# Course Structure & Syllabus

# of

# B.Tech Programme

# in

## Production Engineering

**(From the Session 2015-16)**

# VSSUT, BURLA

# COURSE STRUCTURE

**1ST YEAR**

| FIRST SEMESTER | | | | SECOND SEMESTER | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | | **Contact Hrs.** | **CR** | **Theory** | | **Contact Hrs.** | **CR** |
| **Course Code** | **Subject** | **L-T-P** | | **Course Code** | **Subject** | **L-T-P** | |
| | Mathematics - I | 3-1-0 | 4 | | Mathematics - II | 3-1-0 | 4 |
| | Physics/Chemistry | 3-1-0 | 4 | | Chemistry/ Physics | 3-1-0 | 4 |
| | Engineering Mechanics/ Computer Programming | 3-1-0 | 4 | | Computer Programming/ Engineering Mechanics | 3-1-0 | 4 |
| | Basic Electrical Engineering/ Basic Electronics | 3-1-0 | 4 | | Basic Electronics/ Basic Electrical Engineering | 3-1-0 | 4 |
| | English for Communication/ Environmental Science | 3-1-0 | 4 | | Environmental Science/ English | 3-1-0 | 4 |
| | | | **20** | | | | **20** |
| | **Sessional** | | | | **Sessional** | | |
| | Applied Physics Laboratory/Chemistry Lab | 0-0-3 | 2 | | Chemistry Lab/Applied Physics Laboratory | 0-0-3 | 2 |
| | Workshop-I/ Engineering Drawing | 0-0-3 | 2 | | Engineering Drawing/ Workshop-I | 0-0-3 | 2 |
| | Basic Electrical Engg. Lab/ Basic Electronics Lab | 0-0-3 | 2 | | Basic Electronics Lab/ Basic Electrical Engg. Lab | 0-0-3 | 2 |
| | Business Communication Skill/ Programming Lab | 0-0-3 | 2 | | Programming Lab/ Business Communication Skill | 0-0-3 | 2 |
| | | **15-5-12** | **28** | | | **15-5-12** | **28** |

## 2ND YEAR

| THIRDSEMESTER | | | | FOURTHSEMESTER | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | | **Contact Hrs.** | **CR** | **Theory** | | **Contact Hrs.** | **CR** |
| **Course Code** | **Subject** | **L□T□P** | | **Course Code** | **Subject** | **L□T□P** | |
| MA 15 | Mathematics-III | 3□1□0 | 4 | MA 15 | Mathematics -IV | 3□1□0 | 4 |
| ME | Engineering Thermodynamics | 3□1□0 | 4 | CS 15 | Object Oriented Programming / Data Base Management System | 3□1□0 | 4 |
| EL 15 | Elements of Electrical Machines | 3□1□0 | 4 | PE 15-031 | Theory of Machine | 3□1□0 | 4 |
| PE 15-003 | Basic Manufacturing Processes | 3□1□0 | 4 | PE 15-029 | Strength of Materials | 3□1□0 | 4 |
| HM 15 | Engineering Economics | 3□1□0 | 4 | HM 15 | Organizational Behavior | 3□1□0 | 4 |
| | | | | | | | |
| **Sessional** | | | | **Sessional** | | | |
| EL 15 | Electrical Machines Lab. | 0□0□3 | 2 | ME 15 | Thermal and Material Testing Lab. | 0□0□3 | 2 |
| ME 15 | Machine Drawing | 0□0□3 | 2 | PE 15-096 | Dynamics and Production Engg. Lab. | 0□0□3 | 2 |
| PE 15-092 | Production Practice□I | 0□0□3 | 2 | PE 15-091 | Production Practice□II | 0□0□3 | 2 |
| PE 15-099 | CAD Lab. | 0 - 0 - 3 | 2 | CS 15 | OOP Lab./ DBMS Lab. | 0□0□3 | 2 |
| | **Total** | **15□5□12** | **28** | | **Total** | **15□5□12** | **28** |

# 3RD YEAR

| FIFTHSEMESTER | | | | SIXTHSEMESTER | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | | **Contact Hrs.** | **CR** | **Theory** | | **Contact Hrs.** | **CR** |
| **Course Code** | **Subject** | **L□T□P** | | **Course Code** | **Subject** | **L□T□P** | |
| PE 15-032 | Theory of Metal Cutting | 3 □1 □0 | 4 | PE 15-012 | Inspection and Metrology | 3□1□0 | 4 |
| PE 15-006 | Design of Machine Elements | 3 □1□0 | 4 | PE 15-028 | Statistical Methods and Design of Experiments | 3□1□0 | 4 |
| PE 15-022 | Production and Operational Management | 3 □1 □0 | 4 | PE 15-036 | Tool Design | 3□1□0 | 4 |
| ME 15 | Fluid Mechanic s& Fluid Power Engineering | 3 □1 □0 | 4 | PE 15-033 | Theory of Metal Forming | 3□1□0 | 4 |
| PE 15-017 | Material Engineering & Metallurgy | 3 □ 1 □ 0 | 4 | | Core Elective-I | 3 □ 0 □ 0 | 4 |
| | | | | | | | |
| **Sessionals** | | | | **Sessionals** | | | |
| PE 15-090 | Production Engg. Lab.I(Metal Cutting) | 0□0 □3 | 2 | PE 15-089 | Production Engg.Lab.II (Metrology) | 0□0□3 | 2 |
| ME 15 | Heat Power & Hydraulic Machines Lab. – II | 0□0 □3 | 2 | PE 15-088 | Production Engg.Lab.III (SimulationLab.) | 0□0□3 | 2 |
| PE 15-093 | Optimisation Engg. Lab | 0□0 □3 | 2 | PE 15-087 | Production Engg. Lab. IV (Metal Forming) | 0□0□3 | 2 |
| PE 15-097 | Design of Machine Element Sessional | 0□0 □3 | 2 | PE 15-084 | Tool Design Sessional | 0□0 –3 | 2 |
| | **Total** | **15□5□12** | **28** | | **Total** | **15□5□12** | **28** |

# 4TH YEAR

| SEVENTHSEMESTER | | | | EIGHTHSEMESTER | | | |
|---|---|---|---|---|---|---|---|
| Theory | | Contact Hrs. | CR | Theory | | Contact Hrs. | CR |
| Course Code | Subject | L□T□P | | Course Code | Subject | L□T□P | |
| PE 15-019 | Non Traditional Machining | 3□1 □0 | 4 | PE 15-026 | Robotics and FMS | 3□1□0 | 4 |
| PE 15-002 | Automation and NC Machine | 3□1 □0 | 4 | PE 15-024 | Quality Assurance & Reliability | 3□1□0 | 4 |
| PE 15-021 | Principle of Machine Tools | 3□1 □0 | 4 | | Open Elective□II | 3□1□0 | 4 |
| | Core Elective-II | 3□1 □0 | 4 | | | | |
| | Open Elective□I | 3□1□0 | 4 | | | | |
| **Total20Total** | **12** | | | | | | |
| **SESSIONALS** | | | | **SESSIONALS** | | | |
| PE 15-086 | Production Engg.-V(NTM/NC LAB) | 0□0 □3 | 2 | PE 15-085 | Seminar | 0 – 0– 3 | 2 |
| PE 15-094 | Minor Project | 0□0 □3 | 2 | PE 15-098 | Comprehensive Viva Voce | 0 – 0– 0 | 2 |
| | | | | PE 15-095 | Major Project | 30– 0– 6 | 8 |
| | **Total** | **15□5□6** | **24** | | **Total** | **09□3□ 9** | **24** |

| **Core Elective□I(AnyOne)** | | | | **Core Elective□II(Anyone)** | | | |
|---|---|---|---|---|---|---|---|
| BPE-016 | Manufacturing Resource Planning | | | PE 15-035 | Tribology in Design and Manufacturing | | |
| BPE-009 | Finite Element Method in Manufacturing | | | PE 15-014 | Maintenance Engineering & Management | | |
| BPE-001 | Advanced Casting and Welding | | | PE 15-020 | Precision Engineering | | |
| BPE-034 | Total Quality System and Engineering | | | PE 15-023 | Project Management | | |
| BPE-010 | Industrial Hydraulics | | | PE 15-027 | Safety Engineering | | |
| **Open Elective -I(AnyOne)** | | | | **Open Elective –II (AnyOne)** | | | |
| PE 15-004 | Computer Integrated Manufacturing | | | PE 15-013 | Instrumentation and Control | | |
| PE 15-018 | Mechatronics | | | PE 15-007 | Entrepreneurship &E- Business | | |
| PE 15-030 | Surface Engineering Principles and Systems | | | PE 15-025 | Rapid Prototyping | | |
| PE 15-015 | Manufacturing & Design of Composites | | | PE 15-005 | Design for Manufacturing &Assembly | | |
| PE 15-008 | Ergonomics work design | | | PE 15-011 | Industrial Management and Operation research | | |

# SYLLABUS

## FIRST & SECOND SEMESTER
**(COMMON TO ALL BRANCHES)**

## PHYSICS – I (3 – 1 – 0)

**Module I (10 Hours)**

**Interference**

Superposition of waves - coherent and incoherent superposition, Intensity distribution.

Two source interference theory, Interference in thin films. Newton's Rings, Determination of wavelength of light and refractive index of liquid.

**Diffraction**

Diffraction: Introduction, Types of diffraction , Fraunhofer diffraction at a single slit, Plane Diffraction grating, Diffraction spectra, Determination of wavelength of light, angular dispersion, resolving power of grating.

**Polarization**

Polarization: Introduction, Types of Polarization, Production of polarized light(elementary idea) Brewster's law, Malu's law, Double refraction(only statement, explanation), Construction and working of :Nicol prism, Half wave plate and Quarter wave plate, Application of polarization (Polarimeter: Construction, Principle,Working).

**Module II (10 Hours)**

**Electromagnetism**

Vector Calculus : Gradient, Divergence, Curl of vector field, Gauss divergence theorem. Stoke's theorem, Green's theorem, Maxwell's electromagnetic equation in differential form and integral form , Electromagnetic wave equation: in vacuum and conducting medium. Pyonting vector ,Pyonting theorem, preliminary ideas about waveguides.

**Module III (10 Hours)**

**Quantum mechanics**

Need for Quantum Physics, wave particle duality, Davisson Germer experiment, Schroedinger wave equation ( time dependent and time independent), properties of wave function, Operators , eigen value , eigen function, expectation value, probability density, Simple applications: particle in a box, finite well, step potential and tunneling

**Module IV (10 Hours)**

**Lasers**

Introduction, Characteristics of lasers, Einstein's coefficients & Relation between them, Lasing action, Population inversion, Different types of Lasers (Ruby Laser,He-Ne Laser), Three and Four level pumping schemes, Applications of LASER(elementary ideas)

**Fiber optics**

Introduction, Principle of wave propagation in Optical Fiber, Structure of Optical Fiber,Types of Optical Fibers, Acceptance angle and acceptance cone, Numerical aperture, Applications of optical fibers in communications

**Nanomaterials**

Introduction, Classification, Physical characteristics and applications (fundamentals)

**Text books:**


1. Optics – A.K.Ghatak
2. Concepts of Modern Physics – A. Beiser


**Reference Books:**


1. Electricity & Magnetism – D. Griffiths
2. Quantum Mechanics – Gascirowicz
3. Lasers, theory and applications - K. Thyagarajan and A.K. Ghatak, New York : Plenum Press.
4. Quantum Mechanics – M. Das and P.K Jena
5. An Introduction to Fiber Optics - A.Ghatak, K.Thyagarajan: Cambridge University Press.
6. .Nano Materials by B.Viswanathan,Narosa Book Distributer

**List of Experiments**

1. To Determine the Young's Modulus (Y) of the material of a Wire by Searle's Method.
2. Determination of Surface Tension of water by Capillary rise method.
3. Determination of Acceleration due to gravity by using a Bar Pendulum.
4. To determine thermal conductivity of a bad conductor by using Lee's Apparatus.
5. Determination of Wavelength of monochromatic light with the help of a Newton's Ring Apparatus.
6. Determination of Grating element of a Diffraction grating using spectrometer.
7. To verify the laws of transverse vibration of string by using sonometer.
8. To determine the Rigidity modulus of the material of a wire by using Barton's apparatus.
9. To draw the characteristics of a Bipolar Junction Transistor.
10. To draw the V-I characteristics of a P. N Junction diode.

# CHEMISTRY – I **(3 – 1 – 0)**

**Module–I 10 Hours**

Failure of Classical Mechanics, Schrodinger's Wave Equation (Need not be Derived), Energy for 1-D Potential Box, Interaction of Wave with Matter
Fundamental of Microwave, IR, UV-Vis Spectroscopy:
Basic Concept of Spectroscopy, Selection Rule, Numericals, Frank-Condon Principle,

**Module – II 10 Hours**

Thermodynamics of Chemical Processes: 05 Hours
Concept of Entropy, Chemical Potential, Equilibrium Conditions for Closed Systems, Phase and Reaction Equilibria, Maxwell Relations
Definition of Terms: Phase, Components, Degree of Freedom, Phase Rule Equation. Phase Diagrams: One Component Systems – Water and Sulphur, Two Component System – Lead-Silver, Cooling Curves, Iron-Carbon Phase Diagram

**Module–III 10 Hours**

Electrode Potentials and its Relevance to Oxidation and Reduction, Measurement of EMF, Determination of pH, Hydrogen, Glass, Quinhydrone Electrodes, Dry Cells, Fuel Cells and Corrosion: Concept, Galvanic Corrosion

**Module–IV 10 Hours**

Kinetics of Chemical Reactions: 05 Hours
Reversible, Consecutive and Parallel Reactions, Steady State Approximation, Chain
Engineering application of materials: 05 Hours
Organometallics and Nanomaterials

1) P. W. Atkins, Elements of Physical Chemistry, 4th Edition, Oxford University Press
2) C. N. Banwell and E. M. MacCash, Fundamentals of Molecular Spectroscopy, 5th Edition,
3) P. K. Kar, S. Dash and B. Mishra, B.Tech. Chemistry Vol. I, Kalyani Publications

# Chemistry Laboratory

(Any ten Experiments)

1. Determination of amount of sodium hydroxide and sodium carbonate in a Mixture.
2. Determination of Total hardness of water by EDTA method.
3. Estimation of calcium present in the limestone.
4. Preparation of aspirin.
5. Standardization of $KMnO_4$ using sodium oxalate.
6. Determination of ferrous iron in Mohr's salt by potassium permanganate.
7. Determination of Rate constant of acid catalyzed hydrolysis of ester.
8. Determination of dissolved oxygen in a sample of water.
9. Determination of Viscosity of lubricating oil by red wood Viscometer.
10. Determination of Flash point of given oil by Pensky Marten's Flash point Apparatus.
11. Determination of available chlorine in bleaching powder.

**Reference Book**: B.Tech practical Chemistry-Kalyani publisher

# MATHEMATICS - I

## Subject – Mathematics I (Calculus, Linear Algebra and Numerical Method) (3-1-0)

***Module 1: (10 Lectures)***

Open sets, Closed sets, Limit points of a set, Limits, Continuous functions, Functions continuous on closed intervals, The derivative, Increasing and decreasing functions, Statement and applications of Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Extremum values; Riemann integral: Definition and existence of the integral, Integral as a limit of sums, some integrable functions, Fundamental theorem of calculus, Mean value theorems for integral calculus.

***Module 2: (10 Lectures)***

Matrices, Vectors: Addition and Scalar Multiplication, Matrix Multiplication, Linear Systems of Equations, Gauss Elimination, Linear Independence, Rank of a Matrix, Vector Space, Solutions of Linear Systems: Existence, Uniqueness, Determinants, Cramer's Rule, Gauss-Jordan Elimination, Vector Spaces, Inner Product Spaces,

***Module 3: (10 Lectures)***

Eigenvalues, Eigenvectors, Some Applications of Eigenvalue Problems, Symmetric, Skew-Symmetric, and Orthogonal Matrices, Eigenbases, Diagonalization, Quadratic Forms, Complex Matrices and Forms, IncIusion of Matrix Eigenvalues, Power Method for Eigenvalues

***Module 4: (10 Lectures)***

Numerical methods in general, Introduction, Solution of Equations by Iteration, Interpolation, Numerical Integration and Differentiation

**Text Books:**

1) S.C. Malik and S. Arora, Mathematical Analysis, New Age International
2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd

Chapters: S.C. Malik - 2(2.1- 2.3), 5(5.1-5.3), 6(6.1, 6.3-6.7), 7(7.1), 9(9.1, 9.6, 9.7, 9.9,9.10)
E. Kreyszig - 7(7.1-7.5, 7.7, 7.8,7.9), 8, 20 (20.7, 20.8), 19(19.1, 19.2, 19.3, 19.5) 9th Edition

**Reference Books:**

1) George B. Thomas , Jr. and Ross L. Finney, Calculus and Analytic Geometry, Addison Wesley Publishing Company
2) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Taylor & Francis
3) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

# MATHEMATICS - II

## Differential Equations (3-1-0)

***Module 1: (10 Lectures)***
Basic Concepts, Modeling, Separable ODEs, Modeling, Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation, Population Dynamics, Existence and Uniqueness of Solutions. Homogeneous Linear ODEs of Second Order, Homogeneous Linear ODEs with Constant Coefficients, Euler-Cauchy Equations, Existence and Uniqueness of Solutions, Wronskian, Nonhomogeneous ODEs, Solution by Variation of Parameters.

***Module 2: (10 Lectures)***
General linear differential equations of order n, Differential Operators, Homogeneous Linear ODEs, Homogeneous Linear ODEs with Constant Coefficients, Nonhomogeneous Linear ODEs, Conversion of an nth-Order ODE to a System, Basic Theory of Systems of ODEs.

Power Series Method, Theory of the Power Series Method, Frobenius Method, Sturm-Liouville Problems, Orthogonal Functions.

***Module 3: (10 Lectures)***
Laplace Transforms, Laplace Transform, Inverse Transform, Linearity. s-Shifting, Transforms of Derivatives and Integrals, ODEs, Unit Step Function, t-Shifting, Short Impulses, Dirac's Delta Function, Partial Fractions, Convolution, Integral Equations, Differentiation and Integration of Transforms.

***Module 4: (10 Lectures)***
Partial differential equations, Basic Concepts, Modeling: Vibrating String, Wave Equation Solution by Separating Variables, Use of Fourier Series, D' Alembert's Solution of the Wave Equation. Characteristics, Heat Equation: Solution by Fourier Series, Solution of PDEs by Laplace Transforms.

**Text Book:**

1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9$^{th}$ edition.

Chapters: 1(1.1-1.5, 1.7), 2(except 2.4, 2.8, 2.9), 3, 4(4.1, 4.2), 5(5.1, 5.2, 5.4), 6(6.1-6.5), 12(12.1-12.5, 12.11)

**Reference Books:**


1) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Taylor & Francis
2) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press
3) J. Sinha Roy and S. Padhy, Ordinary and Partial Differential Equation, Kalyani Publisher.
4) Richard Bronsan and Gabriel Costa, Scahum's Outline of Differential Equations, McGraw Hill
5) Paul Duchateau and D.W. Zachmann, Scahum's Outline of Partial Differential Equations, McGraw Hill
6) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill

# English for Communication

(Credit: 4-0-0)

Objective- For developing the ability to communicate effectively in professional environment by enhancing their skills in communication.

**Module 1:Fundamentals of Communication (10 Hours)**

- Communication: Process, pattern and stages of communication, channels and types of communication and Barriers to Communication.
- Functions of language: Descriptive, Expressive and Social Functions.
- Formal and Informal English
- Plain English ( Cross cultural communication)
- Bias free language

**Module 2: Communicative Grammar (10 Hours)**

- Time, Tense and Aspects
- Verbs of State and Events
- Use of Modal Verbs
- Passive and Active Voice
- Conditionals

**Module 3: Sounds of English (10 Hours)**

- The Speech Mechanism and Organs of Speech
- Consonant Sounds of English
- Vowel Sounds of English
- Stress Pattern: Syllable, Stress and Intonation.
- Problem sounds for Indian Speakers

**Module 4: Business and Official Writing (10 Hours)**

- Paragraph writing and Sentence Linker
- Business and Official Letters
- Report and Proposal writing,
- Notice, Circular and Memo writing
- Résumé (CV) Writing.

**Text Books:**


1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Better English Pronunciations By J. D.O Conner ( Cambridge University Press)
3. A Communicative Grammar of English by G.N. Leech and Jan Svartik (OUP)

**Reference Books**: "Business communication" by Ramachandran, Lakshmi and Krishna (Macmillan)

## ENGLISH COMMUNICATION SKILLS (Credit: 0-0-2)

**Objective: For enhancing corporate readiness among students by inculcating several skills of communication through activities.**

**Laboratory Activities:**

1. **Giving Introduction ( Self and others)**
2. **Group Discussion**
3. **Interviews**
4. **Role Play**
5. **Listening skill Development**
6. **Reading skill Development**
7. **Writing skill Development**
8. **Speaking skill Development**
9. **Meeting**
10. **Presentation**

Books Recommended:

1. Soft Skills – By Dr K Alex ( S Chand)

# ENGINEERING MECHANICS

**Module – I (10 Hours)**

1. **Concurrent forces on a plane**: Composition, resolution and equilibrium of concurrent coplanar forces, method of moment, friction (chapter 1). (7)
2. **Parallel forces on a plane**: General case of parallel forces, center of parallel forces and center of gravity, centroid of composite plane figure and curves(chapter 2.1 to 2.4) (4)

**Module - II (10 Hours)**

3. **General case of forces on a plane**: Composition and equilibrium of forces in a plane, plane trusses, method of joints and method of sections, plane frame, principle of virtual work, equilibrium of ideal systems.(8)
4. **Moments of inertia**: Plane figure with respect to an axis in its plane and perpendicular to the plane, parallel axis theorem(chapter 3.1 to3.4, 5.1, appendix A.1 to A.3) (3)

**Module - III (10 Hours)**

5. **Rectilinear translation:** Kinematics, principle of dynamics, D Alembert's Principle, momentum and impulse, work and energy, impact (chapter 6). (11)

**Module – IV (10 Hours)**

6. **Curvilinear translation:** Kinematics, equation of motion, projectile, D Alembert's principle of curvilinear motion. (4)
7. **Kinematics** of rotation of rigid body (Chapter 9.1) (3)

**Text book**:

1. Engineering Mechanics: S Timoshenko & Young; 4th Edition (International Edition) Mc Graw Hill.

**Reference books**:

1. Fundamental of Engineering mechanics (2nd Edition):
S Rajesekharan & G Shankara Subramanium; Vikas Pub. House Pvt ltd.

2. Engineering mechanics: K.L. Kumar; Tata MC Graw Hill.

# SESSIONAL

**Workshop Practice - I** **Workshop Practice-I**
**(**Consists of 3 sections) **:**

1. Carpentry Section: Wooden rack/bench/chair/stool (any one)
2. Fitting Section: Paper Wt., Square or Rectangular joint (male and female joint) (any one)
3. Black Smith Section : Weeding hook/Hexagonal headed bolt blank (any one )

# COMPUTER PROGRAMMING

**L-T-P: 3-1-0** **Cr.-4**

**Module I: (10 Hours)**

Introduction to computing- Block architecture of a computer, bit, bytes, memory, representation of numbers in memory. Introduction to problem solving- Basic concepts of an algorithm, program design methods, flowcharts.C Language Fundamentals- Character set, Identifiers, Keywords, Data Types, Constant and Variables, Statements. Input &Output - Input & Output Assignments, Formatted Outputs. Operatorsand Expressions-Operators, Precedence of operators.

**Module II: (10 Hours)**

Decision Control Structure, Loop Control Structure and Case Control Structure.Functions- Monolithic vs Modular programs, User defined vs standard functions, formal vs Actualarguments, Functions category, function prototypes, parameter passing, Recursion.Arrays- 1D Array, 2D Array & Multi-Dimensional Array. Strings- Declaration &Initialization,String Handling Functions.

**Module III: (10 Hours)**

Pointers- Pointer variable and its importance, Pointer Arithmetic, Passing parameters, pointer to pointer, pointer to function.Dynamic Memory Allocation.Structure- Nested Structure, Array of Structures, Pointer to Structure, Structure & Functions, typedef, Enumerated Data Type, Bit Fields. Union- Array of Union Variables, Union inside Structure.Storage Class.

**Module IV: (10 Hours)**

Preprocessor Directives- Types, Pragma Directives, Conditional Directives.Files- Reading data from Files, Reading data from Files, Writing data to Files, Error Handling during File Operations.Advanced Issues in Input & Output – using *argc*&*argv*.Operation on Bits.

**Text Books:**


1. C: The Complete Reference: Herbert Schildt
2. Computer Fundamentals &Programming in C: ReemaThareja, Oxford University Press.


**Reference Books:**


1. Let us C- Y.Kanetkar, BPB Publications.
2. Programming with ANSI and Turbo C- Kamthane, A.N. Pearson Education
3. C How to Program- Deitel and Deitel, Pearson Education.
4. The C programming Language- Brian W. Kernighan and Dennis M. Ritchie,Prentice-Hall.


# PROGRAMMING LAB (CS15-984)

**L-T-P: (**0-0-3) **Cr:** 2

Introduction to OS : Linux/Unix, Dos, Windows, Vi editor, File Handling, Directory Structure, File Permissions, Creating and editing simple c programs, Compilation and Execution

C programming on variables and expression assignment, simple arithmetic loops, If-else, Case statements, Break, Continue, Go to

Single and Multidimensional arrays

Functions, Recursion, File handling in C

Pointers, address operator, Declaring pointers and operators on pointers, Address of an array, Structures, Pointer to structure, Dynamic memory allocation

Fundamental Programs on Data Structures (Stack, Queue, Linked lists, Trees, Graphs)

# (EL15-002) BASIC ELECTRICAL ENGINEERING (3-1-0)

**MODULE-I (10 HOURS)**

DC Networks: Kirchhoff's laws, node and mesh analysis, Delta-star and star-delta transformations. Superposition, Thevenin's and Norton's theorem. Transients, in R-L, R-C and R-L-C circuits with DC. Excitation.

Single Phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, j- operations, complex representation of impedances, phasor diagrams, power factor, power in complex notation, solution of series and parallel circuits. Introduction to resonance in series RLC circuit.

Three Phase AC Circuit: Three phase EMF generation, delta and star connection, Line and Phase quantities. Solutions of 3-phase circuits with balanced load. Power in 3-phase balanced circuits.

**MODULE-II (10 HOURS)**

Magnetic Circuits: B-H Curve, Hysteresis, Permeability and reluctance, solution of simple magnetic circuits, Hysteresis and Eddy current losses.

DC Generator: Different types, Principle of Operation of DC generator, EMF equation, methods of excitation. DC Motor: Back e.m.f., speed and torque of a DC Motor, Conditions for maximum Power. Speed control of DC shunt motor.

Transformers: Construction and Principle of operation of single-phase transformer, EMF equation, Single-phase autotransformer.

**MODULE-III (10 HOURS)**

Three phase Induction Motor: Construction and principle of operation, types; Slip-torque characteristics.

Synchronous Machines: Construction & principle of operation of Synchronous generator and motor. EMF equation, Voltage regulation, Applications and starting of Synchronous motor.

Introduction to single-phase induction Motor.

**MODULE-IV (10 HOURS)**

Measuring Instruments: DC PMMC instruments, Extension of range by shunts and multipliers. Moving iron ammeters and voltmeters, Dynamometer type Watt meters, Induction type Energy Meter.

Power supply systems: Principle of generation - thermal, hydel and nuclear. Transmission and distribution of electric energy. Introduction to Electric Heating & Welding.

**TEXT BOOKS**

[1]. Edward Hughes (revised by Ian McKenzie Smith), “Electrical & Electronics Technology”, Pearson Education Limited. Indian Reprint 2002, 10th Edition.

[2]. D.Kulshreshtha, “ Basic Electrical Engineering” TMH, 1st Edition.

**REFERENCE BOOKS**

[3]. H.Cotton, “Advanced Electrical Technology", CBS Publishers, New Delhi, 7th Edition.

[4]. C.L. Wadhwa, “Electrical Engineering”, New Age International Publishers, 2nd Edition.

[5]. S. Parker Smith, “Problems in Electrical Engineering”, Asia Publications, 10th Edition.

## (EL15-003) BASIC ELECTRICAL ENGINEERING LAB (0-0-3)

1. Preliminary: Preparation of symbol chart for various systems & components as per ISS, To study the constructional & operational features for Voltmeter, Ammeter, Wattmeter, Frequency meter, multi-meter and Rheostat, Study of safety rules as per ISS
2. Measurement of the armature & field resistance of D.C. Machine by volt-amp method. & Starting and speed control of a D.C. shunt motor
3. Study of BH Curve
4. Determination of open circuit characteristics (O.C.C) of D.C shunt generator when separately excited at different speeds.
5. Measurement of earth resistance and insulation resistance
6. Starting of Induction motor and measurement of three phase power & power factor by 2-wattmeter method.
7. Calibration of a single phase Energy Meter by directed loading & Phantom loading

# BASIC ELECTRONICS (3-1-0)

**UNIT-1** **(10 Hours)**

Introduction to Electronics: Signals, Frequency Spectrum of Signals, Analog and Digital Signals,
Linear Wave Shaping Circuits: RC LPF, Integrator, RC HPF, Differentiator.
Properties of Semiconductors: Intrinsic, Extrinsic Semiconductors, Current Flow in Semiconductors,
Diodes: p-n junction theory, Current-Voltage characteristics, Analysis of Diode circuits, Rectifiers, Clippers, Clampers, Special diodes- LED, Photo diode, Zener Diode.

**UNIT-II** **(14 Hours)**

Bipolar junction Transistor (BJTs): Device Structure and Operation, Current-Voltage Characteristics, BJT as an Amplifier and as a Switch, Introduction to Power Amplifiers, A,B and C types.
JFET: Physical Structure, Operation and Characteristics MOSFET: Physical Structure, Operation and Characteristics, Feedback Amplifiers & Oscillators: General Feedback Structure, Properties of Negative Feedback, Four Basic Feedback Topologies (block diagram only), Basic Principles of Sinusoidal Oscillators( Crystal, Hartley & Collpit).
Operational Amplifiers (OP-AMPs): The Ideal OP-AMP, Inverting Configuration, Non-Inverting Configuration. OP-AMP Applications (Adder, Subtractor, Integrator, Differentiator).

**UNIT-III** **(10 Hours)**

Digital Fundamentals: Binary Numbers, Signed-binary numbers, Decimal-to-Binary & Binary-to-Decimal Conversion, Binary Addition, Subtraction, Multiplication and Division, Hexadecimal Number Systems, Logic Gates, Boolean Algebra, De Morgan's Theorems, Laws of Boolean Algebra, RS Flip flop, JK Flip flop.

**UNIT-IV** **(10 Hours)**

Introduction to Electronic Instruments: CRO: CRT, Waveform Display, Applications of CRO, Electronic Multimeter, Audio Signal Generator: Block diagram, Front Panel Controls.
Principles of Communication: Fundamentals of AM & FM, Block diagram of Transmitters & Receivers.

**TEXT BOOKS:**

**1.** Microelectronics Circuits, A.S Sedra, K.C. Smith, Oxford University Press. Selected portions from chapters 1 to 3, 5, 8, 13.
**2.** Electronics Fundamentals and Applications, D Chattopadhyay and P.C. Rakshit, NewAge International Publications. Selected portions from chapters 4 to 12,14, 16 to 18,20,21.

**REFERENCE BOOKS:**

**1.** Integrated Electronics, Millman and Halkias, TMH Publications.
**2.** Electronic Devices & Circuit Theory, R.L Boylestad and L. Nashelsky, Pearson Education.

## BASIC ELECTRONICS LAB
## LIST OF EXPERIMENTS

1. Familiarity with electronic components and devices( Testing of semiconductor diode, Transistor, IC Pins connection) Digital multimeter should be used.
2. Study and use of CRO to view waveforms and measure its Amplitude and Frequency.
3. V-I Characteristics of a Semiconductor Diode. Determining DC and AC resistance.
4. Clipper and Clamper Circuit.
5. Half Wave and Full Wave Rectifier without Capacitor filter. Record of Waveforms, Measurement of Average and RMS value.
6. V-I (Output) Characteristics of N-P-N Transistor in CE Configuration.
7. OP-AMP: Inverting and Non-Inverting Configuration. Record of Waveforms.
8. Verification of Truth table of Logic gates (AND, OR,NOT, NAND, NOR, EX-OR)

## CE 15001: ENVIRONMENTAL SCIENCE & ENGINEERING (3-1-0) CR-04

**Module – I** **(6 Hours)**

Components of Earth System: Lithosphere, Cryosphere, Atmosphere, Hydrosphere, Biosphere and Outer space.
Ecological concepts and natural Resources: Ecological perspective and value of environment, Environmental auditing, Biotic components, Levels of organizations in environment Ecosystem Process: Energy, Food chain, Environmental gradients, Tolerance levels of environmental factor.
Natural Resources covering Renewable and Non-renewable Resources, Forests, water, minerals, Food and land (with example of one case study); Energy, Growing energy needs, energy sources (conventional and alternative).Hydrological cycle, water balance, energy budget, precipitation, infiltration, evaporation and evapotranspiration.

**Module – II** **(15 Hours)**

Environmental Pollution: Definition, Causes, effects and control measures of: Water pollution, Air pollution, Noise pollution, Soil pollution, Marine pollution, Thermal pollution, Nuclear hazards
Environmental Issues: Climate change, Global warming, Acid rain, Ozone layer depletion, Sustainable development, Bio gas, Natural gas, Biodiversity, Urban problems related to energy, water scarcity, Water conservation, rain water harvesting, artificial recharge, watershed management, carbon trading, carbon foot print
National Ambient Air quality Standards, Noise standards, Vehicle emission standards

**Module – III** **(12 Hours)**

Drinking water standard (IS 10500), Water Quality Criteria and wastewater effluent standards
Water treatment: Water sources and their quality, Lay out of a water treatment plant and working of each unit/ principles of each process i.e. Screening, Aeration, Sedimentation, coagulation, flocculation, Filtration, Disinfection. Miscellaneous treatment: Removal of color, tastes and odour control, removal of iron and manganese, fluoridation and defloridation. Advanced water treatment: Ion exchange, electro-dialysis, RO, desalination

Working principles of ready-made water filter/purification system commercially available
Lay out of a wastewater treatment plant and working of each unit.

**Module – IV** **(7 Hours)**

Solid waste management: Source, classification and composition of MSW, Storage and transport of MSW, MSW management, Waste minimization of MSW, Reuse and recycling, Biological & thermal treatment (principles only), land fill

Biomedical Waste management – sources, treatment (principles only) and disposal

Hazardous Waste Management- Introduction, Sources, Classification, treatment (principles only)
Introduction to e-waste management.
Environmental impact Assessment: Project screening for EIA, Scoping studies
Environmental policies and acts (Air, Noise, Water, Forest, E-waste, Hazardous waste acts).

**Text Book:**

1 Environmental Engineering, G. Kiely, TMH, 2007

**Reference Books:**

1 Environmental Engineering, H.S. Peavy, D.R.Rowe and G. Tchobanoglous, McGraw Hill, 1985.
2 Introduction to Environmental Engineering, M. L. Davis and D. A Cornwell, McGraw Hill International, 2005.

## CE 15002: ENGINEERING DRAWING (0-0-3) CR-02

*(Minimum 8 sheets and 2 Auto Cad classes)*

Introduction to Engineering Drawing: Drawing instruments, lines, lettering and dimensioning.

Scales: Plain, Diagonal and Vernier Scales.

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

Orthographic Projections: Concepts, Orthographic projections of points, Lines, Planes and Solids.

Sections of solids; Development of surfaces

Isometric Projections: Principles, Isometric Scale, Isometric Views, Isometric Views of lines, Planes, Simple and compound Solids,

**Introduction to Auto-Cad:**

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

**Text Book:**

1 Engineering drawing by N.D. Bhatt and V.M Panchal, Charotar Publishing House, Anand.

**Reference Books:**

1. Engineering Drawing by Venugopal, New Age publisher.

# THIRD SEMESTER

## MATHEMATICS - III

## (Multivariable Calculus and Special Functions) (3-1-0)

***Module 1: (10 Lectures)***
Vector and Scalar Functions and Fields, Derivatives, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field; Line Integrals, Path Independence of Line Integrals, Double Integrals, Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals, Divergence Theorem of Gauss, Further Applications of the Divergence Theorem, Stokes's Theorem.

***Module 2: (10 Lectures)***
Fourier series and integral, Dirichlet criterion, Parseval's identity, the convolution theorem.

***Module 3: (10 Lectures)***
Orthogonal curvilinear coordinates, Jacobians, gradient, divergence, curl and Laplacian in curvilinear coordinates, Special curvilinear coordinates.

***Module 4: (10 Lectures)***
Gama function, The Beta function – Dirichlet integral; Other special functions– Error function, exponential integral, sine and cosine integrals, Bessel's Equation, Bessel Functions $J_{\square}(x)$, Bessel Functions of the Second Kind $Y_{\square}(x)$, Legendre's Equation, Legendre Polynomials $P_n(x)$.

**Text Books:**

1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd. - 9th Edition
   Chapters: 5(5.3, 5.5, 5.6), 9(9.4, 9.7, 9.8, 9.9), 10, 11(11.1-11.3, 11.6, 11.7), A3.4, A3.1

**Reference Books:**

1) S.C. Mallik and S. Arora, Mathematical Analysis, New Age International
2) Milton Abramowitz and Irene A. Stegun, *Handbook of Mathematical Functions*, National Bureau of Standards, Applied Mathematics Series - 55
3) **Yury A. Brychkov, Handbook of Special Functions: Derivatives, Integrals, Series and Other Formulas, CRC Press**
4) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Taylor & Francis
5) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

# BME 204: Engineering Thermodynamics (E,EEE,MS)

**Module – I**

1. **Basic Concepts**:- Thermodynamic systems and surrounding, state properties, processes and cycles. Thermodynamic equilibrium, heat and work transfer across boundaries, Quasi-static processes.
2. **First Law of Thermodynamics** :- First law for a closed system undergoing a cycle and undergoing a change of state. Internal energy as a system properties. Application of first law to different thermodynamic processes. (10)

**Module – II**

3. **Second Law Of Thermodynamics** :- Reversible and irreversible processes. Refrigerator and heat pump. Equivalence of Kelvin-Plank and Clausis statements, Carnot theorem and its efficiency. Inequality of Clasius and entropy concept. Change of entropy for various thermodynamic processes.
4. A**ir Standard Cycle & Introduction to I.C. Engine**: Otto, diesel and dual cycles, description and operation of four and two stroke cycle engine, comparison of SI and CI engines, valve timing diagram, power output and efficiency calculation. (10)

**Module – III**

5. **Steam And Steam Generator** :- Properties of steam, measurement of dryness fraction, use of steam table. T-S and H-S diagrams for representing thermodynamic processes.Boiler,Classification of boiler, comparison between water tube boiler and fire tube boiler. Boiler mountings and accessories. Description of Cochran & Babcock -Wilcox boiler.
6. **Steam Nozzles** :- Types of nozzles, isentropic flow through nozzles, effect of friction on nozzle efficiency. Critical pressure ratio and maximum discharge, throat and exit area. (10)

**Module – IV**

7. **Steam Turbines & Condensers**:- Turbine type and applications. Impulse turbine, pressure and velocity compounding, velocity diagram, work output, losses and efficiency. Impulse reaction turbine, velocity diagram, degree of reaction, work output, losses and efficiency. Jet and surface condensers. Condenser vacuum and vacuum efficiency.
8. **Heat Transfer** : Basic modes of heat transfer, one dimensional steady state, conduction through slab,cylinder and sphere ; basic theory of radiant heat transfer, black body & mono chromatic radiation, total emissive power.

**Text Book***:*

1. Engineering Thermodynamics by P.K.Nag, TMH

## (3RD SEMESTER)

## ELEMENTS OF ELECTRICAL MACHINES (3-1-0)

(For Mechanical and Production Engineering Students)

### MODULE I (10 LECTURES)

D.C Generator – construction and principle of operation, E.M.F. equation ; types of generator; no load and load characteristics; Voltage build-up of shunt Generator; voltage regulation, Application.

D.C Motor –construction and principle of operation, back E.M.F; torque and speed equations; characteristics and performance curves; speed control of series and shunt motors; motor starters; industrial application. Losses and Efficiency of D.C machines.

### MODULE II (10 LECTURES)

Single phase Transformer – construction and principle of operation; E.M.F. equation; Phasor diagram; actual and approximate equivalent circuits; open and short circuit tests, voltage regulation; losses and efficiency.

Three Phase Transformer – Construction and principle of operation; connection of three single –phase units in wye, delta, open delta configurations; Autotransformer; conventional transformer connected as Autotransformer. Special Transformers – induction heating and high impedance and high frequency transformer.

### MODULE III (10 LECTURES)

Three- phase alternators – construction and principle of operation; E.M.F. equation; distribution and pitch factors; Synchronous reactance; performance of alternators on no-load and load; Phasor diagram; voltage regulation, power calculations of turbine and hydro-generators, synchronization of a generator.

Three-Phase Synchronous Motor- construction and principle operation; V- curves; Phasor diagram; methods of starting; applications.

### MODULE IV (10 LECTURES)

Three-Phase induction Motor- construction of slip ring and squirrel cage type induction motors, Phasor diagram and equivalent circuit; torque-slip characteristics; maximum torque calculations; open and short-circuit tests; losses and efficiency; starting of induction motors; speed control; Induction generator.

Single-Phase Induction Motor - construction and principle of operation; capacitor- start and capacitor-run motors.

### BOOKS


[1]. J.Nagrath & D.P.Kothari, *"Theory and problems of Electrical Machines"*, TMH Publication, New Delhi

[2]. P. S. Bhimbra, *"Electrical Machinary"*, Khanna Publishers, New Delhi

## PE 15-003: BASIC MANUFACTURING PROCESSES (3-1-0)

Module – I

Manufacturing process: Definition, Classification of manufacturing process, Sand Casting : Pattern – materials, allowances, types, molding types, molding procedure , molding and properties, testing of molding sand, cores, core materials, properties of core making. Melting and founding of cast iron, degasification, design of casting and risering, pouring and feeding of casting, casting defects and inspection. [10]

Module II

Special casting: Shell mould casting, investment casting, permanent mould casting, Die casting, and centrifugal casting. [05]

Module – III

Fusion welding processes: Introduction, oxy-fuel gas welding, arc welding processes-I (consumable electrode): principle, equipment, power sources, principle of metal transfer, Electrodes, Submerged arc welding, Gas Metal Arc Welding, arc welding processes-II (non-consumable electrode): Gas Tungsten Arc Welding, Plasma Arc Welding, Other welding processes: Thermit welding, Brazing, soldering, Laser beam welding, Gas and Arc cutting, Defects in welding. [10]

Solid state welding process: Introduction, Cold welding, Ultrasonic welding, Friction welding, Resistance welding, [04]

Module – IV

Metal Forming Process:

Extrusion: Classification, Advantages, Limitations and applications [02]

Wire Drawing: Classification, Advantages, Limitations and applications [02]

Rolling: Cold and Hot Rolling processes, Classification, Advantages, Limitations and applications [04]

Sheet Metal Working: Deep drawing process [03]

TEXT BOOK(S):


1. Manufacturing Technology (Foundation Forming & Welding)- P.N. Rao, Tata McGraw Hill.
2. Principles of manufacturing materials and processes- J.S.Campbell, Tata McGraw Hill.
3. Basic Manufacturing Process- D. Mishra IndiaTech Publisher, New Delhi.


REFERENCE(S):


1. Principles of manufacturing materials and processes- J.S.Campbell, Tata McGraw Hill.
2. Manufacturing Engineering and Technology, 4th Edition- S.Kalpakjian and S.R. Scsimid, Pearson Education.
3. Materials and processes in manufacturing- DeGarmo, Black and Kohser, Prentice Hall of India.
4. Principle of Metal Casting- Heine, Loper and Rosenthal, Tata McGraw Hill.

# HU M01 ENGINEERING ECONOMICS (3-1-0)

***Module I (10 Hours)***

Theory of Demand: Modern Utility Theory, The Neumann-Morgenslern Approach, The Friedman-Savard Hypothesis, Uncertainty and Consumer Behaviour,Expectedvalue of Perfect Information, Revealed Preference Theory, Intertemporal Choice Slutsky Equation, Annual Economic Worth, Present Value, Discount Rate-IRR and NPV.

***Module II (10 Hours)***

Profit Maximization: Theory of Production-Laws of Production, Returnto Scale and Variable Proportions, Equilibriumof Firm, and Choice of Optimal Combination of Factors, Cost Minimization-Calculus Analysis of Cost Minimization, Average and Marginal Cost-The Short Run Cobb-Douglas Cost Function. Constant Returns to Scale and cost functions, long run and short run cost curves-factor prices and cost functions, the envelop Theorem for Constrained Optimization, Cost Control Techniques, Critique of The Principle Of Profit Optimization And Modern Theories of Firms-Baumol's Sales Maximization Hypothesis, MonisModel of Managerial Enterprise, Hall And Hitch Report and Full-Cost Pricing Principle, Bain's Limit Pricing Theory.

***Module III (10 Hours)***

Analysis of Public Projects: Benefit-Cost Analysis, Public Goods,Private Goods, Common Property, Free Rider Problem, Market Failure and Externalities, Private And Social Cost,Social Welfare Functions- Welfare Maximization and Pareto Optimality, Market Responses to Externalities-Mergers, Social Conventions, Property Right And Bargaining Coase Theorem.

***Module IV (10 Hours)***

Linear Models: Simple Regression Model the Problem and Estimation, Classical Normal Linear Regression Model, Two Variable Regression-Interval Estimation and Hypothesis Testing; MultipleRegression Analysis-The Problem of Estimation, Dummy Variable Regression Models, Multiple Parameter Sensitivity Analysis, Linear Programming-Graphic and Simplex Method; Game Theory-The Pay-Off Matrix of Game, Nash Equilibrium, The Mixed Strategies and The Prisoner's Dilemma.

**Text Books:**


1. Varian,H.R.(1992). Introduction to Micro Economic analysis, Norton and Company, New York.
2. Wooldridge, J.M.(2009) Introductory Econometrics-A Modern Approach, South Western CENGAGE learning.
3. Pearce,D.W. and Turner(1990) Economics of Environment and Natural Resources, Harvester Wheatsheaf, New York.
4. Damodaran, S.(2012) Managerial Economics, Second Edition, OUP

## SESSIONAL

**EE…… ELECTRICAL MACHINES LAB-I (0-0-3)**

1. Open circuit and short circuit test on single phase transformer.
2. Swinburne test and brake test of DC shunt machine.
3. Load characteristics of DC shunt generator.
4. To determine the voltage regulation of alternator by EMF method.
5. Synchronization of alternator with infinite bus.
6. Speed control of a three phase induction motor by rheostatic, cascading and pole changing methods.

**BME 293: Machine Drawing (M,MS)**

Screw threads,Screwed fastening,Keys,Cotter joints,Knuckle joints, Rivetted joints,Flange coupling,Engine parts,Introduction to computer graphics, computer aided drawing.

**PE 15-092: PRODUCTION PRACTICE-I (0-0-3)**

7. Turning Shop: Job on Centre Lathe with taper & thread cutting. Study of Turret lathe.
8. Machine Shop: Gear cutting using index head on milling machine and Gear hobbing machine.
9. Job on planner and slotting machine and surface grinding machine.

**PE 15-099 CAD Lab. (0-0-3)**

1. Introduction to CAD
2. Interactive graphics for Generation of polyhedron, cylinder, sphere, cone etc.
3. 3D viewing and transformation, hidden surface removal.
4. Generation of curves and surfaces; Geometric modelling
5. Preparation of product assembly details.
6. Aggregation for assembly

# FOURTH SEMESTER

## MATHEMATICS - IV

(Complex Analysis, and Probability and Statistics) (3-1-0)

***Module 1: (10 Lectures)***
Complex Numbers, Complex Plane, Polar Form of Complex Numbers, Powers and Roots Derivative, Analytic Function, Cauchy-Riemann Equations, Laplace's Equation, Exponential Function, Trigonometric and Hyperbolic Functions, Logarithm, General Power; Line Integral in the Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivatives of Analytic Functions

***Module 2: (10 Lectures)***
Sequences, Series, Convergence Tests, Power Series, Functions Given by Power Series, Taylor and Maclaurin Series, Laurent Series, Singularities and Zeros, Infinity, Residue Integration Method, Residue Integration of Real Integrals; Geometry of Analytic Functions: Conformal Mapping, Linear Fractional Transformations, Special Linear Fractional Transformations, Conformal Mapping by Other Functions.

***Module 3: (10 Lectures)***
Random Variables, Probability Distributions, Mean and Variance of a Distribution, Binomial. Poisson, and Hypergeometric Distributions, Normal Distribution

***Module 4: (10 Lectures)***
Introduction. Random Sampling, Point Estimation of Parameters, Confidence Intervals, Testing Hypotheses, Decisions, Regression, Fitting Straight Lines, Correlation.

**Text Book:**

1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd

Chapters: 13, 14, 15(except 15.5), 16, 17(except 17.5), 24(24.5-24.8), 25(25.1-25.4, 25.9)

**Reference Books:**

1) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
2) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Taylor & Francis
3) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

## CS: 15-025 OBJECT ORIENTED PROGRAMMING

**L-T-P: 3-1-0** **Cr.-4**

**Module – I** **(10 Lectures)**

Introduction to object oriented programming, user-defined types, polymorphism, and encapsulation. Getting started with C++ syntax, data-type, type conversions, functions, exceptions and statement, namespaces, exceptions, explicit and mutable, operators, flow control, functions, recursion. Arrays, pointers, this pointer, generic pointer and structures.

**Module – II** **(10 Lectures)**

Abstraction mechanisms: Classes, private, public construction, member functions, static members, references etc. class hierarchy, derived classes. Inheritance: simple inheritance, polymorphism, aggregation, object slicing, base initialization virtual functions.

**Module – III** **(12 Lectures)**

Prototypes, linkages, operator overloading, ambiguity, friends, member operators, operator function, I/O operator etc. Memory management: new delete, object copying copy constructors, assignment operator, this input/output. Exception handling: Exceptions and derived classes, function exception declarations, Unexpected exceptions, Exceptions when handling exceptions, resource capture and release etc.

**Module – IV** **(08 Lectures)**

Templates and standard Template library: template classes, declaration, template functions, containers, algorithms, iterators, manipulating string objects, hashes, iostreams and other type.
Projects design and development using C++.

**Text Books:**


1. Ashok N. Kamthane- Object oriented programming with ANSI & Turbo C ++.,Pearson Education.
2. E. Balguru Swamy – C ++, TMH publication.


**Reference Books:**


1. Programming with ANSI C++, 2/e, Bhushan Trivedi, Oxford University Press
2. H. Schildt – C++, The Complete Reference, TMH.
3. Robort Lafore-Object-oriented programming in Microsoft C ++
4. The C++ Programming Language (4th Edition), Bjarne Stroustrup, Addison-Wesley Publications.
5. Object-Oriented Programming Using C++, 4/e, Farrell Joyce, CENGAGE Publications.

**CS15-012 DATABASE MANAGEMENT SYSTEMS, L-T-P: 3-1-0**
**Cr.-4**

**Module – I** (10 Lectures)

**Database System Architecture**–Introduction to Database Systems, Data Abstraction, Data Independence, Three-Schema Architecture, Data Definitionsand Data Manipulation Languages.

**Data Models** -Hierarchical, Network, Relational Model and Object Oriented Data models, Entity-Relationship (E-R) Model, Mapping E-R Model to Relational Model.

**Module – II** (10 Lectures)

**Relation Query Languages:**Relational Algebra, SQL, Integrity Constraints, Tuple and Domain Relational Calculusand QBE.

**Relational Database Design:** Functional dependencies, Armstrong's Axioms,Dependency Preservation, Lossless design, Normal Forms: 1NF, 2NF, 3NF, BCNF, 4NF, 5NF.

**Module – III** (12 Lectures)

**Query processing and Optimization:** Evaluation of Relational Algebra Expression, QueryEquivalence, Join strategies, Query optimization Algorithms.

**Transaction Processing:**Transaction concept, Transaction state, Concurrent executions, Serializability.

**Concurrency Control and Recovery:** Concurrency control, Locking and Time-stampbased schedules, Multi-version and Optimistic Concurrency control schemes, Recovery System.

**Module – IV** (08 Lectures)

**Advanced Topics: (**Introduction to concepts only)Object- Oriented and object Relational databases, Temporal Data Base, Spatial Data Base, Logical Database,Web databases, Distributed Databases, Data Mining and Warehousing, Semantic Web and Ontology.

**Text Books:**

1. Elmaski & Navathe- Fundamentals of Database systems, 4$^{th}$Edition, PearsonEducation
2. A. Silberschatz, H. F. Korth, S. Sudarshan-Database System Concepts, 5$^{th}$ Edition, McGraw Hill International Edition.

**Reference Books:**

1. Bipin Desai- An introduction to Database System, Galgotia publication.
2. G.W.Hansen and J.V.Hansen, Database Management and Design, 2$^{nd}$Edition, PHI

## PE 15-031: THEORY OF MACHINE (3-1-0)

Module-I

Mechanism: Basic Kinematic concepts and definitions, mechanism, link, kinematic pair, classification of kinematic pairs, degree of freedom, kinematic chain, binary ternary and quaternary joints and links, degrees of freedom for plane mechanism, grubler's equation, inversion of mechanism, four bar chains and their inversions, single slider crank chain, double slider crank chain and their inversion. [10]

Module-II

Friction of a screw and nut, square threaded crew, V-threaded screw, pivot and collar, friction circle, friction axis, friction clutches, transmission of power by single plate, multiplate and cone clutches. [06]

Gear trains: simple train, compound train, reverted train, epicyclic train and their application. [04]

Module-III

Toothed gears: Theory of shape and action of tooth properties methods of generation of standard Tooth profiles, Standard proportions, Interference and Under-cutting, methods of Eliminating Interference, Minimum numbers of teeth to avoid interference. [05]

Module-IV

Governors: Centrifugal Governors-watt and Porter Governors, Spring loaded Governor-Hartnell Governor ,sensitiveness, stability, Isochronism ,Hunting, Governor effort and power, curves of controlling force. [05]

TEXT BOOK(S):


1. Theory of machines – SS Ratan, Tata McGraw Hill.
2. A Textbook of theory of machines (in S.I units) – R.K.Bansal, Laxmi Publication.


REFERENCE(S):


1. Mechanism and machine Theory- Rao and Dukkipati, Wiley Eastern Ltd.
2. Theory of Machines –Thomas Beven.

## PE 15-029: STRENGTH OF MATERIALS (3-1-0)

Module-I

Analysis of axially loaded members: Composite bars in tension and compression-temperature stresses in composite rods-statically indeterminate problem. [04]

2D Stress system, Principal Planes, Principal stress, Mohr's stress circle, Members in biaxial state of stress: Stresses in thin cylinders, thin spherical shells under internal pressure-wire winding of thin cylinders. [04]

Strain & deformation: Two dimensional state of strain, Principal Strains, Calculation of principal stresses from principal strains, Strain measurement. [04]

Module-II

Shear force and bending moment diagrams for simple beams: Support reactions for statically determinate beams, relationship between bending moment and shear force, shear force and bending moment diagrams. [06]

Simple bending of beams: Theory of simple bending of initially straight beams, distribution of normal and shear stress, composite beams. [04]

Module-III

Torsion in solid and hollow circular shafts, Twisting moment, strength of solid and hollow circular shafts, Strength of shafts in combined bending and twisting, Close-coiled helical springs. [06]

Deflection of Beams: Slope and deflection of beams by integration method and area-moment method. [04]

Module-IV

Buckling of columns: Euler's theory for initially straight columns with various end conditions. [04]

Theories of failure: maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, Maximum strain energy theory and maximum distortion energy theory. [04]

TEXT BOOK(S):

1. Strength of Materials- G.H.Ryder, Macmillan India.
2. Mechanics of Materials- J.M.Gere and S.Timoshenko.

REFERENCE(S):

1. Mechanics of Materials-I- E.J. Hern; Paragaman.
2. Introduction to Mechanics of Solids- Crandell, Dahl and Lardner, McGraw Hill.

**BHU-1301 ORGANISATIONAL BEHAVIOUR (3-1-0)**

**Module-1(8 hours)**

OB: Learning objectives, Definition & Meaning, Why to study OB, An OB model, New challenges for OB Manager

LEARNING: Nature of learning, How learning occurs, Learning & OB, Case Study Analysis

**Module-2 (10 hours)**

PERSONALITY: Meaning & Definition, Determinants of Personality, Personality Traits, Personality & OB

PERCEPTION: Meaning & Definition, Perceptual process, Importance of Perception in OB

MOTIVATION: Nature & Importance, Herzberg's Two Factor theory, Maslow's Need Hierarchy theory, Alderfer's ERG theory, Case Study Analysis

**Module-3 (10 hours)**

COMMUNICATION: Importance, Types, Barriers to communication, Communication as a tool for improving Interpersonal Effectiveness

GROUPS IN ORGANISATION: Nature, Types, Why do people join groups, Group Cohesiveness & Group Decision Making- managerial Implications, Effective Team Building

LEADERSHIP: Leadership & management, Theories of leadership- Trait theory, Behavioural Theory, Contingency Theory, Leadership & Followership, How to be an Effective Leader

CONFLICT: Nature of Conflict & Conflict Resolution

TRANSACTIONALANALYSIS: An Introduction to Transactional Analysis, Case Study Analysis

**Module-4 (12 hours)**

ORGANISATIONAL CULTURE: Meaning & Definition, Culture &Organisational Effectiveness

HUMAN RESOURCE MANAGEMENT: Introduction to HRM, Selection,Orientation,Training& Development, Performance Appraisal, Incentives

ORGANISATIONAL CHANGE: Importance of Change, Planned Change & OB Techniques

INTERNATIONAL OB: An Introduction to Individual & Interpersonal Behaviour in Global Perspectives

Case Study Analysis

**Text Books/References:**

[1] Stephen P. Robbins, Organisational Behaviour, Printice hall of India, New Delhi,2000.

[2] K. Aswathappa, Organisational Behaviour, Himalaya Publishing House, Bombay, 1997.

[3] S. S. Khanka, "Organisational Behaviour", S. Chand Publication, Revised edition 2009.

## SESSIONAL

**BME 298 : Thermal & Materials Testing lab. (MS)**

**A. Thermal**

1. Study of IC engine(cut model)
2. Study of Modern carburetor
3. Study of Fuel Injection system of diesel engine.
4. Study of power Transmission system.

**B. Materials testing lab**

1. Determination of tensile strength of ductile material using UTM.
2. Determination of hardness number of different materials using Rockwell hardness testing machine.
3. Ericson cupping test and impact test for 3 different specimen.
4. Fatigue Test of a given specimen

## PE 15-096: DYNAMICS & PRODUCTION LAB. (0-0-3)

*To conduct any six, three from each lab.*

*Dynamics lab.*

1. Determination of gyroscopic couple.
2. Performance characteristics of spring loaded governor.
3. Determination of critical speed of rotating shaft.
4. Experiment on static and dynamic balancing apparatus.
5. Determination of natural frequency under damped and un-damped vibration.
6. Study of interference and undercutting for gear.

*Production lab.*

1. Determination of green compressive strength of moulding sand.
2. Determination of grain fineness number of moulding sand.
3. Determination of clay content in moulding sand.
4. Determination of permeability of moulding sand.

## PE 15-091: PRODUCTION PRACTICE-II (0-0-3)

1. Welding: Study of basic principle of Arc (A.C and D.C) and Gas Welding. A welding joint will be prepared by each student.
2. Study advanced welding technique TIG and MIG.
3. Foundry Shop: Al-sand casting, study of melting furnace.
4. Study of Brazing and Soldering process.

## CS15-998 OOP LABORATORY / CS15-991 DBMS Lab

## CS15-998 OOP LABORATORY () L-T-P: (0-0-3)

**Cr:** 2

1. Programs on concepts of class and objects ( 1 class )
2. Programs using Inheritance ( 1 class )
3. Programs using Polymorphism ( 1 class )
4. Programs on use of Operator overloading ( 1 class )
5. Programs on use of memory management ( 1 class )
6. Programs on exception handling and use of templates ( 1 class )
7. Programs on file handling in C++ ( 1 class )
8. Design a problem on stock and accounting of a small organization, railway reservation, payroll preparation and optimization problem ( 3 classes )

## CS15-991 DATABASE MANAGEMENT SYSTEMS LAB L-T-P: (0-0-3)

**Cr:** 2

1. Use of SQL Syntax for creation, insertion, updation, and deletion operation.
2. Use of SQL for Single table retrieval and group by clauses.
3. Use of SQL for sub-queries, set operations, and date manipulations.
4. Use of SQL for multiple table retrieval using join.
5. Use of Creation and Manipulation of SQL Views.
6. Programming approach using PL/SQL.
7. Use of PL/SQL Cursors(implicit, explicit, and parameterized).
8. Concurrency control using LOCK.
9. Data Redundancy using ROLLBACK, SAVEPOINT, and COMMIT
10. Use of Package (ORACLE)

# FIFTH SEMESTER

## PE 15-032: THEORY OF METAL CUTTING (3-1-0)

Module-I

Basic shapes of machine tools. Wedge action, function of different angles of cutting tools, tool geometry, and Nomenclatures ASA, ORS systems. Conversion of angles, geometry of twist drill & slab milling cutter, grinding of single point cutting tool. Tool materials. [06]

Mechanism of chip formation: Mode of failure under stress- fracture & yielding mechanism. Types of chips, Factors involved in chip formation, shear plane, effect of cutting variable on chip reduction coefficient, chip formation in drilling and milling. [04]

Module-II

Force system in turning- Merchant circle diagram, velocity relationship .Stress in conventional shear plane, Energy of cutting process, Ernst & Merchant angle relationship, Forces in drilling and plane slab milling. Measurement of forces-dynamometer for measuring turning & drilling forces. [12]

Module-III

Thermodynamics of chip formation: The shear plane temperature-interface temperature from dimensional analysis-Experimental determination of chip tool interface temperature. Coolants-Theory of cutting fluid action at the chip tool interface, Techniques for application of cutting fluids. [10]

Module-IV

Tool wear: Criteria of wear. Machinability and tool life, Flank wear. Taylor's tool life equation, Crater wear, Causes and mechanism of tool failure. Vibration & chatter in machining. Economics of metal machining. [08]

TEXT BOOK(S):

1. Metal cutting Theory & Practice- A.Bhattacharya, C.B.Pub.
2. Production Technology- P.C Sharma.

REFERENCE(S):

1. Fundamentals of Metals machining & machine Tools- Boothroyd- International student Edition.
2. Theory of Metal cutting- Milton Shaw

## PE 15-006: DESIGN OF MACHINE ELEMENTS (3-1-0)

Module-I

Morphology of design process, Basic requirements for machine, elements and machines, Design procedures, Engineering Materials, their properties and Manufacturing considerations in design.

Design of fastening elements: Riveted and welded joint for pressure vessels & structural joints, Design of bolted joint, cotter and knuckle joints. [12]

Module-II

Design of shaft, keys and couplings.Design of belt and rope drives, pulleys. [08]

Module-III

Design of springs: closed coil helical springs of circular section.Concentric springs, spiral springs and leaf springs.Theory of failure: Application to practical problems. [10]

Module-IV

Design of engine components, Clutches, Piston and Connecting rod [10]

TEXT BOOK(S):

1. Design of Machine Elements- V.B.Bhandari, TMH.
2. Machine Design- P.C.Sharma &D.K.Agarwal, S.K.Kataria and Sons.

REFERENCE(S):

1. Mechanical Engineering Design- Shigley, Mischke, Budnyas, McGraw Hill.
2. Design Data Handbook- K. Mahadeban & K. Balaveenath Reddy

**PE 15-022: PRODUCTION & OPERATION MANAGEMENT (3-0-0)**

Module I

Operations function in an organization, Manufacturing vs. Service operation. Design in products, services & processes, new product design, Product life cycle, Design for services, Services process technology. Value Engineering, Standardization, Make or buy Decision.[05]

Process technology: project, job shop, batch, assembly line, continuous manufacturing, Process technology life cycle, Process technology trends, CAD, CAM, GT,FMS and CIM.[05]

Module II

Job Design & work Measurement, Method study: Techniques of analysis, recording, improvement & standardization. Work measurement: work measurement principles using stop watch time study, predetermined motion time standard & work sampling, standard time estimation. [06]

Demand Forecasting: Principles & methods, moving average, double moving average exponential smoothing, double exponential smoothing, Forecasting error analysis. [04]

Module III

Facility location: Factor influencing plant & warehouse location, impact of location on cost & revenue. Facility location procedure & models; qualitative models, Breakeven analysis, Single facility location model, Multi facility location model, Minimax location, Total & partial covering model.[05]

Plant Layout: layout types; Process layout, Product layout, Fixed position layout, planning, tools and techniques of plant layout, travel chart, Systematic layout planning, CORELAP, ALDEP and CRAFT.

[05]

Module IV

Production control: Loading, Sequencing and scheduling-Assignment model, Single machine scheduling: Basics and performance evaluation criteria, methods for minimizing mean flow time, parallel machines: minimization of makespan, flowshop sequencing: 2 and 3 machine cases: Johnson's rule and CDS heuristic. Jobshop scheduling: priority dispatching rules. [06]

Inventory control: types of inventory, objectives of inventory control, inventory costs and deterministic models, inventory control systems, safety stock. [4]

TEXT BOOK(S):

1. Production systems: planning analysis and control- J.L.Riggs, John Wiley.
2. Production and Operations Management- R.Panneerselvam, PHI.

REFERENCE(S):

1. Production and Operation Management- E.E.Adam and R.J.Ebert, PHI.
2. Production and Operations Management- S.N.Chary, Tata McGraw Hill.

# BME 308 : Fluid Mechanics & Fluid Power Engg. (MS)

**Module** - I

1. **Introduction**: Physical properties of fluids, Density, Specific weight, Specific volume, Specific gravity, Compressibility, Elasticity, Surface tension, Capillarity, Vapour pressure, Viscosity, Ideal and real fluids, Concept of shear stress, Newtonian and Non Newtonian Fluids. (5)
2. **Fluid Statics**: Pressure-Density-Height relationship, Manometers, Pressure on plane and curved surface, Centre of pressure, Buoyancy, Stability of immersed and floating bodies, Fluid masses subjected to uniform acceleration, Free and Forced vortex. (5)

**Module** - II

3. **Fluid Dynamics**: Basic Equations- equation of continuity, One-dimensional Euler's equations of motion and its integration to obtain Bernoulli's equation and Momentum equation. (4)
4. **Dimensional Analysis and Principles of Model Testing** : Dimensional homogeneity, Dimensional analysis, Rayleigh's method and Buckingham Theorem. Similarity laws and model studies. Distorted models.(4)

**Module** - III

5. **Drag and lift** : Drag and lift coefficient, pressure drag and friction drag on stream lined body and bluff body. Boundry layer separation & its control. Drag over flat plate. Profile drag. Drag characteristics of sphere , cylinder and disc .Circulation and lift on a circular cylinder,magnus effect. Circulation and lift on a Airfoil.(6)
6. **Hydraulic Turbines**: Classification of turbines, Different heads and efficiencies of turbines, Study of Pelton , Francis and Kaplan turbines, Specific speed and unit quantities, performance of turbines, Governing of turbines, Cavitations in reaction turbines, Principles of similarity applied to turbines.(6)

**Module** - IV

7. **Centrifugal Pump**: Principle , classification, pressure changes in a pump .Velocity vector diagrams and work done, minimum speed of pump to deliver liquid, multistage pumps. Similarity Relations and specific speed.(6)
8. **Reciprocating pump**: Principle of working, slip, work done, effect of acceleration and frictional resistances, separation, air vessels.(4)

**Reference Books** :


1. Fluid Mechanics & Hydraulics Machines –By:Modi and Seth, Standard Book House,New Delhi
2. Fluid Mechanics & Hydraulic Machines- By Dr.R.K.Bansal Laxmi Pub.(p) Ltd.)
3. Introduction to Fluid Mechanics & Fluid Machines – By S. K .Som & G .Biswas, TMH Pub. (p) Ltd
4. A Textbook of Fluid Mechanics and Hydraulic Machines by Dr. R K Bansal, Laxmi Pub.
5. Fundamentals of Fluid Mechanics by Som & Biswas, TMH.

**PE 15-017: MATERIALS ENGINEERING & METALLURGY (3-1-0)**

Module-I

Introduction to materials- Metal and alloys, ceramics, polymers and semiconducting materials—introduction and application as engineering materials. Defects in solids- Point, line and surface defects. Diffusion in solids. Deformation of metals- Elastic and plastic deformation, slip, twin, dislocation theory, critical resolved shear stress, Bauschinger's effect, work hardening, recovery, recrystallization and grain growth.

[10]

Module-II

Equilibrium Diagrams: Experimental methods for construction of equilibrium diagrams, Isomorphous alloy system, Types of Nucleation, determination of the size of critical nucleus, equilibrium cooling and heating of alloys, lever rule, coring, miscibility gaps – eutectic reactions.

[08]

Module-III

Transformation in solid state, allotropy, order-disorder transformation, eutectoid, peritectoid reaction and complex phase diagrams, relation between equilibrium diagrams and physical properties of alloys.Study of important binary phase diagrams Fe-Fe3C. Phase transformations in steels pearlitic, martensitic and bainitic transformations cooling curves. Isothermal transformation diagrams, transformations on continuous cooling. [12]

Module-IV

Heat treatment- Iron-carbon system. Annealing, normalising, hardening, critical cooling rate, hardenability, age hardening, surface hardening, tempering, Thermal properties- High temperature materials, materials for cryogenic application, thermally insulating materials. (Specific heat, thermal conductivity, thermal expansion). Steels: High Speed Steel, Stainless Steel and Tool Steels.

[10]

TEXT BOOK(S):

1. Introduction to Physical Metallurgy – S.H. Avner, TMH.
2. Material Science and Engineering- V.Raghavan, PHI.

REFERENCE(S):

1. Physical Metallurgy – Y.Lakhtyn, MIR.
2. Physical Metallurgy - V. Raghavan, PHI.
3. Elements of Material Science and Engineering- L .A. Vanblack. Addison-Wesley (Indian edition).
4. Material Science and Engineering: An Introduction- W.D.Callister, Wiley.

## SESSIONAL

**BME 393: Heat Power & Hydraulic Machines Lab. – II (MS)**

1. Heat balance in Rusten Diesel Engine(single cyl.)
2. Study of modern Carburator
3. Study of fuel Injection system
4. Load test on variable compression ratio engine
5. Expt. On Reciprocating pump
6. Expt. On hydraulic ram
7. Pelton Turbine with generator loading.
8. Franci’s Turbine with generator loading.

# PE 15-090: Production Engineering Lab.-I (Metal Cutting) (0-0-3)

1. To observe the variation of horizontal and vertical forces with variation in cutting speed, depth of cut and feed using a lathe tool dynamometer.
2. Study of chip formation in different speed and feeds.
3. Determination of cutting forces in drilling in drill tool dynamometer.
4. Study of vibration and tool chatter during cutting.

**PE 15-093: Optimization Lab. (0-0-3)**

1. Generation of Pseudo-random numbers
2. Chi-square test as test of independence.
3. Single factor ANOVA test for equality of means.
4. Hypothesis testing of means with different conditions.
5. Two factor factorial design.
6. Chi-square test as test of goodness of fit.

**PE 15-097: Design of Machine Element Sessional (0-0-3) (Any Five)**

1. Design drawing of riveted joint
2. Design and drawing of cotter joint
3. Design and drawing of knuckle joint
4. Design of shafts subjected to combined loading
5. Design and drawing of flange coupling
6. Design of spring
7. Design of clutch
8. Design of connecting rod
9. Design of piston

# SIXTH SEMESTER

## PE 15-012: INSPECTION AND METROLOGY (3-1-0)

Module-I

Metrology: Need of Inspection, Precision and accuracy, Accuracy and cost, Sources of error, Types of error, and Geometry of form on shape. Line standard, end standard, limits, fits, tolerances-Hole & shaft basis system, Interchangeability, selective assembly, ISO system for limits & fits, Limit gauges-Snap, plug, ring, taper, position gauges-Gauge design, Taylor's principle. Wear allowance, Screw allowance Screw thread gauge, Thread pitch gauge. [10]

Module-II

Comparators- Characteristics, Relative Advantages of various types of comparators-Mechanical, optical, Pneumatic, Fluid displacement type, Measurement by light wave Interference optical flat. [06]

Measurement of straightness- Autocollimator flatness testing measurement of circularity-types of irregularities. Angular measurement-Sine bar, Sine center,angle gauges, measurement of angle of tapered hole. [06]

Module-III

Surface Measurements- Roughness and waviness, Surface texture, cut off length, RMS & CLA values, Surface roughness measuring instruments, Principle of working. [04]

Metrology of screw thread- Errors in threads, measurement of element of threads, 2-wire &3- wire methods, Measurement & testing of gears-Measurement of error, rolling test, gear tooth calliper, base tangent comparator. [06]

Module-IV

Non destructive testing- X-ray examination, radiography, Ultrasonic inspection, magnetic test, machine vision system-principle, application, Laser inspection. [08]

TEXT BOOK(S):

1. Engineering Metrology- R.K. Jain
2. Production Technology- P.C. Sharma

REFERENCE(S):

1. Engineering Dimensional Metrology- Miller, Edward Arnold pub.
2. Precision Engineering in Metrology- R.L. Murty, New Age Int.

## PE 15-028: STATISTICAL METHODS & DESIGN OF EXPERIMENTS(3-1-0)

Module I

Sampling Distribution, Types, Random Sampling, Sample Size & Standard Error, Point Estimate, Hypothesis testing, Hypothesis testing of mean with different conditions, differences in mean, Chi squares as test of independence, test of goodness fit. [08]

Module II

Experiments with single factor, Analysis of variance, Fixed effect model, Estimation of model parameters, Comparison of individual treatment means, Orthogonal contrasts, Schaffer method of comparing contrasts, Comparing pairs of treatment means. Model adequacy checking, plot of residuals, Choice of sample size, OC curves, Method of CI estimation, Fitting response curves, regression approach orthogonal polynomials. [12]

Module III

Factorial Design, Two factor factorial design, Statistical analysis of fixed effect model, Estimation, Choice of sample size, Random & Mixed model, Fitting response curves and surface. General factorial design.

$2^k$ Factorial Design, single replicate, Addition of center points to $2^k$ design, Yates algorithm for $2^k$ design, $3^k$ design, Yates of Algorithm for $2^k$ design. [10]

Module IV

Response surface methods & design, Methods of steepest Ascent, Analysis of $2^{nd}$ order model. Fitting response surface, evolutionally operation.
[06]

Taguchi contribution to experimental design; Quality engineering, Philosophy, Taguchi approach to parametric design. [04]

TEXT BOOK(S):

1. Statistics for Management- Richard I. Levin , PHI.
2. Design & Analysis of Experiments- D.C. Montgomery, John Wiley & Sons.

REFERENCE(S):

1. Design and Analysis of Experiments- J.Antony, Butterworth-Heinemann.
2. Statistics for Engineers: An introduction- J.Morrison, WileyBlackwell.

## PE 15-036:TOOL DESIGN (3-1-0)

Module I

Design of single point cutting tools, tool strength and rigidity calculation, selection of tool angles, chip breakers, carbide tipped tools, High production cutting tools. [06]

Form Tools; Method of determining the profile of circular and flat form tool, analytical and graphical method. [04]

Module II

Cutting process in broaching, Geometric elements of broach teeth, Design of internal & external surface broach, Calculation of no. of teeth, Rigidity, Cutting force, Power. [06]

Forging Design-Upset forging, Forging allowances, Forging die design, Drop forging dies and auxiliary tools. [04]

Module III

Design for sheet metal works, Press working shearing action center of pressure, clearance cutting force, die block design, punch design, punch support, stop, pilot stripper, knockout, blanking & piercing die design, progressive & compound die design, drawing dies, metal flow, Blank diameter, Drawing force. [10]

Module IV

Jigs & fixture design; Location & clamping, principles of location clamping devices, materials for locating & lamping elements, Design principles, Design of drilling jig, Milling fixture. [10]

TEXT BOOK(S):


1. Fundamental of tool Design- ASTME, PHI.
2. Metal cutting theory & cutting tool design- Arshinov.
3. A Text Book of Production Engineering- P.C. Sharma, S.Chand& Co.


REFERENCE(S):


1. Tool Design- Donaldson, Le Cain &Goold, TMH.
2. Fundamental of tool Engineering Design- Basu, Mukherjee & Mishra, Oxford & IBH.

## PE 15-033: THEORY OF METAL FORMING (3-1-0)

Module I

Review of two dimensional stress and strain, state of stress in three dimensions, Stress tensor, Invariants, Mohr's circle for 3-dimensional state of stress, strain at a point- Mohr's circle for strain, Hydrostatic & Deviatory components of stress, Elastic stress-strain relations. [08]

Module II

Elements of theory of plasticity; Flow curve, True stress & true strain, Yield criteria for ductile metals, Von Misses & Teresa yield criteria, combined stress tests. The yield locus, Anisotropy in yielding, Yield surface, levy-Misses, Prandtl-Reuss Stress-Strain relation, Classification of forming processes variables in metal forming and their optimization.

[10]

Module III

Analysis of deformation processes- Method based on homogeneous compression slip line field theory, Upper bounds and lower bounds, Slab method of analysis.

[06]

Flow stress determination, Hot working, Cold working, Strain rate effect, Friction and lubrication, Deformation zone geometry, Workability, Residual stress.

Module IV

Analysis of metal forming processes (only limited portion), forging: Load calculation in plane strain forging, Rolling: Forces & geometrical relationship in rolling, Rolling load and torque in cold rolling, Von-Karman work equation, [6]

TEXT BOOK(S):


1. Mechanical Metallurgy: By- Dieter, Mc Graw Hill Book Co.
2. Plasticity- Chakraborty- McGraw Hill.


REFERENCE(S):


1. Engineering Plasticity: BY- Johson& Mellor, Van Nostrand.
2. Metal working –Avitzur, Mc Graw Hill
3. Industrial Metal working- G.W. Rowe

# Core Elective-I

## BPE-016 Manufacturing Resource Planning (3-1-0)

**Module-1**

Introduction to Manufacturing Resource Planning: MRP-I and MRP-II: History and evolution, General concepts, Comparison of MRP and Traditional Systems, Benefits, Pre-Requisites of MRP: Bill of materials, Reasons for Failure of MRP, Manufacturing Strategies [6]

Introduction to Just-in-Time, Scheduling in JIT: Just-In-Time (JIT) Production Management, JIT and MRP II, JIT with MRP: A Comparison, Application of Genetic Algorithm in Scheduling. [4]

**Module-II**

Aggregate Planning: Formulating Aggregate Production Models, Variations in Model Formulation, Pricing/Promotion Decisions, Rough Cut Capacity Planning, Capacity Requirement Planning.Material requirement planning & Resource Planning procedure: Independent and Dependent Demand Items, Master Production Scheduling, MRP- Inputs, Outputs, Reports, MRP Table Definitions, MRP Evaluations, Closed Loop MRP Systems and MRP II, Introduction to ERP Systems [10]

**Module-III**

Production planning and control: objectives, functions, organization for PPC, Loading, scheduling: Job Shop Scheduling, Set-up dependent scheduling, Flow Shop Scheduling, Special techniques in scheduling, dispatching function, progress monitoring and control. [6]

Evolution of Manufacturing Control Systems: Order Point system, Materials Management and Accounting System, Organization and policies in respect of production planning and control [4]

**Module-IV**

Inventory Control: Introduction to Cycle Inventory, Role of Cycle Inventory in Supply Chains, Cycle and Safety Inventory: Lot-Sizing with Multiple Products**:** Inventory models under uncertainty Introduction to Safety Inventory, Role of Safety Inventory in Supply Chains, Continuous Review Policy (CRP), Periodic Review Policy (PRP), Safety Stock Evaluations, Inventory Pooling, Network Design in Supply Chains [10]

TEXT BOOK(S):


1. Manufacturing Resource Planning (MRP II) with Introduction to ERP, SCM, and CRM (McGraw-Hill Professional Engineering) by Khalid Sheikh
2. Beyond Manufacturing Resource Planning (MRP II): Advanced Models and Methods for Production Planning by Andreas Drexl, Alf Kimms
3. Manufacturing Resource Planning: MRP II: Unlocking America's Productivity Potential by Oliver Wight.

## BPE-009 Finite Element Method in Manufacturing (3-1-0)

**Module-I**

Basics of FEM- Initial value and boundary value problems- weighted residual, Galerkin and Raleigh Ritz methods- Review of Variational calculus- Integration by parts- Basics of variational formulation. Steps in FEA- Discretization, Interpolation, derivation of element characteristic matrix, shape function, assembly and imposition of boundary conditions- Solution and post processing- One dimensional analysis in solid mechanics and heat transfer.

[12]

**Module-II**

Global and Natural co-ordinates- Shape functions for one and two dimensional elements- Three noded triangular and four noded quadrilateral element- Nonlinear analysis- Isoparametric elements- Jacobian matrices and transformations- Basics of two dimensional axi-symmetric analysis. [08]

**Module-III**

FE analysis of metal casting- Special considerations, latent heat incorporation, gap element- Time stepping procedures- Crank- Nicholson algorithm- Prediction of grain structure- Basic concepts of plasticity- Solid and flow formulation- Small incremental deformation formulation- FE analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency.

[10]

**Module-IV**

Pre Processing, Mesh generation, element connecting, boundary conditions, input of material and processing characteristics- Solution and post processing- Overview of application packages such as ANSYS and DEFORM- Development of code for one dimensional analysis and validation.

[10]

**Text Book(s):**

1. An Introduction to the Finite Element Method- J.N. Reddy,McGraw-Hill.
2. Finite Element Method in Engineering- S.S. Rao, Pergammon Press.

## BPE-001: Advanced Casting and Welding(3-1-0)

### Module-I

Casting processes: Classification, Metal mould casting processes, advanced casting processes, investment casting, Rheocasting, mould and core making materials and their characteristics.

Technology of Selected casting Processes: Clay bonded, synthetic resin bonded, inorganic material bonded mould and core making, sand additives, mould coating, continuous casting process, centrifugal casting process. [10]

### Module-II

Casting defects, inspection, diagnosis and rectification, mechanization and automation in foundries, use of robots, casting design, near net shape casting, pollution control, energy and waste management in foundries. [04]

Physics of welding arc, characteristics of arc, modes of metal transfer, welding fluxes, electrode coating, classification of electrode, characteristics of welding power source, pulsed and inverter type power source, power source for resistance welding, weldability, weldability tests, Weldability of cast iron, Plain carbon steel, Determination of preheating temperature, Stainless steel, use of Scheffler' s diagram. [10]

### Module-III

Heat flow in welding, significance, theory of heat flow, cooling rate determination, selection of welding parameters based on heat flow analysis, residual stress, types and control of distortion. Analysis of fatigue of welded joint, fracture and toughness testing and its application on welded joint, [06]

### Module-Iv

Analysis of fatigue of welded joint, fracture and toughness testing and its application on welded joint, automated welded joint, microprocessor based of control resistance and arc welding, quality assurance in welding, effects of welding fumes on environment. [10]

TEXT BOOK(S):


1. Principle of Metal Casting- Heine, R.W. Loper ,C. Philip and C.R.Rosenthal, McGraw Hill.
2. Principle of Metal Casting- P.L.Jain,TMH
3. Manufacturing Technology- P.N.Rao,TMH
4. Welding Engineering and Technology- R.S. Parmar Khanna publisher


REFERENCE(S):


1. Metallurgy of Welding Technology-D. Seferian, Chapman & Hall
2. Welding and Welding Technology- R.Little, TMH.

## BPE 408:PE-I: Total Quality Systems & Engineering(3-1-0)

**Module-I**

Principles of Quality Management- Pioneers of TQM, Quality costs, Quality system Customer Orientation, Benchmarking, Re-engineering, Concurrent Engineering.

Leadership- Organizational Structure, Team Building, Information Systems and Documentation, Quality Auditing- ISO 9000- QS 9000.

[12]

**Module-II**

Single Vendor Concept- JIT, Quality Function deployment, Quality Circles, KAIZEN, SGA, POKA-YOKE, Taguchi Methods.

[08]

**Module-III**

Methods and Philosophy of Statistical Process Control, Control Charts for Variables and Attributes, Cumulative sum and exponentially weighted moving average control charts, Others SPC Techniques- Process Capability Analysis- Six sigma accuracy.

[10]

**Module-IV**

Acceptance Sampling Problem, Single Sampling Plans for attributes, Double, multiple and sequential sampling, Military standards, The Dodge-Roming sampling plans. [10]

**Text Book(s):**


1. Total Quality Management for Engineers- M. Zairi, Woodhead Publishing.
2. Introduction to Statistical Quality Control- D.C. Montgomery, John Wiley and Sons.


**Reference Book(s):**


1. ISO 9000- A Manual for Total Quality Management- S. Dalela and Saurabh, S.Chand and Company Ltd.
2. Statistical Quality Control- E.L. Grant and Leavensworth, McGraw-Hill.

**BPE-010 Industrial Hydraulics (3-1-0)**

**Module-I**

Introduction - Pascal's law - Advantages and Disadvantages of hydraulic systems - Requirements of hydraulic oil - Maintenance of hydraulic oils: Heat exchanges, Filters and Strainers etc. - Reservoir design criteria - Principle hydraulic jack - Pipes, Packing and Seals.

[8]

**Module-II**

Various types of pumps and motors like Gear type, Piston type ,(radial &axial),Vane type (intra vane etc.) - Selection criteria for a specific application like Injection molding machines, Extrusion, Blow molding etc. - Working principles and Performance.

[8]

**Module-III**

Types - Classification - Details of pressure control - Flow control; Methods of flow control, Meter in, Meter out, Bleed off, Flow control valves like pressure compensated and non pressure compensated in detail with applications. Directional control valves; One way (check valves) of various types inline, right angle, restriction, pilot operated etc., two way valves rotary type, spool type, operating controls, spool central conditions, deceleration valves. Pressure controls - relief valves of types simple and compound, venting and relief valves, unloading valves, sequence valves and its applications, counter balance valve, brake valve, pressure reducing valves like direct acting and pilot operated etc. Principles of operation - Application in molding machines

[12]

**Module-IV**

Types like weight loaded, spring loaded, gas charge with and without separator, piston type - with advantages and limitations and applications - intensifiers - its purpose, type like single acting and double acting, applications with various circuits. Introduction - Construction and its mechanism –Various types of valves like Mechanical , Electrohydraulic, single stage/two stage spool type, High performance servo valves with torque motors , Its application in industries

[12]

**Books:**


1. **Industrial Hydraulics Manual 5th Ed. 2nd Printing**

Eaton Hydraulics Training Services (Vickers)

2. **Industrial hydraulics**

**John J. Pippenger, Tyler Gregory Hicks**

Gregg Division, McGraw-Hill, 1979


## SESSIONAL

**BPE 394: Production Engineering Lab.-II (Metrology) (0-0-3)(Any Three)**

1. To study the large tool maker's microscope and to measure the pitch, depth and angle of the thread of a given specimen.
2. Calibration of slip gauge using sine bar.
3. To study the gauge blocks or slip gauge to measure the diameter of holes and distance between their centres.
4. To measure displacement by means of LVDT transducer.
5. Gear measurement and inspection.

**BPE 395: Production Engg. Lab.-III (Simulation)(0-0-3)**

7. Generation of Pseudo-random numbers
8. Chi-square test as test of independence.
9. Single factor ANOVA test for equality of means.
10. Hypothesis testing of means with different conditions.
11. Two factor factorial design.
12. Chi-square test as test of goodness of fit.

**BPE 396: Production Engineering Lab.-IV(Metal Forming) (0-0-3)**

1. Ring Compression Test.
2. Disc Compression Test
3. Deep Drawing.
4. Forward Extrusion and Backward Extrusion.
5. Spinning.

**BPE 397: Tool Design Sessional (0-0-3)**

1. Determination of tool geometry in ASA, ORS and NRS.
2. Design of single point cutting tool.
3. Design of form tool.
4. Design of internal and surface broach tool.
5. Design of progressive and compound die for sheet metal.
6. Design for Jig for 2D and 3D jobs.

# SEVENTH SEMESTER

## PE 15-019: NON-TRADITIONAL MACHINING (3-1-0)

Module-I

Introduction: Need for Non-traditional Machining, Classification, process selection. Ultrasonic machining: Principle, Transducer, Magnetostrictive material, Analysis for Material Removal Rate by Shaw, Effect of process parameters, Application. [08]

Module-II

Abrasive Jet Machining: Principle, Application, Advantages and disadvantages, Variables in AJM, Water Jet Machining- Jet Cutting equipment, Principle, advantages, Practical Application. [06]

Electrochemical Machining: Principle, Faraday's law, Material Removal Rate, Dynamics of ECM process, Tool design, Advantages, Application, Limitation, Electro –chemical grinding, Deburring and Honing. [06]

Module-III

Electro Discharge Machining: mechanism of material removal, Basic EDM circuitry and principles of operation, Analysis of relaxation circuits, Concepts of critical resistance, Machining accuracy and surface finish, Tool Material, Dielectric fluid, Application limitation. [06]

Laser Beam Machining: Lasing process and principle, population inversion, Principle of Ruby laser, Nd: YAG Laser and CO2 Laser, Power control of laser output, Application. [06]

Module-IV

Electron Beam Machining: Basic principle, Controlling parameters and focal distance, Application. Ion Beam Machining: Principle and Mechanism, Application. [04]

Plasma Arc Machining: generation of Plasma, Equipments, Torch, Classification, Direct and indirect torches and applications, parameters effecting cutting, Advantages. [04]

TEXT BOOK(S):

1. Modern machines process- P.C.Pandey and H.S.Shan. TMH
2. Non Conventional Machining- P.K.Mishra,Narosa.

REFERENCE(S):

1. Manufacturing Processes- Amstead, Ostwald &Begeman, John Wiley & Sons.

Processes and Materials of Manufacturing- Lindberg, PHI.

## PE 15-002: AUTOMATION AND NUMERICAL CONTROL MACHINES (3-1-0)

Module-I

Introduction: Automation, types, Reasons for automation, Types of production, Functions in manufacturing, Automation Strategies, Costs in manufacturing.

Flow Lines: Automated Flow lines, transfer mechanisms, Automation for machining operations, Line balancing- basic concepts, general procedure, rank positional weight method.computer aided line balancing (CALB), Manual & Flexible assembly line, Automated assembly systems-Types, Part feeding device. [08]

Module-II

Fundamentals of CAD: The design process, Application of computer for design, automated drafting, creating manufacturing data base, benefits of CAD, Design workstation – graphic terminal, operator input and output devices, Software of graphic system- graphic package, Data Base Structure, Wireframe Model and Solid Model, Graphics standards. [08]

Module-III

Numerical Control: Components of NC system, NC procedure, NC co-ordinate system, motion control, applications, NC part programming-manual part programming, computer assisted part programming, ATP language-macro statements, programming with interactive graphics, NC part programming using CAD/CAM. Writing simple part programme. [08]

Computer control in NC: Problems with conventional NC. Controller technology, CNC, DNC Adaptive Control.

Module-IV

Automated material handling: Type of equipment, Principles of material handling, Conveyor system. [06]

Group Technology cell formation: Part classification & coding, Computer Aided Process Planning (CAPP) - Retrieval & Generative type process planning system.

TEXT BOOK(S):

1. Automation, Production System and CIM- M.P.Groover, PHI.
2. CAD/CAM- Groover & Zimmers, PHI.

REFERENCE(S):

1. CAD/CAM/CIM- Radhakrishnan & Subramanyan, Wiley Eastern.
2. CAD/CAM Theory and Practice- I. Zeid, TMH.

## PE 15-021:PRINCIPLES OF MACHINE TOOLS (3-1-0)

Module-I

General classification of machine tools, working and auxiliary motions, hydraulics transmission and its elements, mechanical transmission and its elements, general requirement of machine tools. [02]

Kinematics of Machine Tools:- Stepped and stepless drive, basic consideration in the design of drives, variable speed range in machine tools, graphical representation of speed, structure diagram, selection of optimum ray diagram, design of speed and feed gearboxes, stepless regulation of speed and feed rates. [08]

Module-II

Machine Tool Structure: Design criteria, materials, static and dynamic stiffness, basic design procedure, design of beds and columns, model technique in design of machine structures. [08]

Module-III

Guide ways and Power Screw: Classification of guide ways, material and lubrication, design criteria and calculation of slide ways, design of guides under hydrostatic lubrication, aerostatic sideways, antifriction guide ways, combination guide ways, classification of power screws, design principle of power screw, recirculation power screw assemblies, elimination of backlash. [08]

Module-IV

Control system in Machine Tools: Classification, control, Changing speeds and feeds, ergonomic considerations applied to design of control members, principle of automatic and adaptive control. [04]

TEXT BOOK(S):

1. Machine Tool Design- N.K.Mheta,TMH

REFERENCE(S):

1. Design of Machine Tools- S.K.Basu and D.K.Pal, Oxford&IBH.
2. Principle of Machine Tools- G.C.Sen and A.Bhattacharya, New Central Book Agency

**Core Elective-II**
**(Any One)**
**PE 15-035: TRIBOLOGY IN DESIGN AND MANUFACTURING (3-1-0)**

Module-I

Surfaces, friction and wear- Topography of the surfaces - Surface features - Surface interaction - Theory of Friction - Sliding and Rolling Friction, Friction properties of metallic and non-metallic materials - friction in extreme conditions - Wear, types of wear - Mechanism of wear - Wear resistance materials - Surface treatment - Surface modifications – Surface coatings. [10]

Module-II

Lubricants and their physical properties lubricants standards - Lubrication Regimes Hydrodynamic lubrication - Reynolds Equation, Thermal, inertia and turbulent effects - Elasto hydrodynamic and plasto hydrodynamic and magneto hydrodynamic lubrication - Hydro static lubrication - Gas lubrication. Design and performance analysis of thrust and journal bearings - Full, partial, fixed and pivoted journal bearings design - Lubricant flow and delivery - power loss, Heat and temperature rotating loads and dynamic loads in journal bearings - special bearings - Hydrostatic Bearing design.
[12]

Module-III

Geometry and Kinamatics - Materials and manufacturing processes - contact stresses - Hertzian stress equation - Load divisions - Stresses and deflection - Axial loads and rotational effects, Bearing life capacity and variable loads - ISO standards - Oil films and their effects - Rolling Bearings Failures.
[8]

Module-IV

Surface topography measurements - Electron microscope and friction and wear measurements - Laser method - Instrumentaton - International standards - Bearings performance measurements - Bearing vibration measurement. [08]

TEXT BOOK(S):

1. Basic Lubricaton Theory- A.Cameron,Ellis Herward Ltd.
2. Introduction to Triboloty of Bearing- B.C. Majumdar, AH Wheeler.

REFERENCE(S):

1. Engineering Tribology- J.A.Williams, Oxford Univ. Press.
2. Tribology Hand Book- M.J.Neale, Butterworth Heinemann.

## PE 15-014: MAINTENANCE ENGINEERING & MANAGEMENT (3-1-0)

Module-I

Importance of maintenance, Objectives of maintenance, Types of maintenance, Maintenance systems, Planned and unplanned maintenance, Breakdown maintenance, Corrective maintenance, Opportunistic maintenance, Routine maintenance, Preventive maintenance, Predictive maintenance, Condition based maintenance systems, Design-out maintenance, Selection of maintenance systems.

[10]

Module-II

Maintenance planning and scheduling, establishing a maintenance plan, Safety precautions – Characteristics of items to be maintained, Classification of items, Maintenance procedure, Guidelines for matching procedures to items, Maintenance organization, Resource characteristics, Resources structure, Maintenance control, Administrative structure, Training of maintenance personnel.

[10]

Module-III

System operations and documentation, Documenting maintenance operations, Record keeping, Data collection and analysis, Failure statistics, Planning and scheduling plant shutdowns, Depreciation and Machine Life, Replacement policies, Spares and types of spares, spares planning.

[10]

Module-IV

Network techniques in maintenance activities, Evaluation of maintenance performance. Total productive maintenance – development and scope, Basic systems of TPM, Procedures and steps. Productivity circles, TPM as a part of TQM, benefits of TPM. [10]

TEXT BOOK(S):

1. Maintenance Planning and Control- A. Kelly, East WestPress.
2. Mechanical Fault Diagnosis- R.A.Collacott, Chapman and Hall.

REFERENCE(S):

1. Managing Maintenance Resources- A.Kelly, Butterworth-Heinemann.
2. Handbook of Maintenance Management- Levitt Joel, Industrial Press.

## PE 15-020: PRECISION ENGINEERING (3-1-0)

Module-I

Precision Engineering: Micromilling and Microdrilling, MicroElectroMechanical Systems, Microelectronics fabrication methods, Principles of MEMS, mechanical MEMS, Thermal MEMS, Magnetic MEMS. [04]

Nanotechnology- Carbon nanotubes and Structures, Processing system of nanometre accuracies, mechanism of material processing, Nano Physical processing of atomic bit-units, Nano-chemical and electrochemical atomic-bit processing. [06]

Module-II

Nano-Measuring Systems of Sub-Nanometre Accuracy and Resolution: In process or in situ measurement of position of processing point, Post process and on machine measurement of dimensional features and surface, Mechanical measuring systems, Optical measuring systems, Electron beam measuring systems, Pattern recognition and inspection systems. [10]

Module-III

Nano-Positioning System of Nanometre Accuracy and Repeatability: Guide systems for moving elements, Servo control systems for tool positioning, Computer aided digital ultra precision position control, Future development of micro actuators. [10]

Module-IV

Applications of Nanotechnology: Nano-grating system, Nano lithography, Photolithography, Electron beam lithography, Machining of soft metal mirrors with diamond turning, Mirror grinding of ceramics, Ultra-precision block gauges, balls for rolling bearings, Fabrication CCD's, VCR head assemblies, Optical fibres. [10]

TEXT BOOK(S):

1. Nanotechnology- N. Taniguchi, Oxford University Press.
2. Micromanufacturing and Nanotechnology- N.P.Mahalik, Elsevier.

REFERENCE(S):

1. Foundation of MEMS- C.Liu, Prentice Hall.
2. Introduction to Nanotechnology- C.P.Poole and F.J.Owens, Wiley Interscience.

## PE 15-023: PROJECT MANAGEMENT (3-1-0)

Module-1
Project Management: An Overview, Project Selection Project Identification and Screening Project Appraisal: Part I Project Appraisal: Part II Project Selection
Project Planning: Development of Project Network, Project Representation, Consistency and Redundancy in Project Networks **[10]**

Module-II
Project Scheduling: Basic Scheduling with A-O-A Networks, Basic Scheduling with A-O-N Networks, Project Scheduling with Probabilistic Activity Times, Time/Cost Trade-offs in Projects Linear Time-Cost Trade-offs in Projects: A Heuristic Approach.
Resource Considerations in Projects: Resource Profiles and leveling, Limited Resource Allocation, Project Implementation Project Monitoring and Control with PERT/Cost
Team Building and Leadership in Projects, Project Completion, Project Completion, Review and Future Directions **[10]**

Module-III
Production Management: Introduction to Production Systems and a Generalized Model of Production, Life cycle of a Production System and Major managerial Decisions.
Financial Evaluation of Production Related Decisions: Performance Measures of a Production System, Financial Evaluation of Capital Decisions, Decision Trees and evaluation of risk. **[10]**

Module-Iv

Designing Products and Services:Introducing New ProductsandServices,Product Mix Decisions

Production Planning Over Medium Term Horizon:Aggregate Production Planning-Basic Concepts, Modeling Approachescapacity requirements planning.

Operational Decisions over the Short Term:Basic Inventory Principles,Inventory Modeling,Inventory related Decisions,Material Requirements Planning, and Scheduling of Job Shops. [10]

TEXT BOOK(S):
1. Project Management by Nagarajan K
2. Project Management by Panneerselvam R.&Senthilkumar P.

REFERENCE(S):
1. Elements of Project Management Paperback by K. Nagarajan

## PE 15-027: Safety Engineering (3-1-0)

Module-I CONCEPTS AND TECHNIQUES

History of Safety movement –Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -productivity, quality and safety-line and stafffunctions for safety-budgeting for safety-safety policy.Incident Recall Techniquedisaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

[10]

Module-II BIOLOGICAL AND ERGONOMICAL HAZARDS

Classification of Biohazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets building design. Work Related Musculoskeltal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries.

[12]

Module-III

Hazardous waste management in India waste identification, characterization and classification technological options for collection, treatment and disposal of hazardous waste selection charts for the treatment of different hazardous wastes methods of collection and disposal of solid wastes [10]

Module-Iv SAFETY EDUCATION AND TRAINING

Importance of training-identification of training needs-training methods – programmes, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

[8]

TEXT BOOK

1. Rao, CS, “Environmental pollution engineering:, Wiley Eastern Limited, New Delhi, 1992.
2.S.P.Mahajan, “Pollution control in process industries”, Tata McGraw Hill Publishing Company, New Delhi, 1993.
3.Varma and Braner, “Air pollution equipment”, Springer Publishers, Second Edition
4.Hand book of “Occupational Safety and Health”, National Safety Council, Chicago, 1982

REFERENCE

1.Encyclopedia of “Occupational Health and Safety”, Vol.I and II, published by International LabourOffice, Geneva, 198

**Open Elective -I**

**(Any One)**

## PE 15-004: COMPUTER INTEGRATED MANUFACTURING (3-1-0)

Module-I

Introduction: The meaning and origin of CIM, The changing manufacturing and management scenario, External communication, Islands of automation and software, Dedicated and open systems, Manufacturing automation protocol, Product related activities of a company, Marketing engineering, Production planning, Plant operations, Physical distribution, Business and financial management. [06]

Computer Aided Process planning: Role of process planning in CAD/CAM integration, Approaches to computer aided process planning- Variant approach and Generative approaches, CAPP and CMPP process planning systems. [04]

Module-II

Shop Floor Control and FMS: Shop floor control-phases, Factory data collection system, Automatic identification methods- Bar code technology, Automated data collection system, FMS-components of FMS - types -FMS workstation, Material handling and storage systems, FMS layout, Computer control systems-application and benefits. [10]

Module-IIII

CIM Implementation: CIM and company strategy, System modeling tools-IDEF models, Activity cycle diagram, CIM open system architecture (CIMOSA), Manufacturing enterprise wheel, CIM architecture, Product data management, CIM implementation software. [06]

Data Communication: Communication fundamentals, Local area networks, Topology, LAN implementations, Network management and installations. [04]

Module-IV

CIM System: Open System Open systems inter connection, Manufacturing automations protocol and technical office protocol (MAP /TOP). [04]

Database for CIM: Development of databases, Database terminology, Architecture of database systems, Data modeling and data associations, Relational data bases, Database operators, Advantages of data base. [06]

TEXT BOOK(S):


1. Automation, Production Systems and Computer Integrated Manufacturing- M.P.Groover, Pearson Education.
2. Computer Integrated Manufacturing System- Y. Koren, McGraw-Hill.


REFERENCE(S):


1. CAD/CAM/CIM- P. Radhakrishnan, S. Subramanyan and V. Raju- New Age International.
2. Computer Integrated Manufacturing- Paul G. Ranky, Prentice Hall International.

## PE 15-018: MECHATRONICS (3-1-0)

Module-I

Introduction: Introduction to Mechatronics: Mechatronic system, measurement systems, control systems and response of systems, Open and Closed loop System, Transfer Function, Sequential Controller, Microprocessor based controller. [04]

Basic System models: Mathematical models, Introduction to Mechanical, Electrical, Fluid and Thermal systems, Rotational and Transnational systems, Electro-Mechanical, Hydraulic- Mechanical systems. [04]

Module-II

Sensors and transducer: Desirable features, Displacement, position and proximity sensors, Velocity, motion and Force sensors, Time of flight sensors, Binary force sensor, temperature and Pressure measurement, Sensor selection. [04]

Actuation Systems: Actuation Systems, Pneumatic and Hydraulic systems, Directional control valves, Rotary actuator, Mechanical actuation systems- Mechanical Systems, Electrical Actuation Systems- Electrical Systems, Relays and Solenoids, DC brushed motors, DC brushless motors, DC servo motors, Stepper Motors. Drive selection. [06]

Module-III

Microcontrollers: 8051 Microcontroller, Microprocessor structure, Digital Interfacing, Analog Interfacing, Applications Programming- Assembly/ C (LED Blinking, Controlling a stepper motor). [06]

Interfacing: Interfacing microcontrollers with general purpose three-state transistors, interfacing relays, Interfacing solenoids, Interfacing stepper motor, Interfacing with sensors, Interfacing with RS 232 and RS485. [06]

Module-IV

Programmable Logic Controllers: Basic Structure, Programming- Ladder diagram, Timers, Internal Relays and Counters Shift Registers, Master and Jump Controls, Data Handling, Analog input / output, PLC Selection, Application. [10]

TEXT BOOK(S):


1. Mechatronics- W Bolton, Pearson Education.
2. Mechatronics Principles and Applications- G.C.Onwubolu, Elsevier Butterworth-Heinemann.


REFERENCE(S):


1. Mechatronics Source Book- Newton C Braga, Thomson Publications.
2. Introduction to Mechatronics and Measurement Systems- D.G.Alciatore and M.B.Histand, McGraw Hill.

## PE 15-030: SURFACE ENGINEERING PRINCIPLES AND SYSTEMS (3-1-0)

Module-I

Mechanisms of Wear and Metal Cleaning: Basic Mechanisms of wear-abrasive, adhesive wear, contact fatigue, Fretting corrosion, Testing of wear resistance, practical diagnosis of wear, general cleaning process for ferrous and non ferrous metals and alloys selection of cleaning processes, alkaline cleaning, emulsion cleaning, ultrasonic cleaning, pickling salt bath descaling, abrasive bath cleaning, polishing and buffing shot peening. [10]

Module-II

Thermal Spraying Processes and Electrodeposited Coatings: Thermal spraying materials, characteristics of thermal spray processes, Design for thermally sprayed coatings coating production, spray fused coatings, Principles of electroplating, Technology and control-electroplating systems, Properties and applications of electrodeposits, Non aqueous and electroless deposition, plasma coating. [10]

Module-III

Hot Dip Coating and Diffusion Coating: Principles, Surface preparation, Batchcoating and continuous coating process, Coating properties and application, Principles of cementation, Cladding-vacuum deposition, Sprayed metal coating, Structure of diffusion coatings, Chemical vapour deposition (CVD), Physical vapour deposition (PVD). [06]

Non-Metallic Coating Oxide and Conversion Coatings: Plating coating, lacquers, rubbers and elastomers, viterous enamels, anodizing Chromating, application to aluminium, magnesium, tin, zinc, cadmium copper and silver, phosphating primers. [06]

Module-IV

Quality Assurance, Testing and Selection af Coatings: The quality plan, design, testing and inspection, thickness and porosity measurement, selection of coatings, industrial applications of engineering coatings. [08]

TEXT BOOK(S):

1. Engineering Coatings-design and application- S. Grainger, Jaico Publishing House.
2. Principles of Metals surface treatment and protection- D. R. Gabe, Pergamon.

REFERENCE(S):

1. Electroplating Handbooks- N.V.Parathasarathy, Prentice Hall.
2. Advances in surface treatment- Niku-Lavi, Pergamon.

## PE 15-015: MANUFACTURING AND DESIGN OF COMPOSITE (3-0-0)

Module I

Introduction to composite materials, Matrix material, Reinforcement and interfaces, Classification: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, relative merits and demerits, applications. Hybrid Composites, Nanocomposites, Properties and performance of composites, Applications. [10]

Module II

Matrix resins-thermoplastics and thermosetting matrix resins, Coupling agents-surface treatment of fillers and fibres. Reinforcing fibres- Natural fibres (cellulose, jute, coir etc), boron, carbon, ceramic glass, aramids, polyethylene (UHMWPE), polybenz-thiazoles etc., Particulate fillers-importance of particle shape an size, Critical fibre length.

[10]

Module III

Fabrication techniques: Pultrusion, filament winding, prepreg technology, injection and compression moulding, bag moulding, resin transfer moulding, reaction injection moulding. [10]

Module IV

Macromechanical Behaviour: Stress strain relations of anisotropic materials-Engineering constants for orthotropic and isotropic materials-Plano stress condition-Stress-strain relations for a lamina of arbitrary orientation-strength of an orthotropic lamina. Micromechanics of Composites: Mechanical properties, Thermal properties, Mechanics of load transfer from matrix to fiber, anisotropic behavior, Fatigue and creep. [10]

Text books


1. K.K.Chawla, Composite Materials – Science & Engineering, Springer-Verlag, New York, 1987.
2. R.M.Jones – Mechanics of composite Materials, Mc Grew Hill Book Co.,
3. Fibre-Reinfored composites-Materials, Manufacturing and Design. P.K.Mallick Marcel Dekken, Inc. New York & Basel.


Reference books


1. F.L.Matthews and R.D.Rawlings, Composite Materials: Engineering and Science, Chapman & Hall, London, 1994.

**PE 15-008: ERGONOMICS AND WORK DESIGN (3-1-0)**

Module – I

Human factors in a production system: characteristics features of man-machine system: quantitative and qualitative visual displays; Human factors associated with speech communication. [6]

Module – II

Introduction to kinesiology; Biomechanics and bioengineering aspects of human motor activity; performance analysis of body members in making specific types of movements; and conceptual relationships of stimuli and responses. [6]

Module – III

Design of control function. Tools and related control devices and control systems. Design of work place and work-components; Applied anthropometry, activity analysis: concepts of productivity and its improvement strategies; Design of individual work place.

Human performance under heat, cold, illumination, vibration, noise, pollution. Static and dynamic conditions. [12]

Module – IV

Application of results from human factors data and analysis in work study; work design; Method study and work measurement techniques; performance rating and time standards. [6]

Text Books:

1.Ergonomics for Beginners: A Quick Reference Guide, Third Edition, Jan Dul ,Bernard Weerdmeester, CRC Press.

2. Introduction to Ergonomics, Third Edition, R.S. Bridger, CRC Press.

3. Human Factors in Engineering and Design, Ernest J. McCormick, Mark S. Sanders (Editor) McGraw-Hill Inc., US; 6th Revised edition edition (1 March 1987).

## SESSIONAL

**PE 15-086 : PRODUCTION ENGINEERING LABORATORY-V (NTM/NC Lab.) (0-0-3)**

(Any five)

1. Electro Discharge Machining.
2. Ultrasonic Machining.
3. Abrasive Jet Machining.
4. Laser Beam Machining.
5. Machining in CNC Lathe by writing part programs.
6. Machining in CNC milling by writing part programs.
7. Pick and place operation with revolute robot.
8. Programming of AS/RS.

**PE 15-094: MINOR PROJECT (0-0-3)**

# EIGHTH SEMESTER

**PE 15-026: ROBOTICS AND FLEXIBLE MANUFACTURING SYSTEMS (3-1-0)**

Module-I

Robot Fundamentals: Definitions, History of robots, Laws of Robotics, Robot Specification, Anatomy of a Robot, Robot classifications, Function line diagram representation of robot arms, common types of arms, Robot end effectors- Types, Tools as end effectors, Considerations in gripper selection and design, Robot application in Manufacturing- Material Transfer- Material handling, loading and unloading, Processing - spot and continuous arc welding and spray painting, Assembly and Inspection. [04] Manipulator Kinematics: Homogeneous coordinate transformation, matrix representations of coordinate transformation, D-H representation of kinematics linkages, Forward and Inverse Kinematics of manipulators, Euler's angle and fixed rotation for specifying position and orientation. Differential transformation and manipulators, Jacobians. [08]

Module-II

Robotics Dynamics: Velocity Kinematics, Acceleration of rigid body, Lagrange-Euler Formulation, Newton–Euler's formulation. [04]

Robot Actuators and Sensors: Internal and external sensors, Position- potentiometric, Optical sensors, Encoders - absolute, incremental, Touch and slip sensors, Velocity and acceleration sensors, Proximity sensors, Force and torque sensors. Actuators- Hydraulic, Pneumatic and Electrical, Comparison of actuating systems and their relative merits and demerits. [06]

Module-III

Robot Controllers: Open and close loop control, Manipulator control problem, Linear control, PD and PID control schemes, Force and torque control in robotic manipulators. [04]

Robot Programming: Methods of robot programming- Textual and Leadthrough, WAIT, SIGNAL and DELAY commands, Capabilities and limitations of leadthrough programming, Robot language structure, Motion, sensor and end effectors commands, Programming examples. [06]

Module-IV

Flexible Manufacturing Systems: Types of production, Characteristics, Applications, Flexibility in Machining systems, Need for FMS, Flexible Automation, Where to apply FMS technology, Components of FMS- FMS layout configurations, Planning the FMS, Workstations, Material Handling systems, Automatic Guided vehicle systems, Automated storage and retrieval systems, FMS Layout configurations, Applications and benefits of FMS, problems in implementing FMS. [08]

TEXT BOOK(S):


1. Industrial Robotics- Groover M P et al, Pearson Edu.
2. Robotics and Control- Mittal R K &Nagrath I J, TMH.


REFERENCE(S):


1. Robotics Technology and Flexible Automation- S.R.Deb, TMH.
2. Robotic Engineering- Richard D. Klafter, PHI.
3. Robotics- Fu K S et al., McGraw Hill.

## PE 15-024:QUALITY ASSURANCE AND RELIABILITY (3-1-0)

Module-I

Quality Control: Causes of variation, standard errors of mean, Process capability analysis, Natural tolerance limits, Specification Limits, Trial and Revised Control limits, Rational Subgroups, Control Charts for variables (X, R, S, CUSUM, EWMA), Control Charts for attributes.(P, np) [06]

Sampling Plans: Design of single sampling plan, double, multiple and sequential sampling plans, O.C. curve, AOQ, AOQL, ATI, AFI, ASN. [04]

Module-II

Quality Engineering: Taguchi's quadratic loss function, Off line & online quality control, importance of parameter selection design, experimental design principle for product and process design, two-level experimental for full factorial and fractional factorial design, S/N ratio, Inner and outer arrays. [10]

Module-III

Total Quality Control: Components of TQM, TQM Implementation, Quality function deployment, PDCA cycle, Quality Circle: Implementation, Training for QC, Kaizen and Poke Yoke Systems, Quality Cost, Concept of Zero defect, Quality assurance systems- ISO 9000, 14000, 18000. [10]

Module-IV

Reliability: System effectiveness, Mission reliability, Design adequacy, Operational readiness, serviceability, performance indices, their evaluation, uses and limitation, reliability models of maintained systems, relationship between reliability and maintainability, system with components in series, parallel and standby, Maintainability prediction. [10]

TEXT BOOK(S):


1. Fundamentals Of Quality Control & Improvement- A.Mitra, PHI
2. Introduction to Statistical Quality Control- D.C.Montogomery, John Wiley & Sons.
3. Total Quality Control- A.V.Feigenbaum, TMH.


REFERENCE(S):


1. Statistical Quality Control- E.L. Grant and R.S. Leavenworth, McGraw Hill.
2. Taguchi techniques for Quality Engineering- P.J.Ross, McGrawHill.
3. Quality Assurance through ISO 9000- H.D. Gupta, South Asia publication.

**Open Elective –II**
**(Any One)**
**BPE 414: PE-IV: INSTRUMENTATION AND CONTROL (3-1-0)**

Module-I

Basic detector-transducer elements: Electrical transducer, sliding Contact devices, Variable-inductance transducer elements. The differential transformer, Variable-reluctance transducers, Capacitive transducers. The piezoelectric effect, photo-electric transducers, Electronic transducer element. [04]

Intermediate Modifying system: Electrical intermediate modifying devices, input circuitry. The simple current sensitive circuit, ballast circuit, voltage-dividing potentiometer circuit, voltage balancing potentiometer circuit, Resistance bridges. [04]

Terminating Devices and Methods; Introduction, CRO recording techniques. [02]

Module-II

Strain Measurement:The electrical resistance strain gauge. The metallic resistance strain gage, selection and installation factors for metallic strain gages, Circuitry, Metallic strain gage, the strain gage ballast circuit, the strain gage bridge circuit, Temperature compensation. [04]

Measurement of Pressure :Pressure measuring systems, Pressure measuring transducers, Gravitation transducers, Elastic transducers, Elastic diaphragms, Secondary transducers used with diaphragms, Strain gage pressure cells, Measurement of high pressures. Measurement of low pressures, Dynamic characteristic of pressure measuring systems, Calibration methods. [06]

Module-III

Temperature Measurement:Use of bimetals pressure thermometers. Thermocouples, Pyrometry. Calibration of temperature measuring devices. [04]

Vibration and shock:Measurement and test methods – Vibrometers and accelerometers, Elementary vibrometes and vibration detectors, Elementary accelerometers, the seismic instrument. [06]

Module-IV

Description of open and closed loop control systems and their block diagrams. Use of Block diagrams and signal flow graph to find overall transfer function.1st and 2nd order systems and their response to step and sinusoidal input, Error analysis, static and dynamic error coefficients. [04]

Routh's stability criterion, The Root-Locus method. Bode plot and Nyquist plot, Gain margin and phase margin. [06]

TEXT BOOK(S):

1. Mechanical Measurements- T.G. Beckwith & N.Lewis Buck, Oxford and IBH.
2. Modern Control Engineering- K.K. Ogata, PHI.

REFERENCE(S):

1. Instrumentation, Measurement and Analysis- B.C.Nakra, TMH.
2. Control Systems Emgineering- I.J.nagrath and M.Gopal, New Age international.

**PE 15-007 Entrepreneurship & E- Business (3-1-0)**

Module-I

Entrepreneurship- definition. growth of small scale industry lies in developing countries and theirpositions vis-a-vis large industries, role of small scale industries in the national economy,characteristics and types of small scale industries; demand based and resources based ancillaries and sub-control types. Government policy for small scale industry;stages in starting a small scale industry.

[08]

Module-II

Project identification- assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balanceand output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods.

[06]

Module-III

Evaluation of E-Business Infrastructure and Capacity Planning: Quantitative analysis of authentication and payment services, Capacity planning methodologies, Performance models for e-business sites, Modelling web-server workload. [06]

Module-IV

Prerequisite: None Managing Business in the Digital World: Introduction, How IT has changed the concepts of traditional MIS with examples and case studies. Basic understanding of e-business building blocks, Emerging e-Business models, B2B, B2C, C2C etc., Case-studies on e-auctions, electronic markets, electronic procurement, automated supply chains, e-marketing, e-customer relationship management, e-finance systems, and negotiations support systems. [08]

TEXT BOOK(S):


1. Scaling for E-Business: Technologies, Models, Performance, and Capacity Planning, Daniel A. Menasc, Virgilio A. F. Almeida, Prentice Hall
2. Management Information Systems- Managing Information Technology in E Business Enterprises, James A. Brien, TMH
3. Forbat, John, “Entrepreneurship” New Age International.
4. Havinal, Veerbhadrappa, “Management and


REFERENCE(S):


1. Auction Theory, Vijay Krishna, Academic Press

2. Entrepreneurship” New Age International
3. Joseph, L. Massod, “Essential of Management", Prentice Hall of India.


**PE 15-025: RAPID PROTOTYPING (3-1-0)**

Module-I

Introduction: Definition of Prototype, Types of prototype, Need for the compression in product development, Survey of applications, Growth of RP industry, Classification of RP systems. [04]

Stereolithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Application. [04]

Module-II

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications. [06]

Solid Ground Curing: Principle of operation, Machine details, Applications, Aminated Object Manufacturing: Principle, of operation, LOM materials, process details, application. [06]

Module-III

Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer, GenisysXsprinter HP system 5, object Quadra systems, Laser Engineering Net Shaping (LENS). [04]

Rapid Tooling: Indirect Rapid tooling -Silicon rubber tooling- Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3D keltool, Direct Rapid Tooling- Direct, AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, ProMetal, Sand casting tooling, Laminate tooling, Soft Tooling vs. Hard tooling. [06]

Module-III

Software for RP: STL files, Overview of Solid view, magics, mimics, magic communicator, etc. Internet based software, Collaboration tools, Rapid Manufacturing Process Optimization: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation. Surface digitizing, surface generation from point cloud, surface modification- data transfer to solid models. [10]

TEXT BOOK(S):

1. Stereolithography and other RP& M Technologies- Paul F. Jacobs, Society of Manufacturing Engineers, NY.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling- D.T. Fham and S.S.Dimov, Springer Verlag.

REFERENCE(S):

1. Rapid Prototyping: Principles and Applications in Manufacturing- C.C. Kai and L.K.Fai, World Scientific Co.
2. Rapid Prototyping & Manufacturing- Paul F. Jacobs, McGraw-Hill.

**PE 15-005 : Design for Manufacturing & Assembly (3-0-0)**

Module I

Introduction to manufacturing, various manufacturing processes. DFMA and its role in the integrated product development process.

[8]

Module II

Introduction to mechanical assemblies, Various examples, Assembly in the context of product development, Introduction to design for manufacturing and assembly, DFMA case studies, Impact of DFMA to various Industries, General requirements for early materials and process selection, Selection of manufacturing process, process capabilities, selection of materials. [10]

Module III

Design with materials, design for Brittle fracture, Design for Fatigue failure, Design for corrosion resistance, Design for wear resistance, designing with plastics, Product design for manual assembly.Design for injection molding, Design for die casting, design for powder metal processing, Design for sand casting, design for investment casting, Linking CAD and DFMA, Geometric representation in CAD, Extraction of DFMA data from CAD System.

[12]

Module IV

Design for injection molding, Design for die casting, design for powder metal processing, Design for sand casting, design for investment casting, Design for sheet metal working, Design for hot forging, Linking CA and DFMA, Geometric representation in CAD, Extraction of DFMA data from CAD System. [10]

TEXT BOOK(S):


1. D. E. Whitney, (2004) Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development, Oxford University Press, New York.
2. Geoffrey Boothroyd (2005) Assembly Automation and Product Design, SecondEdition, CRC press, Taylor & Francis, Florida, USA
3. A.K. Chitale and R.C. Gupta, (1999) Product design and Manufacturing, Prentice Hall of India, New Delhi.


REFERENCE(S):


1. Product Design for Manufacture and Assembly G. Boothroyd and P. Dewhurst, Boothroyd Dewhurst, Inc. 1989 Marcell Dekker, Inc. 1994.
2. O. Molloy, S. Tilley and E.A. Warman (1998) Design for Manufacturing and assembly, First Edition, Chapman &Hall, London, UK.


**PE 15-011: INDUSTRIAL MANAGEMENT & OPERATION RESEARCH (3-1-0)**

Module-I

Concepts of Management and Organization – Functions of Management, Evolution of Management Thought : Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs, Systems Approach to Management.

[08]

Module-II

Designing Organizational Structures : Basic concepts related to Organization - Departmentation and Decentralisation, Types of mechanistic and organic structures of organization (Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization, Cellular Organization, team structure, boundaryless organization, inverted pyramid structure, lean and flat organization structure) and their merits, demerits and suitability.

[10]

Module-III

Linear Programming: Problem Formulation, Graphical solution, Simplex method, Transportation Problem: Formulation, Optimal solution, unbalanced transportation problem. Assignment problem: Formulation, Optimal solution, Variants of Assignment Problem- Traveling Salesman problem.

Theory of Games: Minimax (maximin) Criterion and optimal strategy, Solution of games with saddle points, Rectangular games without saddle points, 2x2 games, dominance principle.

[12]

Module-IV

Waiting Lines: Single Channel, Poisson arrivals, exponential service times, with infinite population and finite population models.

Inventory: Single item, Deterministic models, Instantaneous production. Instantaneous demand and continuous demand and no set up cost.

[10]

TEXT BOOK(S):


1. Manufacturing Organization and Management- Amrine, Pearson.
2. Introduction to Operations Research- Taha, PHI.
3. Operations Research- R.Pannerselvam, PHI.


REFERENCE(S):


1. Industrial Engineering and Management- O.P. Khanna, Dhanpat Rai & Sons.
2. Operations Research- S.D.Sharma-Kedarnath.
3. Introduction to Operations Research- Hiller & Libermann, TMH.


## SESSIONAL

**PE 15-085:** Seminar - 0-0-3
**PE 15-098:** Comprehensive Viva voce - 0-0-0
**PE 15-095:** Major project - 30-0-6