by Shubin EEE
4. Practical Plant Layout - by Muther McGraw Hill
5. Value Engg. In Manufacturing - by Prentice Hall ASTME

B.TECH. (6th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 304 QUALITY CONTROL AND RELIABILITY

L	T	P/D	Cr
3	1	-	3.5

1. Introduction

Quality-Basic concepts: issues in quality, factors affecting quality, creating quality by design, product development cycle, economics of quality, various definitions, ISO definition of quality and its meanings, and various phases till TQM and its meanings to industries, customers and employees, contribution of quality gurus etc. towards quality concepts. Total Quality management: its scope application and implementation. Quality circle: its objectives, Structure and techniques, Variability concept in manufacturing-cycle, fishbone diagrams, charts in time philosophy, six sigma concept. **(10 hrs)**

2. Quality Control

Basic statistical concepts, various types of distributions, General theory X and R chart. Decision Preparatory to the control charts. Trial control limits. Selection of sub-groups. Chart with variable subgroups. Reject and revoke, limits for average on X charts, modified control limits, specification limits, practical limitations. Control chart for fraction defectives, calculation and plotting of control limits, sensitivity of p chart, applications. Control charts for Defects, difference between defect and defective, calculation and plotting of control limits, application. Pi charts and u charts, plotting of charts. Tests for various control charts. Test for various control charts process capability-inherent and potential capability. **(12hrs)**

3. Acceptance Sampling

Acceptance sampling: its need and advantages, Acceptance by Attributes, single sampling plans. O.C. curve, selection of sampling plans, Acceptance number, Type A and Type B errors, Double sampling plan and its analysis, Multiple and sequential sampling, AOQ and A.O.Q.L., Acceptance Sampling plans under risk. Design of various sampling plans, Dodge-Roming type system for acceptance sampling by attributes (use of various tables). Determination of process average, Acceptance sampling by variables. **(10 hrs)**

4. Reliability

Control of reliability, factors affecting reliability, pattern of failure, mean time to failure, Fundamental of statistical concepts, consideration of reliability in series and parallel system, effect of redundancy and reliability, method of reliability evaluation, reliability optimization, application of Binomial theorem, reliability O.C. curve, Availability and Maintainability, means to improve reliability, reliability control during manufacture.

(10 hrs.)

Recommended Books:

1. Statistical Quality Control by Grant and Leaven, McGraw-Hill
2. Quality Control and Reliability by Mahajan, DhanpatRai
3. Quality Contrl by Hansen, Prentice-Hall
4. Statistical Quality Control by O P Khanna, DhanpatRai Publications

B.TECH. (6th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 306 TOOL ENGINEERING

L	T	P/D	Cr
3	1	-	3.5

1. **Cutting Tool Design**
   Basic concepts of single and multi-point tool geometry and tool angles, design of single point cutting tools, design of multi-point cutting tools for milling, drilling, reaming, and broaching operations, design of form tools. **(9hrs)**

2. **Jigs and Fixtures**
   Introduction, difference between jig and fixture, principles of location and clamping, locating methods and devices, clamping methods and clamping devices, calculation of clamping force, Jig bushes, Types of jigs and Milling fixtures: Turning fixtures, Grinding fixtures, Boring and broaching fixtures,assembly and welding fixtures, hydraulic and pneumatic clamp actuation, indexing devices, Different Materials for jigs and fixtures, Economics of Jigs and Fixtures, drawing and design of jigs and fixtures for given components **(9hrs)**

3. **Sheet metal die design**
   Types of dies: Progrssive, compound and combination, Die construction: screws and dowels, die block, Punch design: Plain punches, pedestal punches, punches mounted in punch plates, perforator type punches, Quill punches, back-up plate, slug ejection, Pilots, stripper and stock guide: channel and spring stripper, Die stops: solid stop, pin stop, latch stop, pivoted auto stop, stock strip layout, component design for blanking, strip development **(7hrs)**

4. **Forging die design**
   Parting plane, draft, fillet and corner radii, shrinkage allowance, die wear allowance, finish allowance, cavities, drop forging die design: flash, stock, fullering impression, edging impression, blocking impression, finishing impression, location of impressions, Die inserts, Upset forging die design **(7hrs)**

5. **Process Planning**
   Product cycle in manufacturing, product quality: accuracy of machining, accuracy of assembly, part print analysis: functional surfaces; tolerance stacking, errors in machining: location errors, elastic deformation of machining complex, effect of clamping force, cutting tool wear, thermal deformations; operation selection: classifying operations, eliminating operations, planning for cylindrical surfaces; Tolerance analysis **(8hrs)**

Suggested Books:

1. Rodin, R., “Design and Production of Metal-Cutting Tools”,Mir Publishers, 1968
2. Arshinov, V., Alekseev, G., and Weinstein, N., “Metal Cutting Theory and Cutting Tool Design”, Mir Publishers, 1976
3. Bhattacharyya, A., and Ham, I., “Design of Cutting Tools”, ASTME 1969
4. Hoffman, E.G., “Jigs and Fixture Design”, Thomson Delmar Learning 2003
5..Grant Hiram E, “*Jigs & Fixtures*”, Tata McGraw Hill,1994.
6..Curtis Mark A, “*Tool Design for Manufacturing*”, John Wiley & Sons,1996.

7..Donaldson Cyril, "*Tool Design*", Tata McGraw Hill 1997.
8..Sharma P C, " *Production Engineering*", S Chand & Company,1997.
9. Joshi, P.H., Jigs and Fixtures, TMH.
10. Hinman, Press Working of Metals, McGraw-Hill.
13. P.N. Rao, Manufacturing Technology, TMH
14. Pandey and Singh, Production Engineering Sciences
15.ASTME: Fundamentals of Tool Design, Prentice-Hall
16. S.A.J. Parsons, Production tooling equipments, Macmillan, London
17. Eary,D.P. and Johnson, G.E., Process Engineering, Prentice-Hall, 1962.

B.TECH. (6th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 308 COMPUTER AIDED DESIGN AND MANUFACTURING

L	T	P/D	Cr
3	1	-	3.5

Introduction

Introduction to CAD, CAM, Computer integrated manufacturing system, Computer aided process planning and group technology. Basics of geometric and solid modeling, Explicit, Implicit, Intrinsic and parametric equations.

(4 hrs)

Transformations

Introduction, Transformation of points and line, 2-D rotation, Reflection, Scaling and combined transformation, Homogeneous coordinates, 3-D scaling, Shearing, Rotation, Reflection and translation, Combined transformations, Orthographic and perspective projections.

(6 hrs)

Curves

Algebraic and geometric forms, Straight lines, Circles, Conics, Hermite curve, Bezier curves and B-spline curves.

(6 hrs)

Surfaces

Algebraic and geometric forms, Tangents and twist vectors, Normal. plane surface, Ruled surface, Surface of revolution, Tabulated cylinder, Bi-cubic hermite surface, Bezier surface, B-spline surfaces.

(6 hrs)

Solids

Solid models and representation scheme, Fundamentals of Solid Modeling, Boundary representation, Constructive solid geometry.

(6 hrs)

Numerical Control

Introduction, Basic components of an NC system, The NC procedure, ND coordinate system, NC motion control systems, Applications of numerical control. Introduction to CNC, DNC and adaptive control manufacturing systems.

(6 hrs)

NC part programming

Introduction, Tape coding and format (NC tape coding, formation of instructions, NC words), Manual part programming, Computer assisted par programming.

(6 hrs)

Reference Books:

1. CAD/CAM: By Groover and Zimmer, Prentice Hall
2. CAD/CAM : Theory and Practice - By I. Zeid, Tata McGraw Hill
3. Mathematical Elements for Computer Graphics:B**y** Rogers & Adams, McGraw Hill.

B.TECH. (6th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-310 NON-CONVENTIONAL MANUFACTURING PROCESSES

L	T	P/D	Cr
3	1	-	3.5

Introduction

Unconventional machining processes, their classification, considerations in process selection.
(8 hrs)

Ultrasonic Machining

Elements of process, design of cutting tool, metal removal mechanism, effect of parameters, economic considerations, limitations and applications, surface finish.
(8 hrs)

Electrochemical Machining

Elements of process, process chemistry, metal removal mechanism, tool design, accuracy, surface finish, work material characteristics, economics, advantages, limitations and applications, Electrochemical grinding, debarring, honing and Chemical machining.
(10 hrs)

Electric Discharge Machining

Principle and mechanism of metal removal, generators, electrode feed control, electrode material, tool electrode design, EDM wire cutting, surface finish, accuracy and applications.
(6 hrs)

Jet Machining

Principal and metal removal mechanism of abrasive and water jet machining, process variables, design of nozzle, advantages, limitations and applications.
(7 hrs)

Other Machining Processes

Principles, metal removal mechanism, process parameter, advantages, limitations and application of plasma arc machining, Electron beam machining and laser beam machining.
(10 hrs)

Reference Books

1. Modern machining processes by P.C. Pandey and H.S. Shan, TMH.
2. Machining Science by Ghosh and Mallik, Affiliated East West
3. Nontraditional Manufacturing processes by G.F. Benedict, Marcel Dekker.
4. Advanced Methods of Machining by J.A. McGeongh, Chapman and Hall.
5. Electrochemical Machining of Metals by Rumyantsev and Davydov, Mir Publis.

6. Rapid prototyping: Principles and applications in Manufacturing

B.Tech. (Common for all branches 5th/6th Semesters)

HUT-311 BUSINESS MANAGEMENT

L	T	P/D	Cr
3	1	-	3.5

UNIT-I **Business Environment**

Business : Concept, nature and objectives. Social Responsibility of Business.

Environment: Meaning of environment, Constituents of business environment; Economic, social, political, legal and technological environment.

UNIT-II **General Management**

Management: Definition, Nature and significance , Henry Fayol's Principle of Management; Human Relations Approach, Functions of Management (i) Planning, (ii) Organising (iii) Staffing (iv) Directing and (v) Controlling.

UNIT-III **Financial Management**

Introduction of Financial Management, Objectives of Financial Decisions, Status and duties of Financial Executives. Financial Planning – Tools of financial planning. Management of working capital, Factors affecting requirements of working capital. Capital structure decisions. Features of appropriate capital structure.Sources of finance.

UNIT-IV **Personnel Management**

Personnel Management – Meaning, Nature and Importance; Functions of Personnel Management – (a) Managerial Functions and (b) Operative functions. Job Analysis: Meaning and Importance; Process of Job Analysis; Job Description and Job specification. Human Resource Development-Meaning and concept.

UNIT-V **Production Management**

Production Management : Definition and Objectives
Plant location: Ideal plant location. Factors affecting plant location.
Plant Layout : Ideal plant layout, factors affecting plant layout.
Work Measurement : Meaning, Objectives and Essentials of work Measurement.
Production Control : Meaning and importance of production control and steps involved in production control.

UNIT-VI **Marketing Management**

Nature, scope and importance of marketing management. Modern Marketing concepts. Role of marketing in economic development. Marketing Mix. Marketing Information System. Meaning, nature and scope of International Marketing.

Reference Books:

1. Business Environment – Francis Charurilam (Himalaya Publishing House).
2. Management – Harold, Koontz and Cyrilo' Donell (McGraw Hill)
3. Principles of Personnel Management – Edwin B. Flippo (McGraw Hill)
4. Personnel Management and Industrial Relations – D.C. Sharma and R.C. Sharma)(SJ Publications, Meerut)
5. Basic Marketing – Cundiff and Still (PHI, India)
6. Marketing Management – S.A. Sherlekar (Himalaya Publishing House Bombay)
7. Principles and Practice of Management – L.M. Prasad
8. Financial Management – I.M. Pandey (Vikas Publishing House, New Delhi)
9. International Marketing – Vornterpestre and Ravi Sasathy.
10. Production Management – E.S. Buffa& W. H. Tausart, Richand D. Irwin, Homewood, Illionis.
11. Personnel Management – C.B. Mamoria, (Himalaya Publishing House)

B.TECH. (6th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
ET-326 CONTROL SYSTEM (PRACTICAL)

L	T	P/D	Cr
-	-	2	1.0

LIST OF EXPERIMENTS

1. To find the transfer function of first and second order system
2. To determine the error detector characteristics and control application of LVDT, Potentiometer
3. To obtain open loop response of thermal system and design PID control of the system
4. To study the characteristics for the following converters
   i) Voltage to current converter
   ii) Current to voltage converter
   iii) Voltage to frequency converter
   iv) Frequency to voltage converter
   v) Light Transducer
   vi) Temperature transducer
5. To study speed control/Position control Characteristics of DC Motor
6. To study frequency response of given system
7. Comparison of different control actions on different processes
8. Demonstration study of Industrial Process control

PI- 312 CAD/CAM (PRACTICAL)

L	T	P/D	Cr
--	-	3	1.5

LIST OF EXPERIMENTS

1. To perform 2D scaling, reflection, rotation and translation transformations of a geometric entity.
2. To perform 3D scaling, reflection, rotation and translation transformations of a geometric entity and show its application for a unit cube.
3. To generate the top, front and side views of a truncated cube.
4. To generate isometric projection and apply it to view a given object.
5. To generate dimetric projection and apply it to view a given object in different orientations.
6. To perform single point perspective projection and use it to view a truncated cube.
7. To perform joining a set of points in space by Hermite curve segments and demonstrate the manipulation of curve shape by varying the geometric conditions.
8. To generate a Bezier curve for a given set of control points and demonstrate the manipulation of curve shape by varying the geometric conditions.
9. To generate a B-Spline curve for a given set of control points and demonstrate the manipulation of curve shape.
10. To generate and view a ruled surface between two given rails.
11. To generate and view a Bezier surface for a given mesh of control points.

B.TECH. (6th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-314 SEMINAR-I

L	T	P/D	Cr
-	-	2	1.0

The students are required to deliver a seminar on some emerging areas of Industrial Engineering such as:

- CAD/CAE/CAPP/CIM
- Business Process Reengineering (BPR)
- Industrial Automation
- Flexible Manufacturing Systems (FMS)
- Six Sigma Philosophy
- Productivity Management
- Learn Manufacturing, Agile Manufacturing
- JIT Production System
- Total Quality Management (TQM)
- Enterprise Resource Planning (ERP)
- Management Information Systems
- Linear/Non-linear Optimization
- Genetic Algorithm/Neural network approach for optimization problems
- Supply Chain Management
- Research Methodology
- Any other topic related to Production and Industrial Engineering.

The student will deliver a power point presentation for about 30 minutes in the seminar on any of the above topics. This will be followed by question answer session for about 10 minutes. The questions/queries on the topic will be asked by the teacher and class students. The students will also prepare a detailed report in MS word and after proper binding (spiral form) will submit it to the teacher concerned. The report is to be submitted at least one week prior to the presentation. The awards will be given according to the student's presentation, report submitted, topic of presentation and the discussion or question answering after the presentation.

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 401 ENGINEERING ECONOMY

L	T	P/D	Cr
3	1	-	3.5

1. **Introduction:** Nature and purpose of engineering economy studies, functions of engineering economy, physical and economic laws, consumer and producer goods. **(4hrs)**
2. **Interest and Annuity Relationships:** Productivity of capital, nominal and effective interest, interest factors, CAF, PWF, SPWF, SCAF, SFF, and CRF, deferred annuities, perpetuities and capitalized cost, equivalence, gradient factors, GPWF and GUSF. **(6hrs)**
3. **Depreciation:** Classification of depreciation, methods of computing depreciation, economic life and mortality data, capital recovery and return. **(6hrs)**
4. **Industrial Costing:** Classification of costs: Direct material, direct labour and overheads, fixed and variable cost, semi-fixed cost, increment, differential and marginal cost, sunk cost and its reasons, direct and indirect cost, prime cost, factory cost, production cost and total cost. **(6hrs)**
5. **Cost Analysis:** Break-even analysis, two and three alternatives, graphical solution, break-even charts, effects of changes in fixed and variable cost, minimum cost analysis, economic order quantity, effect of risk and uncertainty on lot size. **(4hrs)**
6. **Replacement Studies:** Reason of replacement, evaluation of proposals, replacement because of inadequacy, excessive maintenance, declining efficiency, obsolescence, MAPI formula. **(6hrs)**
7. **Cost Estimation:** Difference between cost estimation and cost accounting, qualifications of an estimator, estimating procedure, estimate of material cost and labour cost, estimate of cost in machining, forging, welding and foundry operations. **(6hrs)**
8. **Economy Study Patterns:** Basic economy study patterns and their comparison, effect of taxation on economic studies. **(4hrs)**

Suggested Books:

1. Ardalan, A., “Economic and Financial Analysis for Engineering and Project Management”, CRC Press 1999
2. Grant, E.L., Grant, W., and Leavenworth, R.S., “Principles of Engineering Economy”, 8th Ed., John Wiley & Sons 2001
3. Eschenbach , T.G., “Engineering Economy by Applying Theory to Practice (Engineering Technology)”,
2nd Ed., Oxford University Press 2003
4. Blank, L.T., and Tarquin, A.J., “Engineering Economy”, McGraw-Hill 2005
5. Hartman, J.C., “Engineering Economy and the Decision-Making Process”, Prentice-Hall 2006
6. Engineering Economics by E.PaulDegermo

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-403 MEASUREMENTS AND INSTRUMENTATION

L	T	P/D	Cr
3	1	-	3.5

Introduction

Definition, application of measurement instrumentation, functional elements of a generalized measuring system, measuring standards, types of measurement, types of input to measuring instruments and instrument system, classification of measuring instruments, merits and demerits of mechanical measuring systems, comparison of mechanical measuring system with electrical measuring systems, calibration. (**6 hrs**)

Generalized performance characteristics of instruments

Introduction, types of error, types of uncertainties, propagation of uncertainties in compound quantity, Static performance parameters: accuracy, precision, resolution, static sensitivity, linearity, hysteresis, dead band, backlash, and drift., sources of error, selection of a measuring instruments, mechanical and electrical loading, fundamentals of dynamic characteristics, generalized mathematical model of measuring systems, **(12 hrs**)

Statistical analysis of experimental data

Introduction, types of measuring data, statistical attributes, various method of presentation, estimation of presentation and uncertainties, confidence level, precision and statistical treatments of single and multi sample type experimental data, Chauvenet's criteria of rejecting a dubious data, curve fitting, best linear calibration and its precision, significant figures and rounding off. Overall uncertainty estimation of measuring systems, common sense approach, and engineering applications. (**8 hrs**)

Transducers

Introduction, primary function, classification, electrostatic transducers: principle theory, types, advantages, and limitations, Fixed contact mechano-resistive transducers: classification, and uses, Metallic resistance strain gauge: types, construction theory of operation, Adhesive: property, selection criteria, mounting of strain gauges, Mathematical analysis of ballast and DC Wheatstone bridge circuits, characteristic and comparison of ballast and DC Wheatstone bridge circuits, temperature effects and their compensation. (**8 hrs**)

Measuring of non-electrical physical quantities

Measurement of load, force, and thrust using resistant strain gauges, Elastic load cells, proving rings, fluid pressure measurement in pipe and containers, using strain gauges, Measuring of

torque in transmission shaft under axial and bending loads in varying ambient conditions. (**6 hrs**)

Reference Books:

1. Mechanical measurements & controlby D.S. Kumar, Metropolitan book
2. Instrumentation and Mechanical measurements by A.K. Tayal, Galgotia Publ.
3. Measurements systems application and design by E. Doebelin, McGraw-Hill

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-405 ENTERPRENEURSHIP DEVELOPMENT

L	T	P/D	Cr
3	1	-	3.5

Entrepreneurship
Introduction; Characteristics of an Entrepreneur; Benefits of Entrepreneurship; Problems, Rewards, Fears & Myths in Entrepreneurship, Types of Entrepreneurship, Types of Entrepreneurs..

(6 hrs)

Planning for an Enterprise
Procedures and Formalities for Setting up Eterprise, Sources of Information, Incentives and benefits available to SSI Units and New Entrepreneurs.

(7 hrs)

Selecting Good Business Proposal
Searching for Opportunities, Selecting Right Product, Market Survey and Research, Demand Forecasting, Techno-Economic Feasibility Assessment – Preliminary Project Repot (PPR).

(7 hrs)

Establishing an Enterprise
Selecting Right Infrastructure, Buying Right Machinery, Sources of Technology and Evaluation, Recruiting Right People.

(6 hrs)

Financial Planning
Sources of Finance, Debt Financing, Venture Capital Sources, Lease Finance, Banking Policies & Incentives Available to Entrepreneurs, Loans-Types and Benefits, Costing, Break-Even-Analysis.

(8 hrs)

Market Analysis
Sales Plans and Manufacturing Plans, Types of Selling, Sales Promotion, Market Surveys and Research.

(6 hrs)

Reference Books:

1. Entrepreneurship Development and Project Management by Dilip M. Sarwate (Everest Publishing House)
2. A Hand Book for New Entrepreneurs by EDI, Ahemdabad
3. Entrepreneurship by Hisrich Peters (Tata McGraw)
4. Cost and Management Accounting by Williamsons (Prentice Hall of India)
5. Project Management – Strategic Design and Implementation by David Cleland (McGraw Hill)

PRODUCTION AND INDUSTRIAL ENGINEERING
PI-405 PRODUCT DESIGN AND DEVELOPMENT

L	T	P/D	Cr
3	1	-	3.5

Introduction

Definitions, What is industrial design, Assessing the need for ID, Product and process cycles, Ethics, Societal and economic considerations in engineering, Technological forecasting, Technological innovation and designprocess.

(4 hrs)

Design Process

Importance of product design, Considerations of a good design, Detailed descriptions of design process, Role of marketing, Organization for design and role of computers in design.

(4 hrs)

Concept generation & concept selection

Concept generation process, Basic methods, Information gathering and brain storming, Conventional aids, brain ball, C-Sketch/6-3-5 method: advanced methods: Direct search, Systematic search with physical principles and classifying schemes: Morphological analysis, Factors that determine effective decision making, Estimating technical feasibility, Concept selection process- basic and advanced methods.

(4 hrs)

Product Modeling

Model preparation & selection method, Construction of product models, Physical models/ prototypes, Types of prototypes, Uses of prototypes, Rapid prototyping techniques, Dimensional analysis, Similitude and scale models, Geometrical modeling on the computer, Computer visualization.

(6 hrs)

Design for Robustness

Quality design theory, General robust design model, Robust design model construction, Taguchi's method; noise variable matrix, Design variable matrix, Experimental matrix, Signal to noise ratio, Selection of target design, Optimization methods, Evaluation considerations in optimization, Design optimization.

(6 hrs)

Design for manufacturing and assembly

Estimation of manufacturing costs, Reducing the cost of components and assemblies, Design for assembly, Design for piece part production, Cost driver modeling and manufacturing cost analysis.

(4 hrs)

Economic decision-making

Economic Equivalence, Decision making preliminaries, Opportunity definition, Break-Even analysis, Applications of break-even Analysis, Make or buy decision, Deterministic evaluation, Payback period, Annual equivalent, ARR, NPV and IRR methods, Depreciation, benefits - cost analysis. Replacement analysis, Decision tree analysis.

(6 hrs)

Cost evaluation

Categories of cost, cost indexes, Estimation of plant cost, Design cost, Manufacturing costs, Value analysis in costing, Value analysis vs. value engineering, Overhead costs, Activity based costing, Learning curve, Cost models, Life cycle costing.

(6 hrs)

Reference Books:

1. Ulrich Karl T and Eppinger Steven D, "*Product design and Development*", McGraw-Hill Inc, 2000.
2. Trott Paul, "*Innovation Management and New Product Development*", Financial Times Professional Ltd, London, 2000.
3. Otto Kelvin and Wood Kristen, "*Product Design*", Pearson Education, Delhi, 2001.
4. Bruce M and Cooper Rachel, "*Creative Product Design*", John Wiley & Sons Ltd., New York, 2000
5. R. Paneerselvam, "Engineering Economics", Prentice Hall of India (PHI), New Delhi, 2004.
6. Hartman, "Engineering Economy and Decision Making Process", Pearson Education Asia, 2007.

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- ELECTIVE- I

L	T	P/D	Cr
3	1	-	3.5

Students will opt for an elective from the list of elective-I

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
OPEN ELECTIVE-I

			L T	P/D	Cr
3	1	-	3.5		

Students will opt for an elective offered by other branches.

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-409 MEASUREMENTS AND INSTURMENTATION (PRACTICAL)

L	T	P/D	Cr
-	-	2	1

List of Experiments

1. Study of a strain gage based cantilever beam and measurement of strain on the beam
2. Study of an inductive pick up and measurement of linear displacement
3. Study of a LDR and measurement of linear displacement
4. Study of capacitive pick up and measurement of angular displacement
5. Study of temperature transducers and measurement of temperature of fluid
6. Study of a LVDT (strain gage based) and measurement of linear displacement
7. Study of a torque pick up and measurement of torque
8. Study of a pressure pick up and measurement of pressure of fluid
9. Study of load cell and measurement of load with load cell
10. Study of non-contact type speed pick up and measurement of rotational speed
11. Comparison of sensitivity of thermocouple, thermister and RTD

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-411 PROJECT -I

L	T	P/D	Cr
-	-	6	9

The student is expected to take up a project under the guidance of teacher from the Institute. The project must be based on the Production and Industrial Engineering problems, which can

be extended to full academic session in two parts. The student may be asked to work individually or in-group with not more than four students. Viva-voce is based on the preliminary report submitted by student(s) related to project.

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-413 PRACTICAL TRAINING REPORT

L	T	P/D	Cr
-	-	-	**3.5**

The students are required to undergo an Industrial training of about 6 weeks duration in Public Sector undertakings, (HMT, BHEL, IOC etc.) and private sectors of repute like MUL, Hero-Honda Ltd. etc. during the summer vacations at the end of 6th semester.

The training report will be submitted by the students alongwith the certificate indicating the duration of training and the nature of Project-done.

The students will be assessed through a viva-voce.

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-415 SEMINAR-II

L	T	P/D	Cr
-	-	2	1.0

The students are required to deliver a seminar on some emerging areas of Production and Industrial Engineering such as :

- CAD/CAE/CAPP/CIM
- Business Process Reengineering (BPR)
- Industrial Automation
- JIT Production System
- Total Quality Management (TQM)
- Enterprise Resource Planning (ERP)
- Management Information Systems

- Flexible Manufacturing Systems (FMS)
- Six Sigma Philosophy
- Productivity Management
- Learn Manufacturing, Agile Manufacturing
- Linear/Non-linear Optimization
- Genetic Algorithm/Neural network approach for optimization problems
- Supply Chain Management
- Any other topic related to Production & Industrial Engg.

The student will deliver a power point presentation for about 30 minutes in the seminar on any of the above topics. This will be followed by question answer session for about 10 minutes. The questions/queries on the topic will be asked by the teacher and class students. The students will also prepare a detailed report in MS word and after proper binding (spiral form) will submit it to the teacher concerned. The report is to be submitted at least one week prior to the presentation. The awards will be given according to the student's presentation, report submitted, topic of presentation and the discussion or question answering after the presentation.

LIST OF ELECTIVE-I (Any one in 7th Semester)

Sl No.	**Course No**	**Name of Elective Subject**	**Offered as Open Elective To Other Branches**
1.	PI-421	Computer Integrated Manufacturing	NO
2.	PI-423	Supply Chain Management & Logistics	YES
3.	PI-425	Industrial Robotics	YES
4.	PI-427	Experimental Design	NO
5.	PI-429	Automobile	NO

		Engineering	
6.	PI-431	Marketing and Financial Management	YES
7.	PI-433	Soft Computing	YES
8.	PI-435	Industrial Engineering & Organization	YES (Not for Mech& PI students)

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 421 COMPUTER INTEGRATED MANUFACTURING

L	T	P/D	Cr
3	1	-	3.5

Introduction
Introduction to manufacturing enterprise, External and internal changes, World-class winning criteria, Introduction to CIM concepts, Three step process for CIM implementation.
(6 hrs)

Manufacturing Systems
Manufacturing classifications, Product development cycle, Enterprise organization.
(4 hrs)

Design Automation: Computer-Aided Design and Engineering

Introduction, General system operation, CAD classification: Hardware and software platforms, Application of CAD to manufacturing systems, Design for manufacturing and assembly, Computer-aided engineering analysis and evaluation.

(6 hrs)

Manufacturing Planning and Control

Introduction, planning the manufacturing planning and control system, master production schedule, inventory management, product data management.

(5 hrs)

Material Planning, Production Scheduling and Operating Systems

Material requirement planning, Capacity requirement planning, MRP II, Just-in-time manufacturing. **(5 hrs)**

Enterprise Resoruce Planning

MRP II – a driver of effective ERP systems, information technology, the decision to implement ERP system, Features of modern manufacturing planning and control systems.

(5 hrs)

Production Support Machines and Systems

Industrial robots, automated material handling systems, automated guided vehicles, automated storage and retrieval systems.

(4 hrs)

Machine and System Control

System overview, Cell control, Proprietary versus Open system interconnect software, Device control, programmable logic controllers, Computer numerical control, Automatic tracking, Network communications.

(5 hrs)

Reference Books:

1. Computer-integrated manufacturing, James A. Rehg and Henry W. Kraebber, Pearson Education.
2. Computer Integrated Manufacturing Technology and Systems, U. Rembolt, C. Blume, R. Dillmann, Dekker, 1985.
3. Computer Integrated Design and Manufacturing, D.D. Bedworth, M.R. Henderson, P.M. Wolfe, McGraw Hill.
4. Systems Approach to Computer Integrated Design and Manufacturing, N. Singh, John Wiley & Sons.

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 423 SUPPLY CHAIN MANAGEMENT AND LOGISTICS

L	T	P/D	Cr
3	1	-	3.5

Understanding the Supply Chain
Objectives of supply chain, Stages of supply chain, Supply chain process cycles, Customer order cycle, Replenishment cycle, Manufacturing cycle, Procurement cycle, Push/pull view of supply chain processes, Importance of supply chain flows, Examples of supply chain.

(6 hrs)

Supply Chain Performance
Supply chain strategies, Achieving strategic fit, Product life cycle, The minimize local cost view, The minimize functional cost view, The maximize Company profit view, The maximize supply chain surplus view. **(6 hrs)**

Supply Chain drivers and Obstacles

Four drivers of supply chain – inventory, transportation, facilities, and information, A framework for structuring drivers, Role of each driver in supply chain, Obstacles to achieve strategic fit.

(4 hrs)

Planning Demand and Supply in a Supply Chain

Role of forecasting in a supply chain, Forecasting methods in a supply chain, Basic approach to demand forecasting, Time series forecasting methods, Role of aggregate planning in a supply chain, Aggregate planning resources.

(6 hrs)

Managing economies of scale in a supply chain

Role of cycle inventory in a supply chain, Economies of scale to exploit fixed costs, Economies of scale to exploit quantity discounts, Short term discounting, Estimating cycle inventory related costs, Determining appropriate level of safety inventory.

(6 hrs)

Transportation in a supply chain

Facilities affecting transportation decisions, Modes of transportation and their performance characteristics, Design options for a transport network, trade-offs in transportation decision, Tailored transportation, Routing and scheduling in transportation, Making transportation decisions in practice.

(8 hrs)

Coordination in a Supply chain

Lack of supply chain coordination and the Bullwhip effect, Effect of lack of coordination on performance, Obstacles to coordination, Managerial levers to achieve coordination, Achieving coordination in practice**.** **(4 hrs)**

Reference Books:

1. Christopher Martin, "*Logistics and Supply Chain Management*", Pearson Education Asia, (2002).
2. Meindl Peter, "*Supply Chain Management – Strategy, planning and operation's"*, Pearson Education, Asia (2002).
3. Kapoor K K, KansalPurva, "*Marketing logistics: A Supply Chain Approach*", Pearson Education Asia (2003).
4. Monks T.G., "*Schaum's Outlines Operations Management*", Tata McGraw Hill (2001).
5. Buffa, "*Modern production/operations Management*", Wiley Eastern Ltd. (2000)

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 425 INDUSTRIAL ROBOTICS

L	T	P/D	Cr
3	1	-	3.5

Robotic Manipulation

Automation and robots, Robot classification, Applications, Robot specifications. **(3 hrs)**

Direct Kinematics (The Arm Equation)

Dot and Cross products, Coordinate frames, Homogeneous coordinates, Link Coordinates, The arm equation, Five-axis articulated robot (Rhino XR-3), Four-axis SCARA robot (Adept One), Six-axis articulated robot (Intelledex 660). **(4 hrs)**

Inverse Kinematics (Solving the Arm Equation)

The Inverse kinematics problem, General properties of solutions, Tool Configuration, Inverse kinematics of Five-axis articulated robot (Rhino XR-3), Inverse Kinematics of Four-axis SCARA robot (Adept One), inverse kinematics of Six-axis articulated robot (Intelledex 660), and Inverse kinematics of a three-axis planar articulated robot, a robotic work cell.

(6 hrs)

Workspace Analysis and Trajectory Planning

Workspace analysis, Work envelope of a five-axis articulated robot (Rhino XR-3), Work envelope of a four-axis SCARA robot (Adept One), Workspace fixtures, The pick and place operations, Continuous path motion, Interpolated motion, Straight line motion.

(4 hrs)

Differential Motion and Static

The tool configuration and Jacobean matrix, Joint space singularities, Generalized inverses, Resolved motion rate controls, rate control of redundant robots, rate control using {1}-inverses, The manipulator Jacobean, Induced joint torque and forces.

(5 hrs)

Manipulator Dynamics

Lagrange's equation, Kinetic and potential energy, Generalized force, Lagrange-Euler dynamic model, Dynamic model of a two-axis planar articulated robot, Dynamic model of a three-axis SCARA robot, Direct and inverse dynamics, Recursive Newton-Euler formulation, Dynamic model of a one-axis robot (inverted pendulum).

(6 hrs)

Robot Control

The control problem, State equations, Constant solutions, Linear feedback systems, Single axis PID control, PD gravity control, Computed torque control, Variable structure control.

(5 hrs)

Robot Vision

Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transformations, Structured Illumination, Camera Calibration. **(4 hrs)**

Task Planning

Task level programming, Uncertainty, Configuration space, Gross motion planning, Grasp Planning, Fine motion planning, Simulation of planar motion. **(3 hrs)**

Reference Books:

1. Industrial Robotics by M.P. Groover, McGraw Hill
2. Industrial Robotics and Automation by S.R.Deb Tata McGraw Hill

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 427 EXPERIMENTAL DESIGN

L	T	P/D	Cr
3	1	-	3.5

Introduction
Objectives for experimental design, Basic design concepts, Steps in designing the experiments, Types of experimental designs, Analysis of means, Six sigma.

(6 hrs)

Statistical Inference
Generation of hypotheses, Testing of hypotheses, OC curve, Tests on means, Tests on variances, Assessing normality, ANOVA rationale, Confidence limits on means, Components of variance.

(8 hrs)

Completely Randomized Design
Model for a completely randomized design with a single factor, ANOVA for a completely randomized design, Randomized block design, Incomplete block design, Latin square design, One way ANOVA, Two way ANOVA, Balanced ANOVA.

(8 hrs)

Full Factorial Design
Nature of factorial designs, Estimation of Interactions, Main effect estimates, The 2^3 design, Built-in-replication, 3^3 design, Confounding systems, Block confounding without replication.

(6 hrs)

Robust Designs
DOE and Taguchi approach. Experimental Design using orthogonal arrays, Experimental design with two and three level factors, ANOVA for Taguchi method, Signal-to-Noise Ratio, Case study on application of robust design.

(6 hrs)

Regression
Simple Linear Model, Least Squares line, Lack of fit test, Curvilinear Regression, Orthogonal polynomials.

(6 hrs)

Reference Books:

1. Modern Experimental Design by Thomas P Ryan, John Wiley Publishers, NY, 2003.
2. Design of Experiments using the Taguchi Approach by Ranjit K Roy, John Wiley, NY, 2006.
3. Fundamental Concepts in Design of Experiments, Charles R. Hicks, Oxford University Press, NY, 1999.

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 429 AUTOMOBILE ENGINEERING

L	T	P/D	Cr

3 1 - 3.5

Introduction to Automobile Engineering

Brief history of automobiles, Main components of an automobile, Brief description of each component. **(4 hrs)**

Power requirements in an automobile

Brief description of constructional details and working of a four stroke I.C. Engine (S.I. Engines and C.I. Engines) including overhead cam shaft, Multi-cylinder engines, Introduction to recent developments in I.C. Engines- Direct injection systems, Multi-point fuel injection systems, Microprocessor based fuel supply systems, Multi valve engines, Mechanical balancing, Firing Order, Power balancing, Power overlap, Power flow charts.

(6 hrs)

Transmission System of Automobile

Introduction, Brief description of different components of Transmission System.

Clutch: Introduction to Clutch and its different types, Principle of Friction Clutch, Clutch Lining and friction materials used in Friction Clutches, Torque transmitted, Brief description of Cone Clutch, Single Plate and Multiplate Clutches, Dry and wet clutches, Automatic clutch action, Centrifugal clutches, Electromagnetic clutches, Fluid Flywheel.

Gear Box: Air resistance, gradient resistance and rolling resistance coming across a moving automobile, Tractive effort, Variation of tractive effort with speed, Performance curves (object and need of a gear box), Sliding mesh gear box, Control mechanism, Sliding type selector mechanism, Ball type selector mechanism, Steering column gear shift control, Constant mesh gear box, Synchromesh device, Automatic transmission in general, AP automatic gear box, Torque converter, Torque converter with direct drive, Lubrication of Gear Box.

Propeller Shaft: Functions and requirements of a propeller shaft, Universal joints, Constructional forms of universal joints, Flexible-ring joints, Rubber-bushed flexible joints. Constant-velocity joints.

Differential: Principle of operation, Constructional details of a typical differential unit, Traction control differentials, Multi-plate clutch type traction control device, Traction control by viscous coupling.

The back axle: Live back axles, The final drive, Single reduction live axles, Torque reaction, Driving thrust, Torque and thrust member arrangements, Springs serving as torque and thrust members, Hotchkiss Drive with torque reaction member, Single combined torque-thrust reaction member, with springs taking only vertical and lateral loads, Transverse radius rods, Three radius rods, Axle construction, Effects of wheel bearing layout on axle loading, Some actual bearing arrangements, Axle casing construction, The double reduction axles (both steps at the center of the axle and one step at center of axle, the other at road wheels).
(**6 hrs**)

Running System

Wheels and rims, Tyre-its function and constructional details.

Brakes: Functions and methods of operation, Brake efficiency, Elementary theory of shoe brake, Brake shoe adjustments, A modern rear-wheel brake, Disc brakes, Brake linkages, Leverage and adjustment of the brake linkage, Servo- and power-operated brakes, Vacuum brake operation, Hydraulic Brakes-constructional details and working, BendixHydrovac, Direct-acting vacuum servos, Power-operated brakes, A dual power air brake system, Compressed air

systems, Actuating cylinders for air brakes.

(6 hrs)

Suspension System

Suspension principles, Road irregularities and human susceptibility, Suspension system, Damping, Double tube damper, Single tube damper, Lever arm type damper, Springs-Leaf springs, Coil and torsion springs, variable rate springs, Composite leaf springs, Rubber springs, Air springs, Adjustable and self-adjusting suspensions, Interconnected suspension system, Interconnected air and liquid suspensions, Independent suspension system, Different independent suspension layouts, McPherson strut type, Rear suspension-live axle, Torque reaction and axle guidance, Watt's linkage, Rear suspension-dead axles, Rear suspension-independent, McPherson strut rear suspension.

(**6 hrs**)

Steering Mechanism

Steering geometry, Castor, Camber, Kingpin inclination, Combined angle, Toe-in, Steering system-basic aims, Ackerman linkage, Steering linkages for independent suspension, Center point steering, Costarring or trailing action, Cornering power, Self-righting torque, Steering characteristics-over steer and under steer, Axle beam, Stub-axle construction, Steering column, Reversible and irreversible steering, Rack-and-pinion steering mechanism, Effect of toe-in on steering, Power steering, Vickers System.

(**6 hrs**)

Recent trends in Automobile Engineering

Multi-fuel automobiles, Automobiles running on alternate sources of energy, Emission control through catalytic converter, Double catalytic converter, Aspects of pollution control in Automobiles. (**6 hrs**)

Reference Books :

1. The Motor Vehicle by Newton, Steeds and Garrette Basic
2. Automobile Engineering by Kirpal Singh
3. Automobile Engineering by K.M. Gupta, Umesh Publications
4. Auto mechanics by Crouse

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 431 MARKETING AND FINANCIAL MANAGEMENT

L	T	P/D	Cr
3	1	-	3.5

Introduction

Need, Want, Demand, Production, Product, Selling, Marketing and societal concepts of marketing, Types of goods.

(4 hrs)

Marketing Process
Analyzing marketing opportunities, Researching and selecting target markets, Positioning the offer, Designing and marketing strategies, Planning marketing program, Organizing, Implementing & controlling marketing efforts. **(4 hrs)**

Consumer Behavior & Market Research
Factors affecting consumer behavior, stages in purchasing, Market research, Market segmentation and target market selection. **(4 hrs)**

Organizational Buying
Salient features, Factors affecting organizational purchase marketing mix, Product, Product levels, Product hierarchy, Product line, Types of distributions, Channel management decisions, Product mix, Product life cycle, Procedure for new product development, Branding and packaging. **(6 hrs)**

Price
Pricing objectives, Price elasticity of demand, Methods of pricing, Discounts, Discriminatory pricing. **(4 hrs)**

Distribution
Need for middleman and their functions, Vertical marketing system **(4 hrs)**

.

Promotion Mix
Advertising, media selection, Frequency and timing of advertisement, steps in developing effective communication, Sales promotion, Personal selling, Publicity. **(5 hrs)**

Sales Force Management
Recruitment, Training, Motivating sales representatives, Controlling and evaluating.
(5 hrs)

Basic Valuation Concepts:
Time value of money, Methods of dealing with time value of money, Future value of a single cash flow, Future value of annuity, Present value of a single cash flow, Present value of annuity, Risk and return concept, Valuation of bonds, Securities and equities, Principles of accounting, Balance sheet, Income statement, Financial ratios. **(5 hrs)**

Reference Books:

1. WinerRusselS , "Marketing Management", Prentice Hall of India, 1998.
2. Guilitinan Joseph P , Gordon W Paul and Thomas J Maddaen, "Marketing Management: Strategies and Programs", McGraw Hill Publication, 1996.
3. Dolan Robert J, "Marketing Management: Text & Cases", McGraw Hill Publication, 2000.
4. Lamb Charles W and McDaniel Carl D., "Marketing", South Western College Publication, 2004.

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PI-433 Soft Computing

L	T	P/D	Cr
3	1	-	3.5

Artificial Neural Network

Fundamentals of Neural network
Neural Network-An overview, characteristic of neural network, model of an artificial neural network , Basic building blocks of Artificial Neural Network (Network Architecture, learning methods, Activation function) **(6hrs)**

Early Neural network architecture
Basic fundamental neuron model(McCulloch –Pitts neuron model),learning rules, Hebb net, perceptron, ADALINE Network, MADLINE Network **(6hrs)**

Back propagation Networks
Introduction, back-propagation network, generalized delta rule, Architecture, training algorithm, selection of parameters, learning in back-propagation , effect of learning rate and momentum term, local minima and global minima , advantages and disadvantages
(6 hrs)

Fuzzy logic

Fuzzy set theory
Crisp set, operations on crisp set properties of crisp set, Fuzzy sets, membership function, basic fuzzy set operations ,properties of fuzzy set, crisp relations(Cartesian product, other crisp relation, operations on relation), fuzzy relation and operations on fuzzy relation
(6 hrs)

Fuzzy systems
Crisp logic (law of propositional logic, Inference in propositional logic), predicate logic(Interpretation in predicate logic, inference in predicate logic), fuzzy logic : fuzzy quantifiers, fuzzy inference, fuzzy rule base system, defuzzification (centroid method, centre of sum method, mean of maxima defuzzification) **(6 hrs)**

Genetic algorithm
Introduction, creation of off springs, working principle, encoding, fitness function, basic operators (reproduction, cross over, mutation), generational cycle , convergence of genetic algorithm **(6 hrs)**

Matlab programming
Introduction , matrix and arrays, plot data, annotate graphs, create script and functions, introduction to Artificial neural network, Genetic algorithm and Fuzzy logic toolbox
(6hrs)

Reference books
1. Neural networks, Fuzzy logic and Genetic algorithm by S. Rajasekaran and G.A. Vijayalakshmi Pai

2.Introduction to fuzzy logic using MATLAB by S.N. Sivanandam, S.Sumathi, S.N.Deepa
3. Introduction to Neural Network using MATLAB by S. N. Sivanandam, S. Sumathi, S.N.Deepa
4.Genetic algorithm in search, optimization and Machine learning by David E. Goldberg
5. Fuzzy logic with engineering applications by Timothy J. Ross

6. Matlab programming for engineers by Stephan J.Chapman

B.TECH. (7th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-435 INDUSTRIAL ENGINEERING AND ORGANIZATION

L	T	P/D	Cr

3 1 - 3.5

Introduction

Introduction to industrial engineering, techniques and application of industrial engineering Pioneers of Scientific Management. **(4 hrs)**

Sales Forecasting

Introduction, objectives and importance Methods: Collective opinion method, Economic indicator method, and regression analysis, moving average method, time series analysis, Numerical Problems. (**4 hrs)**

Production Planning and Control

Objectives, functions, preplanning and planning, routing, estimating, scheduling: master schedule, daily schedule, Gantt chart, dispatching" centralized vs. decentralized control, follow up and progress reporting. **(4 hrs)**

Inventory control

Introduction, functions, inventory control importance and functions, inventory costs, factors affecting inventory control, ABC analysis, simple inventory control model, Numerical Problems. **(6 hrs)**

Inspection and Quality Control

Inspection, definition, objectives and functions of inspection. Quality control definition and objectives, Difference between Inspection and quality control. Statistical quality control, quality control charts Numerical problems. **(8 hrs)**

Factory Organization

Principles of organization, Primary and operating fundamentals of organization, type of organization, military or line organization, functional organization, line, staff and committee, type of organisation. (**4 hrs)**

Work Study and work Measurement

Definitions, objectives, purpose and scope, method study procedure, Time study, Objectives of work measurement. Basic procedure for time study. (**3 hrs)**

Product Design and Development

Introduction, product developments, product characteristics,' role of product development, 3-S (Standardization, simplification and specialization) Break even analysis. Numerical Problems. **(4 hrs)**

Depreciation

Introduction, Purpose of calculating Depreciation, Types. Methods of calculating depreciation. Numerical Problems. **(3 hrs)**

Reference Books:

1. Production planning and control by S. Eilon, Prentice Hall
2. Industrial Engineering and Management by Ravi Shankar, Galgotia Pubs.
3. Introduction to Work study by LL.O.
4. Industrial Engg. & Operation Mgt. by S.K. Sharma &Savita Sharma

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-402 PRODUCTIVITY ENGINEERING AND MANAGEMENT

L	T	P/D	Cr
3	1	-	3.5

Introduction: Productivity Basics
Concern and the significance of Productivity Management, The rationale of Productivity Management, Some perspectives of Productivity, Productivity measurement: A case for reappraisal. **(6 hrs)**

Productivity Measurement Models: A Review
Concepts of Productivity: a review, Basis for review, Review of models of productivity measurements, A critical appraisal of various approaches, Need for new approach **(6 hrs)**

Productivity Measurement: a Conceptual Framework
Objectives of Productivity measurement, MBO and productivity measurement, systems approach to productivity measurement, Performance objectives. **(8 hrs)**

Productivity, Measurement in Manufacturing Sector
Productivity measurement in small sized, medium sized and large sized organization, Case studies. **(6 hrs)**

Productivity Measurement in Service Sector
Need for measuring productivity in service sector, difficulties in measuring productivity in service sector, Productivity of an R&D system, Productivity of an educational institution **(6 hrs)**

Productivity Management and Implementation Strategies
Productivity management system, Productivity policy, Organization and planning, Productivity measurement evaluation, Productivity improvement strategies. **(8 hrs)**

Reference Books:

1. Productivity Management by PremVrat, Sardana and Sahai
2. Industrial Engineering and Management by Ravi Shankar, Galgotia Publications

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-404 VALUE ENGINEERING

L	T	P/D	Cr
3	1	-	3.5

1. **Value Engineering Concepts:** Advantages, applications in product development, process mprovement, service improvement and system design, problem recognition, role in productivity, criteria for comparison, elements of choice. **(5hrs)**

2. **Analysis of Functions:** Anatomy of function; Values: Use, antique, cost, esteem and exchange; Primary versus secondary versus tertiary/unnecessary functions; Functional Analysis: Function Analysis System Technique and quantitative evaluation of ideas, case studies. (**10hrs)**

3. **Value Engineering Techniques:** Selecting products and operations for VE action, timing; VE programmes, determining and evaluating functions, assigning rupee equivalents, developing alternate means to required functions, decision making for optimum alternative, use of decision matrix, make or buy decisions, measuring profits, reporting results and follow up. (**18hrs)**

4. **Implementation:** Action plan, record progress, report progress, review meetings, problems in implementation, human factors. **(3hrs)**

5**. Managing VE:** Level of VE in the organization, size and skill of VE staff, small plant VE activity management supports; Audit of savings. (**6hrs)**

Suggested Books:

1. Miles, L.D., “Techniques of Value Analysis and Engineering”,Eleanor Miles Walker ,1989
2. Park, R.J. “Value Engineering : A Plan for Invention”, St. Lucie Press ,1999
3. Michaels, J.V., and Wood, W.P., “Design to Cost”, Wiley Interscience , 2004
4. Tufty, H.G., “Compendium on Value Engineering”, The Indo American Society ,1983
5. Jagannathan, G., “Getting More at Less Cost”, Tata McGraw-Hill 1992

PI-406 MAINTENANCE ENGINEERING

L	T	P/D	Cr
3	1	-	3.5

Introduction
Importance of maintenance, Objectives, Duties and policies of maintenance, Organization and structure of a maintenance system, Factors affecting maintenance, types of maintenance systems, Concept of Maintainability, Availability and Reliabilty.

Maintenance Policies and Planning
Maintenance strategies, optimum maintenance policies, Planned maintenance procedure, Scientific safety aspects in maintenance, Development of planned maintenance schedule, Budgeting and cost control, Maintenance man power planning, Maintenance downtime analysis.

New Trends in Maintenance
Terotechnology, Condition Based Maintenance, Total Productive Maintenance (TPM), Reliability Centered Maintenance, Computerized Maintenance Management System (CMMS), Available CMMS softwares, Lean maintenance, Five Zero Maintenance concept, 5-S concept in Maintenance.

References &Text Books:

1. Maintenance Planning & Control by Anthony Kelly EWP-NWP
2. Principles of Planned Maintenance by Clifton R.H. McGraw Hill
3. Maintenance Engineering & Management by Sushil Kumar Srivastava
4. Maintenance & Spare parts Management by P. Gopalakrishnan& A.K. Banerji
5. Reliability Engineering by A.W. Von Prentice Hall

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- ELECTIVE- II

L	T	P/D	Cr
3	1	-	3.5

Students will opt for an elective from the list of elective-II

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
OPEN ELECTIVE-II

L	T	P/D	Cr
3	1	-	3.5

Students will opt for an elective offered by other branches.

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-408 PROJECT -II

L	T	P/D	Cr
-	-	6	9

The student is expected to take up a project under the guidance of teacher from the Institute. The project must be based on the Production and Industrial Engineering problems. It can either be an extended part of Project-I taken in 7th semester or a new project. The student may be asked to work individually or in-group with not more than four students. Viva-voce is based on the report submitted by student(s) related to project.

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-410 COMPREHENSIVE VIVA-VOCE

L	T	P/D	Cr
-	-	-	3.0

Students are expected to be thoroughly conversant with the overview of the Production and Industrial Engineering. Apart from that, they may be asked questions of general nature such as their views regarding curriculum, lab facilities, industry-institute interaction, continuing education, research and higher education, job opportunities etc.

PI-412 GENERAL FITNESS AND PROFESSIONAL APTITUDE

L	T	P/D	Cr
-	-	-	3.5

Students will be assessed through viva-voce. Students are expected to present their resume including overall activities in the Institute during their academic tenure such as sports, extra-curricular activities, NSS, NCC etc. They are supposed to be aware of problems and challenges in Indian Industry.

LIST OF ELECTIVE-II (Any one in 8th Semester)

Sl No.	Course No	Name of Elective Subject	Offered as Open Elective To Other Branches
1.	PI-422	Total Quality Management	YES
2.	PI-424	Flexible Manufacturing System	NO
3.	PI-426	Management Information System	YES
4.	PI-428	Enterprise Resource Planning	YES
5.	PI-430	Modeling and Simulation	NO
6.	PI-432	Materials Management	NO
7.	PI-434	Energy Management	YES

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-422 TOTAL QUALITY MANAGEMENT

L	T	P/D	Cr
3	1	-	3.5

Concept of Quality

Products and services, quality of products and services, definition of quality, dimensions of quality and their measure. **(4 hrs)**

Customer-Supplier Chain

Concept of external and internal customer, concepts of process and models of process, customer and supplier requirements, customer orientation. **(6 hrs)**

Quality Management Practices

Various approaches to control and management of quality,: inspection oriented, statistical process control oriented, assurance oriented and TQM oriented approaches.
(8 hrs)

Cost of Quality

Productivity and quality relationship, concept of cost of quality, cost of conformance, prevention, appraisal and failure cost, internal and external failures, quality cost estimation in engineering and service industries. **(8 hrs)**

Organizing for Quality

Company wide organization for quality management, prevention, control and improvement, continuous improvement process. **(8 hrs)**

Human Aspects in Management of Quality

Commitment, motivation, and involvement for quality,top management, management and worker participation, zero defects, quality circle, small group activity.
(6 hrs)

Reference Books:

1. Total Quality Management by Suresh Modi
2. Total Quality Control by Armand Feigenbaum
3. In pursuit of Quality by David Hurchings

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-424 Flexible Manufacturing System

Introduction: FMS definition and classification of manufacturing systems, Automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

FMS Equipment: Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

Group Technology: GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production.

FMS related problem and Solution Methodology:
· FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks.
· FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems.
· Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control.
· FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

Books:
1. Automation, Production System & Computer Integrated Manufacturing- Groover Englewood
2. Design and Operation of SMS Rankey IFS
3. Flexible Manufacturing System Wernecks Spring-Verlag
4. FMS in Practice Bonctto Northox Ford
5. Flexible Manufacturing Cells and systems W.W. Luggen Prentice Hall India
6. Performance Modelling of Automated Manufacturing Systems – Narahari and Vishwandham, PHI

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING

PI-426 MANAGEMENT INFORMATION SYSTEM

L	T	P/D	Cr
3	1	-	3.5

The meaning and role of MIS

What is MIS? Decision support systems, Systems approach, The systems view of business, MIS, MIS organization within the company management organizational theory and the systems approach. Development of organizational theory, Management and organizational behaviour, Management information and the system approach. **(8 hrs)**

Systems for decision making

Evolution of an information systems, basic information systems, Decision making and MIS, MIS as a technique for making programmed decision assisting information systems, Strategic and project planning for MIS : General business planning, appropriate MIS planning-general, MIS planning –details. **(8 hrs)**

Conceptual system design

Define the problems, Set system objectives, Establish system constraints, Determine information needs, Determine information sources, Develop alternative conceptual; Designs and select one document the system concept, Prepare the conceptual; Design report .
(8 hrs)

Detailed System Design

Inform and involve the organization, Aim of detailed design, Project management of MIS detailed design, Identify dominant and trade off criteria, Define the subsystems, Sketch the detailed operating subsystems and information flow, Determine the degree of automation of each operation, Inform and involve the organization again, Inputs, And processing, early system testing, Software, Hardware and tools, Propose an organization to operate the system, Document the detailed design, Revisit the manager –user.

(8 hrs)

Implementation evaluation and maintenance of the MIS

Plan the Implementation / Acquire floor space and plan space layouts, Organize for implementation, Develop, Procedures for implementation, Train the operating personnel, Computer related acquisitions, Develop forms for data collection and information dissemination, Develop the files, Test the system, Cutover, Document the system, Evaluate the MIS control and maintain the system. Pitfalls in MIS development: Fundamental weakness, Soft spots in planning, Design problems, Implementation.

(8 hrs)

Reference Books:

1. Management Information system by W.S. Jawadekar- Tata McGraw Hill.

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-428 ENTERPRISE RESORUCE PLANNING

L	T	P/D	Cr
3	1	-	3.5

Introduction
Evolution of ERP, Reasons for growth of ERP market, Advantages of ERP, Integrated management information, Business modeling, Integrated data model.
(4 hrs)

ERP and related technologies
Business process reengineering, Management information system, Decision support system, Executive information system (EIS),Data warehousing, Data mining, on-line analytical processing (OLAP),Supply chain management.
(5hrs)

ERP- A Manufacturing perspective
ERP, CAD/CAM, Material requirement planning, Manufacturing resource planning-II, Distributed requirement planning (DRP), JIT an Kanban, Product data management, Data management, Benefits of PDM. **(6 hrs)**

ERP modules
Finance, Plant maintenance, Quality management, Materials management **(4 hrs)**

ERP market
SAP AG, Baan Company, Oracle Corporation, PeopleSoft, JD Edwards world Solutions Company, System Software Associates, Inc. (SSA), QAD, Benefits of ERP.
(5 hrs)

ERP Implementation life cycle
Pre-evaluation screening, Package evaluation, Reengineering, Testing, Post implementation., Vendors, Consultants and users, ERP case studies, In-house implementation – pros and cons.
(8 hrs)

Future direction in ERP
Introduction, New markets, New channels, faster implementation methodologies, Business models and BAPIIs, Convergence on Windows NT, Application platforms, New business segments. **(8 hrs)**

Reference Books :

1. Ptak, Carol A., Schragenheim Eli, "*ERP"*, CRC Press ,2003
2. Leon, "*ERP Demystified*", Tata Mcgraw-hill, 1999
3. Raman, Thothathri A, DiwanParag; "*ERP Genie : Have One Of Your Own"*, Vikas Publishing House Pvt Ltd,2002
4. Garg, Vakharia,Jaico, "ERP", Strategy Publishing House,2002
5. Sadagopan; ERP: A managerial perspective,Tata Mcgraw-hill,2001

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI- 430 MODELING AND SIMULATION

L	T	P/D	Cr
3	1	-	3.5

1. Introduction to Modeling: Concept of system, continuous and discrete systems; Types of models and simulation; Discrete event simulation: Time advance mechanisms, components andorganization of simulation model, steps in simulation study, advantages and disadvantages of simulation (**6hrs)**

2. Statistical Models in Simulation: Discrete, continuous, Poisson and empirical distributions, output data analysis for a single system, comparing alternative system configurations, statistical procedures for comparing real world observations with simulation output data, generation of arriving processes, verification and validation of simulation models.
(**12hrs)**

3. Stochastic Simulation: Random number generation: Properties of random numbers, techniques of generating random numbers, generation of random variates, Monte Carlo simulation and its applications in queuing models and inventory models. (**10hrs)**

4. Simulation of Manufacturing and Material Handling Systems:
Models of manufacturing systems, models of material handling systems, goals and performance measures; Issues in manufacturing and material handling simulation: Modeling downtime failures, trace driven models. (**8hrs)**

5. Case Studies on Simulation Packages: Simulation of queuing system (bank/job shop), simulation of manufacturing and material handling systems. (**6hrs)**

RECOMMENDED BOOKS

1. Banks, J., Nelson, B.L., Carson, J. S., and Nicol, D., “Discrete EventSystem Simulation”, Pearson Education, 2000
2. Law, A.M., and Kelton, W.D., “Simulation Modeling and Analysis”,McGraw-Hill,1999
3. Schwarzenbach, J., and Gill, K.F., “System Modeling and Control”,Butterworth-Heinemann,1992
4. Carrie, A., “Simulation of Manufacturing Systems”, John Wiley &Sons, 1988
5. Viswanadham, N., and Narahari, Y., “Performance Modeling ofAutomated Manufacturing System”, Prentice-Hall of India, 1992.
6. Theory of Modeling & Simulation, B.P. Zeigler, Taqgon Kim and Herbert Praehofer, Academic Press.
7. Handbook of Simulation: Principles, Methodology, Advances, Applications & Practice, Jerry Banks.
8. Discrete Systems Simulation, Khoshnevis.
9. Simulation Made Easy, Charles Harrell and KerimTumay, Engineering and Management Press.
10. Simulation with Arena, W. David Kelton, Randall P. Sadowski, and Deborah A. Sadowski, McGraw-Hill.
11. ProModel Software - Student Version, Published by the Day Grp.

PI-432 MATERIALS MANAGEMENT

L	T	P/D	Cr
3	1	-	3.5

Integrated approach to materials management

Introduction, materials productivity and role of materials management techniques in improved materials productivity. Cost reduction and value improvement, value analysis for right choice and rationalization of materials**.**

(6 hrs)

Purchasing function

Objectives, purchase requisitions, types of specification, centralized versus decentralized purchasing, timing of purchases. Purchasing research, identification of right sources of supplies. Make or buy decisions, vender selection and vender rating. Negotiations, purchase price analysis and price determination. Purchasing organization, procedures, forms, records and reports. Purchasing as a dynamic profession, transition to supply management.

(8 hrs)

Inventory management

Inventory concepts, reasons for holding inventory, types of inventory, inventory reduction tactics. Inventory turnover ratio, Selective Inventory management: ABC, VED, and FSN analysis etc., identifying critical items with selective inventory management.

(6 hrs)

Operating policies

Continuous review system, periodic review system, comparative advantages and disadvantages of continuous and periodic review systems, hybrid systems, Inventory management across the organization.

(6 hrs)

Optimizing Inventory

Assumptions for Wilson's lot size model, inventory costs, hidden costs, composition of costs, estimation of inventory related costs, lead time, stock out point, number of time periods, calculating Economic Order Quantity (EOQ), sensitivity analysis of EOQ model.

(6 hrs)

Stores management

Introduction, stores functions, stores organization, stores systems and procedures, stores accounting and verification systems, stores address systems, stores location and layout, store equipment.

(6 hrs)

Standardization and codification:

Classification of materials. Codification, objectives of codification, essential features of codification system, Brisch and Kodak systems, colour coding systems.Standardisation and variety reduction.

(4 hrs)

Reference Books:

1. Arnold and Chapman "*Introduction to Materials Management*", Pearson Education Asia, Fourth Edition, (2001)
2. Narsimhan, Mcleavey&Billington, "*Production Planning & Inventory Control*", Prentice Hall of India, Second Edition (2003)
3. Dobler Donald W., Burt David N., "*Purchasing and Supply Management*", Tata McGraw Hill, Sixth Edition (2001)
4. Menon K S, "*Purchasing and Inventory Control*", Wheeler Publishing New Delhi, Third Edition (1997)
5. Krajewski L J and Ritzman L P, "*Operations Management*", Pearson Education Asia, Sixth Edition (2004)

B.TECH. (8th SEMESTER)
PRODUCTION AND INDUSTRIAL ENGINEERING
PI-434 ENERGY MANAGEMENT

L	T	P/D	Cr
3	1	-	3.5

Planning for Energy Management

Initiation phase, Audit and analysis phase, Implementation phase, General methodology for building and site energy audit, Site survey, Methodology, Site survey-electrical system, Steam and water systems, Building survey methodology, Basic energy audit instrumentation, Measurement for building surveys.

(6 hrs)

Management of Heating and Cooling

General principles, The requirements for human comfort, Description of typical systems-dual duct HVAC system. Multi zone HVAC systems, Variable and volume systems, Terminal repeat system, Evaporative systems, Package system, Basic principle governing HVAC system, Package system, Basic principle governing HVAC system operation, Energy management opportunities in HVAC systems, **(6 hrs)**

Electrical Load and Lighting Management

General principles, illumination and human comfort, Basic principles of lighting system, Typical-illumination system and equipment, Fundamentals of single phase and 3 phase A.C. circuits, energy management opportunities for lighting systems, Motors and electrical heat, Electrical and analysis and their parameters, Peak, demand control.
(8 hrs)

Management of Process Energy

General principles, Process heat, Combustion, Energy saving in condensate return, Steam generation and distribution, Automotive fuel control, Hot water and water pumping, Direct and indirect fired furnaces over, Process electricity, Other process energy forms-compressed air and manufacturing processes, Problems.

(6 hrs)

The Economics of Efficient Energy Use

General consideration, Life cycle costing, Break-even analysis, Cost of money, Benefit/cost analysis, Payback period analysis, Prospective rate of to return, Problems.

(5 hrs)

Energy Considerations in Buildings

Environmental conformation, Passive design, Conservation building envelope design consideration, Integration of building system, Energy storage problems.

(5 hrs)

Use of Computer for Energy Management

Energy management principle involving computers, Basics of computer use, Analysis-engineering and economic calculations, Simulation, Forecast, CAD/CAM controls – microprocessor and minicomputers, Building cycling and control, Peak demand limiting and control: Industrial power management, Problems. **(6 hrs)**

Reference Books:

Energy Management Principles by Criag B. Smith, Published by Pergamon Press.