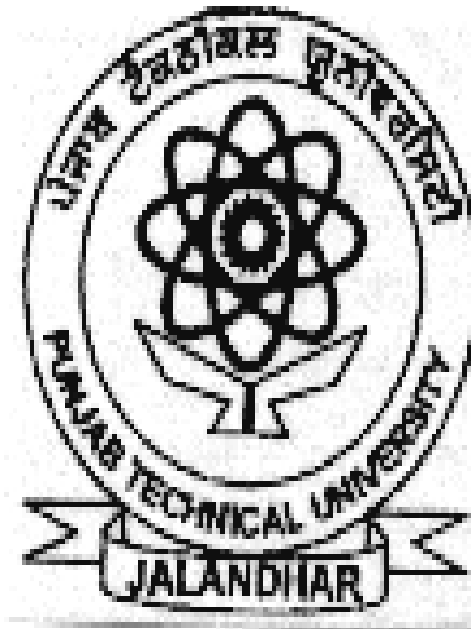


# TEACHING SCHEDULE & STUDY SCHEME

M. TECH. PROGRAMME

(Production Engineering)



PUNJAB TECHNICAL UNIVERSITY, JALANDHAR

August, 2004

**DETAILED SYLLABUS AND OTHER CONDITIONS FOR THE**  
**PROPOSED COURSE**  
**M.TECH. PRODUCTION ENGINEERING**

**Schedule of Teaching**

Lecture	Tutorials	Total
4	0 (per week)	4

**Schedule of Examination**

Time (Hrs.)	Theory Marks	Sessional Marks	Viva Marks	Total
3	100	50		150
		50	50	100
		100		100
		Satisfactory/not Satisfactory		

**SEMESTER-I**

PE-501 Metal Casting  
 PE-502 Metal Cutting  
 PE-503 Metal Forming  
 PE-504 Welding Technology  
 PE-505 Computer Aided Design & Manufacturing  
 PE-506 Lab-I

**SEMESTER-II**

PE-507 Non Conventional Machining Processes  
 PE-508 Jig, Fixtures & Die Design  
 PE-509 Production Planning & Control  
 PE- Elective-I  
 PE- Elective-II  
 PE-518 Lab -II

**SEMESTER-III**

PE- Elective-III  
 PE- Elective-IV  
 PE-580 Project  
 PE-590 Seminar

**SEMESTER-IV**

PE-500 Dissertation

**LIST OF ELECTIVES****ELECTIVE-I**

PE-510 Machine Tool Design  
 PE-511 Cutting Tool Design  
 PE-512 Industrial Tribology  
 PE-513 Diagnostic Maintenance & Monitoring

**ELECTIVE-II**

PE-514 Advanced Operations Research  
 PE-515 Management of Production Systems  
 PE-516 Simulation of Industrial Systems  
 PE-517 Materials Technology

**ELECTIVE-III**

PE-519 Mechnatronics  
 PE-520 Robotics & Indl. Automaton  
 PE-521 Metrology & Industrial Inspection  
 PE-522 Computer Aided Process Planning

**ELECTIVE-IV**

PE-523 Methods Engineering & Ergonomics  
 PE-524 Product Design & Development  
 PE-525 Entrepreneurship  
 PE-526 Statistics & Reliability Engineering

## PE- 501 METAL CASTING

L	T	P
4	0	0

Structure of silica and different types of clays, bonding mechanism of silica – water-clay systems. Swelling of clays, sintering adhesion and colloidal clay; silica grain shape and size distribution standard permeability A.F.S. clay (8 Hours)

Characteristics, Ingredients and additives of moulding sand, core sands (3 Hours)

Solidifications of Metals, nucleation, free energy concept, critical radius of nucleus. Nucleation and growth in metals and alloys. constitutional super cooling. Columnar equiaquiesced and dendritic structures. Freezing of alloys centreline feeding resistance. Rate of solidification, time of solidification, mould constant. Fluidity of metals, volumes re-distribution. Analysis of the process. (10 Hours)

Riser design shape, size and placement. Effect of appendages on risering. Effective feeding distances for simple and complex shapes. Use of chills, gating design, filling time. Aspiration of gases. Top, bottom and inside gating. Directional solidifications stresses in castings. Metal mould reactions. Expansion scale and metal penetration. Analysis of the process (10 hours)

Various moulding and casting processes, hot box, cold box process, investment, shell moulding, full mould process, die casting, ceramic shell mould, vaccum moulding etc. (6 Hours)

Non-ferrous Die-casting of Aluminium and its alloys, brass and bronze. (3 Hours)

### Books:

1. Fundamentals of Metals Casting by Flimm; Addison Wesley.
2. Principles of Metal Casting by Heine Loper and Resenthal; McGraw Hill.
3. Product Design & Process Engineering by Hiehl and Draper; McGraw Hill.
4. Foundry Practice by Salman & Simans; Issac Pitman.
5. Metals Handbook- Metal Casting; ASME.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 502 Metal Cutting

L	T	P
4	0	0

Introduction, system of Tool nomenclature, Tool Geometry, Mechanism of Chip, formation and forces in orthogonal cutting, Merchant's force diagram. (3 Hours)

**Oblique Cutting:** Normal chip reduction coefficient under oblique cutting, true shear angle, effective rake, influx region consideration for deformation, direction of maximum elongation, effect of cutting variables on chip reduction co-efficient, forces system in oblique cutting, effect of wear land on force system, force system in milling, effect of helix angle. (7 hours)

Fundamentals of Dynamometry, Theoretical determination of forces, angle relations, heat and temperature during metal cutting; distribution, measurement, analysis, theoretical estimation of work piece temperature, hot machining (7 hours)

Fundamental factors, which effect tool forces: Correlation of standard mechanised test. (Abuladze – relation), nature of contact and stagnant phenomenon, rates of strains, shear strain and normal strain distributions, cutting variables on cutting forces. (7 Hours)

**Cutting Tools:** Tools materials analysis of plastic failure (from stability criterion), Analysis failure by brittle fracture, wear of cutting tools, criterion, flank and crater wear analysis, optimum tool life, tool life equations, (Taylor's woxen etc) Tool life test, machining optimisation, predominant types of wear; abrasive, adhesive, diffusion wear models, wear measurements and techniques, theory of tool wear oxidative mathematical modelling for wear, test of machinability and influence of metallurgy on machinability. Economics of Metal machining (9Hours)

**Abrasive Machining:** Mechanics of grinding, cutting action of grit, maximum grit chip thickness, energy and grit force temperature during grinding, wheel wear, grinding, process simulation, testing of grinding wheels, mechanics of lapping and honing, free body abrasion. (7 Hours)

### Books:

Principles of Machine tools by Sen & Bhattacharya by New Central Book Agency.

Machining of Metals, by Brown; Prentice hall.

Principles of Metal cutting by Shaw; Oxford I.B.H.

Metal cutting theory & Cutting tool design by Arshimov & Alekree, MIR Publications.

Machining Science & Application by Knowenbergl Longman Press.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 503 Metal Forming

L	T	P
4	0	0

Plasticity – True stress and true strain, true stress-strain curves, selection of stress-strain curves for cold and hot working, yield of isotropic plastic material, yield criteria. Tresca maximum shear-strain-energy criterion, plastic incompressibility, Poisson's ratio for plastic deformation flow rule, strain hardening function, heat generation and heat transfer in metal forming processes, temperatures in Quasi continuous forming operations. Examination of Metal forming processes. (12 Hours)

Prediction of working loads and maximum deformation analysis of the processes of wire drawing/tube drawing, strip drawing and extrusion. various parameters/variables affecting the processes of wire drawing, tube drawing, strip drawing and extrusion; various methods of tube drawing and their comparison. Working loads for plain strain forging of strip and disc under conditions of well lubrications and sticking of material with die and under mixed conditions, prediction of working loads under above approach (simple plain strain and axis symmetric problems) (8 Hours)

Lubrication in metal forming processes, principles and mechanism of lubrications, hydrodynamic and their film lubrication, boundary and extreme pressure lubricants, solid lubricants, lubricants used for rolling and cold drawing, forging, extrusion and deep drawing processes; defects in various metal forming processes like rolling, forging, extrusion, wire drawing and deep drawing and their causes and remedial measures. (8 Hours)

Theory and deep drawing of circular blanks, analysis of the process, prediction of radial stress and punch load, ironing, wrinkling, blank holding and various parameters/variables affecting the deep drawing process. (6 Hours)

Rolling : Classification of rolling mills, analysis of the process. Prediction of roll pressure for flat strip rolling in the leading and lagging zones, roll separating forces, torque on the roll, affect of front and back tensions, affect of support rolls, various factors which affect rolling force. (6 Hours)

### Books :

An Introduction to the Principles of Metal working by Rowe, Arnold.

Metal forming analysis by Avitzler, McGraw hill.

Plasticity for mechanical Engineering by Johnson & Merlore; Van Northand.

High Velocity working Metals by ASME; EEE

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 504 Welding Technology

L	T	P
4	0	0

Introduction: Basic classification of welding processes, weldability, weld thermal cycle, metallurgy of fusion welds, solidification mechanism and microstructural products in weld metal, epitaxial, cellular and dendritic solidification, metallurgical changes in weld metal, phase transformation during cooling of weld metal in carbon and low alloy steel, prediction of microstructures and properties of weld metal. Heat affected zone, re-crystallization and grain growth of HAZ, gas metal reaction, effects of alloying elements on welding of ferrous metals. (6 Hours)

Welding Arc: Arc efficiency, temperature distribution in the arc; arc forces, arc blow, electrical characteristics of an arc, mechanism of arc initiation and maintenance, role of electrode polarity on arc behaviour and arc stability, analysis of the arc. (5 Hours)

Coated Electrodes: Electrode coatings, classification of coatings of electrodes for SMAW, SAW fluxes, role of flux ingredients and shielding gases, classification of solid and flux code wires, (5 Hours)

Fusion Welding reviews: Critical reviews of manual metal arc welding (MMAW) GTAW, GMAW, FCAW and CO welding processes, plasma arc, submerged arc welding, electro gas and electro slag welding, analysis of the process. (5 Hours)

Welding power sources: Arc welding power sources basic characteristics of power sources for various arc welding processes, duty cycles, AC, DC welding power source, DC rectifiers, thyristor controlled rectifiers, transistorised units, inverter systems. Arc length regulation in mechanised welding processes, (5 Hours)

Metal Transfer and Melting Rate: Mechanism and types of metal transfer, forces affecting metal transfer, modes of metal transfer, metal transfer in various welding processes, effect of polarity on metal transfer and melting rate. (5 Hours)

Solid State welding: Theory and mechanism of solid state welding. Techniques and scope of friction welding, diffusion welding, cold pressure welding and ultrasonic welding. High energy rate welding. Analysis of the Process. (5 Hours)

Welding Techniques using Radiation energy: Technique, scope and application of the electron beam and laser welding processes. (5 Hours)

Books:

Welding processes & technology by Dr. R.S.Parmar Khanna Publishers

Welding Engineering & Technology by Dr. R.S.Parmar Khanna Publishers

Modern Arc Welding Technology by S.V. Nandkarni Oxford & IDH publishing Co.

Principles of Welding Technology by L.M. Gourd ELBS/ Edward Arnold

The Physics of welding by Lancaster; Pergaman Press.

The Metallurgy of welding by Lancaster; George Allen & Unwin Ltd. U.K.

Welding handbook, Vol. 1 & 2, seventh edition; American welding society.

Metal Handbook, Vol 6, 73; ASME

Procedure Handbook of ARC welding; Lincoln Electric Co. USA.

The Solid phase welding of metals by Tylecote; Edward Arnold Pvt. Ltd.

Welding & Welding Technology Richard L. Little, McGraw Hill.

Welding Technology by Rossi; McGraw Hill.

Welding Technology by Koenigsberger and Adaer; Macmillan.

**Note:** Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 505 Computer Aided Design and Manufacturing

L	T	P
4	0	0

**Introduction:** CAD/CAM contents and tools; history of CAD/CAM development; CAD/CAM market trends; Definition of CAD/CAM tools, Industrial look at CAD/CAM. (3 Hours)

**CAD/CAM Hardware:** Introduction; types of systems; CAD/Cam systems evaluation criteria; input devices; output devices, hardware integration and networking; hardware trends. (3 Hours)

**CAD/CAM Software:** Introduction; graphics standards; basic definition and modes of graphic operations; user interface; software modules, modelling and viewing; software documentation; software development; efficient use of CAD/CAM Software; Software trends. (5 Hours)

**Microprocessor based CAD/CAM:** Introduction; several features, system implementation; hardware components and configuration; micro-based CAD software; file translation; operating systems, mechanical applications; micro-CAD trends; product distribution trends. (5 Hours)

**Mathematical Representation of Curves:** Introduction; wire frame models; wire frame, entities, curves representation, parametric representation of analytical and synthetic curves, curve, manipulation; design and Engineering applications. (5 Hours)

**Mathematical Representation of Surfaces:** Introduction, surface models, surface entities, surface representation, parametric representation of analytic and synthetic surfaces, surface manipulation. (4 Hours)

**Mathematical Representation of Solids:** Introduction, solid models, solid entities, solid representation, fundamentals of solid modelling, half –spaces; boundary representation; constructive solid geometry sweep representation, solid modelling based applications; design and engineering applications. (4 Hours)

**Geometric Transformations:** Introduction; transformation of geometric models, mappings of geometric models; inverse transmission and mappings; projections of geometric models; design and Engineering applications. (4 Hours)

**Mechanical Assembly and Tolerancing:** Introduction; assembly modelling, representative schemes, generation of assembling sequences; tolerance concepts. (4 Hours)

**Part Programming and Manufacturing:** NC, CNC and DMC machines, part programming, manufacturing processes, process planning, tool path generation; design and Engineering applications. (4 Hours)

**Books:**

CAD/Cam by Mikell P. Groover Mecry Wo Elimmers, Jr. 1991.

The CAD/Cam Hand Book by Bedford Masa Chusetles.

Automation, Production Systems, and Computer Aided Manufacturing, Prentice Hall by Groover M.P.

Numerical Control and Computer Aided Manufacturing by Pressman, R.N. and William, J.E. John Wiley & Sons New York.

CAD/CAM Theory and practise by Ibrahim Zeid; Tata McGraw Hill, New Delhi (1998)

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

**PE--506 Lab-I**

**Max. Marks: 100**

Time Allowed: 2hrs

One lab /field/industrial oriented project /problem will be allocated to each student related to the subjects related to the subjects taught in 1<sup>st</sup> semester.

## PE- 507 Non - Conventional Machining Processes

L	T	P
4	0	0

New Technology, Introduction, Mechanical Processes, Abrasive jet Technology, Ultrasonic machining, whirling jet machining. Fundamental principles, process parameters, characteristics, Tool design, Metal removal rate-analysis, important part design, Analysis of the Process.

(10 Hours)

Chemical and Electro-chemical machining –Introduction. Principles & scheme, Process parameters, metal removal rate, dynamic and hydro-dynamic & hydro-optimisation, electrolytes.

(9 Hours)

EDM: Introduction-basic principles & scheme, circuitry controls, metal removal rate, machining accuracy, optimisation, selection of tool material and tool design, Di-electric, Analysis.

(8 Hours)

Laser Beam Machining & Electron beam machining back ground, production of Laser, machining by Laser and other applications, Electron beam action, Dimensionless analysis to establish correlation, behaviour EBM parameters.

(8 Hours)

High Velocity forming of metals, explosive forming principles and applications, Electro-hydraulic and other applications, Analysis of the process.

(5 Hours)

Books:

Non-traditional machining methods; ASME.

New Technology by Bhattayacharya; I.E. (India)

Ultrasonic cutting by Rozenberg; Consultants Bureau; N.Y.

Electro-spark machining of metals; Vol. 2 by Lazarenko; consultant Bureau; N.Y.

Electro chemical machining by DE Baar; McDonald.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 508 - Jig, Fixture & Die Design

L	T	P
4	0	0

Jigs and Fixtures: Elements of jigs and fixtures, costs calculations. Locating element, clamping elements, procedure in designing. Jig and fixtures: Fits and tolerances analysis. (4 Hours)

Non-Standard clamping devices, centerlizers, equalizers, actuators (Pneumatic, hydraulic electric and electronic.) (7 Hours)

Automatic loading and unloading devices. (6 Hours)

Types of Frunions : Single, double and multi-axis and indexers. (6 Hours)

Transfer line jigs & fixtures for the operation of Multi-drilling, boring, milling and grinding. (6 Hours)

Assembly line fixtures. (4 Hours)

Universal Jigs and Fixtures. (4 Hours)

Transfer-devices, transfer machine, modulation-design concept, in process gauging. (7 Hours)

Design of Dies: Elements of Dies and Punch. Types and design procedure, progressive dies, drawing die, bending die etc. Analysis (4 Hours)

### Books:

Jigs and Fixtures Design by Franklin-D-Jones.

Jigs and Fixtures by Colovin; F.H. and Massachusettes Institute of Technology.

Jigs and Fixtures Design by Hardy; H.W.

Jigs and Fixtures Design by Haughton; P.S.

Jigs and Fixtures by Parson.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 509 Production Planning & Control

L	T	P
4	0	0

Introduction; Pre-planning, market survey, machine and process capacity, capacity analysis; Effects of cyclic and random variations; Routing route sheets, common charts; Scheduling; various techniques of scheduling; Production order, despatching of production orders, job card Inventory control, inventory costs, lot size models, back orders and last sales, quantity discounts, safety, stock, elementary control under risk; Materials purchasing, quotations; Rate controls; Introduction to value analysis. (40 Hours)

### Books:

1. Elements of Production Planning and Control by Eilon Macmillan.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 510 Machine Tool Design

L	T	P
4	0	0

Introduction, Classification of machine tools, elements of machine tools, selection of speed and feed, gear box design various types of clutch systems, Sohopke and Report drives, double bond gears analysis, Lohr criterion for optimising double bond gear. (5 Hours)

Stepless drives, mechanical stepless drive analysis, hydraulic step less drive & circuit analysis, design features, throttle valves, tracer controlled hydraulic circuit, hydraulic servo controls, electrical stepless drive circuits and charters tics. (6 Hours)

Strength and rigidity consideration, process capability and compliance, design of lathe bed, use of stiffness in bed, design of radial drill column and milling machine column. (3 Hours)

Analysis of spindle bearings, slides and guides, design of spindle/arbor, antifriction and journal bearings, hydro-dynamic action in slides, analysis of hydrostatic bearings, roller guides, recirculating ball analysis, stick slip motion in guides-models, force analysis of lathe guide ways. (6 Hours)

Vibrations of machine tools and dynamic rigidity: Effects of vibrations, source of vibrations, self excited vibration, single degree of freedom chatter, velocity principle and related models, regenerative principles, chatter in lathe, drilling milling and grinding. Tlusty and palace model, Peters model, elimentation of machine tool structures matrix, finite elements and lumped constant models. (7 Hours)

Automation: Automation drives for machine tools, degree of automation, semi-automatics, analysis of collect action, design, of collet, bar feeding mechanism, tooling layout, single spindle, multi-spindle automatic, transfer machine, indexing Geneva mechanism, analysis, Swiss type automatic machine loading and unloading. Transfer-devices, modular –design concept in process gauging. (7 Hours)

Control system of machine tools : Control: Mechanical, electrical, hydraulic, numerical, fluidic, basic principle of cam control, hydraulic controls, fluid controls, numerical controls, feed back systems, primary systems programming. Basic Devices, adaptive control. (6 Hours)

**Books:**

Machine tool design by Mehta; Tata Mc Graw Hill.

Principles of machine Tools by Sen & Bhattacharya; New Central Book Agency.

Machine Tool design by Basu & Pal; Oxford & IBH

Machine tool Design Vol. I to IV by Acherkan; Mir Publishers.

Design principles of Metal cutting machine tools: Koerigsberger; Pergaman Press.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 511 Cutting Tool Design

L	T	P
4	0	0

Fundamentals of Cutting tools design, cutting tools and their principal elements, Tool geometry, system of nomenclatures and their interrelations, setting for the grinding of various basic cutting tool (turning, drilling, milling) (8 Hours)

Tool materials, developments of various tool materials, their relative characteristics, modern trend in tool development, concept of tool life. (5 Hours)

Single point tools; purpose and principle types and their characteristics, design procedure of single point tools, design of various high production tools, design of carbide tools. (5 Hours)

Form tools; purpose and types, design procedure and sharpening. (3 Hours)

Drills; purpose and principal types and their construction and geometry, development in the shape of twist drills analysis. (3 Hours)

Milling Cutters; Purpose and types and their construction procedure of profile sharpened and form relieved cutters, design of hobs, analysis. (4 Hours)

Broaches: Purpose and types, design features of various broaches. (3 Hours)

Introduction of numerically controlled tools and their applications. (3 Hours)

### Books:

Principles of machine tools By Sen & Bhattacharya; New Central book Agency.

Metal cutting theory and cutting tool design by Arshinov & Alekreev; Mir Publishers.

Principles of Metal cutting By Shah; Oxford. IBH

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 512 Industrial Tribology

L	T	P
4	0	0

### Introduction:

Friction, wear and lubrication, types of contact: conforming and non-conforming. Types of motion; rubbing sliding. Oscillating. Rolling. and Surface of interactions: elastic and plastic deformations. Properties of materials. Surface energy and flash temperature theory. (8 Hours)

### Friction:

Laws of sliding friction, concept of adhesion, Tabor's mode of friction elastic thermo friction, rolling friction, measurement of friction. (7 Hours)

### Wear:

Laws of wear. Types of wear such as adhesive, delamination, abrasive, fatigue, corrosive, fretting, erosive, electrical and oxidative. Measurement of wear in dry at the sphere and different environments. Prevention and control of wear and friction in machines, wear of cutting tool and dies, study of abrasion in grinding, lapping and honing. (5 Hours)

### Lubrication:

Mechanisms of lubrication, Boundary. Squeeze film hydrodynamic and elasto hydro-dynamic and hydro static lubrications plasto hydrodynamic lubrication, solution of Reynolds's equation in two and three-dimensional flow. Pressure distribution load carrying capacity friction forces in oil film and Co-efficient of friction in journal bearing. Solid lubricants types and applications. (5 Hours)

### Bearing Design:

Design of bearing: clearance in journal bearing. minimum film thickness, Sommerfeld Number, Oil grooves and flow of oil in axial and circumferential grooves cavitations and turbulence in oil bearings. Heat generation and cooling of bearing Hydrostatic and dynamic and their applications in machine Tools. Design of air bearing and other gas bearing. (5 Hours)

### Rolling Friction:

Reynold's slip, Hertz contact concept selection of roller bearings and their methods of lubrication design aspects and modes of bearing failures and elasto hydro dynamic lubrication. (5 hours)

### Solid Lubricants:

Their applications in metal forming processes. (5 Hours)

### Books:

1. Sharma Aggarwal, A Text Book, Kataria
2. Main Engg. Hand Book, A M/c Desig.', McGraw Hill.
3. Industrial Tribology, Tribology failures and their analysis, Dr. B.S. Prabhu

**Note:** Eight questions out of entire syllabus and well distributed are to be set; students are required to attempt 5 questions.

## PE- 513 Diagnostic Maintenance and Monitoring

L	T	P
4	0	0

Introduction to maintenance techniques. Preventive and predictive Maintenance	(6 Hours)
Observational and Estimation Techniques.	(4 Hours)
Non-Destructive Testing.	(5 Hours)
Malfunction Analysis of Materials.	(6 Hours)
Wear Analysis through thermography and Ferrography	(6 Hours)
Application of Diagnostic Maintenance to Industrial Machines and plants such as Sugar Industry, Textile Mills, Thermal Power plants and Railways.	(6 Hours)
Maintenance planning and control of a large factory, work planning and work control.	(5 Hours)
Replacement Analysis.	(5 Hours)

### Books:

Maintenance planning and control- Kelly, A. Buttersworth & Co. 1984  
 Maintenance and spare parts Management – Krishanan G, Prentice Hall – 1991.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 514 Advanced Operations Research

L	T	P
4	0	0

**Linear Programming:** The Theory of simplex solution, alternative optimal solution, unbounded solutions, infeasible solutions, formulation of LP models for Production scheduling, network planning, inventory Maintenance and capital budgeting and similar industrial problems. Two phase method, revised simplex method and dual simplex method sensitivity analysis. The dual problem and its role for post optimality analysis. The transportation and assignment models. Travelling salesman model, and their industrial applications. (9 Hours)

**Dynamic Optimisation Models:** Formulation of dynamic optimisation models for common Industrial problems. Optimisation of non-linear objective function by dynamic programming. (6 Hours)

**Non-linear Optimisation Models:** Non-linear objective queuing function of unconstrained variables, quadratic programming. (5 Hours)

**Queues Models:** Queuing with single and parallel channels with limited and unlimited service. Bulk input, bulk service, priority queue discipline. (5 hours)

**Simulation Models:** Generation of Random number. Use of Coeff. random numbers for system simulation. Use of computers for system simulation. (5Hours)

**Heuristic Models:** Need for heuristic programming, examples of heuristic models for travelling salesman problems, facilities design and assembly line balancing. (5 Hours)

**Optimisation techniques :**Introduction, theory and algorithms; classical method; non-linear optimisation, unconstrained optimisation, constrained optimisation; langrangian multiplier method. (5 Hours)

### Books:

Fundamental of Operation research by Ackoff & Sasieni : wiley Eastern.

Principles of OR with applications to managerial decisions by Wagner; Prentice Hall

Introduction to OR by Hillier & Lieberman Holder day.

Operation Research by PK Gupta & DS Hira.

Note: Eight questions out of entire syllabus and well distribution are to be set; students are required to attempt 5 questions.

## PE- 515 Management of Production Systems

L	T	P
4	0	0

Systems Theory and concepts: Systems defined, functional elements of a system, general system theory, systems theory and organization, systems concept and management. The systems approach, planning and systems concepts. Control and systems concepts, Information and systems concepts. (7 Hours)

Quantative techniques of system analysis: Systems analysis, problem solving, scientific method, mathematical analysis, models, computer techniques of analysis. Linear programming input output analysis, queuing Monte-Carlo techniques, Simulation, Industrial dynamics (7 Hours)

Behavioural Aspects of System Design: The motivation factors in System design, leadership factors in system design. The need for systematic human relationships, the need for systems change, resistance to change, behavioural consequences of system changes, Microanalysis of complex, man-machine open systems, concept as a basis of human integration, meeting the human and social problems. (7 Hours)

Flow system: Increasing complexity in distribution and production, increasing cost of a distribution, the total flow system, planning the transformation, service system, integrating systems. (6 Hours)

Program Management: Impact of advancing Technology, large scale integrating system. Program Management, concept functional stages of program-management organisational modifications, matrix organization, applications of program Management. (7 Hours)

Management Cybernetics: Management cybernetics in controlling a manufacturing firm, production and inventory control systems, production, inventory, and employment control systems, the enterprise control systems. (6 Hours)

### Books:

Elements of production planning and control by Eilon; Macmillan.

Automatic Production system and computer integrated manufacturing by Groover; Prentice Hall.

Manufacturing systems Engineering by Hitachi; Taylor & Francis. Hitogni.

Manufacturing systems and Analysis by Baudin ; Yourdon.

Management of systems by Nauhria, R.N. & Parkash, Rajnish.

Modern Production Management by Elwood, S. BuffaWiley, Eastern (1984)

Production/ Operations Management by Rishards I. Koin TMH (1979)

Note: Eight questions out of entire syllabus and well distribution are to be set; students are required to attempt 5 questions.

## PE-516 - Simulation of Industrial Systems

L	T	P
4	0	0

1. Introduction and overview, concept of system, system environment, elements of system, system modeling, types of models, Monte Carlo method, system simulation, simulation - a management laboratory, advantages & limitations of system simulation, continuous and discrete systems.
2. Simulation of continuous systems: characteristics of a continuous system, comparison of numerical integration with continuous simulation system. Simulation of an integration formula.
3. Simulation of discrete system: Time flow mechanisms, Discrete and continuous probability density functions. Generation of random numbers, testing of random numbers for randomness and for auto correlation, generation of random variates for discrete distribution, generation of random variates for continuous probability distributions-binomial, normal, exponential and beta distributions; combination of discrete event and continuous models.
4. Simulation of queuing systems: Concept of queuing theory, characteristic of queues, stationary and time dependent queues, queue discipline, time series analysis, measure of system performance, Kendall's notation, auto covariance and auto correlation function, auto correlation effects in queuing systems, simulation of single server queues, multi server queues, queues involving complex arrivals and service times with blanking and reneing.
5. Simulation of inventory systems: Rudiments of inventory theory, MRP, in-process inventory. Necessity of simulation in inventory problems, forecasting and regression analysis, forecasting through simulation, generation of Poisson and Erlang variates, simulation of complex inventory situations.
6. Design of Simulation experiments: Length of run, elimination of initial bias, Variance, Variance reduction techniques, stratified sampling, antipathetic sampling, common random numbers, time series analysis, spectral analysis, model validation, optimization procedures, search methods, single variable deterministic case search, single variable non-deterministic case search, regenerative technique.
7. Simulation of PERT: Simulation of - maintenance and replacement problems, capacity planning, production systems, reliability problems, computer time sharing problem, the elevator system.
8. Simulation Languages: Continuous and discrete simulation languages, block structured continuous languages, special purpose simulation languages, SIMSCRIPT, GPSS SIMULA importance and limitations of special purpose languages.

### Reference books:

Simulation and Modelling	Loffick	Tata McGraw Hill
System Simulation with Digital Computer	Deo Narsingh	Prentice Hall
System Simulation	Hira, D.S.	S. Chand & Co.
Computer Simulation and Modelling	Meelamkavil	John Willey
System Simulation	Gerden	Prentice hall

Note: Eight questions out of entire syllabus and well distribution are to be set; students are required to attempt 5 questions.

## PE- 517 Materials Technology

L	T	P
4	0	0

Material science fundamentals. Properties of single and multiphase. Materials. Fatigue, creep and fracture process. Ferrous materials and alloying properties. Engineering properties of non-ferrous and refractory materials-ceramics, plastics, fibre reinforced and composite materials. Environmental degradation of materials and surface modification techniques. Non-Destructive testing. (40 Hours)

## References:

1. Physical Metallurgy Principles by R.E. Reed Hill - (Van Nostrand)
2. Engineering Physical Metallurgy & Heat treatment by YU. Lakhtin - (Mir Publishers)
3. Physical Metallurgy for Engineers by D.S. Clark & W.R. Varney - (CBS)
4. Engineering Physical Metallurgy Part - 1 by R.A. Higgins
5. Solid State Transformation by V. Raghavan - [Prentice Hall]
6. Phase Transformations in Materials by A.K. Jena & M.C. Chaturvedi - (Prentice Hall)
7. An Introduction to Metallurgy by A. Cottrell - (ELBS)
8. Material Science & Engineering by V. Raghavan.
9. Introduction to Material Science for Engineers by James F. Shackelford.  
(Macmillan Publishing co. New York.)
10. Non-Destructive Testing techniques by Shirvastav.
11. Non-Destructive Testing hand books of American Society of Non-Destructive Testing.

Note: Eight questions out of entire syllabus and well distribution are to be set; students are required to attempt 5 questions

**PE--518 Lab-I**

**Max. Marks: 100**

Time Allowed: 2hrs

One lab /field/industrial oriented project /problem will be allocated to each student related to the subjects related to the subjects taught in 2<sup>nd</sup> semester.

**PE- 519 Mechatronics**

L	T	P
4	0	0

Control Engineering: Open loop and closed loop control system, system components, hydraulic, thermal, pneumatic processes and their electrical analogies. (6 Hours)

Process Control: Concept of measurement of electrical and non-electrical parameters, displacement, force, temperature, pressure etc. and related signal conditioning techniques. Valves, drives and actuators, PID controllers, multivariable and multi-loop processes, basic circuits using pneumatic and PLC's. (15 Hours)

Sensors and Signal Conditioners: Transducers for Industrial processes, signal conditioning, output devices and displays. (6 Hours)

Microprocessors and Interfacing: Microprocessors/ Microcontroller architecture and programming memory, Input/output operations and interfacing, peripherals, typical applications of Microprocessors, system design concept through case studies. (13 Hours)

Book :

Computer Control of Manufacturing system by, Koren, McGraw Hill.

Production Systems and CIM, Groover, PHI.

Flexible Manufacturing systems, by Maleki, Prentice Hall.

Feedback Control Systems, BC. Kuo, PHI.

Measurement Systems, by EO. Doebelin, McGraw Hill.

Note: Eight questions out of entire syllabus and well distribution are to be set; students are required to attempt 5 questions.

## PE- 520 Robotics and Industrial Automation

L	T	P
4	0	0

Introduction to Robot Technology: Robot Physical configuration, basic Robot motions.

(2 Hours)

Types of Manipulators: Constructional features, advantages and disadvantages of various kinematic structures, servo and Non- servo manipulator.

(3 Hours)

Actuators and Transmission System: Pneumatic, Hydraulic and Electrical actuators and their characteristics and control systems.

(3Hours)

Feed Back Systems and Sensors: Encoders and other feed back systems, vision, ranging systems, textile sensors.

(3Hours)

Programming Languages: Description of VAN, RAI and other Languages.

(3 Hours)

Artificial Intelligence: Logged Locomotion, Expert system.

(4 Hours)

Concept of spatial description and transformations, manipulator Kinematics; Inverse manipulator, Kinematics Jacobians; velocities and static forces; manipulator dynamics, position control of manipulators, force control of manipulators, robot programming languages and systems.

(4 Hours)

Concept of automation in Industry, mechanisation and automation classification of automation systems.

(3 Hours)

Air Cylinders- their design and mountings, pneumatic and hydraulic valves, flow control valves metering valves, direction control valves, hydraulic servo systems, pneumatic safety and remote control circuits.

(6 Hours)

Basis of Automated work piece handling: Working principles and techniques, job orienting and feeding devices. Transfer mechanisms automated feed out of components, performance analysis.

(5 Hours)

Assembly automation, automatic packaging and automatic Inspection.

(3 Hours)

### Books:

CAD/CAM by Groover and Elimmers (Jr.)

CAD/CAM Handbook, Bedford Masschusettes.

Automation Production Systems & Computer Aided Manufacturing.

Robotics for Engineers by Royen MIT Press.

Robot Manipulators by Paul MIT Press.

Robotics by Hall & Hall.

Robot Motion by Brady MIT Press.

Numerical Controlled Computer Aided manufacturing by Press man and Elimmers, John Wiley & sons. New York.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are

required to attempt 5 questions.

## PE – 521 Metrology &amp; Industrial Inspection

L	T	P
4	0	0

Standards of Measurement: Line, End and Wavelength standards. Primary secondary and working standards. Limits, Fits & tolerances, Interchangeability, design & manufacture of gauges, use of slip gauges, dial indicators, sine bars, auto-collimators, taper gauges, optical projectors and microscopes, straightness, flatness and square ness testing. (8 Hours)

Instruments for Measuring Surface finish & Roughness: Classes of instruments, the Taylor-Hobson telesurf, plastic replica techniques, numerical assessment of roundness. (7 Hours)

Calibration of Working Standards by Interferometry : Application of interferometry, calibration of gauges by interference, by interference method, the gauge length interferometer, obliquity correction the absolute length gauge interferometer. (5 Hours)

The Calibration of working standards by direct comparison in series: Different types of comparators such as the pneumatic, optical, electrical and electronic comparators principle of amplification-magnification, sensitivity and response, the calibrations of end gauges in sets, ruling and calibration of standard scales. (5 Hours)

Measurement of Gear and Screw Threads: Measuring methods for run out, pitch, profile, lead, backlash, tooth thickness, composite elements, inspection equipment quality control screw thread terminology, measurement over wires, one wire measurement, three wire measurement, standard specifications and formulas, tolerances, thread gauge measurement, measurement, measuring equipment, application of thread gauges. (10 Hours)

Management of Inspection and quality control : Communication of specifications, the nature of dimensions, selection of gauging equipment, kind of inspection, quality control Management (5 Hours)

## Books :

- |    |                                      |   |  |
|----|--------------------------------------|---|--|
| 1. | Metrology and Measuring Instruments  | - | Taher  |
| 2. | Dimensional Metrology                | - | Miller                                       |
| 3. | Dimensional Metrology                | - | Khare & Vajpayee                             |
| 4. | Engineering Metrology                | - | R.K.Jain                                     |
| 5. | Engineering Metrology                | - | IC Gupta                                     |
| 6. | Industrial Inspection Methods        | - | Michelon, Leno C. Harper & Brothers, NY 1950 |
| 7. | The Science of Precision Measurement | - | The DoALL Co, Des Plaines Illinois.          |
| 8. | Inspection & Gauging                 | - | The Industrial Press New York, 1951.         |

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 522 Computer Aided Process Planning

L	T	P
4	0	0

**Introduction:** Traditional process planning, process planning elements, product design evaluation; selection of tooling and process parameters; operation sequence evaluation., (7 Hours)

### Group Technology

Production, advantages; part families; classification and coding systems, production analysis. Design of machine cells. (8 Hours)

### Production Systems at Operation Level

Manufacturing support systems and concepts at the level of production processes; computer generated time standards; machinability data system; cutting condition optimization. (5 Hours)

### Production Systems at Plant Level

Communication oriented production information and control system (COPICS); material requirements planning\_ capacity planning; shop floor control and operation scheduling. (5 Hours)

### Automated Process Planning

Advantages of automated process planning; Standardization of manufacturing process plans; variant process planning\_ its features\_ and different stages; different variant systems; advantages and limitations of variant process planning; generative process planning; its features; design strategies; planning; modeling and coding scheme; decision mechanism for software; decision trees for process; process, information; artificial intelligence; overview & application; search strategies for AI production systems; resolution and reduction systems; knowledge acquisition; machine selection; cutting tool selection; software; various generative process planning systems; advantages of generative process planning systems; case studies. (15 Hours)

### Recommended Books:

An Introduction to the Automated Process Planning	Chand & Wysk	Prentice Hall
Computer Aided Design & Manufacturing	Groover & Zimmers	Prentice Hall
Group Technology; Prod. Method in Manufacturing	Gallagher & Knight	Ellis Hosewood
Principle of Artificial Intelligence	Nil son	Springer Verlag
Automation; Pro6uction System & Computer Integrated Manufacturing	Groover	Prentice Hall

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## PE- 523 Methods Engineering and Ergonomics

L	T	P
4	0	0

Introduction to Industrial Engineering and productivity measurement of productivity, Introduction to work study, methods-study principles and motion economy, filming techniques and micro-motion analysis, Introduction to work measurement. Time study, performance allowances, work sampling, predetermined motion system, standard data system, job evaluation of merit rating. Wage incentive plans, MTM (Methods Time Measurement) (7 Hours)

Introduction of Ergonomics, man/ machine/environment systems concept. Development of ergonomics. (3 Hours)

Design Approach: A new design, modification, of existing design, assessment of design. Limitation of man and machine with respect to each other, posture-standing at work, seated at work, work station heights and seat geometry. Human anthropometry and its use in work place layout, Analysis. (7 Hours)

Controls: Hand controls and foot controls, location of controls and work place envelope. Recommendation about hand and foot push buttons, rotary selector switches, hand wheels, crank levers etc. Instruments and displays. (7 Hours)

Work Load: Static and dynamic muscular work. Human motor activity, metabolism, physical work load, measurement of physical work load, mental work load, measurement of mental work load, repetitive and inspection work, work duration and rest pauses, principles of motion economy, Analysis. (6 Hours)

Climates: a. Heat Humidity: Body heat balance, effective temperature scales, zones of discomfort, effect of heat on body and work performance. (2 Hours)

b.) Vibration: Terminology, Response of body to low frequency (LF) vibration, vibrations and discomfort, effect on health of worker, high frequency vibration, effect of H.F. vibrations, methods of reducing vibrations, analysis. (4 Hours)

c.) Noise: Terminology, physiological effects of noise, annoyance of noise, speed interference, hearing loss, temporary and permanent thresh hold shift, effect of noise on performance, reduction of noise, personal noise protection. Analysis. (4 Hours)

**Books:**

Methods Engineering Study – Krick, EV.

Work study and Ergonomics – Shah, H.S. Dhanpat Rai & Sons-1992.

Introduction of Ergonomics – Bridger- Tata McGraw Hill-1995.

Work Study – Khanna, OP- Dhanpat Rai & Sons-1995.

Sound, Noise and Vibration Control- Lyle, F.Yerges-Van Nostrand-1978.

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 524- Product Design And Development

L	T	P
4	0	0

Importance of product design in industry. Principal requirements of good product design.

Factors and considerations affecting product design. Ergonomic factor in product design.

Product design methodology and techniques. Basic elements and concepts of visual design.

(18 Hours)

Materials, forms, function and color relationships. Product graphics, product development and testing. Packaging materials their characteristics and applications. Packaging design considerations

(12 Hours)

Value engineering, concept, advantage and applications. Value, types of values. Analysis of function, using and evaluating functions. Value engineering techniques. Value control.

(10 Hours)

### REFERENCES

Industrial Design	Mayall	Mc Graw Hill
Product Design & Process Engineering	Niebel & Draper	Mc Graw Hill
Introduction to Design	Asimov	Prentice Hall
Value Engineering	Mudge	Mc Graw Hill

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 525 Entrepreneurship

L	T	P
4	0	0

Introduction: Factors leading to Industrial development Entrepreneur definition and various concepts, self awareness. Motivational aspects, attitude development, creativity, coping with uncertainties, resilience. (8 Hours)

Information: Industrial potential, environmental scanning, Identification of opportunities, dynamics of an opportunity, business opportunities recognition. Government policy for Industrial development. Choice of Technology Research for patents, product development. (12 Hours)

Planning: Planning of an Industrial unit, project planning, identification of market and demand for product, role of significant variables, execution of projects legal aspects, financial aspects and labour laws, feasibility studies, sectoral, Industrial and unit level feasibility, exposure to past, present and future. Entrepreneurial Management: Business finance Management through elementary concept-break even, working capital knowledge of various institutions and their mode of assistance. Elements of Production processes, quality control, Inspection methods. Production planning group dynamics. (20 Hours)

Books:

Entrepreneurship development programme in India and its relevance to developing countries by VG Patel; EDI- India; Ahmedabad (1987)

Developing of New Entrepreneurship by EDI India; Ahmedabad (1987)

Self –made Impact making Entrepreneurship by G.R. Jain and M.A.Ansari ; by EDI India; Ahmedabad (1988)

Note: Eight questions out of entire syllabus and well-distributed are to be set; students are required to attempt 5 questions.

## PE- 526 Statistics and Reliability Engineering

L	T	P
4	0	0

**Statistics**: Introduction; Principal uses of Statistics, Sampling, Frequency Distributions; Normal Distribution; Logarithmic normal distribution; Poisson distribution; correlations; Probability, Tests of significance; the Chi-Square tests; Differences in means of large samples; Differences in means of small samples; The t-test; Confidence limits; Analysis of Variances; Time Series, Monte-Carlo Method. (15 Hours)

**Reliability**: Introduction, Reliability concepts and patterns of failure; Reliability Management; Reliability for system effectiveness. (4 Hours)

**Reliability and Hazard Rates**: Failure data; Reliability function; Failure rate and hazard rate; Common distributions in failure mechanisms-Exponential, Weibull, Gamma, Lognormal Extreme Value; Model selection for component failures; Failure analysis. (7 Hours)

**Reliability Prediction and Analysis**: Reliability prediction based on Exponential Distribution; System Reliability analysis- Block diagram method, fault tree and sconces tree methods, event tree method, failure mode, failure mechanisms. (7 Hours)

**Reliability Design**: Design for Reliability, Design process, assessment methodology, Reliability allocation, Reliability improvements, Selection of Components to improve system Reliability. (7 Hours)

**Books:**

1. Reliability Engg. & Terotechnology, by A. K.Gupta, Machmillan India Ltd. Delhi (1996)
2. Introduction to Reliability Engg. by E.E,Levis, Wiley & Sons New York
3. Reliability Engg. by L.S. Shrinath Affiliated East West Press
4. Probality and Statistics for Engineers by R.A. Johnson, Prentice Hall of India Pvt. Ltd, New Delhi (1995)

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