

## B TECH in MECHANICAL ENGINEERING

| Year | THIRD SEMESTER          |  |  |    |   |           |           |  |    |   | FOURTH SEMESTER        |    |           |              |   |   |    |    |  |  |
|------|-------------------------|--|--|----|---|-----------|-----------|--|----|---|------------------------|----|-----------|--------------|---|---|----|----|--|--|
|      | Sub. Code               | Subject Name   | L                                      | T  | P | C         | Sub. Code | Subject Name                                   | L  | T | P                      | C  | Sub. Code | Subject Name | L | T | P  | C  |  |  |
| II   | MAT 2151                | Engineering Mathematics - III                                | 2                                      | 1  | 0 | 3         | MAT 2260  | Engineering Mathematics - IV                   | 2  | 1 | 0                      | 3  |           |              |   |   |    |    |  |  |
|      | MME 2151                | Kinematics of Machinery                                      | 3                                      | 1  | 0 | 4         | MME 2251  | Dynamics of Machinery                          | 3  | 1 | 0                      | 4  |           |              |   |   |    |    |  |  |
|      | MME 2152                | Manufacturing Technology                                     | 4                                      | 0  | 0 | 4         | MME 2252  | Fluid Mechanics                                | 3  | 1 | 0                      | 4  |           |              |   |   |    |    |  |  |
|      | MME 2153                | Material Science and Metallurgy                              | 3                                      | 0  | 0 | 3         | MME 2253  | Metrology and Measurements                     | 3  | 1 | 0                      | 4  |           |              |   |   |    |    |  |  |
|      | MME 2154                | Strength of Materials  | 3                                      | 1  | 0 | 4         | MME 2254  | Thermodynamics - II                            | 2  | 1 | 0                      | 3  |           |              |   |   |    |    |  |  |
|      | MME 2155                | Thermodynamics - I   | 2                                      | 1  | 0 | 3         | ****      | Open Elective - I                              | 3  | 0 | 0                      | 3  |           |              |   |   |    |    |  |  |
|      | MME 2171                | Computer Aided Mechanical Drawing And Modelling (CAMDAM) Lab | 0                                      | 1  | 3 | 2         | MME 2271  | Strength of Materials Lab                      | 0  | 1 | 3                      | 2  |           |              |   |   |    |    |  |  |
|      | MME 2172                | Workshop Practice - I  | 0                                      | 0  | 3 | 1         | MME 2272  | Workshop Practice - II                         | 0  | 0 | 3                      | 1  |           |              |   |   |    |    |  |  |
|      |                         |  | 17                                     | 4  | 9 | 24        |           | 16   | 5  | 9 | 24                     |    |           |              |   |   |    |    |  |  |
|      |                         |  | <b>Total Contact Hours (L + T + P)</b> |    |   | <b>30</b> |           | <b>Total Contact Hours (L + T + P)</b>         |    |   | <b>30</b>              |    |           |              |   |   |    |    |  |  |
| III  | <b>FIFTH SEMESTER</b>   |  |  |    |   |           |           |  |    |   | <b>SIXTH SEMESTER</b>  |    |           |              |   |   |    |    |  |  |
|      | HUM 3151                | Engg. Economics and Financial Management                     | 2                                      | 1  | 0 | 3         | HUM 3152  | Essentials of Management                       | 2  | 1 | 0                      | 3  |           |              |   |   |    |    |  |  |
|      | MME 3151                | CAD - CAM  | 3                                      | 1  | 0 | 4         | MME 3251  | Heat Transfer                                  | 2  | 1 | 0                      | 3  |           |              |   |   |    |    |  |  |
|      | MME 3152                | Finite Element Methods                                       | 2                                      | 1  | 0 | 3         | MME 3252  | Mechanical Design - II                         | 3  | 1 | 0                      | 4  |           |              |   |   |    |    |  |  |
|      | MME 3153                | Mechanical Design - I  | 3                                      | 1  | 0 | 4         | MME ****  | Program Elective - I                           | 3  | 0 | 0                      | 3  |           |              |   |   |    |    |  |  |
|      | MME 3154                | Turbo Machines   | 3                                      | 1  | 0 | 4         | MME ****  | Program Elective - II                          | 3  | 0 | 0                      | 3  |           |              |   |   |    |    |  |  |
|      | ****                    | Open Elective - II   | 3                                      | 0  | 0 | 3         | ****      | Open Elective - III                            | 3  | 0 | 0                      | 3  |           |              |   |   |    |    |  |  |
|      | MME 3171                | Mechanical Lab - I   | 0                                      | 1  | 3 | 2         | MME 3271  | Finite Element Methods (FEM) Lab               | 0  | 1 | 3                      | 2  |           |              |   |   |    |    |  |  |
|      | MME 3172                | Metrology Lab  | 0                                      | 0  | 3 | 1         | MME 3272  | Mechanical Lab - II                            | 0  | 1 | 3                      | 2  |           |              |   |   |    |    |  |  |
|      |                         |  |  | 16 | 5 | 9         | 24        |  | 16 | 3 | 12                     | 23 |           |              |   |   |    |    |  |  |
|      |                         |  | <b>Total Contact Hours (L + T + P)</b> |    |   | <b>30</b> |           | <b>Total Contact Hours (L + T + P)</b>         |    |   | <b>31</b>              |    |           |              |   |   |    |    |  |  |
| IV   | <b>SEVENTH SEMESTER</b> |  |  |    |   |           |           |  |    |   | <b>EIGHTH SEMESTER</b> |    |           |              |   |   |    |    |  |  |
|      | MME ****                | Program Elective - III                                       | 3                                      | 0  | 0 | 3         | MME 4298  | Industrial Training                            |    |   |                        |    |           |              |   |   |    | 1  |  |  |
|      | MME ****                | Program Elective - IV  | 3                                      | 0  | 0 | 3         | MME 4299  | Project Work / Practice School                 |    |   |                        |    |           |              |   |   |    | 12 |  |  |
|      | MME ****                | Program Elective - V   | 3                                      | 0  | 0 | 3         | MME 4296  | Project Work (Only for B.Tech honour Students) |    |   |                        |    |           |              |   |   |    | 20 |  |  |
|      | MME ****                | Program Elective - VI  | 3                                      | 0  | 0 | 3         |           |  |    |   |                        |    |           |              |   |   |    |    |  |  |
|      | MME ****                | Program Elective - VII                                       | 3                                      | 0  | 0 | 3         |           |  |    |   |                        |    |           |              |   |   |    |    |  |  |
|      | ****                    | Open Elective - IV   | 3                                      | 0  | 0 | 3         |           |  |    |   |                        |    |           |              |   |   |    |    |  |  |
|      |                         |  | 18                                     | 0  | 0 | 18        |           |  |    |   |                        |    |           |              |   |   | 13 |    |  |  |
|      |                         |  | <b>Total Contact Hours (L + T + P)</b> |    |   | <b>18</b> |           | <b>Total Contact Hours (L + T + P)</b>         |    |   | <b>13</b>              |    |           |              |   |   |    |    |  |  |

## **Minor Specializations**

### **I. Machine Design**

MME 4041: Design For Manufacture and Assembly  
MME 4042: Design of Mechanical Systems  
MME 4043: Mechanical Vibration  
MME 4044: Tribology

### **II. Materials and Manufacturing Engineering**

MME 4045: Composite Materials  
MME 4046: Heat Treatment of Metals and Alloys  
MME 4047: Lean Manufacturing  
MME 4048: Production Planning and Control

### **III. Thermal Engineering**

MME 4049: Computational Fluid Dynamics  
MME 4050: Design of Thermal Power Plant System  
MME 4051: Refrigeration and Air Conditioning  
MME 4052: Theory of IC Engines and Emissions

### **IV. Material Science**

PHY 4051: Physics of Low Dimensional Materials  
PHY 4052: Physics of Photonic & Energy Storage Devices  
CHM 4051: Chemical Bonding  
CHM 4052: Chemistry of Carbon Compound

### **V. Business Management**

HUM 4051: Financial Management  
HUM 4052: Human Resource Management  
HUM 4053: Marketing Management  
HUM 4054: Operation Management

### **VI. Computational Mathematics**

MAT 4051: Applied Statistics and Time Series Analysis  
MAT 4052: Computational Linear Algebra  
MAT 4053: Computational Probability and Design of Experiments  
MAT 4054: Graphs and Matrices

### **Programme Electives**

MME 4062: Automatic Control Engineering  
MME 4063: Automobile Engineering  
MME 4064: Bio Fluids Mechanics  
MME 4065: Corrosion Science Engineering  
MME 4066: Elements of Mechatronics Systems  
MME 4060: Ergonomics  
MME 4067: Fatigue and Fracture  
MME 4068: Fluid Drives and Controls  
MME 4069: Friction and Wear

MME 4057: Industrial Robotics  
MME 4070: Introduction to Combustion  
MME 4071: Jet Propulsion and Rocket Technology  
MME 4072: Machine Tool Technology  
MME 4073: Machine Tools and Metrology  
MME 4074: Materials Characterization  
MME 4075: MEMS and Nano Technology  
MME 4076: Micro Machining  
MME 4077: Modeling and Simulation of Dynamic Systems  
MME 4078: Non-Conventional Energy Systems  
MME 4079: Non Destructive Testing  
MME 4080: Operations Research  
MME 4053: Organizational Behaviour  
MME 4054: Personal Management and Industrial Relations  
MME 4081: Pipe Systems Engineering  
MME 4082: Plant Engineering and Maintenance  
MME 4083: Plant Layout and Material Handling  
MME 4084: Power Plant Engineering  
MME 4055: Project Management  
MME 4085: Statistical Quality Control  
MME 4086: Supply Chain Management  
MME 4056: Technology Management  
MME 4087: Total Quality Management  
MME 4088: Work Systems Engineering

### **Open Electives**

MME 4301: Energy Engineering  
MME 4302: Industrial Safety Engineering  
MME 4303: Internal Combustion Engines  
MME 4304: Introduction to Alternate Fuels and Applications

### THIRD SEMESTER

#### **MAT 2151: ENGINEERING MATHEMATICS - III [2 1 0 3]**

Gradient, divergence and curl. Line, surface and volume integrals. Green's divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation- Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One-dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

#### **References:**

1. Erwin Kreyszig: Advanced Engineering Mathematics, (5e). 1985 Wiley Eastern.
2. S.S.Sastry : Introductory Methods of Numerical Analysis (2e).1990, Prentice Hall.
3. B.S.Grewal : Higher Engg. Mathematics, (1989e), Khanna Publishers
4. Murray R.Spiegel : Vector Analysis, (1959e), Schaum Publishing Co.

#### **MME 2151: KINEMATICS OF MACHINERY [3 1 0 4]**

Link or element, pairing of elements, Grubler's criterion, kinematic chain, mechanism, mobility of mechanism, inversions, machine. Types of Kinematic chain and their mechanisms, working principle and construction of Hooke's joint, Ackermann and Davis steering gear, Geneva mechanism and Ratchet mechanism. Relative velocity, determination of velocity in mechanisms by relative velocity method. Instantaneous Centers: Definitions, theorems and different methods. Determination of acceleration in mechanism, Klein's construction for slider crank mechanism. Law of gearing, Types of gears and associated terminologies. Types of Gear trains, Automobile four speed gear box and differential mechanism. Torque calculations. Ratio of tensions in belt and rope drive, Power transmitted, condition for maximum power to be transmitted by belt. Flat pivot and Collar friction, Power loss due to friction, problems on single plate and multi-plate clutches. Classification of cams and followers, Displacement, Velocity & acceleration-time curves. Cam profile diagrams of disc cam with knife edge follower, roller follower, flat foot mushroom follower and basic concepts of roller oscillating follower.

#### **References:**

1. Hamilton H. Mabie, Charles F. Reinholtz, Mechanisms and Dynamics of Machinery (4e), Wiley's Publication, 1987.
2. Ballaney P. L., Theory of Machines and Mechanism, Khanna Publications, New-Delhi, 2009.
3. Rattan S. S, Theory of Machines, Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2009.
4. Singh V. P., Theory of Machines, Dhanpat Rai & Co. (P) Ltd, New-Delhi, 2010.
5. Rao J.S., Rao V. Dukkipati, Mechanism and Machine Theory, New Age International Publishers Year, 2012.

#### **MME 2152: MANUFACTURING TECHNOLOGY [4 0 0 4]**

Concept of Moulding, materials and types, sand testing. Different types of casting techniques, applications, advantages and limitations. Welding types, applications, advantages and limitations. Mechanical working of metals, different processes and its significance. Theory of metal cutting, cutting and machining parameters, tool life equation and numericals.

Different types of machine tools, applications, advantages and limitations. Concept of grinding and finishing operations. Non-conventional machining techniques and its applications, advantages and limitations. Processing of plastics and rapid prototyping concepts.

#### **References:**

1. Rajput R. K., A Text book of Manufacturing Technology, Laxmi Publications Private Limited, 2011.
1. Rao P. N., Manufacturing Technology, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
2. Jain R. K., Production Technology, Khanna Publishers, Delhi, 2001.
3. Benedict G. F., Non Traditional Machining Techniques, Marcel Decker, New York, 1990.
4. Chua C K, Leong K F and Lim C S, Rapid Prototyping: Principles and Applications, World Scientific, Singapore, 2003.

#### **MME 2153: MATERIAL SCIENCE & METALLURGY [3 0 0 3]**

Introduction, crystal structures, packing factor of cubic and HCP structure, co-ordination number, Miller indices, crystal imperfections-point & line defects, homogeneous and heterogeneous nucleation, mechanism of solidification – nucleation and crystal growth, dendritic growth. Phases-single phase and multiphase solids, Gibb's phase rule, solid solutions and types, Intermediate phases, binary equilibrium equilibrium and non-equilibrium cooling, invariant reactions of eutectic, peritectic, monotectic, eutectoid and peritectoid, Lever rule and its application on isomorphous and eutectic systems, equilibrium and non-equilibrium cooling of an alloy and congruent melting alloy phase. Allotropy and polymorphism, cooling curve for pure iron, Fe-C equilibrium diagrams, study of iron-carbon system in detail with emphasis on the invariant reactions. Plain carbon steels & Alloy steels, Cast irons-grey, white and malleable cast irons. Types and explanation of Brasses, Bronzes and Al-Cu alloys. Classification of composites based matrix materials & reinforcements, manufacturing of fibrous composites, laminated composites, particulate composites (Hand lay-up, Filament winding, Pultrusion, Slip casting and Stir casting), advantages and application of composites.

#### **References:**

1. Avner S.H., Introduction to Physical Metallurgy, (3e), McGraw Hill, 2004
2. William D. Callister, Materials Science and Engineering, John Wiley & Sons, 2007
3. Gupta K.M., Material science, Metallurgy and Engineering Materials, Umesh Publication, 2012
4. Raghavan V, Material Science and Engineering, (4e), Prentice Hall of India, 1989
5. K K Chawla, Composite Materials Science and Engineering, Springer Verlag, 2012.
6. R M Jones, Mechanics of Composite Materials, McGraw-Hill, New York, 1999.

#### **MME 2154: STRENGTH OF MATERIALS [3 1 0 4]**

Stress, Simple stress, strain, Hooke's law, Factor of Safety, Poisson's Ratio, Compound bars, Temperature stress and strain, Engineering constants, Volumetric strain, Strain energy. Shear force and bending moments in beams in cantilever, simply supported, overhanging beams with concentrated load, uniformly distributed load, uniformly varying load and externally applied moment. Stresses in beams - Theory of simple bending, shearing stress in beams, Principal stresses- Stresses in a uniaxial & biaxial member, principal plane and principal stress. Beam

deflection- slope and deflection at a section for different types of beams and loads using double integration method and Macaulay's method. Torsion- Analysis of torsion of circular bars, shear stress distribution, Columns and struts: Classification of columns, strength of columns, end conditions, Euler's formula, Rankine's formula. Thin and thick cylinders- circumferential and longitudinal stress in thin cylinders, lame's theory for evaluation of stresses in thick cylinders.

**References:**

1. Popov E.P, Engineering Mechanics of Solids, Prentice-Hall of India, New Delhi, 1997.
2. Beer F. P. and Johnston R, Mechanics of Materials (3e), McGraw-Hill Book Co, 2002.
3. Nash W.A, Theory and problems in Strength of Materials, Schaum Outline Series, McGraw- Hill Book Co, New York, 1995.
4. Kazimi S.M.A, Solid Mechanics, Tata McGraw-Hill Publishing Co, New Delhi, 1981.
5. Ryder G.H, Strength of Materials (3e), Macmillan India Ltd., 2002.
6. Singh D. K., Mechanics of Solids, Pearson Education, 2002.
7. Timoshenko S, Elements of Strength of Materials, Tata McGraw-Hill, New Delhi, 1997.

**MME 2155: THERMODYNAMICS - I [2 1 0 3]**

Basics of thermodynamics, Macroscopic and Microscopic points of view, system and surroundings, property and state, thermodynamic equilibrium, change of state, process and cycle. Zeroth law of thermodynamics, concept of temperature, temperature scales. Work and Heat-Thermodynamics definition of work, displacement work for different thermodynamic processes, definition of heat, comparison between heat and work. First law for a closed system undergoing a cyclic process, non-cyclic process, Energy is a property of a system, First law for an open system, steady flow energy equation and its applications. Limitations of first law, definition of heat engine and reversible heat engines and their performance, two statements of second law, corollaries of second law, reversible and irreversible processes, Carnot cycle, statement of third law, thermodynamic temperature scale. Clausius inequality, entropy - property, principle of increase of entropy, Temperature-entropy diagram, entropy relations to other thermodynamic properties. Pure substance, Definition, two property rule, specific heats of pure substances, phases, equilibrium between phases, PvT surface, P-T diagram, triple point and critical point, dryness fraction and its measurement, Tabulated properties, State change of a system involving pure substance, constant volume, constant pressure, constant temperature and constant entropy processes. Ideal and real gases, Definition, universal gas constant, Thermodynamic processes, Evaluation of properties of mixture of ideal gases, adiabatic mixing of ideal gases, Vander Waal's equation of state, law of corresponding states, compressibility factor, generalized compressibility chart.

**References:**

1. Nag P. K., Engineering Thermodynamics, McGraw - Hill Education India Pvt. Ltd., 2013.
2. Yunus A. Cengel and Michael A. Boles, Thermodynamics: An Engineering Approach, Tata McGraw - Hill Education, 2011.
3. Gordon J. Van Wylen and Richard E. Sonntag, Fundamentals of Classical Thermodynamics, Wiley, 1986.
4. Rogers G. F. C., and Yon Mayhew "Engineering Thermodynamics: Work and Heat Transfer", Prentice Hall, 1996.
5. Gupta S. C., Thermodynamics, Pearson Education, 2009.

**MME 2171: COMPUTER AIDED MECHANICAL DRAWING AND MODELLING LAB [0 1 3 2]**

Mechanical Part / Component Drafting using Software: Introduction to Machine Drawing, Conventions, Sectional Views, Screw Thread Terminologies and Thread Forms, Hexagonal & Square Head Bolts, Nuts and Screws, Joints: Knuckle Joint, Strap Joints, Socket and Spigot Joints, Gib & Cotter Strap Joint, Couplings: Flange, Oldham's and Universal Coupling, 2D Assembled drawing of Mechanical Components. Modelling of Mechanical Part / Component using Software: Introduction and Sketcher exercises, Solid Modelling, Surface Modelling, Assembly Modelling  
Mini Project: Projects on drafting, part modeling, assembly, and sectional/exploded views in mechanical engineering applications.

**References:**

1. Gopalkrishna K. R., Machine Drawing, Subhas Publications, Bangalore, 2002.
2. Bhat N. D., Machine Drawing, Charotar Publishing House, 2002.
3. Venugopal K., Engineering Drawing and Graphics + Auto CAD, New age International Publishers, Delhi, 2002.
4. Sham Tickoo, CATIA for Engineers and Designers, Dreamtech Press New Delhi, 2005.

**MME 2172: WORKSHOP PRACTICE – I [0 0 3 1]**

Preparation of models using Welding techniques, Demonstration of Forging and Foundry practice, Lathe and CNC Turning Centre, Acceptance tests on machine tools

**References:**

1. Hajra Chaudhury S. K., Hajra Choudhury A. K. and Nirjhar Roy, Elements of Workshop Technology, Vol. I, Media Promoters and Publishers Pvt. Ltd., 2003.
2. Hajra Chaudhury S. K., Hajra Choudhury A. K. and Nirjhar Roy, Elements of Workshop Technology, Vol. II, Media Promoters and Publishers Pvt. Ltd., 2003.
3. Peter Smid, CNC Programming Hand book, Industrial Press, New York, 2000.

**FOURTH SEMESTER**

**MAT 2260: ENGINEERING MATHEMATICS - IV [2 1 0 3]**

Special Functions: Series solutions of Bessel and Legendre differential equations, Recurrence formulae, generating functions and Orthogonal properties for  $J_n(x)$  and  $P_n(x)$ . Probability, finite sample space, conditional probability and independence, Bayes' theorem, one dimensional random variable: mean and variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least square principle of curve fitting. Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications.

**References:**

1. Kreyzig E - Advanced Engineering Mathematics, (7e), Wiley Eastern.
2. Meyer P.L. - Introduction to probability and Statistical applications, (2e), American Publishing Co.
3. Hogg & Craig - Introduction of Mathematical Statistics, (4e).1975 MacMillan.
4. B.S.Grewal: Higher Engg. Mathematics, (1989e), 1989, Khanna Publishers.

### **MME 2251: DYNAMICS OF MACHINERY [3 1 0 4]**

Static force analysis, Analysis of a Bell Crank Lever, Slider crank mechanisms, Four-bar mechanism, Drag link Mechanism, Toggle mechanism, Stone Crusher mechanism, Mechanisms involving gears and Cams, Plate links. Determination of inertia forces, Crank effort, Types of Flywheel, Crank effort diagram or Turning moment diagram, determination of flywheel size for single cylinder, multi-cylinder I. C. engine and press work. Balancing of rotating masses. masses rotating in the same plane and in different planes, balancing of reciprocating masses, balancing of multi-cylinder in-line engines & V-engines, multi-cylinder radial engines using direct and reverse crank concept. Principle and working of centrifugal governors, characteristic of Governors, Stability, sensitiveness, isochronism, hunting, Controlling force, effort and power of Porter and Hartnell Governors. Gyroscopic couple of a spinning disc, gyroscopic effect on the movements of an air-craft, ship and automobiles, stabilization of ships. Condition for stability of four wheelers and two wheelers during a turn.

#### **References:**

1. Ballaney P. L., Theory of Machines and Mechanism, Khanna Publications, New-Delhi, 2009.
2. Rattan S. S., Theory of Machines, Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2009.
3. Singh V. P., Theory of Machines, Dhanpat Rai & Co. (P) Ltd, New-Delhi, 2010.
4. Robert L. Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, McGraw-Hill, 2012.
5. Rao J.S., Rao V. Dukkipati, Mechanism and Machine Theory, New Age International Publishers Year, 2012.

### **MME 2252: FLUID MECHANICS [3 1 0 4]**

Properties of fluids - viscosity, surface tension, capillarity, compressibility, vapour pressure; Newtonian and non-Newtonian fluids; pressure intensity and its variation in a static fluid, pressure measurement – manometers; hydrostatic pressure forces on plane and curved submerged surfaces; buoyancy - stability of completely immersed and floating bodies; fluid kinematics - velocity and acceleration, continuity equation, translation, rotation and deformation of a fluid element; velocity potential function and stream function; vortex flow; fluid dynamics - Euler's and Bernoulli's equations, Impulse momentum equation, flow measuring devices; Rayleigh's method and Buckingham's Pi-theorem method of dimensional analysis, types of similarity, dimensionless numbers; viscous flow between fixed parallel plates and in a circular pipe; Turbulent flow - Reynold's experiment, Major loss and Minor losses in pipe flow, Siphon, Hydraulic gradient and Total energy line; Flow past immersed bodies - Lift and drag; Boundary layer concept - Boundary layer thickness - displacement, momentum and energy thickness.

#### **References:**

1. Cengel Yunus. A. and Cimbala John M., "Fluid Mechanics - Fundamentals & Applications", Tata McGraw Hill publications, 2011.
2. Frank M. White, "Fluid Mechanics", McGraw-Hill, 7th edition, 2011.
3. S. K. Som, Gautam Biswas and S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill publications, (3e), 2012.
4. Bruce R. Munson, Donald F. Young and Theodore H. Okiishi, Fundamentals of Fluid Mechanics, Wiley, 2005.
5. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House, New Delhi, 2000.

### **MME 2253: METROLOGY AND MEASUREMENTS [3 1 0 4]**

Methods of Measurement, Generalized Measurement System & its elements, Static Characteristics of Instruments & measurement systems. Methods of pressure measurement - Elastic pressure elements. Methods of temperature measurement. Types of electrical resistance strain gauges, Theory of operation of wire wound strain gauge, Gauge Factor, Strain gauge bridge circuit, Calibration Circuit, Temperature compensation, Strain measurement on static and rotary shaft, Orientation of strain gauges. Numerical on strain calculation. Measurement of Force & related numerical. Methods of Torque & Shaft power measurement. Classification of flow measuring devices. Working principle, velocity measuring devices. Types of fits. Taylor's principle for design of gauges, Numerical on design of gauges, Types of gauges. Straightness measurement using Autocollimator. Squareness measurement using Engineer's Square tester and Optical Square. Flatness measurement. Surface roughness types and measurement. Screw thread terminology. Pitch error in threads. Measurement of the elements of the threads – Effective diameter using screw thread micrometer, two wire and three wire methods. Numerical on screw threads.

#### **References:**

1. Beckwith Thomas G., Mechanical Measurements, Pearson Education, Delhi, 2003.
2. Jain R.K., Engineering Metrology, Khanna Publishers, New Delhi, 1997.
3. Sawhney A.K., Mechanical Measurement & Instrumentation, Dhanpat Rai & Co, New Delhi, 2002.
4. Nakra B.C. and Chaudry K.K., Instrumentation, Measurement & Analysis, Tata McGraw Hill, New Delhi, 2002.
5. Raghavendra N.V. and Krishnamurthy L., Engineering Metrology and Measurements, Oxford University Press, 2013.

### **MME 2254: THERMODYNAMICS - II [2 1 0 3]**

Carnot, Otto, Diesel and Dual cycles, Performance testing of IC Engines, principle of combustion in SI and CI engines. Vapour power cycles like Rankine, Reheat, Regenerative and Binary vapour cycles. Reciprocating air compressor-multistage compression with perfect and imperfect inter cooling. Refrigeration cycles-Bell-Coleman cycle, vapour compression and vapour absorption cycle, Properties of refrigerants. Gas turbine cycles with inter cooling, reheating and regeneration. Nozzles and Diffusers-Isentropic flow, sonic velocity, Mach number, steam nozzles. Stoichiometry-analysis of products of combustion from boiler and engine exhaust.

#### **References:**

1. Nag P. K., Basic and Applied Thermodynamics, Tata McGraw Hill, 2006.
2. Mayhew A. and Rogers B., Engineering Thermodynamics, Longman Green & Co. Ltd. London. E.L.B.S. Edition, 1990.
3. Yunus A. Cengel and Michael A. Boles, Thermodynamics: An Engineering Approach, Tata McGraw - Hill Education, 2011.
4. Rolle Kurt C., Thermodynamics and Heat power, Pearson Education, 2005.
5. Nijaguna and Samaga, Thermodynamics data handbook.

### **MME 2271: STRENGTH OF MATERIALS LAB [0 1 3 2]**

Mechanical characterization of Metals: Tension, Hardness, Impact, Torsion, Bending and Fatigue test on mild steel specimen. Non Destructive testing to detect flaw on mechanical components. Heat treatment of Steel, Microstructure analysis of metals, Study on sliding wear parameters and sliding wear properties.

**References:**

1. Suryanarayana A.V.K., Testing of Metallic Materials, PHI, 1990.
2. Khanna and Justo, Highway Materials Testing, Nemchand, 1989.
3. Technical Teacher's Training Institute, Laboratory Manual of Strength of Materials, Oxford University Press, 1983.
4. Raghavan V, Material Science and Engineering, (4e), Prentice Hall of India, Delhi, 1989.
5. Rajan T. V., Sharma C. P. and Alok Sharma, Heat Treatment Principles and Techniques, PHI Publication, Delhi, 1999.

**MME 2272: WORKSHOP PRACTICE - II [0 0 3 1]**

Exercises on spur gear and helical gear cutting using milling & gear hobbing machines. Practice of shaping operations, Exercises on grinding operations. Machining using CNC Vertical Machining Center and use of Non-conventional machines.

**References:**

1. Hajra Chaudhury S. K., Hajra Choudhury A. K. and Nirjar Roy, Elements of Workshop Technology, Vol. II, Media Promoters and Publishers Pvt. Ltd., 2003.
2. Peter Smid, CNC Programming Hand book, Industrial Press, New York, 2000.

**FIFTH SEMESTER****HUM 3151: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]**

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation, Sinking fund and service output methods, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios.

**References:**

1. Prasanna Chandra., Fundamentals of Financial Management, Tata Mc-Graw Hill Companies, New Delhi, 2005.
2. James L Riggs, David D Bedworth and Sabah U Randhawa., Engineering Economics, Tata McGraw - Hill Publishing Company Ltd, New Delhi, 2004.
3. T. Ramachandran., Accounting and Financial Management, Scitech Publications Pvt. Ltd. India, 2001.
4. Eugene F. B. & Joel F. H., Fundamentals of Financial Management, (12e), Cengage Learning Publisher, 2009.
5. M. Y. Khan & P. K. Jain., Financial Management, (5e), Tata McGraw Hill Publication, New Delhi, 2008.
6. Thuesen G.J., Engineering Economics Prentice Hall of India, New Delhi, 2005.
7. Blank Leland T. Tarquin Anthony J. Engineering Economy, McGraw Hill, Delhi, 2002.
8. Chan S. Park, Fundamentals of Engineering Economics, (3e), Pearson Publication, 2013.

**MME 3151: CAD-CAM [3 1 0 4]**

Introduction to Computer aided design, need, benefits, applications of CAD, Graphics hardware and Graphics displays. Techniques for geometric modeling, Types and representation of curves, Types and representation of surfaces: Analytic surfaces, Synthetic Types and representation of solids. Numerical control and CNC programming, Computer numerical control, CNC part programming, Advanced features in CNC programming, Adaptive control machining systems. Industrial Robotics, Robot anatomy, Physical configurations, Basic robot motions, Motion systems, Robot programming, End effectors, Work cell design, robotic application. Manufacturing systems - Computer integrated manufacturing systems, benefits of CIM, FMS components, FMS layouts, Analysis methods of FMS, Benefits of FMS, Flexible manufacturing and Distributed manufacturing. Group technology concept, part families, classification & coding, production flow analysis, machine cell design. Computer aided process planning, types and advantages, machinability data systems. Computer aided manufacturing resource planning, Material resource planning, MRP input and output records, Enterprise resource planning, capacity requirements planning. Computer aided quality control, Automated inspection offline online. Contact & non-contact co-ordinate measuring machines, machine vision.

**References:**

1. Ibrahim K Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, New Delhi, 1998.
2. Groover Mikell P., Automation, Production Systems, and Computer Integrated Manufacturing, Prentice Hall of India, New Delhi, 2008.
3. Rao P. N., CAD/CAM, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2005.
4. Radhakrishnan P., Computer Numerical Control Machines, New Central Book Agency (P) Ltd., Kolkata, 2004.
5. Principles of Computer Aided Design and Manufacturing / Fanlic / Amirouche / Pearson.

**MME 3152: FINITE ELEMENT METHODS [2 1 0 3]**

Review of matrix algebra, Eigen value problem, Gauss quadrature integration; Displacement and potential energy of a 3D Elastic Body, Minimum potential energy principle, Rayleigh-Ritz and Galerkin's methods; definitions and terminologies in finite element method (FEM), displacement polynomial function, Pascal's triangle, Shape functions for linear and higher order quadrilateral (Lagrange and Serendipity) and triangular elements; finite element formulation of 1D (bar element) structural problem by direct stiffness method and Galerkin's approach, Elimination and Penalty methods of handling boundary conditions; finite element formulation of 1D (bar, truss and beam elements), 2D (triangular, quadrilateral elements) and 3D (tetrahedral and hexahedral elements) structural problems by isoparametric approach;

**References:**

1. Chandrupatla T. R. and Belegundu A. D. (2001), "Introduction to Finite Elements in Engineering", Pearson Education, New York.
2. Daryl L. Logan (2007), "A First course in Finite Element Method"—Fourth India Edition, Thompson Ltd., India
3. David V. Hutton (2005), "Fundamentals of Finite Element Analysis", Tata McGraw Hill, India.
4. J. N. Reddy (2006), "An Introduction to Finite Element Method", Third Edition, McGraw Hill International Edition, New York.
5. Larry J. Segerlind (1984), "Applied Finite Element Analysis" Second Edition. John Wiley, New York.

### **MME 3153: MECHANICAL DESIGN - I [3 1 0 4]**

Introduction: Materials and their properties: Principal stresses, Theories of failure, Strength under combined axial, bending & torsional loads, Stress concentration, S-N diagram, Low cycle and high cycle fatigue, Endurance limit, Variables affecting fatigue strength, Fluctuating stresses, Goodman & Soderberg equations, Curved beams: Stress equation, Stresses in different cross sections subjected to combined axial and bending in one plane. ASME code for design of transmission shafts, Mises Hencky theory for transmission shafting, Design of shafts subjected to bending in two planes in addition to axial loads. Types of keys, Design of square, rectangular & taper keys and splines, Riveted joints: Types of joints, Modes of failure, Strength and efficiency, Design stresses, Structural joints of lap and butt type, Welded joints: Types of welds, Strength, Welded joints subjected to eccentric loading, Welded pressure vessels, Stresses in bolts, Effect of initial tension, eccentric loading, Design of knuckle and cotter joints. Stresses in power screw, Efficiency, Force & torque requirement to lift load

#### **References:**

1. Bhandari V. B., Design of Machine Elements, (3e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2012.
2. Norton R. L., Machine Design - An Integrated Approach, (2e), Prentice Hall Inc. New Jersey, 2007.
3. Juvenile R. C. and Marshek K. M., Fundamentals of Machine Component Design, (5e), John Wiley and Sons, Inc, New York, 2012.
4. Maleev and Hartman, Machine Design, Revised and edited by Drop Grover), CBS Publishers, New Delhi,
5. Hamrock B. J., Jacobson B.O. and Schmid S. R., Fundamentals of Machine Elements, (2e), Mc Graw Hill Inc., New York, 2005.

### **MME 3154: TURBO MACHINES [3 1 0 4]**

Introduction: Classification and types of turbo machines, Dimensional analysis and similitude of incompressible and compressible flow turbo machines, Specific speed and its significance on size and shape, Affinity laws, Euler turbine equation and components of energy transfer with velocity triangles. Degree of reaction, utilization factor, Zero angle turbine, Theoretical head capacity relationship for general pumps and compressors, Effect of exit blade angle on performance. Isentropic efficiencies of turbo machines, Infinitesimal polytropic and finite stage efficiencies for turbines and compressors, Preheat factor for a compressor and reheat factor for a turbine, Pump manometric head, manometric, mechanical, volumetric and overall efficiencies, Minimum starting speed, Need for priming, Cavitation and NPSH, Slip and slip Factor, Main and operating characteristics of pumps, Iso-efficiency graph, h-s diagram of a compressor stage, Stage velocity triangles, Need for limiting inlet relative velocity in high speed compressors: Pre whirl blades, h-s diagram for a general stage, Velocity triangles, Enthalpy and stagnation pressure loss coefficients for rotor and stator, Blade loading, Work done factor, Phenomenon of surging, Condition of stalling, Radial equilibrium equation, Free and forced vortex designs. Tangential flow pelton turbine - working principle, Design parameters and governing of Pelton turbine, Radial flow francis turbine - working principle, Draft tube theory and types of draft tubes, Axial flow kaplan turbine - working principle, Governing of reaction turbines. Main and operating characteristics, Iso-efficiency graph, SFEE across a steam nozzle, h-s diagram of single stage D'laVal Turbine, Nozzle and blade efficiencies, Curtis stage, Rateau turbine, Parsons reaction turbine.

#### **References:**

1. Yahya S.M., Turbomachines, Satya Prakashana, New Delhi.
2. Yahya S.M., Turbines Compressors and Flans, TMH, New Delhi, 2005.

3. Shepherd D.G., Principle of Turbomachinery, Macmillan Co. New York, 1956.
4. Sayers A.T., Hydraulic & Compressible flow Turbomachines, Mc.Graw Hill, 1990.
5. Dixon S.L., Fluid Mechanics, Thermodynamics of Turbomachinery, Pergamon, 2006.

### **MME 3171: MECHANICAL LAB - I [0 1 3 2]**

Determination of viscosity of oil, flash & fire point of oil, lower calorific value of gaseous fuel and dryness fraction of steam. Calibration of pressure gauge and determination of compression ratio. Performance test on different single cylinder, low/high speed four/two stroke petrol & diesel engines. Area measurement by Planimeter. Mould sand testing, Performance test on blower, air compressor. Balancing of revolving masses.

#### **References:**

1. Ganeshan V., Internal Combustion Engines (3e), Tata McGraw Hill, Education Private Limited New Delhi, 2007.
2. Mathur M. L. and Sharma R. P., Course in Internal Combustion Engines, Dhanpath Raj Publishers, New Delhi, 2001

### **MME 3172: METROLOGY LAB [0 0 3 1]**

Study of measuring instruments and gauges, Screw thread measurements, Measurement of effective diameter of external screw threads, Use of Comparators, Measurement of gear dimensions, Radius and angle measurement, Calibration of Micrometer and Vernier caliper, Surface texture and straightness measurement, Use of Profile projector, Coordinate Measuring Machine and Interferometer.

#### **References:**

1. Jain R. K., Engineering Metrology, Khanna Publishers, New Delhi, 1997.
2. Gupta I. C., Engineering Metrology, Dhanpat Rai Publications, New Delhi, 1997.
3. Raghavendra N. V. and Krishnamurthy L. Engineering Metrology and Measurements, Oxford University Press, 2013.

## **SIXTH SEMESTER**

### **HUM 3152: ESSENTIALS OF MANAGEMENT [2 1 0 3]**

Definition of management and systems approach, Nature & scope. The functions of managers. Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, policies & planning premises. Strategic planning process and tools. Nature & purpose of organising, Span of management, Factors determining the span, Basic departmentation, Line & Staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership- leadership behaviour & styles, Managerial grid. Basic control process, Critical control points & standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA, Application of Theory Z. The nature & purpose of international business & multinational corporations, Unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections

**References:**

1. Harold Koontz & Heinz Weihrich.,Essentials of Management, McGraw Hill, New Delhi, 2012.
2. Peter Drucker., Management: Tasks, Responsibilities and Practices, Harper and Row, New York, 1993.
3. Peter Drucker., The Practice of Management, Harper and Row, New York 2004.

**MME 3251: HEAT TRANSFER [2 1 0 3]**

Modes of heat transfer, Governing laws and its derivatives, Electrical analogy, Combined mechanism of heat transfer, Overall heat transfer coefficient, Different types of boundary conditions. General heat conduction equation in Cartesian coordinates, Heat conduction through plane and composite walls, Thermal contact resistance, Radial heat flow through cylinder and composite cylinders, Critical thickness of insulation, Radial heat flow through sphere and composite spheres, Steady state heat conduction with heat generation, Effect of variable thermal conductivity (for plane wall only), Heat transfer from extended surfaces: General energy equation for the fin, Heat transfer from fin of uniform cross section heated at one end and both ends, Efficiency and effectiveness, Application of dimensional analysis to free and forced convection, Dimensionless numbers and their physical significance, Characteristic length, Boundary layer concept, Hydrodynamic and thermal boundary layer in external and internal flow, Empirical correlations for forced and free convection. Types of heat exchangers, Fouling factor, Overall heat transfer coefficient, Analysis of parallel and counter flow heat exchanger - LMTD and NTU method, LMTD correction factor, Radiation: Thermal radiation, Absorption, Reflection and transmission of radiation, Black body, Stefan-Boltzmann, Kirchoff's, Planck's and Wien's displacement Laws, Heat transfer between black surfaces and between gray surfaces, Radiation shield, Electrical analogy of solving radiation problems (only between two bodies/surfaces).

**References:**

1. Holman J. P., Heat Transfer, (10e), Tata McGraw Hill, 2011.
2. Ozisik M. N., Heat Transfer – A Basic Approach, (2e), McGraw Hill, 1985.
3. Yunus A. Cengel and Afshin J. Ghajar, Heat and Mass transfer, (4e), Tata McGraw Hill, 2013.
4. Thirumaleshwar M., Fundamentals of Heat and Mass Transfer, (1e), Pearson Education, 2006.
5. Rajput R. K., Heat and Mass Transfer, (4e), S Chand Publishing, 2008.

**MME 3252: MECHANICAL DESIGN - II [3 1 0 4]**

Types of springs, helical coil springs, Stress and deflection of springs subjected to steady/ fluctuating loads, Stresses in leaf springs. Spur gears: Nomenclature, Stresses in gear teeth, Lewis equation for beam strength of tooth, Static, Dynamic, Limiting load for wear, Helical gears: Nomenclature, Formative number of teeth, Static Strength, Dynamic strength, Limiting load for wear. Bevel gears: Nomenclature, Straight teeth bevel gears, Static strength, Dynamic strength, Limiting load for wear. Worm gears: Nomenclature, Strength design, Efficiency, Heat dissipation. Sliding contact bearings: Journal bearings, Terminology, Hydrodynamic lubrication, Stribeck curve, Heat generation & dissipation. Rolling contact bearings: Life rating, Static load carrying capacity, Dynamic load carrying capacity, Equivalent load, Selection of V belt drive systems, Selection of rope drive systems and chain drive systems, Block brakes, Band brakes, Pivoted Shoe brakes.

**References:**

1. Bhandari V. B., Design of Machine Elements, (3e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2012.
2. Norton R. L., Machine Design - An Integrated Approach, (2e), Prentice Hall Inc. New Jersey, 2007.
3. Juvenile R. C. and Marshek K. M., Fundamentals of Machine Component Design, (5e), John Wiley and Sons, Inc, New York, 2012.
4. Maleev and Hartman, Machine Design, Revised and edited by Drop Grover), CBS Publishers, New Delhi,
5. Hamrock B. J., Jacobson B.O. and Schmid S. R., Fundamentals of Machine Elements, (2e), Mc Graw Hill Inc., New York, 2005.
6. Shigley J. E. and Mischke C. R., Mechanical Engineering Design, (8e), McGraw Hill Inc, New York, 2008.
7. Mahadevan K. and Balaveera Reddy K., Machine Design Data Hand Book, (4e), CBS Publishers and distributors' New Delhi, 2013.

**MME 3271: FINITE ELEMENT METHODS LAB [0 1 3 2]**

FE modelling and analysis of plane truss and beams. FE modelling and analysis of 2D and 3D structural problems, mesh convergence testing. FE modelling and analysis of Shell problems. FE modelling to carry out the Modal and Harmonic analysis of structural components. FE modelling and analysis of 2D and 3D heat transfer problems. Writing and executing programs to prepare FE model and analyze plane and space truss, horizontal beam and plane frame problems, 2D plane stress and plane strain problems.

**References:**

1. Chandrupatla T. R. and Belegundu A. D. (2001), "Introduction to Finite Elements in Engineering", Pearson Education, New York.
2. Daryl L. Logan (2007), "A First course in Finite Element Method"—Fourth India Edition, Thompson Ltd, India

**MME 3272: MECHANICAL LAB - II [0 1 3 2]**

Performance test on vapor compression refrigeration system, air conditioning test rig, twin cylinder Kirloskar engine, MPFI engine and morse test. Parallel and counter flow heat exchangers, Heat transfer from a pin fin under free and forced convection, Determination of thermal conductivity of a metallic bar and insulating powder. Performance test of cross flow and shell and tube type heat exchanger, Heat transfer through a composite wall, lagged pipe and determination of emissivity, Stefan Boltzmann apparatus and calibration of temperature measuring instruments, Compound pendulum, viscous damping and whirling of shafts, Spring mass system and forced vibration

**References:**

1. Ganeshan V., Internal Combustion Engines,(3e), Tata McGraw Hill Education Private Limited, New Delhi, 2007.
2. Mathur M. L. and Sharma R. P., Course in Internal Combustion Engines, Dhanpath Raj Publishers, New Delhi, 2001.
3. Rattan S. S., Theory of Machines, Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2009.
4. Holman J. P., Heat Transfer, (10e),Tata McGraw Hill, 2011.
5. Yunus A. Cengel and Afshin J. Ghajar, Heat and Mass Transfer, (4e), Tata McGraw Hill, 2013.
6. Singiresu S. Rao, Mechanical Vibrations, Pearson Education (Singapore) Pte. Ltd., Delhi, 2004

**SEVENTH SEMESTER**

There are five program electives and one open elective with total of 18 credits to be taught in this semester.



## EIGHTH SEMESTER

### **MME 4298: INDUSTRIAL TRAINING**

Student is undergoing industrial training for a minimum period of 4 weeks during the vacation. After successful completion of training, student is submitting a report to the department and also makes a presentation on training.

### **MME 4299: PROJECT WORK / PRACTICE SCHOOL**

The student is required to carry out a project work in the institution / industry / research laboratory / institution of higher learning. The minimum duration of the project work/practice school is 16 weeks. As part of project work / practice school, the student is also required to prepare a project report and make a presentation on the work carried out.

### **PROGRAM ELECTIVE**

#### **MME 4041: DESIGN FOR MANUFACTURE AND ASSEMBLY [3 0 0 3]**

Morphology of design, different phases, overview of product design, advantages of using DFMA, principles of DFMA in mechanical design, selection of materials and processes. Design guidelines for sand casting, investment casting, metal extrusion, stamping, fine blanked parts, rolled formed section, forging process, machining processes, heat treatment, die casting, injection moulding, sheet metal process, powder metallurgy process, joining processes. Advantages and disadvantages of 3D printing, design guidelines for 3D printing and different assembly techniques, importance of fits, tolerance and surface finish in design, production drawings.

#### **References:**

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, Product Design for Manufacture and Assembly, CRC Press, 2011.
2. James G. Brala, Design for Manufacturability Handbook, McGraw Hill, New York, 1999.
3. Kevin Otto and Kristin Wood, Product Design Pearson Education, Delhi, 2001.
4. Chitale A. K. and Gupta R. C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. George E. Dieter, Engineering Design, McGraw Hill Book Co. Singapore, 2000.

#### **MME 4042: DESIGN OF MECHANICAL SYSTEMS [3 0 0 3]**

Mechanical design process, design factors, design of mechanical systems - Flange coupling, Screw jack, Piston, Connecting rod, Crankshaft- Overhung & Center type, Valve gear mechanism, Single plate clutch, Passenger lift, Concrete mixer, Automobile chassis & suspension. Johnson's method of optimization. Design for manufacture of cast, forged, turned, milled, drilled and ground parts, design for heat treatment, design for assembly.

#### **References:**

1. Bhandari V.B., Design of Machine Elements (3e), Tata McGraw Hill Publishing Company, New Delhi, 2010.
2. Trikha S. N., Machine Design Exercises, Khanna Publishers, Delhi, 2001.
3. Patil S. P., Mechanical System Design, Jaico Publishing House, Mumbai, 2004.
4. George E. Dieter, Engineering Design, McGraw Hill Book Co., Singapore, 2000.
5. Mahadevan K. and Balaveera Reddy K., Machine Design Data Hand Book (4e), CBS Publishers and distributors, New Delhi, 1987.

#### **MME 4043: MECHANICAL VIBRATIONS [3 0 0 3]**

Limits of vibration severity, Natural frequency by Newton's Classical method and Energy method, Longitudinal, lateral and torsional vibration. Viscous damping-different types of viscous damping, Coulomb damping. Steady state forced vibration subjected to harmonic excitation, rotating and reciprocating unbalance, force and displacement transmissibility and reciprocating unbalance, force and displacement transducers, vibrometer, accelerometer, frequency measuring instruments, exciters, Machine condition monitoring using vibration signals. Two degree of freedom system-Classical method and Lagrange's generalized method, Dynamic vibration absorber. Centrifugal pendulum absorber. Multi degree freedom system-Classical method, Influence coefficient method. Matrix iteration method, Rayleigh's method, Dunkerley's method and Holzer's method. Vibration of continuous system.

#### **References:**

1. Singirisu Rao S, Mechanical Vibration, Pearson Education, Delhi, (5e), 2011.
2. S. Graham Kelly, Fundamentals of Mechanical Vibrations, McGraw-Hill, Singapore, (2e), 2000.
3. S. Graham Kelly, Schaum's Outline of Mechanical Vibrations (Schaum's Outline Series), McGraw-Hill Publication, 1996.
4. Rao J. S. and Gupta K., Introductory Course on Theory and Practice of Mechanical Vibrations, New Age Publishers, (2e), 1999.
5. Groover G.K., Mechanical Vibrations, Nem Chand and Bros, (8e), 2009.

#### **MME 4044: TRIBOLOGY [3 0 0 3]**

Types & properties of lubricants, Lubricants additives, Lubrication regimes, Full fluid film lubrication, Equation of continuity, Generalised Reynolds equation, Hydrostatic lubrication, Elastohydrodynamic lubrication. Theories of friction, Friction instability. Theories of wear, approaches to friction control and wear prevention, Friction and wear measurement. Surface engineering, manufacturing of surface layers, superficial-layer, Surface engineering for wear and corrosion resistance. Application of tribology: Rolling contact bearings, Gears, Journal bearings Finite bearings, Biotribology and Nanotribology. Tribo measurement and instrumentation: Surface topography measurements, Electron microscope, Atomic Force Microscope, Experimental methods in tribology.

#### **References:**

1. Cameron A., Basic Lubrication Theory, Ellis Horwood Ltd, Chichester, 1983.
2. Majumdar B.C., Introduction to Tribology of Bearings, A. H. Wheeler & Co. Pvt. Ltd., Allahabad, 1999.
3. Stachowiak G. N., Batchelor A. W. and Stachowick G. B., Experimental methods in Tribology, Tribology Series 44, Editor D Dowson, 2004.
4. Gwidon Stachowiak, Andrew Batchelor, Engineering Tribology, Elsevier, (4e), 2013
5. Tadasz Burakowski, Tadeusz Wierzchon, Surface Engineering of Metals: Principles, Equipments and Technologies, CRC Press, 1998.

#### **MME 4045: COMPOSITE MATERIALS [3 0 0 3]**

Definition, Classification, Types of matrices & reinforcements, Characteristics & selection, Fiber composites, Laminated composites, Particulate composites, Prepregs, Sandwich construction. Glass, Carbon and Advanced fiber manufacturing methods, Applications, Advantages, Disadvantages and Properties. Micro mechanical analysis

of a lamina: Introduction, Derivation of stress, Strain, Modulus of elasticity of fiber reinforced composites. Rule of mixture, Problems to find density, Mechanical properties of composites by using Rule of mixture. Processing of polymer composites: Description of method, Advantages, Disadvantages and Application, Hand-layup, Spray-layup, Compression molding Injection molding, Reaction injection molding, Autoclaving, Resin transfer molding, Filament winding, Pultrusion. Sheet molding, Pre-pegging and challenges in primary processing of composites. Secondary processing of polymer composites: Joining of polymer composites, Adhesive joining, Mechanical joining, Microwave joining, Induction and resistance welding, Drilling of polymer composites, Conventional vs ultrasonic drilling, Remedies for reducing drilling induce damages, Research tools for secondary processing. Testing of polymer composites: ASTM standards and procedures, test for physical properties, mechanical properties Viz., tensile, flexural, impact etc., SEM analysis, case studies. Application developments: Aircrafts, Missiles, Space, Automobile, Electrical and electronics, Marine, Recreational and sports equipment's, Construction. Potential future applications of composites.

**References:**

1. Mein Schwartz, Composite Materials Handbook, McGraw Hill Publication, 1984.
2. Autar K. Kaw, Mechanics of Composite Materials, CRC Press New York.
3. Krishan K. Chawla, Composite Material Science and Engineering, Springer Publication, 1987.
4. Mallik P. C., Fiber Reinforced Composites, Marcel Decker Publication, 1993.
5. Rober M. Jones, Mechanics of Composite Materials, McGraw Hill Kogakusha Ltd, 2008.

**MME 4046: HEAT TREATMENT OF METALS AND ALLOYS [3 0 0 3]**

Iron-Carbon equilibrium diagram, Lever rule, isothermal transformation diagram, heat treatment of steels, phase transformations. Heat treatment processes, annealing, normalising, hardening, tempering, hardenability, determination of hardenability - Grossman's critical diameter method, Jominy end quench test, Factors affecting hardenability. Carburizing, post carburizing treatments, cyaniding and carbonitriding, nitriding, plasma nitriding, boronizing & chromizing, flame hardening, induction hardening, electron beam hardening, laser hardening. Controlled rolling, ausforming, isoforming, marstraining, cryoforming, thermomechanical annealing, thermomechanical treatment of non-ferrous alloys. Steel specification, classification and heat treatment of steels and cast iron. Heat treatment and application of aluminium alloys, titanium alloys, copper alloys, defects, causes and remedies in heat treatment.

**References:**

1. Rajan T. V., Sharma C.P and Alok Sharma, Heat treatment principles and techniques, PHI Publication, Delhi, 1999.
2. Bolton W., Engineering materials technology, Heinmann Newness, New Delhi, 2001.
3. Thelning K. E., Steel and its heat treatment, Butterworth/Heinemann, Oxford, 2000.
4. Romesh C. Sharma, Principles of Heat Treatment of Steels, New Age International (P) Limited, New Delhi, 1996.
5. Vijendra Singh, Heat Treatment of Metals, Standard Publishers Distributors, Delhi, 2012.
6. Avner S. H., Introduction to Physical Metallurgy, (3e), McGraw Hill, New Delhi, 2004.
7. William D. Callister, Materials Science and Engineering, John Wiley & Sons, 2007.

**MME 4047: LEAN MANUFACTURING [3 0 0 3]**

The lean production system, lean revolution in Toyota, basic elements of lean manufacturing, principles and characteristics of lean manufacturing, MUDA and types. Value stream mapping Material and information flow, Selection of the product family, Value stream manager, Using the mapping tool, Drawing the current state map, Characteristics of lean value stream, Drawing the future state map, Achieving the future state. Introduction to Kanban: Data collection, case studies. Kanban Size: Determining the replenishment cycle, Implication of scrap, unplanned downtime and changeover time on replenishment intervals, buffer calculations, Calculation of number of containers, Reality check, Alternate method of kanban sizing, supplier kanban, Finished goods kanban, Production smoothing: Smoothing of total production quantity - Demand fluctuation and production capacity plan, Shortening production lead time: Components of production lead time, shortening processing time through single production and conveyance, Multifunction workers, shortening processing time through small sized lot production, shortening waiting time and conveyance time. Shortening setup time – concepts and techniques: Setup concepts, Concept applications, Analyzing setup actions, Procedure for setup improvements. Standardization of operations: Components of standard operations, Determining the cycle time, Determining the completion time per unit, determining the standard operation routine, Yo i-don system, One shot setup, Determining the standard quantity of work in progress, Preparing standard operation sheet.

**References:**

1. Monden Y., Toyota Production System: An Integrated Approach to Just-In-Time, (4e), CRC Press, U.S.A, 2011.
2. Rother and Shook, Learning to See: Value Stream Mapping to add Value and Eliminate Muda, The Lean Enterprise Institute, U.S.A., 1999.
3. Gross and McInnis, Kanban Made Simple: Demystifying and Applying Toyota's Legendary Manufacturing Process, AMACOM Books, U.S.A., 2003.
4. Fled W., Lean Manufacturing: Tools, Techniques and How to Use Them, CRC Press, U.S.A., 2001.
5. Dailey K. W., The Lean Manufacturing Pocket Handbook, D.W. Publishing Co., 2003.

**MME 4048: PRODUCTION PLANNING AND CONTROL [3 0 0 3]**

Introduction: Functions of production, planning and control. Types of production activities, Production consumption cycle. Forecasting Analysis: Importance and uses of forecasting, Type of forecasts, Qualitative methods of forecasting, Quantitative methods of forecasting, Exponential smoothing, Linear regression analysis, Correlation analysis and Seasonality, Forecast control. Aggregate planning: Need and inputs for aggregate production planning, Pure and mixed strategies of aggregate planning. Aggregate planning approach. Job shop scheduling: Factors affecting job shop scheduling, Index method, Priority sequencing rules, Determination of mean flow time, average job lateness and average number of jobs in the system, Sequencing of 'n' jobs through 'n' machines. Inventory control: Classification of inventories, Economic order quantity, Inventory control models, Effect of quantity discount, Safety stock, Reorder level, Lead time, ABC Analysis. MRP: Product structure tree, MRP inputs and outputs, MRP logic, Problems. Assembly line balancing: Meaning and determination of cycle time and theoretical minimum number of workstations, Precedence diagram, Priority rules for allocation of tasks to workstations, Longest work element time rule, Maximum following tasks rule-Calculation of efficiency and percentage delay loss.

**References:**

1. Monks Joseph G, Operations Management, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2004.
2. Krajewski Lee J. and Ritzman Larry P, Operations Management, Pearson Education (Singapore) Pte. Ltd., Delhi, 2005.
3. Adam Everett E. Jr. and Ebert Ronald J., Production and Operations Management, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Chase Richard B., Aquilano Nicholas J. and Jacobs F. Roberts, Production and Operations Management, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1999.
5. Eilon Samuel, Elements of Production Planning and Control, Universal Publishing Corporation, Mumbai, 1991.

**MME 4049: COMPUTATIONAL FLUID DYNAMICS [3 0 0 3]**

Governing equations of fluid mechanics: Models of Flow, The substantial derivative and divergence of velocity field- its physical meaning, Derivation for finite volume model, fixed and moving with the fluid. Continuity equation: Derivation for infinitesimal element model, fixed and moving with the fluid, The Conservative and Non-conservative forms of the above equations, Derivation of the general 3-D Cartesian momentum and energy equations: Non conservative format and transformation of these into conservative formats., General characteristic of the governing equations: The initial and types of boundary conditions, Mathematical behavior of different classes of partial differential equations, Equilibrium and Marching behavior, Format of the differential equation for the conservation of a general dependent property, Discretization Process-concept and structure, Methods of deriving the discretized equations, Explicit Taylor series expansion, Consistency and Stability criteria, Application of explicit finite difference technique, Application of the explicit finite difference technique to one dimensional steady state heat transfer in a rectangular fin, Implementation of boundary conditions and solution techniques for the above, Extension of the method to 2-D Conduction through a rectangular slab, Explicit, Implicit and Crank Nicholson Method of solving space and time marching in 1D domain, The Basic Four rules criteria in control volume formulation, Discretization of source terms and linearization, Application of control volume technique to two and three dimensional steady diffusion flow problems, Application of control volume technique to 1D unsteady heat transfer problem, Numerical methods for steady one-dimensional convective flow with diffusion: control volume approach, The CDS, the Upwind, and Exact schemes, Properties of discretization schemes: Conservativeness, Boundedness and Transportiveness, illustrative numerical examples on the above, Artificial or false diffusion with UDS. SIMPLE algorithms, Difficulties and Strategies to overcome in convection dominated diffusion problems, the need for staggered grid, Implementation of boundary conditions in CFD.

**References:**

1. John D. Anderson Jr., Computational Fluid Dynamics- The Basics with Applications, International Edition, McGraw Hill. New York, 1995
2. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere / McGraw Hill. New York, 1980.
3. Versteeg H.K. and Malalasekera W, An Introduction to Computational Fluid Dynamics.- The Finite Volume Method, Longman Scientific & Technical. England, 1995.
4. Ghoshdastidhar, Computer Simulation of Flow and Heat Transfer, Tata- McGraw-Hill Book Company. New Delhi, 1998.
5. Muralidhar K and Sundararajan T, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2003

**MME 4050: DESIGN OF THERMAL POWER PLANT SYSTEMS [3 0 0 3]**

Design of Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger Recuperative Air Pre Heater, Economizer, Boiler furnace design, Estimation of inside heat transfer coefficient using Jens & Lottes equation and Thom's correlation. Estimation of pressure drop in two phase flow using Thom's method, Super heater and Re-heater Design: Estimation of flow in each element of a tube assembly. Estimation of attenuation factor and direct radiation from furnace, Design of Steam Condenser-estimation of tube side velocity, surface area and pressure drop for various tube sizes & Plot the graph) and estimation of shell diameter of steam condenser, Design of Cooling Tower.

**References:**

1. Kern D.Q., Process Heat Transfer, McGraw-Hill Publications, 1965.
2. Ganapathy V., Applied Heat Transfer, Penn Well Publishing Company, Tulsa, Oklahoma, 1982.
3. Sarit Kumar Das, Balakrishan A R, Process Heat Transfer, Alpha Science International, 2005.

**MME 4051: REFRIGERATION & AIR CONDITIONING SYSTEMS [3 0 0 3]**

Introduction to refrigeration and air conditioning, basic refrigeration cycles and its analysis. Different types of air refrigeration cycles for aircraft applications. Vapour compression systems- thermodynamic analysis of simple, multi-pressure and compound refrigeration systems. Vapour absorption system- simple and practical absorption systems, comparison with compression systems. Water refrigeration- steam jet system. Vortex and pulse tube and thermoelectric refrigeration systems-simple analysis. Psychrometry, psychrometric chart and analysis of related terms and processes. Air conditioning systems- comfort, industrial cold storages. Cooling and heating load calculations. Different air conditioning methods.

**References:**

1. Manohar Prasad., "Refrigeration and Air-conditioning" New Age International Publisher, 2015
2. S.C.Arora & S. Domkondwar., Course in Refrigeration and Air-conditioning, Danpath Rai. New Delhi, 1992.
3. Cook Norman., Refrigeration and Air-conditioning, Macmillan London, 1995.
4. W.F. Stocker., Refrigeration and Air-conditioning, Tata McGraw Hill, 1978.
5. Marsh & Olive, Principles of Refrigeration, CBS Publishers & Distributors New Delhi, 2001.

**MME 4052: THEORY OF IC ENGINES AND EMISSIONS [3 0 0 3]**

Thermodynamics and classification of IC engines, idealized cycles and processes: Otto, Diesel, Dual and Sterling Cycle. Comparison of Air-standard Cycle, Fuel air cycles and actual cycles. Fundamentals of combustion: Introduction to combustion, modes of combustion, Stoichiometry, heat of formation, adiabatic flame temperature, chemical equilibrium, ignition limits, numericals. IC engine fuels: conventional and non-conventional fuels. Conventional fuels, chemical structure of petroleum products, refining process, products of refinery, required qualities of engine fuels, rating of fuels, SI engine and CI engine fuels. Non-conventional fuels (alternative fuels): Alcohols, LPG, CNG, Hydrogen, Vegetable oils. Combustion in SI and CI engines: Combustion in SI engines: Stages of combustion, factors affecting the different stages of combustion, rate of pressure rise, Normal and abnormal combustion and Combustion Knock. Design and operational factors for

control of knock. Combustion chamber design for SI engines. Combustion Phenomenon in CI engines: Stages of combustion, Delay period physical and chemical delay period, abnormal combustion in CI engines- Diesel Knock. Factors affecting delay period. Control of diesel knock. SI and CI engine combustion chamber designs. Modern developments in IC engines. Electronic injection systems like CRDI, MPFI, TBI and GDI systems, VVT, VVT technologies, Dual fuel engines and stratified charge engines. Engine pollutant formation and control; introduction to pollution, Nitrogen Oxides, kinetics of NO<sub>x</sub> formation in SI engine and CI engine. CO emission, UBHC emission, flame quenching, HC emission from SI and CI engines. Particulate emissions, soot formation, oxidation and adsorption and condensation. Exhaust and non-exhaust emissions: Exhaust emission control methods- thermal reactors, catalytic converters and particulate traps, chemical methods like ammonia injection. Selective Catalytic Reduction (SCR), EGR technique, Non- exhaust emissions - evaporative emissions and crank case emissions and its control.

**References:**

1. Ganeshan V., Internal Combustion Engines, (3e), Tata McGraw Hill Education Private Limited, New Delhi, 2007.
2. Mathur and Sharma, A Course in I C Engines, Dhanpath Rai Publishers, New Delhi, 1981.
3. John B. Heywood, Introduction to Internal Combustion Engines, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
4. Lichty L.C., International Combustion Engines, McGraw Hill, New Delhi, 1951.
5. Edward F. Obert, Internal Combustion Engines and Air Pollution, Harper & Row, Publishers. Delhi, 1973.

**MME 4062: AUTOMATIC CONTROL ENGINEERING [3 0 0 3]**

The course Automatic control engineering mainly deals with the application of automatic control in various systems like temperature control system, water level control system, flow control system etc. These physical systems can mathematically modelled and many physically different systems have the same mathematical model. The advantage of such mathematical models is that these can be solved easily and system stability can be ascertained using mathematical models. In addition, the selection of proper system parameters for safety of a control system can be demonstrated through various plots like Nyquist and Bode plots. Digital control systems play a very important role in handling multi variate systems which can be modelled using state space representation.

**References:**

1. Harrison H.L. and Bollinger J.G., Automatic controls (2e), International Text Book Co. U.S.A, 1968.
2. Raven, Automatic Control Engineering, McGraw Hill, U.S.A, 1995.
3. Benjamin Kuo.C., Automatic Control Systems EEE (7e), Prentice Hall of India Ltd. New Delhi, 1995.
4. Verma S.N., Automatic Control Systems, Khanna Publishers, Delhi, 1990.
5. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall of India Ltd., New Delhi, 2004.

**MME 4063: AUTOMOBILE ENGINEERING [3 0 0 3]**

Automotive engine parts, Spark Ignition (SI) & Compression Ignition (CI) engines, Multi-cylinder arrangements. Cooling requirements & methods. Various lubrication arrangements. Fuel pumps for petrol and diesel engines, Types of carburetors. Fuel injector and Multi-Point Fuel Injection system. Various ignition systems and ignition advance methods. Bendix drive. Clutches- purpose and requirements, Various types of clutches.

Various types of Gearboxes. Drive configuration and parts of drive system, types of rear axle arrangements. Tyre properties, tubed tubeless tyres. Steering geometry, Steering mechanisms and linkage systems. Requirements and Types of suspensions, Telescopic shock absorber. Braking requirements, Brake efficiency and stopping distance, Various Types of brakes, Balance beam compensator, Antilock braking system. Automotive emission control system, Method to control various emissions, Emission standards- Euro and Bharat norms. Modern Vehicles, Construction and operational features of four wheelers available in Indian market, Introduction to electric vehicles & hybrid vehicles.

**References:**

1. Heinz Heisler, Vehicle and Engine Technology (2e), Butterworth-Heinemann Publication, 1998.
2. Kirpal Singh, Automobile Engineering Vol. I & II (13e), Standard Publishers Distributors, 2017.
3. Rajput R. K., Automobile Engineering (2e), Laxmi Publication (P) Ltd, 2017.
4. Jain K. K., Asthana R. B., Automobile Engineering (1e), Tata McGraw Hill Education, 2017.
5. Narang G. B. S., Automobile Engineering (5e), Khanna Publishers, 1995.
6. Giri N. K., Automobile Technology, Khanna Publication, 2002.
7. Ehsani M., Gao Y., Emadi A., Modern Electric, Hybrid Electric, and Fuel Cell Vehicles (2e), CRC Press, 2009.

**MME 4064: BIO-FLUID MECHANICS [2 1 0 3]**

Cardiovascular physiology: Cardiovascular system, The heart-blood vessels, Mechanical model (Winkessel model), Blood. Fundamentals of fluid mechanics: Intrinsic properties of fluid, Conservation laws - Mathematical tools, Mass Conservation, Conservation of momentum, Form of fluid motions equations, Dimensional analysis, Energy conservations & Bio-heat Equation of Mammalian Tissue. Mathematical solutions for bio-fluid problems: How to solve a problem?, Boundary conditions, Mathematical solutions for bio-fluid problems - Shear stress on arterial endothelial cells, NS in a pipe - Validity of the Hagen-Poiseuille relationship in the cardiovascular system, Pulsatile flow, Effect of pulsatility, Wormersley solution. Computational fluid dynamics (CFD) and Flow measurement in the cardiovascular: Computational fluid dynamics, Flow measurement in the cardiovascular. Flow over immersed body (incompressible): General flow characteristics, Lift and drag concepts - Definitions, Drag for different shapes, Drag coefficient, for a sphere in stokes flow, Transport of micro-particles, Characteristic flow past an object, Boundary layer characteristics - Boundary Layer Structure and Thickness on a Flat Plate, Boundary layer thickness, Momentum-Integral Boundary Layer Equation for a Flat Plate, Prandtl / Blasius Boundary Layer Solution, Turbulent boundary layer, Pressure gradient effect on flow - Separation point, Reduction of drag, Biological solution for drag reduction. Rheology of blood, Non-Newtonian fluid: Viscosimetry, Blood composition and viscosity, Cell free marginal layer, Pressure flow relationship for non-Newtonian fluid, Hemodialysis and platelet activation, Time effect viscosity. Introduction to Fluid Machinery and biomedical application: Introduction to Fluid Machinery, Fluid machinery in biomedical.

**References:**

1. K.B. Chandran et al. Biofluid mechanics: the human circulation. Taylor and Francis (2de)
2. Kundu PK, Cohen IM and Dowling DR, "Fluid Mechanics", (5e), Academic Press, 2011

- Mazumdar J, "Biofluid Mechanics", World Scientific, Singapore, 1992
- L. Waite. Applied Biofluid Mechanics. (1e), (2007). McGraw-Hill Professional
- George A. Truskey, Fan Yuan, and David F. Katz. Transport Phenomena in Biological Systems (Pearson Prentice Hall Bioengineering)

#### **MME 4065: CORROSION SCIENCE AND ENGINEERING [3 0 0 3]**

Introduction: Definitions, Technological importance of corrosion study, Corrosion as useful process, Corrosive environments, Consequences of corrosion, Factors affecting corrosion, Economical aspects of corrosion, Corrosion science and corrosion engineering. Fundamental aspects of corrosion: Cell analogy, electrode potential, emf and galvanic series - their uses in corrosion studies, Corrosion cell, Cathodic and anodic reactions, Types of corrosion cells, Reference electrode and their types, Pourbaix diagram for metal-water system. Principles of corrosion: Corrosion rate expressions and calculations, Nernst's Equation, Electro-chemical nature of aqueous corrosion, Faradays' laws of electrolysis, Current density, Factors influencing corrosion rate. Types of corrosion: Characteristic features, causes and remedial measures of different forms of corrosion: Dry & wet corrosion, Uniform, Galvanic, Crevice, Pitting, Crevice, Erosion, Intergranular, Selective leaching, Stress corrosion cracking, Hydrogen damage, Liquid metal attack, Hydrogen embrittlement, Atmospheric corrosion – classification and factors influencing atmospheric corrosion, Introduction to high temperature corrosion, Prevention of high temperature corrosion, Corrosion/ Chemical degradation of non-metallic materials like rubbers, plastics and ceramics. Polarization: Thermodynamics and Kinetics of Electrode Processes- Polarization Curves, Over-Potential, Passivity, Trans-passivity, Measuring polarization, Anodic polarization, Cathodic polarization, Activation Polarization and Concentration polarization.. Corrosion control: Principles of corrosion prevention, Material selection, Design considerations, Control of environment including Inhibitors and Passivators, Coatings – metallic, inorganic, organic, Electroplating of copper, Nickel and Chromium, Electro-less plating, Anodising, Galvanizing, Thermal spraying, Alloy plating, Cathodic and anodic protection, Chemical and electrochemical polishing, Phosphating, Chromating, Chemical colouring. Corrosion Monitoring: Laboratory corrosion tests, Accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by Gravimetric, Tafel polarization, Linear polarization, Cyclic polarization, Impedance spectroscopy, NDT techniques - Ultrasonic, Radiography and Eddy current.

#### **References:**

- Mars G. Fontana, Corrosion Engineering, (3e), Tata McGraw Hill, New Delhi, 2008.
- Zaki Ahmed, Principles of Corrosion Engineering and Corrosion Control, Elsevier Science and Technology Books, 2006.
- Trethewey K. R. and Chamberlain Longman J., Corrosion for students of Science and Engineering, Scientific & Technical New York, USA, 1988.
- Philip A Schweitzer, Fundamentals of corrosion-Mechanisms, Causes and Preventive methods, CRC Press, Taylor and Francis Group, Boca Raton, 2010.
- Uhlig H.H. and Revie R. W., Corrosion and Corrosion Control, Wiley, NY, 1985.
- Shreir L.L., Corrosion. Vol I and II, Butterworths, Kent, 1976.

#### **MME 4066: ELEMENTS OF MECHATRONICS SYSTEMS [3 0 0 3]**

Introduction: Definition, basic concepts and elements of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors, Transducers: Displacement. Piezoelectric actuators, Shape memory alloys. Hydraulic & Pneumatic devices – Power supplies, valves, cylinder sequencing. Data acquisition and translation: Signal conditioning – Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Pulse width Modulation Counters, decoders, ADC, DAC Signal Analysis - Linearization of data, Compensation, Signal Averaging, Fourier analysis. Data presentation system: Display - Cathode ray oscilloscope, LED, LCD, Printers, Magnetic Recording, Controllers and Algorithms: Microprocessor Applications.

#### **References:**

- Alciatore David G & Histan Michael B, Introduction to Mechatronics and Measurement systems, Tata McGraw Hill, 2003.
- Boltan W, Mechatronics, Addison Wesley Longman Ltd, 1999.
- Devdas Shetty & Richard Kolk, Mechatronics System Design, PWS Publishing, 2001
- Dan Nesculescu, Mechatronics, Pearson Education Pvt. Ltd, 2002.
- Bradley D A and others, Mechatronics, Nelson Thornes Chennai, 2004.

#### **MME 4060: ERGONOMICS [3 0 0 3]**

Definitions of Ergonomics, Role of human factors engineer, Types of systems, Elements of man-machine system, System approach to human engineering, Information input and processing, Information theory, Sources and pathways of stimuli, Human sensorimotor system, Biases in decision making. Visual Displays, Quantitative and qualitative displays, Auditory displays, Biomechanics of motion, Functions of controls, Factors influencing design of control, Design of hand and foot controls, Use of Anthropometric data, Work surface, Location of component and general work place arrangement, Industrial fatigue, Causes and elimination of fatigue, Productivity and its improvement, Worker and working environment, Effect of light, colour, noise and vibration on performance.

#### **References:**

- Mark S. Sanders and Ernest J McCormick, Human Factors in Engineering and Design, (7e), McGraw-Hill and Co, Singapore 1992.
- Bridger R.S., Introduction to Ergonomics, Taylor & Francis, (3e), 2008.
- Pulat B. Mustafa, Fundamentals of Industrial Ergonomics, (2e), Waveland Press Inc, Illinois, 1997.
- Khan M. I., Industrial Ergonomics, PHI Learning Pvt. Ltd., New Delhi, 2010.
- Gavriel. Salvendy, Handbook of Human Factors and Ergonomics, (3e), Wiley, Hoboken, New Jersey, 2006.

#### **MME 4067: FATIGUE AND FRACTURE [3 0 0 3]**

Introduction: Background and overview, engineering materials, structure and deformation of materials, fatigue design philosophies, modes of mechanical failure, fatigue mechanisms and microscopic features, macro aspects of fatigue of metals. High-cycle fatigue: Fatigue loading, fatigue testing, stress-life curves: general S-N behavior, fatigue limits, mean stress effects on S-N behavior, constant life diagrams; factors influencing S-N behavior: surface treatments, S-N curve representation and approximations, stress concentration effects, notch sensitivity factor, empirical relations for notch sensitivity factor, life estimation using

S-N approach, cumulative damage and life prediction. Low-cycle fatigue: Monotonic stress-strain behavior, cyclic stress-strain behavior, cyclic strain hardening and softening, Bauschinger effect, shakedown, cyclic creep, cyclic stress-strain curve determination, stress-plastic strain power law relationship, fatigue crack initiation in ductile solids, cyclic deformation and crack initiation in brittle solids. Strain-life approach: strain life curve, determination of fatigue properties, transition life, mean stress effects and strain life equations, notch strain analysis and the strain – life approach, notch stresses and strains, Neuber's rule, examples of life estimation. Linear elastic fracture mechanics: Fracture modes, fracture criteria, mechanisms of fracture & crack growth, Griffith's analysis, energy release rate, elastic crack tip fields, fracture criteria for elastic brittle fracture, stress and displacement field, stress intensity factor, effect of finite size, crack tip plasticity, plastic zone shape and size, R-curves, effect of finite size, effect of specimen dimensions, plane strain fracture toughness, plane stress and transitional behavior. Fatigue fracture mechanics: Fatigue crack growth, empirical fatigue crack growth equations, crack closure and fatigue threshold, crack growth behavior under variable amplitude loading, effect of over load on fatigue crack growth, prediction of fatigue crack growth and life of a structural component, generation of crack growth plots.

**References:**

1. Bannantine Julie A, Jess J Comer and Handrock James L, Fundamentals of Metal Fatigue and Analysis, Prentice Hall, Upper Saddle River, NJ, 1990.
2. Dowling Norman E, Mechanical Behavior of Materials, (2e), Prentice Hall International Inc., New Jersey, USA, 1999.
3. Stephens Ralph I, Fatemi Ali, Stephens Robert R and Henry, Metal fatigue in Engineering, (2e), John Wiley and Sons Inc, New York, 2001.
4. Suresh S, Fatigue of Materials, (2e), Cambridge University Press., UK, 1998.
5. Anderson T. L., Fracture Mechanics-Fundamentals and applications, (2e), CRC Press, London, 1995.

**MME 4068: FLUID DRIVES AND CONTROL [3 0 0 3]**

Pneumatic systems, Structure and signal flow of pneumatic systems, Air generation and distribution, Working of Filter, Lubricator and Pressure regulator, Pneumatic actuators, Control valves for direction and flow, Design of manually operated circuits, Control of multiple actuators, Electro pneumatic sensors, Design of electro pneumatic circuits, Hydraulic power pack and accessories, Hydraulic fluids, Filters, Types of hydraulic pumps, actuators, Pressure control, Flow control and Direction control valves, Calculation of Force, Speed and Power developed in hydraulic systems, Design of Hydraulic circuits.

**References:**

1. Peter Croser and Frank Ebel, Pneumatics Basic Level TP 101, Festo Didactic GMBH & Co, Germany, 2002.
2. Prede G. and Scholz D., Electropneumatics Basic Level, Festo Didactic GMBH & Co, Germany, 2002.
3. Merkle D., Schrader B. and Thomes M., Hydraulics Basic Level TP 501, Festo Didactic GMBH & Co, Germany, 1998.
4. Peter Rohner, Industrial Hydraulic Control, John Wiley & Sons, Brisbane, 1989.
5. Majumdar S.R., Oil Hydraulic Systems Principles and Maintenance, Tata McGraw Hill, New Delhi, 2005.

**MME 4069: FRICTION AND WEAR [3 0 0 3]**

Influence of material properties, rolling friction, Measurement of friction, friction coefficient values. Mechanism of adhesive wear, shapes of

transferred and loose wear particles, size distribution of wear fragments, quantitative laws of adhesive wear, wear coefficients, Abrasive wear, Corrosive wear, Impact wear, Hydrodynamic, hydrostatic and elasto-hydrodynamic lubrication, solid film lubrication, boundary lubrication – single penetration and multiple penetration models. Effectiveness of liquid lubricant and solid lubricant. Rebuilding and surfacing cements, wear tiles, electro spark deposition coatings, fused carbide cloth, thermal/chemical deposited ceramic coatings, centrifugal cast wear coatings, wear sleeves, wear plates.

**References:**

1. Rabinowicz E, Friction and Wear of Materials, John Wiley & Sons, Inc., 1995.
2. Bharat Bhushan, Principles and applications of Tribology, John Wiley & Sons Inc., 1999.
3. Arnell R D, Davies P B, Halling J & Whomes T L, Tribology: Principles and design applications, Macmillan Education Ltd, 1991.
4. Kragelsky I V, Friction Wear Lubrication – Tribology hand book vol 1, 2 & 3, MIR Publishers, 1981.
5. Majumdar B. C., Tribology of Bearings, Wheeler Publisher, 1990.

**MME 4057: INDUSTRIAL ROBOTICS [3 0 0 3]**

Definition of robots, Automation and Robotics, Robot configuration, Robot Motions, Work Volume, Drive System, Control System, Precision of movement, Specification of a robot, Applications of industrial robots, Robot Motion Analysis, Forward and reverse transformation of 2 degree of freedom arm, Arm manipulation for 3 degree of freedom arm, Homogeneous transformations and robot kinematics, Robot Dynamics, Robot end effectors, Force analysis of gripper, Physical support of the end effectors, Guidelines for gripper selection, Sensing systems, Types and features of robot sensors, Machine vision, Robot Control Systems, Mathematical models, Types of controllers, Robot drive system and programming languages.

**References:**

1. Mikell P Groover, Mitchel Weiss, Roger N Nagel, Nicholas G Odrey and Ashish Dutta,
2. Industrial Robotics, (2e), McGraw Hill Education (India) Pvt. Ltd, 2012.
3. Yoram Koren, Robotics, McGraw Hill., 1992.
4. Groover M.P., Cam and Automation, Prentice Hall, 1995.
5. Yu Kozyhev, Industrial Robots Handbook, MIR Pub. 1985.

**MME 4070: INTRODUCTION TO COMBUSTION [3 0 0 3]**

Introduction to combustion, history of combustion, combustion modes and flames, Types of fuels and their properties. Combustion and thermo-chemistry: property relations, laws of thermodynamics applied to combustion, Reactants and product mixtures, Stoichiometry, enthalpy of formation, enthalpy of combustion and heating values, Adiabatic flame temperature, chemical equilibrium, equilibrium products of combustion. Mass transfer: rate laws, species conservation. Chemical kinetics: Important chemical mechanisms, Simplified conservation equations for reacting flows, laminar premixed flames, Simplified analysis. Factors influencing flame velocity and thickness flame stabilization, laminar diffusion flames, Introduction to turbulent flames. Droplet evaporation and burning: Introduction, applications like in Diesel engines, gas turbine engines liquid rocket engines, simple models of droplet evaporation and droplet burning. Combustion and environment: Combustion products to environment and its effect, Quantification of emission and emission control methods.

**References:**

1. Stephen R. Turns, S.R., An Introduction to Combustion- Concepts and Applications(2e), McGraw- Hill, 2000.
2. Mishra D.P., Fundamentals of Combustion, PHI Learning Private Limited New Delhi, 2010.
3. Sharma S.P. and Mohan, C., Fuels and Combustion, Tata McGraw-Hill, 1987.
4. Sarkar. S., Fuels and Combustion, Orient Longman, 2005.
5. Mukunda H.S., Understanding of Combustion, Mc Millan India Ltd, New Delhi 1989.

**MME 4071: JET PROPULSION AND ROCKET TECHNOLOGY [3 0 0 3]**

Jet Propulsion, Thrust equation, Efficiencies: Ram efficiency, thermal efficiency, propulsive efficiency, propeller efficiency. Propulsive Devices: turbo jet, turbo prop engine, turbo shaft engine, Ram jet, pulse jet, Rocket Propulsion, Principle of rocket propulsion, thrust equation, Criteria for Rocket-Motor Performance- specific impulse, total impulse, Chemical Rockets: Solid propellant rockets, types of solid propellant, burning rate, solid propellant grain configurations. Liquid propellant rockets, Feed systems and injectors. Gaseous propellant rockets, Developments in Rocket Technology: nuclear propulsion systems, Electrical propulsion and Hybrid rockets.

**References:**

1. Zucrow, Aircraft and Missile Propulsion, Vol I and II, John Wiley, New York. 1958.
2. Jain J K, Gas Turbine Theory and Jet Propulsion, (7e), Khanna Publishers. New Delhi, 1972.
3. Mathur M L and R P Sharma, Gas Turbines and Jet Propulsion, Standard Publishers Distributors, Delhi, 2000.
4. Yahya S M, Fundamentals of compressible flow with aircraft and rocket propulsion, New Age International Pvt. Ltd. New Delhi, 2004.
5. Ganesan V, Gas Turbines, Tata McGraw-Hill, New Delhi. 2005.

**MME 4072: MACHINE TOOL TECHNOLOGY [3 0 0 3]**

Working and Auxiliary motions in machine Tools, Parameters defining working motions of a machine tool, Machine tool drives-individual drive, Group drive, Mechanical Drives for providing rotational movements, Selection of range of spindle speeds, Typical layouts for intermediate spindle speeds, Construction of speed diagram, Layout of speeds in GP, Saw diagram of a GP series, Rules for layout of speed boxes having sliding clusters, Flow Diagram, Ray diagram, Types of Feed Gear Boxes, Functions and Requirements of machine tool structures, Profiles, Factors affecting stiffness of machine tool structures & Methods of improving it, Commonly used bed and column sections, Antifriction guide ways, Protecting devices, Spindles, Milling & Drilling machines, Antifriction bearings, Elimination of vibration, Machine tool chatter, Vibration isolated tool holders.

**References:**

1. Mehta N K, Machine Tool Design & Numerical control, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2012.
2. Sen and Bhattacharya, Principles of Machine Tools, New Central Book Agency, Calcutta, 2001.
3. CMTI., Machine Tool Design Handbook, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2004.
4. Basu S K, Design of Machine Tools, Oxford & IBH, Delhi, 1989.
5. George Schlesinger, Testing Machine Tools, Pergamon Press, Oxford, 1982.

**MME 4073: MACHINE TOOLS AND METROLOGY [3 0 0 3]**

Machine Tools: Lathe: Types, Parts, Feed Mechanisms, Specifications of lathe, Lathe Operations, Accessories and Attachments, Machining time estimation. Shaper and Planer: Types, Specifications, Crank and slotted link mechanism, Stroke length and position adjustments, Automatic feed mechanisms, Shaper vs Planer, Machining time estimation. Drilling: Operations, Types, Mechanisms, Nomenclature of a drill, Machining time estimation. Milling: Types, Up Milling Vs Down Milling, Types of milling cutters, Operations, Machining time estimation, Dividing head. Grinding: Specification and selection of grinding wheels, Truing, Dressing, Classification of Grinding wheels Finishing Processes: Lapping, Honing and Super-finishing processes. Metrology: Linear and Angular Measurements: Length Measuring Instruments, Angle measuring instruments. Limits, Fits, Tolerances and Gauging: Interchangeability, Terminology, Types of fit, Basic-Hole System, Basic-Shaft System, Problems, Tolerance grades, Metric fits, Design of limit gauges. Comparators: Mechanical, Pneumatic, optical, electrical and electronic comparators. Gear and Screw Thread Measurements: Gear measurement: Introduction and Classification of gears; Forms of gear teeth; Gear tooth terminology; Methods of measuring tooth thickness, tooth profile & pitch, Gear Errors; Screw Thread Measurement: Terminology, Forms of thread, Errors in threads, Measurement of major, minor and effective diameters (2-wire and 3-wire methods). Geometric Form Measurement: Straightness, Flatness, Roundness, Coordinate Measuring Machine.

**References:**

1. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, Pearson.
2. Rao, P.N., Manufacturing Technology–Metal Cutting and Machine Tools, Tata McGraw Hill, New Delhi, 2000.
3. Hajra Chowdary, S.K., and Hajra Chowdary, A.K., Elements of Workshop Technology, Vol. II, Asia Publishing House, Bombay, 2003.
4. I.C. Gupta, Engineering Metrology, Dhanpat Rai & Sons, 2003
5. R. K. Jain, Engineering Metrology, Khanna Publishers, 19/e, 2005.

**MME 4074: MATERIALS CHARACTERIZATION [3 0 0 3]**

Introduction to Optical Microscopy, Principles of image formation and its Applications, Scanning Electron Microscopy. Principles, Resolution, Image Formation, Electron-specimen interaction, Ancillary techniques (EDS, BSDP, Cathodoluminescence, etc.), Science of Imaging and diffraction, Transmission Electron Microscopy, X-ray Diffraction, X-ray Fluorescence, Scanning Auger Microscopy, Electron Backscatter Diffraction (EBSD), Quantitative Micro and Nanostructure.

**References:**

1. J. Goldstein, D. Newbury, D. Joy, C. Lyman, P. Echlin, E. Lifshin, L. Sawyer and J. Michael. "Scanning Electron Microscopy and X-ray Microanalysis", (3e), Springer Science 2003.
2. David B. Williams, C. Barry Carter, "Transmission Electron Microscopy: A Textbook for Materials Science", Springer, pub. 2009.
3. Joseph I Goldstein, Dale E Newbury, Patrick Echlin and David C Joy, "Scanning Electron Microscopy and X-Ray Microanalysis", (3e), 2005.
4. Ray Egerton: "Physical Principles of Electron Microscopy" Springer Science 2005.

**MME 4075: MEMS AND NANOTECHNOLOGY [3 0 0 3]**

General methods of preparation of nano particles, Carbon nanostructures and their Applications. Nanosized Structures, Physical chemistry of nanosystems, Nanoparticles, Nanowires and Nanorods, Thin films- Self assembled monolayers, Experimental techniques- Temperature measurement techniques, Atomic Force Microscopy,

Scanning Tunneling Microscopy, Spectroscopy and Diffraction techniques. Micro Electro Mechanical Systems, MEMS, Micro and Nanoscale Thermal Engineering, Nanofluids preparation and Characterization, Properties of nanofluids, Nanomaterials used in energy and Environmental applications and their Properties. Device applications in hydrogen storage and Production, Fuel cells, Battery, Solar energy conversion, Waste water treatment, Pollution remedies, Nanomaterials in automobiles. Challenges and Scope.

**References:**

1. Charles P Poole, Introduction to Nanotechnology, Wiley-Interscience Publication, 2003.
2. Guozhong Cao, Nanostructures & Nanomaterials, Imperial College Press, 2004.
3. Sobhan C B, Microscale and Nanoscale Heat Transfer, Taylor and Francis Publication, 2008.
4. Mohamed Gad-el-Hak, The MEMS Handbook, Taylor and Francis Publication, 2005.
5. James J Allen, MEMS Design, Taylor and Francis Publication, 2005.

**MME 4076: MICRO MACHINING [3 0 0 3]**

Definition of Micro machining, Need, Classification and Applications of micro machining, types of micro Machines, Micro cutting tools, Sensors and actuators. Traditional micro machining processes like turning, drilling, milling and grinding. Abrasive micro machining and nano finishing, Ultrasonic micro machining, Magneto rheological finishing. Electric discharge micro machining, Wire electric discharge micro machining, Electric discharge grinding, Electric discharge diamond grinding, Laser beam micro machining, Electron beam micro machining, Ion beam micro machining. Chemical Micro machining, Electro chemical micro machining, Electro chemical micro grinding, Electro stream micro drilling, Electro chemical micro deburring, Shaped tube electrolytic micro machining. Bulk micro machining and its applications, Surface micro machining and its applications. Stiction and antistiction in micro machining. Hybrid micro machining like Wafer bonding - Anodic bonding, Fusion bonding, Thin film deposition techniques - CVD and PVD processes, Electro plating, Atomic layer deposition, Spin coating, Evaporation and Epitaxy, Laser ablation technique. Principles of photo lithography, Photo-mask and photo-resists, LIGA and micro molding techniques, Deep X-ray lithography and their applications.

**References:**

1. Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group, 2012
2. Mishra P. K., Nonconventional Machining, Narosa Publishers, New Delhi, 2007.
3. McGeough J. A., Advanced Methods of Machining, Springer, 1988.
4. Kahrizi M., Micromachining Techniques for Fabrication of Micro and Nano Structures, Intech, 2012.
5. Gad-el-Hak M., The MEMS Handbook, Taylor and Francis, 2005.

**MME 4077: MODELING AND SIMULATION OF DYNAMIC SYSTEMS [3 0 0 3]**

Introduction to Modeling, Models of Systems, Subsystems, and Components, Types of systems, Engineering Multipoints, Ports, Bonds, and Power, Bond Graphs, Inputs, Outputs, and Signals, Basic Bond Graph Elements, Causality, Basic System Models Mechanical systems involving translation, rotation, Hydraulic systems, Acoustic systems and Electrical systems, System Models of Combined Systems, Multi Energy Domain systems, Transducers, Transformers, Gyroscopes, Thermo-fluid system, Mechatronic system, State-Space Equations, Automated Simulation, Analysis and Control of Linear Systems.

**References:**

1. Dean C. Karnopp, Donald L. Margolis and Ronald C. Rosenberg, System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems, John Wiley & Sons, Inc. Fifth Edition, 2012.
2. Shuvra Das, Mechatronic Modeling and Simulation Using Bond Graphs, CRC Press, 2009.
3. Wolfgang Borutzky, Bond Graph Methodology Development and Analysis of Multidisciplinary Dynamic System Models, Springer, 2010.
4. Jean U. Thoma, Simulation by Bondgraphs, Springer, 1990.

**MME 4078: NON-CONVENTIONAL ENERGY SOURCES [3 0 0 3]**

Potential of renewable energy resources and applications, Solar radiation at the earth's surface, Measurement of solar radiation, Solar radiation geometry, Empirical equations for predicting the availability of solar radiation, Thermal applications of solar energy, Liquid flat-plate collectors, Principles of wind power, Types of windmill, Site selection, Betz theory, Forces on the blades and thrust on turbines, Types of biomass, Types of biogas plants, Influencing factors for the generation of biogas, Aerobic fermentation, Ethanol production – from wood by acid hydrolysis and from sugar cane, Thermo-chemical method of bio-conversion, Pyrolysis method, Power from the wave, Wave energy conversion by floats - Oscillating float air pump and Buoy-Dolphin type, Tidal energy conversion by single pool system and two pool system, OTEC, Small scale hydel plant, Geothermal energy conversion, Direct energy conversion, Conversion of thermal energy into electricity, Thermo-electric converters, Thermo-ionic converters, Conversion of chemical energy into electricity-Fuel Cells, H<sub>2</sub>-O<sub>2</sub> acidic fuel cell, Conversion of electromagnetic energy into electricity, solar cells.

**References:**

1. S P Sukatme – Solar Energy Principles of Thermal Collection and Storage – Tata Mc Graw Hill, 2005.
2. M M El-Wakil – Power plant Technology - McGraw Hill International, 1984.
3. G D Rai – Non-conventional Energy Sources – Khanna Publications, 1997.
4. S Rao and Dr. B B Parulekar – Energy Technology – Khanna Publishers, 2004.
5. A W Culp – Jr. Principles of Energy Conversion – McGraw Hill International, 2001.

**MME 4079: NON DESTRUCTIVE TESTING [3 0 0 3]**

Introduction and benefits of NDE, selection of NDE technique. Visual Inspections. Penetrant inspections principle, testing procedure and materials, testing methods and systems, sensitivity, standards, applications and limitations. Magnetic particle testing basic principle, testing procedure, equipment, sensitivity, standards, limitations. Ultrasonic testing principle, basic of about soundwave propagation, Ultrasonic Transducers, types of probes. Pulse echo and through transmission methods, normal and angle beam methods. Criteria for probe selection, ultrasonic techniques for stress measurement and material studies. Applications, merits, limitations, standards, standardization and calibration. Radiographic techniques: basic principle, Radiographic imaging film radiography, real-time radiography (radioscopy), radiographic tomography. Geometric factors, radiographic film. Exposure, radiographic sensitivity, evaluating image quality and sensitivity. Radiographic inspection techniques and systems. Applications of radiography in NDE, safety consideration in radiographic inspections. Eddy current testing, Principles and Instrumentation, 3D or phased array ECT. Sensitivity, advanced eddy current test methods, eddy



current testing for conductivity and wall thickness, crack detection. Applications, limitations, standards. Eddy current instruments. Acoustic emission testing, principal, AE sensors, signal parameters, signal analysis, noise, data quality analysis, standards, applications. Thermography: principles, equipment, techniques, applications and codes and standards. Comparison and selection of NDT methods, Case study of NDT for damage inspection/detection and characterization, process monitoring and structural monitoring.

**References:**

1. Don E Bray and Roderic K Stanley, Nondestructive Evaluation: A tool in design, manufacturing and service, Taylor and Francis Group, London, 1997.
2. Paul E Mix, Introduction to Nondestructive Testing-A Training Guide, (2e), John Wiley and Sons, Inc., 2005.
3. NDT Hand Books Vol. 1 – 10, American Society for Nondestructive Testing (ASNT), USA
4. Davis Joseph R., ASM Handbook: Volume 17, Nondestructive Evaluation and Quality Control, ASM International Materials Park, OH.
5. ASNT (Edited), Materials and Processes for NDT Technology, ASNT, USA, 1981.

**MME 4080: OPERATIONS RESEARCH [3 0 0 3]**

Introduction: Definition, Phases, Applications, Advantages and Limitations of Operations Research. Linear programming problems: Assumptions, Formulation of LPP for business and non-business applications. Graphical solutions, Special cases – Degeneracy, Infeasible Solution, Unbalanced and Multiple optimal solutions. Minimization and Maximization cases. Simplex algorithm, Concept of dual, Sensitivity analysis with respect to objective function coefficients and R.H.S. values. Transportation problem: Formulation, North-West Corner (NWC) Method, Least Cost (LC) Method, Vogel's Approximation Method (VAM). Testing the solution by Stepping stone, Modified Distribution (MODI) Method. Maximization, Multiple optimal solutions, Degeneracy and Unbalanced problems. Post optimality analysis. Assignment problem: Solution algorithm for Assignment Problems. Unbalanced, multiple optimal solutions, Maximization and Application problems. Travelling salesman / Job sequencing problem: Solution algorithm for Travelling Salesman Problem, Application to job sequencing problem Game theory: Introduction to game theory, Two-person-zero sum games, Pure and Mixed Strategies, Solution methods for 2 x 2 games, Graphical method (2 x n games; m x 2 games), Simulation of queuing system - Steps in simulation, Application and Limitations, Monte- Carlo technique-Problems involving Waiting line situations and Selection of crew members. Critical Path Method (CPM): General frame work, Introduction to elements of network, conventions adapted in drawing network, analysing the network. Calculation of event and Activity times, Total Float, Free Float, Independent float, Critical path, Determination of project duration, Project Crashing. Applications and Limitations of CPM. Project Evaluation and Review Technique (PERT): Calculation of Probabilistic/Expected event and Activity times, Variance of activity duration, Determination of critical path, probability/expectation of project completion.

**References:**

1. Taha H. A., Operations Research, Pearson Education, (7e), 2002.
2. W.L. Winston, Operations Research, Thomson Asia, 2003.
3. Vohra N. D., Quantitative Techniques in Management, New Delhi, 2007.
4. Sharma S. D., Operations Research, Kedar Nath Ramnath Publications, (14e), 2005
5. Kanthiswaroop, Gupta and Manmohan, Operations Research, Sultan Chand and Sons.

6. Hervey M. Wagnor, Principles of Operations Research, Prentice Hall of India Private Ltd.
7. Paul Loomba, Management, A Quantitative Perspective, MacMillan, New York, 1978.

**MME 4053: ORGANIZATIONAL BEHAVIOR [3 0 0 3]**

Contributing disciplines to OB, Basic OB Model. Learning, Methods of shaping behavior, Values, Attitudes and Job satisfaction, Personality, Determinants of Personality, Personality theories, Major personality attributes, Perception Attribution Theory, Selective perception, Halo effect, Contrast effect, Stereo-typing. Maslow's hierarchy of needs, Theory X and Theory Y, Frederick Herzberg's Motivation and Hygiene Theory, Contemporary Theories, Group Dynamics, Group Behaviour Model, Quality of a good leader, types and theories of leadership. Conflict, Dimensions of Conflict Handling Intentions, Virtual Organisation, Boundary less Organisation, Mechanistic and Organic Model, Factors influencing organisation structure. Work Design, Organisational Change and Organisational Development, Lewin's Three-Step Model and Action research. Organisational Development.

**References:**

1. Luthans Fred, Organisational Behaviour McGraw Hill, New York, 1989.
2. Gupta Rakesh, Organisational Behaviour, KitabMahal, Allahabad, 1998.
3. Davis Keith and Newstrom J.W., Organisational Behaviour at Work, Tata-McGraw Hill, New Delhi, 1997.
4. Moorhead Gregory and Griffin Ricky W., Organisational Behaviour, AITBS, New Delhi, 1999.
5. Carrel Michael R., Fundamentals of Organisational Behaviour, Prentice Hall, New Jersey, 1997.

**MME 4054: PERSONNEL MANAGEMENT AND INDUSTRIAL RELATION [3 0 0 3]**

Human Resource planning and HRM - HRM process-Objectives and scope Wage and salary administration. Promotion-Demotion- Transfer-Layoff. Absenteeism- Recruitment- Selection- Training-Orientaion and Induction-Job evaluation and merit rating. Industrial relation Industrial Disputes-Grievances and grievance handling system-Industrial safety.

**References:**

1. Mamoria, C.B., Personnel Management, Himalaya Publishing House, 2007
2. Megginson, Leon C., Personnel and Human Resource Administration, 1977
3. Beach, D.S., Personnel: The Management of People At Work, 1977.
4. Yoder and Dale, Personnel Management and Industrial Relations, 1972.

**MME 4081: PIPE SYSTEM ENGINEERING [3 0 0 3]**

Introduction: Definition and scope, Importance advantages of transport by pipeline, Piping elements. Codes and standards: ASME codes, Materials of construction, Pipe sizes. Single phase incompressible flow: Flow regimes, Development of velocity profile, Pressure drop calculations, Bernoulli's equation, Major and minor losses, Hydraulic and energy grade lines. Pipe networks: Pipe hydraulics and sizing, Pump and pipe system matching, H-Q curves, Pipes in series and parallel, Pipe network analysis. Structural design of pipe lines: Stress due to internal fluid pressure, Stress due to external fluid pressure, High/low pressure pipes. Planning and construction of pipelines: Piping drawing basics, Development of plot plan, Process piping layout, Utility piping layout,

Selection of supports & expansion joints, Flexibility analysis. Protection of pipelines: Pipeline damage due to corrosion, abrasion, heating and freezing, Protection methods - Lining, coating, insulation, jacketing etc. Industrial pipelines: Non-Newtonian fluid flow, Single phase compressible flows - Flow analysis for ideal gas, flow analysis for real gas, Multi-phase flows – Slurry pipelines, Pneumotransport, Capsule pipelines.

**References:**

1. Henry Liu, Pipeline Engineering, Lewis Publishers, CRC Press LLC, Florida, 2003
2. George A. Antaki, Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair, CRC Press, 2003
3. Bruce E. Larock, Roland W. Jeppson, Gary Z. Watters, Hydraulics of Pipeline Systems, CRC Press LLC, Florida, 2000
4. Mohinder L. Nayyar, Piping Handbook, McGraw-Hill, 2000

**MME 4082: PLANT ENGINEERING AND MAINTENANCE [3 0 0 3]**

Introduction to plant engineering, Industrial buildings, Fire detection and suppression, Introduction to industrial flooring, Floor paints, Self-leveling systems, Heavy duty flooring, Ventilation systems and control, Water purification processes, Membrane processes, Effluents. Noise and Vibration control, Air pollution, Dust and fume control, Introduction to dust collection system, Bag houses, Cyclone separators, Introduction to air pollution, Legislation on air pollution, Maintenance, Responsibilities of the maintenance department, Breakdown maintenance, Scheduled maintenance, Preventive maintenance, Corrective maintenance, Total productive maintenance, Planning, scheduling and economic aspects of maintenance function, Estimation of maintenance work, Maintenance control, Maintenance scheduling, Life cycle costing, Maintenance budgeting and cost control., Techniques of condition monitoring.

**References:**

1. Mobley K. R., Plant Engineer's Handbook, Butterworth-Heinemann, Woburn, 2001.
2. Snow A. D., Plant Engineer's Reference Book, Butterworth-Heinemann, Woburn, 2000.
3. Mobely, Higgins and Wikoff, Maintenance Engineering Handbook, McGraw-Hill, 2008.
4. Mishra and Pathak, Maintenance Engineering and Management, PHI Learning Pvt. Ltd., 2012.
5. Jyoti Mehrotra, Principles and Practice of Total Productive Maintenance, Allied Publishers Ltd., 1998.

**MME 4083: PLANT LAYOUT AND MATERIAL HANDLING [3 0 0 3]**

Principle of plant layout, product, process and combination layout, economics of different types of layout. Factors influencing the layout- manpower, movement, service, material, machinery, waiting, building and change factors, location of storages & delay point. Layout planning- scientific approach, flow process chart, cross chart, string diagram, line balancing, templates evaluation of layout, installation of layout, computerized layout planning. Material handling- principles of material handling, factors in selection of material handling equipment, safety in material handling, types of material handling equipment, modern material handling equipment.

**References:**

1. Buffa E. S. and Rakesh S. K., Modern Production and Operation Management, John Wiley & Sons, New York, 2003.
2. Richard M., Practical Plant Layout, McGraw-Hill, New York, 1955.
3. James Apple M., Plant Layout and Material Handling, John Wiley, New York, 1977.

4. Mathew P. Stephens and Fred E. Meyers, Manufacturing Facilities Design & Material Handling, (5e), Purdue University Press, 2013.
5. David E. Mulcahy, Materials Handling Handbook, McGraw Hill Professional, 1998.

**MME 4084: POWER PLANT ENGINEERING [3 0 0 3]**

Choice of site for power station, load estimation, load duration curve, effect of variable load on power plant, Economics of power generation. Hydro-Electric plants, Storage and pondage, flow duration and mass curves, hydrographs, Different types of fuels used for steam generation. Equipments for burning coal in lump form, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace. Coal and ash handling. Dust collection systems-Electrostatic Precipitator. Accessories for the steam generator such as super-heaters, de-super-heaters, control of super-heaters, economizers, Air Pre-heaters and re-heaters. Cooling towers and ponds, General arrangement of Diesel Power Plant. Gas Turbine Power Plant, Principles of release of nuclear energy. Fusion and fission reactions, Waste disposal.

**References:**

1. Rajput R K, Power Plant Engineering, Laxmi Publication (P) Ltd, 2010
2. Nag P K, Power Plant Engineering, Tata McGraw Hill Publishing Co. Ltd, 2008.
3. Nagpal G R, Power Plant Engineering, Khanna Publishers, 2008.
4. Skrotzki and Vopat, Power Station Engineering Economy, McGraw Hill Book Co.
5. Wrangham D.A., Theory and Practice of Heat Engines, ELBS Edition.

**MME 4055: PROJECT MANAGEMENT [3 0 0 3]**

Concept of project, Importance of project management, Project life cycle, Project management as an integrated approach, Organizing projects within the functional organization, Organizing projects as dedicated teams, Organizing projects within a matrix arrangement, Project manager and their attributes. Feasibility study: Pre-feasibility study, Technical feasibility, Managerial feasibility, Economic feasibility, Financial feasibility, Cultural feasibility, Political feasibility, Environmental feasibility, Market feasibility, Steps of feasibility study. Estimating project times and costs: Factors influencing the quality of estimates, Costs associated with projects, Estimating guidelines for times, costs and resources, Top-down approaches of estimation, Bottom-up approaches of estimation, Hybrid approach of estimation. Risk management process: Risk identification, Risk Assessment - probability analysis, Mitigating risk, Avoiding risk, Transferring risk, Sharing risk, Retaining risk, Contingency planning, Contingency funding and time buffers, Risk response control – change control management, Decision tree analysis, Numerical. Project scheduling: Bar charts and Milestone charts, Elements of network, Development of networks, Work Breakdown Structure (WBS), Critical Path Method, Program Evaluation and Review Technique, Network crashing, CPM updating, Numerical. Project audit and closure: Guidelines for conducting a project audit, Initiating and staffing, Data collection and Analysis, Audit reporting, Conditions for project closure, Evaluation of project team and members.

**References:**

1. Gray C., Larson E. and Desai G., Project Management - The Managerial Process, Tata McGraw Hill Pvt. Ltd., New Delhi, 2013.
2. Paneerselvam R. and Senthilkumar P., Project Management, PHI Learning Pvt. Ltd., New Delhi, 2010.
3. Meredith J. and Mantel S., Project Management - A Managerial Approach, John Wiley & Sons, USA, 2012.
4. Vohra N. D., Quantitative Techniques in Management, New Delhi, 2007.

5. Paul Loomba, Management, A Quantitative Perspective, MacMillan, New York, 1978.

#### **MME 4085: STATISTICAL QUALITY CONTROL [3 0 0 3]**

Definitions of the term quality, Causes of variation, Patterns of variation, Frequency distribution, Measures of central tendency and dispersion, The Normal distribution curve, Inequality theorems, Shewhart's bowl drawing experiments, Control charts for variables ( $\bar{X}$ , R and s charts), Type I and Type II Errors, Process capability analysis, Process capability indexes, Control charts for attributes (p, np, c and u charts), Acceptance sampling by attributes, Single and Double sampling plans, Operating characteristic curve, Acceptable quality level, Lot tolerance percent defective, Average outgoing quality, Average total Inspection, Average fraction inspected, Producers risk, Consumers risk, Acceptance sampling tables, Conventional and Statistical tolerancing, Precision, Accuracy and Reproducibility of method of measurements, Quality costs.

#### **References:**

1. Grant E. L and Levenworth R., Statistical Quality Control, McGraw Hill Publications, 2005.
2. Montgomery D.C., Introduction to Statistical Quality Control, John Wiley and Sons, 2005.
3. Mahajan M.S., Statistical Quality Control, Dhanpat Rai and Co. Pvt. Ltd., 2012.
4. Juran J.M. and Gryna F.M., Quality Planning and Analysis, Tata McGraw Hill Publications, 1995.
5. Bertrand L. Hansen, Quality Control- Theory and Applications, Prentice Hall India, 1987.

#### **MME 4086: SUPPLY CHAIN MANAGEMENT [3 0 0 3]**

Introduction and objectives of supply chain, Decision phases in a supply chain, Purchasing tools and techniques, Value analysis, Project planning and control techniques, Pricing and revenue management, Costing fundamentals, Types of costing, Managing inventory in a supply chain, Economic order quantity, EOQ determination with instantaneous delivery and without shortages, Effect of quantity discount, safety stock, reorder level & lead time. Facility decisions in supply chain:, Factors influencing network design in supply chain, Models for facility location and capacity allocation, Transportation decisions in a supply chain, Routing and scheduling in transportation, Multistage transportation problems, Truck allocation problem, Travelling salesman problem, Vehicle routing problems, Financial evaluation of supply chain Decisions, The impact of financial factors on supply chain decisions, Discounted cash flow analysis, Evaluating supply chain decisions using decision trees.

#### **References:**

1. Chopra and Meindl., Supply Chain Management – Strategy, Planning and Operation, (3e), Pearson Education, New Delhi, 2009.
2. Raghuram and Rangaraj, Logistics and Supply Chain Management: Cases and Concepts, Macmillan, New Delhi, 2000.
3. Simchi-Levi and Kaminski, Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, McGraw-Hill, 2003.
4. Shapiro J., Modelling the Supply Chain, Duxbury Thomson Learning, U.S.A., 2009.
5. Krajewski Lee J. and Ritzman Larry P., Operations Management, Pearson Education (Singapore) Pte. Ltd., Delhi, 2005.

#### **MME 4056: TECHNOLOGY MANAGEMENT [3 0 0 3]**

Management of technology, system model, integrated and holistic model, Timing and innovation, technology and competition, Entrepreneurs and innovation, entrepreneurship in corporations,

entrepreneurship, organizational barriers to innovation, venture team. Business plans for new ventures, successful product innovation, sources of venture capital, Growth of new firms, Dynamics of new firms, corporate systems, dynamic factors affecting growth, Innovation Process, Forecasting Technology, Form of technology change, S-curve jumps from radical to system innovation, Technology life cycle, economic long cycles, Kondratieff waves, Technology and marketing, Sources of innovation, market pull and technology push, Corporate research, Project strategy, sales volume and profitability in product life time, R&D projects, production costs, market share, profit margin.

#### **References:**

1. Gearard H Gaynor, Handbook of technology management, McGraw Hill International Edition, 1996.
2. Betz Frederick, Managing Technology, John Wiley & Sons, 2011.
3. Steele Lowell W and Badaww Michel K., Managing Technology,
4. Narayanan V. K., Managing Technology and Innovation for Competitive Advantage, Prentice Hall, 2001.
5. Rungachari Krishna, Chari C. P., Technology Management and Business Development

#### **MME 4087: TOTAL QUALITY MANAGEMENT [3 0 0 3]**

Definition of quality and Total quality management (TQM), Basic concepts of TQM, Contributions of Gurus of TQM, Benefits of TQM, Characteristics of successful quality leaders, The Deming philosophy, Quality council, Quality statements, Strategic planning. Customer satisfaction, Employee involvement Continuous process improvement, Juran Trilogy, PDSA cycle, Kaizen, Six sigma, Supplier partnership, Performance measures, Quality costs, Benchmarking, Quality function deployment (QFD), QFD process, Failure Mode and Effect Analysis (FMEA), Total Productive Maintenance (TPM), The seven tools of quality control, Statistical fundamentals, Control charts for variables and attributes, Concept of six sigma quality, Taguchi's quality loss function, Quality and environmental management systems, Quality auditing, Case Studies.

#### **References:**

1. Dale H. Besterfield, Carol Besterfield-Michna, Glen Besterfield, Mary Besterfield-Sacre, Hemant Urdhwarsh, Rashmi Urdhwarsh, Total Quality Management. Revised 3rd Edition, Pearson Education, New Delhi, 2012
2. James R. Evans & William M. Lindsay, The Management and Control of Quality, (5e), South-Western Thomson Learning, 2002.
3. Oakland John S, Total Quality Management text with Cases, Elsevier, New Delhi, 2006
4. Dale H. Besterfield, Total Quality Management, Pearson Education, Delhi, 2006.
5. Mukherjee P.N., Total Quality Management, PHI Learning, New Delhi, 2010.

#### **MME 4088: WORK SYSTEMS ENGINEERING [3 0 0 3]**

Productivity in the individual enterprise, Total time of a job, Factors tending to reduce productivity, Techniques for reducing excess work content and ineffective time, Basic procedure of Work study, Basic procedure of Method study, Outline process chart, Flow process charts, Flow diagram, The questioning technique, Multiple activity chart, Travel chart, String diagram, The principles of motion economy, Two handed process chart, Micromotion study, Therbligs, SIMO chart, Work measurement, Time study, Types of elements, Methods of timing the elements, Methods of rating, Standard time determination, Work sampling, Predetermined time standards, Standard Data, Restricted work, Pump diagram, Ergonomics, Anthropometry, Working environment.

**References:**

1. International Labour Office (ILO), Introduction to work study (3e), Oxford & IBH Publishers, Geneva, 2008.
2. Niebel B.W. and Frievalds, A., Methods, Standards, and Work design (12e), McGraw-Hill, 2009.
3. Lakhwinder Pal Singh, Work Study and Ergonomics, Cambridge University Press, 2016
4. Barnes R.M., Motion and Time study (7e), John Wiley, 2009.
5. M S Sanders M.S. and E J McCormic E.J., Human Factors in Engineering Design (7e), McGraw Hill, 1992.

**OPEN ELECTIVE****MME 4301: ENERGY ENGINEERING [3 0 0 3]**

Steam power plant: Different types of fuels used for steam generation, Stokers, Different types, Oil burners, Advantages and disadvantages of using pulverized fuel, Pulverized fuel furnaces, Cyclone furnace, Coal and ash handling, Generation of steam using forced circulation, High and super critical pressures. Applications of diesel engines in power field, Parts and auxiliaries of diesel engines, Layout of diesel power plant. Hydro-electric plant, Hydrographs, Flow duration and mass curves, Storage and pondage in power plants, Penstock, Water hammer, Surge tanks, Gates and valves, General layout of hydel power plants. Principles of release of nuclear energy in nuclear power plants, Fusion and fission reactions, Nuclear fuels used in the reactors, Multiplication and thermal utilization factors, Elements of nuclear reactor, Radiation hazards, Shieldings, and Radioactive waste disposal. Solar radiation at the earth surface, Radiation measuring instruments, working principles of solar flat plate collectors, solar pond and Photovoltaic conversion. Photosynthesis, photosynthetic oxygen production in biomass system, Energy plantation, Biogas production, Classification of bio gas plants, Factors affecting bio gas generation, Thermo chemical conversion on bio mass, Types of gasifiers. Properties of wind energy, Wind velocity and power from wind, Types of wind machines and their characteristics, types of wind mills. Fundamental characteristics of tidal power, Harnessing tidal energy and limitations. Principle of working of ocean thermal energy, Rankine cycle, Limitations of OTEC. Geothermal energy conversion working principle, Types of geothermal stations, Limitations.

**References:**

1. Nag P.K., Power Plant Engineering, Tata McGraw Hill, 2002.
2. Domkundwar, Power Plant Engineering, Dhanpat Rai Publications, 2003.
3. Rai G. D., Non-Conventional Energy Sources, Khanna Publishers.
4. Rao S. and Parulekar B. B., Energy Technology, Khanna Publishers, 2004.
5. Culp A. W., Principles of Energy Conversion, McGraw Hill International, 2001.

**MME 4302: INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]**

Introduction to Safety Engineering, Industrial Accidents, Theories of Accident Causation, Introduction to Health and Toxic Substances, Environmental Control and Noise, Ventilation and its Design Principle, Personal Protection and First Aid, Fire Protection, Machine Guarding, Safeguarding the point of operation, Power presses, Grinding machines, Saws, Belts and Pulleys, Safety consideration regarding material handling and storage. Safety Requirement for Material Handling and Storage, Electrical Hazards, Employee Participation in Promoting Safety, Safety Training, Safety Committees, Teamwork Approach to Promoting Safety.

**References:**

1. Asfahl C R and Rieske D W, Industrial Safety and Health Management, (6e), Pearson Education, 2011.
2. Spellman F R and Whiting N E, The Handbook of Safety Engineering: Principles and Applications, Government Institutes, 2009.
3. Gupta A., Industrial Safety and Environment, (1e), Laxmi Publications Pvt. Ltd., 2006  
Goetsch D L, Occupational Safety and Health for Technologists, Engineers and Managers, (8e), Pearson Education Limited, 2014.

**MME 4303: INTERNAL COMBUSTION ENGINES [3 0 0 3]**

Introduction to IC engine, Analysis of air standard cycles, fuel air cycles and actual cycles. Modes of combustion, Stages of combustion in SI & CI engines, factors influencing the stages of combustion, normal and abnormal combustion, Control of abnormal combustion in SI and CI engines. Combustion chambers in SI and CI engines. Supercharging & Turbo-charging, Analysis of Modern developments in IC engines like Wankel engine, Electronic injection systems in SI engines. Common Rail Direct Injection (CRDI) engines, Multi point fuel injection. (MPFI) engines, dual-fuel engines and stratified charge engines. Introduction to engine Electronics, typical engine management systems, position, displacement and speed sensing, pressure, temperature and air measurement systems, exhaust oxygen sensors.

**References:**

1. Ganeshan V., Internal Combustion Engines, Tata McGraw Hill, Education Private Limited New Delhi, 2007.
2. Mathur and Sharma, A Course in I C Engines, Dhanpath Rai Publisher, New Delhi, 1981.
3. John B. Heywood, Introduction to Internal Combustion Engines, Tata McGraw Hill, Education Private Limited New Delhi, 2011.
4. Lichty L.C., Internal Combustion Engines, McGraw Hill New Delhi, 1951.
5. Edward F. Obert, Internal Combustion Engines and Air Pollution, Harper & Row, Publishers. Delhi, 1973.

**MME 4304: INTRODUCTION TO ALTERNATIVE FUELS & APPLICATIONS [3 0 0 3]**

Introduction to alternative fuels, Need for alternative fuels - Availability of different alternative fuels for SI and CI engines. Properties of potential alternative fuels, Liquid Fuels for S.I. Engines, Requirements of fuels for SI engines-Different Techniques of utilizing alternative liquid fuels- Blends, Neat form, Reformed fuels - Manufacturing, Storage and Safety- Performance and emission characteristics of alternative liquid fuels, Liquid Fuels in C.I. Engines, Requirements of fuels for CI engines-Different techniques for their utilization- Blends, Fuel modifications to suit CI engines, Dual fuelling, Ignition accelerators and other additives, Gaseous Fuels in S.I. Engines, Gaseous Fuels in C.I. Engines, Electrical Vehicles.

**References:**

1. Ramadhas A S, Alternative Fuels for Transportation, CRC Press, Taylor & Francis Group, 2010.
2. Thipse S S, Alternative Fuels: Concepts, Technologies and Developments, Jaico Book Distributors, 2010.
3. Gajendra Babu M K, Alternative Transportation Fuels: Utilization in Combustion Engines, CRC Press, Taylor & Francis Group, 2010.
4. Michael F. Horddeski, Alternative Fuels: The Future of Hydrogen, The Fairmont Press, 2008.
5. James D. Halderman, Hybrid and Alternative Fuel Vehicles, (2e), Prentice Hall, 2010.

## **OPEN ELECTIVES**

### **MCA 4301: INTRODUCTION TO DATABASE SYSTEMS WITH MYSQL [ 3 0 0 3 ]**

Modeling and Designing Databases, Database Design Process, Entity-Relationship Model, Basic Concepts, Constraints, Design of ER database schema, Reduction of ER to schema, Relational model, Super, candidate, primary, foreign key, Schema Diagram, Relational Database design, Functional dependencies, Normal forms, Creating a MySQL Database, Table, Modifying table, constraints, indexes, Basic SQL, Inserting Data, Selecting Data, Updating Data, Deleting Data, MySQL Functions, Numeric, String, Date /Time, Advanced Queries, Sorting, Multiple tables, Inner Join, Left Join, Right Join, Natural Join, Nested queries, Generating summaries, COUNT(), MIN(), MAX(), SUM(), AVG(), Group By, Statistical techniques, Calculating Descriptive statistics, Per-Group Descriptive Statistics, Generating frequency distribution, Calculating correlation coefficients, assigning ranks, Stored routines, stored procedure, stored function, Triggers, Events to schedule Database actions, Managing users and privileges, Importing and Exporting data, importing data with LOAD data and mysql import, importing csv files, exporting query results, tables, importing XML.

#### **References:**

1. Paul Dubois, MySQL Cookbook, O'REILLY, First Edition, 2007.
2. Larry Ullman, Visual Quick Start guide MySQL, Pearson Education, 2nd Edition, 2007.
3. Seyed M. M, Saied Tahaghoghi and Hugh Williams, Learning MySQL, O'Reilly, 2006.
4. Russell J.T. Dyer, MySQL in a Nutshell, O'REILLY, 2nd Edition, 2008.

### **MCA 4302: INTRODUCTION TO VR AND AR TECHNOLOGIES [3 0 0 3]**

Introduction: Input Devices, Output Devices, Displays, Computing Architectures for VR, The Rendering Pipeline, PC Graphics Architecture, Workstation-Based Architectures, Distributed VR Architectures, Modeling, Geometric Modeling, Physical Modeling, Behavior Modeling, Model Management, VR Programming and other Toolkits. Introduction to Unity 3D Engine, 2D Game concepts and basic scripting, 3D Game concepts and environment creation, Advanced game concepts. Introduction to Unity AR: Foundation and Vuforia, working with Vuforia in Unity, ARCore in unity, Mini project on AR. Introduction to VR, Unity for Google cardboard, Basic VR app development for Cardboard, Develop for a specific VR platform.

#### **References:**

1. Jonathan Linowers, Krystian Banbilinski, Augmented Reality for Developers, Packt Publishers, 2017.
2. Edward Lavieri, Getting started with Unity 5, Packt publishing, 2015.
3. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley-IEEE Press, 2003.
4. Sherman, W.R. & A. Craig, Understanding, Virtual Reality: Interface, Application and Design, Morgan Kaufmann, San Francisco, CA, 2003.
5. Philippe Fuchs, Guillaume Moreau, Pascal Guitton, Virtual Reality: Concepts and Technologies, CRC, Taylor and Francis, 2011.

### **MCA 4303: INTRODUCTION TO LINUX AND SHELL SCRIPTING [3 0 0 3]**

Introduction to UNIX/LINUX Operating System: OS concepts, Linux overview, key features of Linux, pros and cons of Linux. Processes: Processes and Files, I/O redirection and pipes, process creation, process attributes standard process file descriptors. File and Process

commands. File systems: Files and directories, file naming and wildcards, file attributes, file permissions. Regular Expressions & filters: find, grep, cut, sort, grep patterns. AWK and SED. Shell and Shell Scripting: The need for shell, types of shells, interactive uses of shell, using shell for creating user commands, functions. Bash shell features: Statements, data structure, built-in commands, environment customization primitives. Linux Editors.

#### **References:**

1. Richard Blum and Christine Bresnahan, Linux Command Line Shell Scripting BIBLE, 3rd Edition, Wiley, 2015.
2. Mark Sobel. A Practical Guide to Linux commands Editor and shell programming, Prentice Hall, 2nd Edition, 2010.
3. Stephen G. Kochan. Unix Shell Programming, 3rd Edition, SAMS Publications, 2003.
4. Bash Reference Manual Download able from GNU Project.
5. Brian W Kerningham and Rob Pike. The Unix Programming Environment, PHI Learning Pvt. Ltd., 2009.

### **MCA 4304: INTRODUCTION TO DATA ANALYTICS [3 0 0 3]**

Introduction - data science, need for analytics, steps in data analysis projects, Data- sources of data, data sets, data warehouses, data types, privacy and confidentiality, samples vs. population. Data summarization and visualization – tables and graphs. Data Preprocessing- cleaning, transformation, dimensionality reduction. Data Analysis and Visualization – descriptive, inferential statistics, uni-variate and multi-variate analysis. Grouping – Cluster Analysis- distance measures, partitioning, hierarchical, density based methods. Market Basket Analysis, Association Analysis, Market Basket Analysis. Classifiers- Bayesian, k-nearest neighbor, neural network, Support Vector Machine, Decision Trees. Prediction- Regression models, Evaluating Classification and Predictive performance, ensemble methods. Anomaly Detection. Forecasting models.

#### **References:**

1. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, 2nd Edition, John Wiley & Sons Publication, 2014.
2. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publication, 2009.
3. Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, Data Mining for Business Intelligence, John Wiley & Sons, 2014.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 2011.
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Addison Wesley, 2005.

## **Minor Specialization: Computational Mathematics**

### **MAT 4051: APPLIED STATISTICS AND TIME SERIES ANALYSIS [2 1 0 3]**

Stochastic and deterministic dynamic mathematical models – forecasting and control, transfer function models, models for discrete control systems. Basic ideas in model building- linear and multiple linear regression. Basic concepts in stochastic processes and Markov chains, Mean square distance, mean square error prediction, prediction of covariance stationary process, ergodic theory and stationary process, applications of ergodic theory, spectral analysis of covariance stationary processes, Gaussian systems, stationary point processes, level crossing problems. ARIMA models, Autoregressive models, moving average models, duality, model properties, parameter estimates, forecasts. Volatility models: ARCH and GARCH modelling, testing strategy for heteroscedastic models, volatility forecasts, Black Scholes model.

#### **References:**

1. G.E.P.Box, G. M. Jenkins, G. C. Reinsel and G M Ljung, *Time Series Analysis-Forecasting and Control*, (5e), Wiley Series, 2016.
2. Anderson T W, *The Statistical Analysis of Time Series*, John Wiley, New York, 1994
3. Samuel Karlin, Howard M Taylor, *First Course in Stochastic process*, Academic Press, New York,
4. C. Chatfield, *The Analysis of Time Series – An Introduction*, Chapman and Hall / CRC, (4e), 2004
5. David Ruppert, *Statistics in Finance*, Springer Publications, 2004

### **MAT 4052: COMPUTATIONAL LINEAR ALGEBRA [2 1 0 3]**

Matrix Analysis: Basic Ideas from Linear algebra, vector norms, matrix norms, orthogonality and SVD, Projections and CS decomposition, the sensitivity of square linear systems. General Linear Systems: Triangular systems, The LU factorization, Round off analysis of Gaussian elimination, Pivoting, Improving and estimating accuracy. Orthogonalization and least squares: Householder and Givens matrices, The QR factorization, The full rank LS problem, Other orthogonal factorizations, The rank deficient LS problem, Weighing and iterative improvement, square and underdetermined systems. The symmetric Eigen value problem: Eigen values properties and decompositions, Power iterations, the symmetric QR algorithm, Jacobi methods, Tridiagonal Methods, Computing the SVD, some generalized eigen value problems.

#### **References:**

1. Gene H. Golub and Charles F. Van Loan, *Matrix Computations*, (4e), Johns Hopkins University Press, 2013.
2. Gilbert Strang, *Linear Algebra and its applications*, (4e), Wellesley Cambridge press, 2009.
3. David S. Watkins, *Fundamentals of Matrix Computations*, (3e), Wiley, New York, 2010.
4. Roger a Horn, *Matrix Analysis*, (2e), Cambridge University Press, 2013.

### **MAT 4053: COMPUTATIONAL PROBABILITY AND DESIGN OF EXPERIMENTS [2 1 0 3]**

Sampling and sampling distributions, Most powerful tests, Uniformly most powerful tests, Likelihood ratio tests, The sequential probability ratio test, Randomized Designs, Inferences about the differences in Means, Paired Comparison Designs, Inferences about the variance of normal distributions, Monte Carlo estimation methods. The analysis of variance, RCBD, LSD and Related Designs, The Graeco - Latin square Design, Balanced Incomplete Block Designs, PBIBD Introduction to Factorial Designs, The Two Factor factorial design, Blocking in a factorial

design,  $2^k$  Factorial Design, Blocking and Confounding in the  $2^k$  Factorial Design, Partial Confounding. Two level fractional factorial designs, three level and mixed level factorial and fractional factorial designs,  $3^k$  Factorial Design, Confounding in the  $3^k$  Factorial Design, Fractional replication of the  $3^k$  Factorial Design, Factorials with mixed levels.

#### **References:**

1. Robert V Hogg and Allen Craig, *Introduction to Mathematical Statistics*, (4e), Macmillan
2. M N Murthy, *Sampling Theory and Methods*, Statistical Publishing Society, 1967
3. C Radhakrishna Rao, *Linear Statistical Inference and its applications*, (2e), Wiley Series.
4. Douglas C Montgomery, *Design and Analysis of Experiments*, (8e), Wiley Series, 2012,
5. D D Joshi, *Linear Estimation and Design of Experiments*, New Age International Publishers, 2009

### **MAT 4054: GRAPHS AND MATRICES [2 1 0 3]**

Graphs and subgraphs, walks, paths and connectedness, distance as a metric, degrees, regular graphs, cubic graphs, bipartite graphs, self-complementary graphs, operations on graphs, extremal graphs, cut points, bridges and blocks, block graphs and cut point graphs. Trees and their characterizations, centres and centroids, block-cut point trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, graphical variations of Menger's theorem. Traversability: Eulerian graphs and Hamiltonian graphs. Line graphs and total graphs. Line graphs and traversability, coverings and independence, critical points and lines. Planarity: Plane and planar graphs, outer planar graphs, Kuratowski's theorem, vertex colouring. Incidence Matrix: Rank, minors, path matrix, 0-1 incidence matrix. Adjacency Matrix: Eigen values of some graphs, determinant, bounds, energy of a graph, antiadjacency matrix of a directed graph, non-singular trees. Laplacian Matrix: Basic properties, computing Laplacian eigen values, matrix tree theorems, bounds for Laplacian spectral radius, edge-Laplacian of a tree.

#### **References:**

1. F. Harary, *Graph Theory*, Narosa Publishers, 1988.
2. J.A Bondy and U.S.R Murthy, *Graph Theory with Applications*, (5e), Elsevier Publishing Co., 1982.
3. D.B. West, *Introduction to Graph Theory*, Pearson Education, Inc., 2001.
4. R.B Bapat, *Graphs and Matrices*, Hindustan Book Agency, 2010.
5. Lowell W Beineke and Robin J Wilson, *Topics in Algebraic Graph Theory*, Cambridge University Press, 2005.

## **OPEN ELECTIVES**

### **MAT 5301: APPLIED GRAPH THEORY [2 1 0 3]**

Graphs and applications of the theorems by Havel and Hakimi, Erdos and Gallai. Cut points, bridges and blocks, block graphs and cut point graphs. Trees and their characterizations, centre and centroids, block-cut points trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, Whitney's theorem. Traversability-Eulerian, Hamiltonian, line graphs and total graphs. Traversability, coverings and independence, theorem of Gallai, critical points and lines. Planarity, genus, thickness, crossing number. Colorability, chromatic number and its bounds, Nordhaus Gaddum theorems, the four and five colour theorems, chromatic polynomial. Matrix Representation -Incident matrix, Adjacency matrix, cycle matrix, cutset matrix, path matrix, Digraphs, Matrix - tree theorem on number of spanning trees. Tournament. Graph theoretic Algorithms: Computer representation of graphs-Input and output, Algorithms for connectedness, Spanning Tree, Fundamental Circuits, Directed Circuits and Shortest paths.

**References:**

1. F. Harary, *Graph theory*, Narosa Publishers
2. Narsingh Deo, *Graph theory with applications to Engineering and Computer Science*, Prentice Hall.
3. Robin J. Wilson, *Introduction to Graph theory*, Logman

**MAT 5302: APPLIED LINEAR ALGEBRA [2 1 0 3]**

Finite dimensional vector spaces, subspaces, linear independence, basis and dimension. Sum and intersection of subspaces. Algebra of linear transformations, range and null space of a linear transformation, Inner-product spaces, metric spaces and Banach spaces, Gram Schmidt orthogonalization, linear operators and their adjoint, self adjoint, unitary and normal transformations, polar decomposition. Matrix algebra, simultaneous equations, Eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, Application of eigen values to solve simultaneous difference and differential equations. Quadratic forms and their classification, constrained optimization. Some computational methods of linear algebra.

**References:**

1. Gantmacher F.R., *The Theory of Matrices*, Chelsea.
2. Gilbert Strang, *Linear Algebra and its applications*, Thomson Learning
3. David C. Lay, *Linear Algebra and its applications*, Pearson Education

**MAT 5303: APPLIED NUMERICAL METHODS [2 1 0 3]**

Matrix Algebra : Solution for linear system of equations – Direct methods: Gauss elimination method, Gauss Jordan method, Crout's (LU decomposition) method. Iterative methods, Jacobi Gauss Seidel and successive over relaxation methods. Computation of inverse of a matrix: Jordan method, Triangularization method, Choleski's method, partition method. Eigen value & Eigen vectors: Given's method for real symmetric matrices, Jacobi's method for real symmetric matrices, Power method. Numerical Solution of Ordinary Differential Equations: Single step methods, Runge- Kutta method, Adam Bashforth's predictor corrector method, Milne's predictor and corrector method. Numerical Solution of Partial Differential Equations: Finite difference approximation to derivatives of Parabolic, Elliptic. Explicit finite difference method, implicit method.

**References:**

1. Jain, Iyengar and Jain: *Numerical methods for Scientific and Engineering Computations*, New Age Publishers
2. Carnahan, Luther and Wikes: *Applied Numerical Methods*, John Wiley
3. Conte S.D and Be Door, *Introduction to Numerical analysis*, McGraw Hill.

**MAT 5304: MATHEMATICAL MODELLING [2 1 0 3]**

Introduction, Techniques, classification and characteristics of mathematical models, mathematical modeling through algebra, ordinary differential equations of first order. Mathematical modeling through systems of ordinary differential equations of first order, Prey- Predator model Mathematical modeling through systems of ordinary differential equations, modeling in medicine A model for diabetic mellitus. Modelling

on population dynamics Mathematical modelling through difference equations. Some simple models. Modelling of economics and finance through difference equations, population dynamics and generation of models through difference equations, modeling in probability theory, examples. Optimization models: Mathematical modeling through linear programming. Mathematical modelling through graphs: elements of graphs, digraphs. Mathematical models for blood flow. Mathematical model for Peristaltic transport of two layered.

**References:**

1. J N Kapur, *Mathematical Modelling*, New age international publishers, (2e), 2015.
2. J N Kapur *Mathematical Models in biology and medicine*, East- West press.
3. J N Kapur *Mathematical models of environment*, INS Academy, New Delhi

**MAT 5305: OPTIMIZATION TECHNIQUES [2 1 0 3]**

Formulation, Linear programming-simplex method, Penalty coarse methods, 2-phase method. Dual Simplex method. Duality theory. Transportation problem-Vogel's approximation method, MODI method, Assignment problem-Hungarian method. Project Management - Networks, Project planning and control using PERT and CPM. Project crashing. Game theory - 2 persons zero sum games, Minimax principle, games with mixed strategies. Dominance theory, solution using Linear programming.

**References:**

1. Bronson Richard - *Theory and Problems of Operations Research*- Schaum series- MGH
2. P.K. Gupta & Man Mohan - *Operations Research* - Sultan Chand & Sons
3. Hamdy A. Taha - *Operations Research* PHI

**MAT 5306: STOCHASTIC PROCESSES AND RELIABILITY [2 1 0 3]**

Static probabilities: Review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities, Chapman Kolmogorov equations. Classification of states, chains of Markov process. Stability of Markov systems, limiting behaviour, random walk. Poisson Processes : assumptions and derivations, related distributions, birth and death processes. Queueing System, general concepts, Model M/M/1 and M/M/S, steady state behaviour, transient behaviour. Wiener processes and Gaussian processes. Differential equations of a Wiener process, Kolmogorov equations, Ornstein – Unlenbeck Process. White noise. Reliability Theory : Definition of Reliability, types of failure, Hazard rate, Laws of failure - normal, exponential & Weibull failure laws - System reliability - in series, in parallel series - parallel system, Parallel - series system & related problems.

**References:**

1. Medhi. J., *Stochastic Processes*, Wiley Eastern.
2. Bhat U R, *Elements of Applied Stochastic Processes*, John Wiley.
3. A Papoulis, *Probability, Random Variables and Stochastic Processes*, McGraw Hill.

### **Minor Specialization: Business Management**

#### **HUM 4051: FINANCIAL MANAGEMENT [2 1 0 3]**

Introduction and objectives of financial management, Evolution of corporate finance, responsibilities. Types of accounts, Golden rules of accounting, Preparation of Journal, Ledger, Trial balance and final accounts. Sources of long term finance, Characteristics of equity capital, Preference capital, Debenture capital & Term loans. Valuation of securities, Concepts, Bond valuation and related models, Bond value theorems, Yield to maturity. Equity valuation; Dividend capitalization approach, Leverage, Operating leverage, Financial leverage, Total leverage, Indifference point analysis. Working capital management, Capital budgeting: appraisal criteria, pay-back period, Average rate of return, Net present value, Benefit cost ratio and Internal rate of return. Risk analysis in capital budgeting, Cost of capital: introduction, cost of debt capital, Preference capital and Equity capital, Weighted average cost of capital, Determination of proportions, Cash management, Dividend decisions.

#### **References:**

1. Prasanna Chandra., Fundamentals of Financial Management, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2006.
2. I M Pandey, Financial Management, Vikas Publishing House Pvt Ltd., New Delhi, 2015.
3. N Ramachandran & Ram Kumar Kakani, Financial Accounting for Management, 3/e, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2011.
4. Eugene F Brigham & Michael C E, Financial Management: Theory and Practice. 12e, Cengage Learning, India, 2008.
5. Maheshwari S.N., Financial Management, Sultan Chand & Co., New Delhi, 2002.

#### **HUM 4052: HUMAN RESOURCE MANAGEMENT [2 1 0 3]**

Introduction, Scope of HRM, Objectives of HRM, Functions, Activities, Roles, HRD organization and responsibilities. Evolution of HRM, Influence of various factors on HRM. Human resource planning: Introduction, Strategic considerations, Nature and scope, Human Resources Inventory, Job analysis, Job design, Job description, Job specification and Job evaluation. Employee Recruitment & Selection: Policy, Process, Tests, modern methods, Interview, Provisional selection, Medical/Physical examinations, Placement, Induction programs and socialization. Training and development: Basic concepts, Employees training Process, Planning, Preparation of trainees, Implementation, Performance evaluation and Follow-up training. Competency Mapping and Career development programmes. Performance appraisal and Merit rating, Promotion, transfers and separations, Wages and salaries administration, Discipline and grievances. Industrial and labour relations and Trade Unionism Overview: Collective bargaining and maintaining Industrial health.

#### **References:**

1. Michael Armstrong ., A Handbook of Human Resource Management Practice: 10th Edition, New Delhi, Kogan Page India, 2006
2. Gary Dessler & Biju Varkey ., Human Resource Management: 12th Edition Dorling Kindersley (India), Noida, 2011
3. T.V. Rao and Pereira D F., Recent experiences in Human Resources Development, Oxford and IBH Publishing, 1986.
4. Subbrao A., Essentials of Human Resource Management and industrial Relations, Himalaya Publishing House, 1999.
5. Aswathappa K, Human Resource Management, Text & Cases McGrawHill 7th Edition, 2006
6. N G Nair and Latha Nair., Personnel Management and Industrial Relations, S. Chand Company, 1995.

#### **HUM 4053: MARKETING MANAGEMENT [2 1 0 3]**

Marketing definition, scope and concepts, Adapting marketing to the New Economy, Marketing strategic planning. Market Demand, Marketing Environment, Marketing Information System, Marketing Research. Segmentation, Targeting and Positioning, Buying Behaviour: Consumer Markets and Business Markets, Competition: Identifying competitors, analysing competitors. Product Life Cycle: Product life-cycle marketing strategies. New Market Offerings: New product development and challenges, Branding. Designing and Managing Services, Price Strategies, Retailing, Wholesaling, Integrated Marketing Communications, Digital Marketing and Trends, International Marketing

#### **References:**

1. Philip Kotler, Kevin Keller, Abraham Koshy & Mithileshwar Jha, Marketing Management – A South Asian Perspective, Pearson Education Inc, New Delhi, 2012.
2. Arun Kumar & N Meenakshi, Marketing Management, Vikas Publishing House Pvt Ltd, New Delhi, 2011.
3. Varshney R L and Gupta S L., Marketing Management, Sultan Chand & Sons, New Delhi, 2004.
4. Adrian Palmer., Principles of Marketing, Oxford University Press, New York, 2000.

#### **HUM 4054: OPERATIONS MANAGEMENT [2 1 0 3]**

Introductions to operations management – process view and supply chain view, types of production activities, competitive priorities and capabilities. Break-even analysis, evaluating services or products, evaluating processes - make or buy decision, decision making under risk, and decision trees. Introduction to forecasting, importance and uses of forecasting, demand patterns, demand management options, judgement methods, causal methods - linear regression, time series method – naïve method, moving average, weightage moving average, and exponential smoothing curve. Planning long-term capacity, measures of capacity and utilization, economies of scale, diseconomies of scale, capacity timing and sizing strategies, sizing capacity cushions, timing and sizing expansion – expansionist strategy, wait and see strategy, and a systematic approach to long term capacity decision. Levels in operations planning and scheduling across the organization, sales and operation planning strategies- chase strategy, level strategy, operations planning using linear programming technique, scheduling job and facility scheduling, and work for scheduling. Theory of constraints, managing bottle necks in manufacturing and service processes, identifying bottle necks, relieving bottle necks, drum buffer rope system, and managing constraints in a line system. Supply chain design across the organization, supply chains for services and manufacturing, measures of supply chain performance - inventory measures, financial measures, inventory and supply chains - pressures for small inventories, pressures for large inventories, types of inventory, inventory reduction tactics, and inventory placement. Costs of quality, total quality management, acceptance sampling, statistical process control - control charts, and process capability. Continuous improvement using lean systems, different types of wastes, strategic characteristics of a lean system, designing lean system layout, and Kanban system.

#### **References:**

1. Krajewski L. J., Ritzman L. P., Malhotra M., and Srivastava S. K., *Operations Management*, 11th edition, Pearson Education (Singapore) Pvt. Ltd., Delhi, 2016.
2. Heizer J. and Render B., *Operations Management*, 11th edition. Pearson Education India, 2016.
3. Khanna R. B., *Production and Operations Management*, 2nd edition, PHI Learning Private Limited, 2015.



## **OPEN ELECTIVES**

### **HUM 4301: COMMUNICATIVE ENGLISH [3 0 0 3]**

(Offered for Lateral Entry Students only)

Common Errors in English: Subject Verb Agreement; Uses of Tenses / Sequence of Tense; Prepositions; Articles; Special Usages; Creative Writing Essay: Types of Essays, Argumentative Essay, Descriptive/ Expository/Narrative Essays; Reading Comprehension; Dynamic text; Critical Evaluation; Group Discussions; Presentation Skills; Essay writing.; Audio texts/speeches -Practice listening skills- summary, commentary, listening exercises. Video Speeches -Theme based speeches - motivational, informative, technical, and persuasive, discussions. Speech - Elements of a good speech, types of speeches, model speech, Speech exercises, individual presentations, peer and facilitator feedback. Formal/Informal communication. Communication Styles- formal and informal, standard English and variations in usages, examples and analysis of faulty usages; Correspondence: formal/informal letters and emails.

#### **References:**

1. Green David., *Contemporary English Grammar, Structures and Composition* Chennai: Macmillan Publications.
2. Thompson AJ & Martinet AB., *A Practical English Grammar*, OUP.
3. Turton N D , Heaton J B., *Longman Dictionary of Common Errors*, 1998.
4. Meenakshi Raman & Sangita Sharma., *Technical Communication; Principles and Practice*, Oxford University Press, 2011.

### **HUM 4302: FILM STUDIES [2 1 0 3]**

History of invention of motion pictures - Daguerre, Muybridge, Edison, Skaldanowsky Brothers, Lumieres; Evolution of film – Lumieres, Melies, Porter, Griffith, Basic techniques – Mise-en-scene, Mise-en-shot, Deepfocus Photography, Longtake, Continuity, Editing, Montage, German Expressionism; French Impressionism; Soviet Montage cinema; Hollywood cinema, Italian Neo-realism; French Nouvelle Vague, Documentary, Directors – Eisenstein, Kurosawa, Godard, Chaplin, Bergman; Mohsen Makmalbaf, Majid Majidi, Keislowksi, Zhang Yimou, Kim Ki Duk, “New Wave” Cinema in India - Bengali; Malayalam; Kannada; Hindi, To be screened- Bicycle Thieves, The 400 blows, Rashomon, Wild strawberries, Battleship Potemkin, Cabinet of Dr. Caligari, The kid, Children of heaven, Hero, Ghatashraddha, Pather Panchali, Mathilukal.

#### **References:**

1. Bordwell, David and Thompson, Kristin., *Film Art: an Introduction*, 7th ed. New York: McGraw-Hill Co., 2004.
2. Kavin, Bruce., *How Movies Work*. Berkeley and Los Angeles: University of California Press, 1992.
3. Cook, David A., *A History of Narrative Film*, 4th ed. New York: W.W. Norton & Co., 2004.

### **HUM 4303: GERMAN FOR BEGINNERS [3 0 0 3]**

Text selections, dialogue and exercises which have been designed to give the absolute beginner grounding in the rudiments of the German language, as well as providing background information about the history, life and culture in Germany. Introduction to the German alphabet and the German language – dialogues & conversations – pronunciation, basic vocabulary lists - key points of grammar - background information about the history and culture of Germany - exercises on vocabulary, grammar and German culture - reading & listening comprehension.

#### **References:**

1. Sally Johnson, Natalie Braber., *Exploring the German Language*, (2E), Cambridge University Press. 2008.
2. Charles Russ., *The German Language Today: A Linguistic Introduction*, Routledge. 1994.

### **HUM 4304: BUILDING BRIDGES: INDO-EUROPEAN INTERCULTURAL DYNAMICS [3 0 0 3]**

The challenges of Intercultural communication - interacting in a diverse world, understanding cultures, alternative views of reality, cultural stereotyping. Foundational Theories in Intercultural Communication - Edward Hall, Samovar, G Hofstede, Understanding cultural Dimensions and Cultural Stereotyping- collectivism/ individualism, power distance, masculine/feminine, cultural metaphors, Intercultural Business Communication Competence - The Role of Language in Intercultural Business Communication, Nonverbal Language in Intercultural Communication, Cultural influence on interpersonal communication, Intercultural Dynamics in the multicultural organizations.

#### **References:**

1. Dodd, Carley H. *Dynamics of Intercultural Communication*, McGraw-Hill, Boston. 1998.
2. Gannon M J and Pillai R. *Understanding Global Cultures*, Sage Publications, California. 2010.
3. Hall, E. T. *The dance of life: The other dimension of time*, Random House, New York. 1983.
4. Hofstede, Geert., *Cultures' Consequences, Comparing Values, Behaviors, Institutions, and Organizations across Nations*, Sage Publications, Thousand Oaks, CA. 2001.
5. Martin, J.N. & Nakayama, T.K., *Intercultural communication in contexts*. 4th Edition. Mountain View, CA: Mayfield. 2007.
6. Samovar, L A and Porter, R., *Communication between Cultures*, Cengage Learning, Wadsworth, CA. 2007.

### **HUM 4305: INTERPRETATION OF LITERARY TEXTS [3 0 0 3]**

Texts-static, dynamic, cryptic and delphic ; Language of literature; Form and structure; Literature verses popular fiction; Text and discourse; Authors and critics; Theories and approaches to literary texts; Formalism, Structuralism, Marxism, Feminism, Deconstruction; Ideational functions and textual Functions; Class, gender and sexuality; Race and nationality; Genre, phonological deviations –sound patterns and figures of speech ; Pragmatic approach to literature; Understanding syntax, Lexical and syntactic analysis of literary texts; Point of view in literary texts and foregrounding; Prediction and making sense of a text; Stylistic analysis of a novel; Kinds of meaning, Rhetorical structure; Pragmatics and discourse analysis; Interpreting cohesive devices and complex functional values; Stylistic approach to literature ; Elements of literary style; Stylistic analysis of selected short stories, Poems, Novels and Plays; Genre, the plot setting, characterization, tone and themes; Stylistics and its implications on narrative techniques; Intertextuality and conceptual blending; Identifying patterns in the texts; Meaning making process in literature; Imagery, metaphor as a mode of thought; Coherence and Cohesion; Context, turn taking and Adjacency Pair; Pro-forms, Discourse markers, Lexical cohesion and presupposition; Recognizing text organization; Critical texts, Shared assumptions on critical texts; The role of schema and the concept of speech acts in literary texts.

#### **References:**

1. Austin, J.L., *How to do Things with Words*, Longman, London, 1992.
2. Barthes, R., *Introduction to the Structural Analysis of Narratives*, Fontana, London, 1977.
3. Blake.N.F., *An Introduction to the Language of Literature*, Macmillan, London. .1990.
4. Carter, R. (ed.), *Language and Literature: An introductory Reader in Stylistics*, Allen and Unwin, London, 1982.
5. Cook, G., *Discourse and Literature*, Oxford University Press, London, 1994.
6. Harold, C.M.(ed.), *Style in Prose Fiction*, Columbia University Press, New York.
7. Leech, G.N., *A Linguistic Guide to English Poetry*, Longman, London, 1969.

### **HUM 4306: PUBLIC SPEAKING [3 0 0 3]**

Public Speaking -Introduction to Public speaking- Voice modulation, Sounds/accents (basics), Articulation, Anxiety management, Logical arguments, Concept of purpose, Audience, Smart use of Body language. Types of speech-Informative speeches - designing and delivery-Persuasive speeches – designing and delivery- Impromptu speeches – designing and delivery -Special occasion speeches- designing and delivery, Presentations - planning and execution -Types of presentation - Informative-Planning and delivery - Persuasive - Planning and delivery - Motivational - Planning and delivery, Other forms of speaking – Debates, Seminars, Panel Discussion, Group Discussion, Tall Tales, Turn Coat, Art of Evaluation-Providing feedback- planning, designing and delivering constructive feedback - Receiving feedback – making use of relevant feedback -Techniques of providing feedback- Speech analysis –Role of the Evaluator.

#### **References:**

1. Duarte Nancy., *Resonate: Present Visual Stories that Transform Audiences*, John Wiley and Sons, 2010.
2. Minto Barbara., *The Pyramid Principle: Logic in writing, thinking and Problem Solving*, Financial Times Prentice Hall, 2002.
3. Berkun Scott., *Confessions of a Public Speaker*, O'Reilly Media, 2009.
4. Goodale Malcolm., *Professional Presentations*, Cambridge University Press, 2005.
5. Carnegie Dale., *The Art of Public Speaking*, 1905.

### **HUM 4307: INTRODUCTION TO PSYCHOLOGY [3 0 0 3]**

Psychology - Meaning, Nature and Scope, Defining Psychology, Meaning of the term Behavior, Nature of Psychology, Scope of Psychology: Branches and fields of Psychology. Development of Psychology - Historic Sketch of Psychology, Modern Age of Psychology, Gestalt Psychology, Psycho Analysis, Contemporary Psychology. Systems of Psychology- The Nervous System, Nature V/s Nurture, Sensation and perception, States of Consciousness. Methods of Psychology - Classical Conditioning, Introspection Method, Naturalistic Method, Experimental Method, Differential Method, Clinical Method, Psycho Physical Method. Personality- Personality types, Personality Disorders, Abnormal psychology, Treatment of personality disorders. Thinking - Nature of Thinking, Types of Thinking, Language and Intelligence. Discussion, Presentation and Assignments.

#### **References:**

1. Boring, E.G., Langfield, H.S. & Weld, H.P., *Foundations of Psychology*, Asia Publishing House, Calcutta, 1963.
2. Carson, R.C., Butcher, J.N. & Coleman, J.C., *Abnormal Psychology & Modern Life*, (8th ed) Scoff, Foresman & Co. 1988.
3. Lahey, B.B., *Psychology: An Introduction*, 6th Ed., Tata McGraw Hill, New York, 1965.
4. Olson, M.; Hergenhahn, B.R., *Introduction to the Theories of Learning*, Prentice-Hall India, 2009.

### **HUM 4308: INTRODUCTION TO PHILOSOPHY, RELIGION AND CULTURE [3 0 0 3]**

Notions of Philosophy; The Origin and Development of Philosophy; Ancient Philosophy; Medieval Philosophy; Modern Philosophy; Contemporary Philosophy; Indian Philosophy; Comparative Religion; Western Philosophy; The Relevance of Philosophy; Branches of Philosophy; Methods of Philosophy; Philosophy and other Branches of Study; Some Problems of Philosophy; Themes of Philosophy; Mind and Body, and the Problem of Universal; Change/Movement time and place; Existence of God and Evolution; Indian Culture; Social Ethics; Logic and Scientific Methods; Philosophy of Language.

#### **References:**

1. Aquinas, Thomas., *On Being and Essence. Trans. Armand Maurer.* Canada: Pontifical Institute of Mediaeval Studies, 1968.
2. John-Terry, Chris., *For the Love of Wisdom: An Explanation of the meaning and Purpose of Philosophy.* New York: Alba House, 1994.
3. Maritain, Jacques., *An Introduction to Philosophy*, London: Sheed and Ward. 1979.
4. Radhakrishnan, S. (Ed)., *History of Philosophy Eastern and Western Vol. II* George Allen and Unwin Ltd., London, 1953.
5. Wallace, William., *The Elements of Philosophy.* New York: Alba House, 1990.

### **HUM 4309: CREATIVE WRITING [3 0 0 3]**

Various literary/prose forms and their characteristics; techniques and strategies for reading; nuances of language and meaning in reading and writing; Writing Exercises - techniques and strategies of writing creatively; Critical Concepts and Terms in Literary Writing; Writing Exercises; creative writing output.

#### **References:**

1. Milan Kundera ., *The Art of the Novel.*
2. The Art of Fiction: Illustrated from Classic and Modern Texts, David Lodge

### **HUM 4310: GRAPHIC NOVELS: HISTORY, FORM AND CULTURE [3 0 0 3]**

Part I: The History of Comic Books, Part 1: Developing a Medium Defining comic books as a medium-Relationships between comic books and other forms of sequential art-The (continental) roots of comics as an art form -The ways in which comic strips and pulps contributed to the emergence of the comic book. The History of Comic Books, Part 2: The Maturation of the Medium-Influence of underground movement, ways in which mainstream publishers began to address more relevant topics, proliferation of independent comics, the increase in the profile and prominence of the medium due to ambitious projects. Part II: Creating the Story: Graphic Storytelling and Visual Narrative-Some narrative structures commonly found in comic books -The types and techniques of encapsulation-The nature of the relationship between the pictorial and linguistic elements of comic books Experiencing the Story: The Power of Comics - About diegetic images that show the world of the story-About interpretive images that comment on the story-The impact art style has on the emotional reactions of the reader; and how the meaning of each image is affected by the relationship to other images in that particular book, in other texts, and in the reader's personal experience-Part III: Comic Book Genres-the definition of genre and the role it plays in shaping the creation of comics products- the characteristics of genres, including character types, narrative patterns, themes, and other conventions-how the example genres of teen humor, romance, funny animals, horror, and memoir developed in comics, and what characterizes each-how the hybridization of genres helps experimentation and expansion of narrative possibilities.

#### **References:**

1. Roger Sabin., *Comics, Comix and Graphic Novels.*
2. Robert Petersen, Allan Moore., *Comics, Manga and Graphic Novels: A History of Graphic Narrative*3. *Comics as Performance, Fiction as Scalpel.*
3. Jeet Heer, Kent Worcester., *Arguing Comics: Studies in Popular culture.*

### **HUM 4311: MANAGEMENT INFORMATION SYSTEMS [3 0 0 3]**

Management information system: Introduction to management, information and system. System concepts, general model of a system and types of systems. Evolution of MIS, models and resources used in the MIS model. Structure of MIS, operating elements of an information system, synthesis of the structure. Information systems for different applications: Transaction processing systems, Human resource management systems and Marketing-application areas. Production planning and Office automation systems. Role of management information in decision making: Concepts of decision making, Decision making process and information needs at different levels of management. Herbert. A. Simon model. Phases in the decision making process, Programmed vs non-programmed decisions, General model of human as an information processor, Allen Newell Simon model. Decision support systems -structure, elements and working. Information as a strategic resource. MIS as a technique for making programmed decisions: Behavioral models of the decision maker and methods. MIS support for decision making. Role of MIS in Organizations -recent trends and e-commerce applications. Development of customized management information system approaches: SDLC -phases in SDLC, Strategic and project planning for MIS, conceptual design and detailed design phases: general business planning and MIS response. MIS Planning and planning cycle. Conceptual system design and Detailed System design. MIS System Implementation, and Pit falls: Pit Falls in MIS development, Fundamental weaknesses, soft spots in planning, design problems and review.

#### **References:**

1. Gordon B. D. and Margrethe H. O., (2005), "Management Information Systems", McGraw-Hill, New York.
2. Kenneth L. and Price J. P., (2003), "Management Information Systems", Macmillan.
3. Jawadekar W. S., (2000) "Management Information System", Tata McGraw Hill.
4. Senn J. A., (2003), "Analysis & Design of Information System", McGraw Hill International Student Edition.
5. Mudrick; Ross (1997) "Information Systems for Modern Management" Prentice Hall of India.
6. James A. O'Brien (1995) "Management Information Systems, Galgotia Publications.

### **HUM 4312: ENTREPRENEURSHIP [3 0 0 3]**

Entrepreneur: Meaning of entrepreneur, evolution of the concept, functions of an entrepreneur, types of entrepreneur, and intrapreneur. Concept of entrepreneurship - evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, barriers for entrepreneurship. Small scale industry: Definition, characteristics, need and rationale. Objectives, scope, role of Small Scale Industries (SSI) in economic development, advantages of SSI, steps to start an SSI - government policy towards SSI, different policies of SSI, impact of liberalization, privatization, and Globalization. Effect of WTO/GATT and supporting agencies of government for SSI. Institutional support: Different Schemes: TECKSOK, KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI, NSIC, SIDBI, and KSFC, New schemes and support for start-ups and new venture under Govt. of India. Preparation of Business plan and project report: components of a successful plan. Meaning of project, project identification, project selection, project report, need and significance of report, contents, formulation, guidelines by planning commission for project report. Network analysis, errors in project report, project appraisal. Identification of business opportunities, market feasibility study, technical feasibility study, financial feasibility study and social feasibility study and documentation and evaluation.

#### **References:**

1. Vasant Desai., Dynamics of Entrepreneurial Development & Management, Himalaya Publishing House, 2007.
2. David H. Holt Entrepreneurship: New Venture Creation, Published by prentice Hall, 1991.
3. Poornima. M. Charantimath., Entrepreneurship Development, Pearson Education, 2006.
4. S.S. Khanka., Entrepreneurship Development, S.Chand& Co, 2007.



## Minor Specialization: Material Science

### **PHY 4051: PHYSICS OF LOW DIMENSIONAL MATERIALS [3 0 0 3]**

**Thin films:** Thick and Thin Film Materials, preparation by physical and chemical methods. Thickness measurement techniques. Theories of nucleation - Capillarity and atomistic theory, effect of deposition parameters on nucleation and growth of thin films. Epitaxial growth. Reflection and Transmission at interface between isotropic transparent media. Reflectance and Transmittance in thin films. Antireflection coatings. Electrical conduction in discontinuous metal films - Quantum mechanical tunneling model. Conduction in continuous metal and semiconducting films. Thermoelectric power in metal films. thin film resistors, thermopiles. Quantum well devices.

**Nanomaterials:** Chemical Synthesis of Nanoparticles: Bottom up approach. Functionalized nanoparticles in different medium. Size control. Self assembly. Nanoparticle arrays. Semiconductor nanoparticles- synthesis, characterization and applications of quantum dots. Magnetic nanoparticles- assembly and nanostructures. Manipulation of nanoscale biological assemblies. Carbon nanotubes and fullerene as nanoclusters. Nanostructured films. Physical Methods of Nanostructure Fabrication: Top down approach. Nanopatterning- Lithography- Optical, X-ray and Electron beam lithography. Ion- beam lithography.

#### **References:**

1. Chopra K. L., *Thin Film Phenomena*, Mc Graw Hill, 1969
2. Milton Ohring, *Materials Science of Thin Films*, Elsevier, 2001
3. Heavens O. S., *Optical Properties of Thin Solid Films*, Dover, 1955
4. Liz-Marzan L. M. and Kamat P. V. (Eds), *Nanoscale Materials*, Kluwer, 2003
5. Nalwa H. S. (Ed), *Nanostructured Materials and Nanotechnology*, Academic, 2002

### **PHY 4052: PHYSICS OF PHOTONIC AND ENERGY STORAGE DEVICES [3 0 0 3]**

**Semiconductors:** Direct and indirect band gaps. Carrier concentrations at thermal equilibrium. Fermi level. Degenerate and non-degenerate semiconductors. Semiconductor Crystal growth techniques Contact phenomenon- semiconductor-semiconductor, metal-semiconductor contacts. Schottky and Ohmic contacts. Preparation of semiconductor devices. IC technology, elements of lithography.

**Photonic Devices:** LED and semiconductor lasers: Radiative and non-radiative transitions, diode laser, population inversion, laser operating characteristics, efficiency, photoconductor, photodiode, avalanche photodiode, phototransistor, material requirement for solar cells, theory and types of solar cells.

**Fuel cells:** Hydrogen energy – merits as a fuel – production of hydrogen, Hydrogen Fuel cells – introduction – difference between batteries and fuel cells, components of fuel cells, principle of working of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of fuel cells. Application of fuel cells – commercially available fuel cells.

#### **References:**

1. Neamen Donald A., *Semiconductor Physics and Devices, basic principles*, Tata McGraw-Hill, 2002
2. Sze S. M., *Physics of Semiconductor Devices*, John Wiley & Sons, 2007
3. Larminie J. and Dicks A., *Fuel Cell Systems Explained*, Wiley, 2003
4. Xianguo Li, *Principles of Fuel Cells*, Taylor and Francis, 2005
5. S. Srinivasan, *Fuel Cells: From Fundamentals to Applications*, Springer, 2006

## OPEN ELECTIVES

### **PHY 4301: FUNDAMENTALS OF ASTRONOMY AND ASTROPHYSICS [3 0 0 3]**

Introduction to astronomy and astrophysics. Properties of ordinary stars: Brightness of starlight; the electromagnetic spectrum; Colours of stars; stellar distances; absolute magnitudes; HR diagram. Stellar evolution: Formation of star; the main sequence; stellar structure; evolution off the main sequence; planetary nebulae; white dwarfs. The death of high mass stars: Supernovae; neutron stars; pulsars; stellar black holes. Normal Galaxies: Types of galaxies; Dark matter in galaxies. Cosmology: The scale of universe; expansion of the universe; open or closed universe; the big bang; the cosmic background radiation; big bang nucleosynthesis. Astronomical instruments.

#### **References:**

1. Marc L Kutner, *Astronomy: A physical Perspective (2e)* Cambridge University Press, 2003
2. Baidyanath Basu, *An Introduction to Astrophysics (2e)*, PHI Learning Pvt. Ltd, 2011.
3. Michael Zeilik, *Introductory Astronomy and Astrophysics (4e)*, Saunders College Pub. 1992.

### **PHY 4302: PHYSICS OF ENGINEERING MATERIALS [3 0 0 3]**

Types of magnetism, ferromagnetic domains, soft and hard magnetic materials, ferrites, magnetic storage, Superconducting materials, Applications of superconductors, Nano-materials, bottom-up and top-down methods, Quantum dots and nano-carbon tubes, Composite materials, micromechanics of composites - Density, Mechanical and Thermal properties, Semiconductors, Metals, semiconductors and insulators, Direct and indirect band-gap semiconductors, Intrinsic and extrinsic semiconductors, Diffusion and drift processes, Crystal growth techniques, Preparation of semiconductor devices.

#### **References:**

1. William F. Smith, *Principles of Materials Science and Engineering (2e)*, McGraw-Hill International Edition, 1990.
2. Nalwa H.S., *Nanostructured Materials and Nanotechnology (2e)*, Academic, 2002.
3. Chawla K. K. *Composite Materials- Science & Engineering (3e)*, Springer-Verlag, 2012.
4. Streetman Ben G. and Banerjee Sanjay Kumar, *Solid State Electronic Devices (6e)* PHI learning Private Limited, 2012.

### **PHY 4303: RADIATION PHYSICS [3 0 0 3]**

Radiation Sources: Fast electron sources-Heavy charged particle sources-Sources of electromagnetic radiation-Neutron sources. Radiation Interaction: Photoelectric and Compton process -pair production. Interaction of heavy charged particles-stopping power-Energy loss characteristics- Bragg curve-Particle range-range straggling- stopping time-energy loss in thin absorbers-Interaction of fast electrons-absorption of beta particles-interaction of gamma rays-gamma ray attenuation-Interaction of neutrons-neutron cross section-neutron induced nuclear reactions. Radiation Detectors and Instrumentation: Semiconductors diodes-JFET-MOSFET-Integrated Circuits-OPAMP and their characteristics-Differential Amplifier-Operational amplifier systems-Pulse Amplifiers. Principles of radiation detection and measurements-Gas filled detectors-Ionisation chambers-Proportional counters-GM counters-Scintillation detectors-Semiconductor detectors-Thermo luminescent Dosimeters-Radiation spectroscopy with scintillators-Gamma spectroscopy-Multichannel pulse analyzer-Slow neutron detection methods-Reactor instrumentation. Industrial uses of nuclear measurements: Radiation detection in industrial environments-Measuring systems for industrial problems-Determination of physical material characteristics by nuclear measurements-Level height determination-Density measurements-Quantity measurements-Thickness measurement-coating thickness measurement.

**References:**

1. Knoll G. F., *Radiation Detection and Measurement (3e)*, Wiley 2010
2. Boylestad R. L., *Electronic Devices and Circuit theory (11e)*, Pearson Education 2016
3. Malvino A. P., *Electronic Principles (7e)*, TMH 2010
4. Foldiak G., *Industrial Applications of Radioisotopes*, Elsevier Science Ltd 1986

**PHY 4304: SOLID STATE PHYSICS [3 0 0 3]**

Review of Crystal structure: Lattice, basis and unit cell, crystal system, symmetry, crystal planes and miller indices, reciprocal lattice, Bragg's law, experimental methods of x-ray diffraction, types of crystal binding, analysis of stress and strain in crystals. Electrical conduction: Free electron gas model, Sommerfeld quantum theory, Fermi energy, parameters of free electron gas at absolute zero, electrical conductivity, Drude-Lorentz theory and Sommerfeld theory of electrical conductivity, Band theory of solids, electrical conduction in metals, insulators and semiconductors. Dielectrics: Static dielectric constant, polarization and polarizability, local field, ferroelectricity, piezoelectricity, frequency dependence of polarizability (electronic, ionic and dipolar), dielectric losses, requirements of insulating materials, applications of dielectric materials. Magnetism: Classification of magnetic materials, classical theory of diamagnetism and paramagnetism, Weiss theory of ferromagnetism, ferrites, hard and soft magnetic materials, garnets, magnetic bubbles, ceramic magnets, applications of magnetic materials

**References:**

1. Kittel C., *Introduction to Solid State Physics (7e)*, Wiley 1996.
2. Rao A., *A first course Solid State Physics*, Asiatech publications 2000.
3. Pillai S.O., *Solid State Physics (6e)*, New age international publications 2006.
4. Wahab M. A., *Numerical problems in Solid State Physics*, Alpha science international publications 2011.
5. Gupta H. C., *Solid State Physics*, Vikas publishing house Pvt. Ltd. 1996.

**PHY 4305: MODERN OPTICS [3 0 0 3]**

Optics: Review of geometrical and physical optics, Dual nature of light, Electromagnetic spectrum, Optical devices, mirrors, lenses, prisms, grating, beam splitters, zone plate, polaroids. Light sources, emission profile. Elements of lasers: Basic requirements in a laser, characteristic properties of lasers. Q-switched and mode locked lasers. CO<sub>2</sub>, Nd: YAG lasers. Applications. Introduction to Non-linear optics. Optoelectronic devices and its application: Photo diodes, solar cells, LED, and diode lasers. DBR and DFB lasers, CCD. Optical Communication: Conceptual picture of the optical communication system, Modulation and Detection

Schemes, properties of optical fibers, discussion on device requirements, OEICS. Optical storage devices: Data recording and read out from optical discs. Holographic data storage systems.

**References:**

1. Ghatak A., *OPTICS (4e)*, Tata McGraw Hill Publishing Company Ltd. 2009.
2. Singh J., *Optoelectronics: An Introduction to Materials and Devices*, TATA McGraw- Hill Companies, Inc. 2014.
3. Wilson & Hawkes, *LASERS*, Prentice-Hall of India Pvt. Ltd. 1987.
4. Hugh Bennett, *Understanding Recordable & Rewritable DVD*, OSTA.org.
5. Hugh Bennett, *Understanding CD-R & CD-RW*, OSTA.org.

**PHY 4306: INTRODUCTORY QUANTUM MECHANICS [3 0 0 3]**

Review of certain basics: Limitations of classical physics, wave-particle duality, De Broglie's hypothesis, matter as wavepacket, Heisenberg's uncertainty principle, Mathematical Formalism: operators; commutation relation; orthonormal functions; eigenvalues and eigenfunctions; the Dirac notation; the postulates of quantum mechanics. The Schrödinger Equation: Introduction, wavefunctions, time dependent Schrödinger equation, conservation of probability, expectation values, Ehrenfest's theorem, time independent Schrödinger equation, stationary states, Schrödinger equation in one dimension: the infinite square potential well; the finite square potential well; the potential barrier; tunneling; the harmonic oscillator. Quantum mechanics in three dimensions: Schrödinger equation in spherical coordinates, separation of variables, the angular equation, the radial equation, Applications (energy eigenvalues and eigenfunctions): the rigid rotator; the hydrogen atom; angular momentum. Identical Particles. Some applications of quantum mechanics in nuclear physics, condensed matter physics, and spectroscopy: alpha decay, nanostructures, STM, vibrational and rotational spectra of molecules etc.

**References:**

1. Verma H.C., *Quantum Physics (2e)*, Surya Publications. 2016.
2. Gasiorowicz S., *Quantum Physics (3e)*, Wiley India Pvt Limited. 2007.
3. Jain M. C., *Quantum Mechanics: A Textbook for Undergraduates*, PHI Learning Private Limited 2012.
4. Griffiths D. J., *Introduction to Quantum Mechanics (2e)*, Pearson Education.
5. Eisberg R. and Resnick R., *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles (2e)*, Wiley-India Pvt Limited. 2009.

### **Minor Specialization: Material Science**

#### **CHM 4051: CHEMICAL BONDING [3 0 0 3]**

Introduction to bonding, Classification. Ionic bond- Lattice energy, Born Haber cycle, Radius-ratio rules, Properties of ionic compounds, Covalent character in ionic bonds. Covalent bond-Covalency, Valence bond theory, Sigma and pi bond, Hybridization, VSEPR Theory, Molecular orbital theory, Bond order, Properties of covalent compounds. Coordination bond - Primary and Secondary valencies, ligands, Valence bond theory of complexes, Crystal field theory of octahedral and tetrahedral complexes, Low and high spin complexes. Metallic bond-Band theory of metals, Conductors, semiconductors and insulators. Secondary bonding- Hydrogen bonding, London forces and dipole-dipole interactions.

#### **References:**

1. J D Lee, "Concise Inorganic chemistry", Wiley India, 2012
2. B R Puri , L R sharma and K C Kalia, "Principle of Inorganic chemistry", Vishal Publishing Co., Punjab, 2017.
3. D F Shriver, P W Atkins, "Inorganic chemistry", Oxford India, 2014
4. A F Cotton, "Basic Inorganic chemistry", Wiley Publishers, 2007

#### **CHM 4052: CHEMISTRY OF CARBON COMPOUNDS [3 0 0 3]**

Introduction to Organic Compounds: Classification, Nomenclature; Alkanes: Homologous series, Preparation; Cycloalkanes: Ring size and strain, Applications; Alkenes: Markovnikov and anti-Markovnikov addition reactions, Reduction, applications; Alkynes: Acidity, preparation, Reduction of alkynes, applications; Alkyl halides: SN1, SN2, E1 and E2 reaction mechanisms; Alcohols: Classification, Acidity, organo-metallic reagents; Aromatic compounds: Electrophilic and nucleophilic substitution reactions; Mechanism of some named reactions; Carbonyl compounds: aldehydes and ketones, carboxylic acids and carboxylic acid derivatives; Heterocyclic compounds: Nomenclature, synthesis and reactivity of thiophene, pyrrole and furan; Carbon materials: Fullerenes, carbon thin films, nanotubes and carbon fibers; Carbon nanotubes: SWNT, MWNT, synthesis, properties and applications; Carbon nanomaterials applications.

#### **References:**

1. B S Bahl and Arun Bahl, "Advanced Organic Chemistry", S Chand, New Delhi, 2012.
2. Robert T. Morrison and Robert N. Boyd, "Organic Chemistry", Pearson, New Delhi, 2016.
3. P.S. Kalsi, "Organic Reactions and Their Mechanisms", New Age International Private Limited, New Delhi, 2017.
4. Ashutosh Tiwari and S. K. Shukla, "Advanced Carbon Materials and Technology", John Wiley & Sons, 2013.
- B. Bhushan ed., "Springer Handbook of Nanotechnology", Springer Publishers, Berlin, 2004.

### **OPEN ELECTIVES**

#### **CHM 4301: ANALYTICAL METHODS AND INSTRUMENTATION [3 0 0 3]**

Spectroscopic methods of analysis: Properties of EMR, General features of spectroscopy, Types of molecular spectra, Interaction of EMR with matter, Instrumentation, Applications, Theory, Instrumentation and applications of Microwave, Raman, Infrared, UV-Visible, NMR spectroscopic techniques. Chromatographic Techniques: General

concepts, Classification, Principles, Experimental techniques of CC, HPLC, TLC, GC and their applications. Electroanalytical methods: Basic principles and applications of conductometric, potentiometric titrations.

#### **References:**

1. D.A. Skoog, J. Holler, F.T.A. Nieman, *Principles of Instrumental Analysis*, 5thEdn, Saunders, Philadelphia, 1992
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, 5thEdn, Saunders College Publishing, Philadelphia, 1988
3. *Vogel's Textbook of Quantitative Chemical Analysis*, GH Jeffery, John Wiley & Sons Inc, 5thEdn, 1989

#### **CHM 4302: FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES [3 0 0 3]**

Adsorption & Catalysis: Physisorption and chemisorption, Adsorption isotherms, Factors influencing adsorption, Adsorption of gases by solids, Adsorption from solution, Introduction to catalysis, Energetics, Catalytic cycles Solutions & Solubility: Ideal and non-ideal solutions, Raoult's law, Thermodynamics of ideal solutions, Vapor pressure and boiling point composition curves, Distillation behaviour of completely miscible & immiscible liquid systems, Azeotropes Colligative Properties: Determination of molar masses from vapor pressure lowering, Osmotic pressure, Boiling point elevation and Depression of freezing point, Vant Hoff's factor Colloids: Types, Preparation and purification of sols, General properties, Optical, Electrical & Kinetic properties of sols, stability of sols, Application of colloids, Emulsions & Gels- Types, Preparation, Properties and their applications.

#### **References:**

1. *Principles of Physical Chemistry*, B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal Publications, New Delhi, (23e), 2008
2. *Principles of Physical Chemistry*, S.H. Maron, C.F. Prutton, IBH Publishing co. New Delhi, (4e), 1985
3. *Fundamentals of Analytical Chemistry*, D.A. Skoog, D.M. West, F.J. Holler, R. Crouch, (4e), Thomson-Brooks, 2007

#### **CHM 4303: SUSTAINABLE CHEMICAL PROCESSES AND PRODUCTS [3 0 0 3]**

Introduction and principles of green chemistry, Examples, Atom economy, carbon efficiency, life cycle analysis, sustainable products, process and synthesis catalysis and green chemistry, examples of fine and bulk chemicals production, catalysts for clean technology. Application of ecofriendly approach to waste treatment. Cleaner production processes, clean synthesis in lab Scale, industrial examples, use of ecofriendly energies. Bio-pesticides, polymers & pharmaceutical products. Electrochemical synthesis, Alternate reaction media using water and other green solvents, ionic liquids & supercritical fluids; phase transfer catalysis.

#### **References:**

1. P.T. Anastas, J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford Univ. Press, Oxford, 2008
2. A.S. Matlack, *Introduction to Green Chemistry*, Marcel Dekker, New York, 2001
3. P. T. Anastas, R. H. Crabtree, *Handbook of Green Chemistry and Catalysis*, Wiley-VCH, Weinheim, 2009

# Inter Institute Open Electives

## Centre for Creative and Cultural Studies (CCCS), Manipal

### IIE 4301: ART APPRECIATION [3 0 0 3]

How to read a visual, how to enjoy or feel an art form, what is Creative Thinking? Indian Art: Heritage & Culture; Art Appreciation: Western Art, Artist & Art Movements: Raja Ravi Verma, Tagore, Da Vinci, Van Gogh; Aesthetics: Beauty, Feel & Expression; Art & Science; Art & Film; Art: Freedom & Society, to be an art literate. A journey to immerse in the world of Art.

### IIE 4302: INDIAN CULTURE AND CINEMA - AN INTRODUCTION [3 0 0 3]

Introduction to Idea of Culture, Identity and tradition, Indian Cultural History, Indian cultural history, Time and space, Indian Art and heritage, Indus valley civilization – Indian Independence, Post-colonial India, Modern India, Indian Cinema, Body, language and feel, Film and culture, Evolution, Interpretation and Reflection, Indian Cinema, Media and the medium, Pioneers and classical films, Culture and art of cinema, Culture, Cinema and Society, Revolutions, ideas, innovations, Culture, Cinema and Peace, Message, purpose and the challenge.

## Manipal Institute of Management, Manipal

### IIE 4304: CORPORATE FINANCE [3 0 0 3]

Introduction to Corporate Finance, Financial Goal, Agency Problems, Managers vs Shareholders Goals, Concepts of Value and Return, Capital Budgeting Decisions, Cost of Capital, Calculation of the Cost of Capital in Practice, Financial and Operating Leverage, Capital Structure, Relevance of Capital Structure, Irrelevance of Capital Structure, Relevance of Capital Structure, Dividend Theory, Dividend Relevance, Dividend Relevance, Dividend and Uncertainty, Dividend Irrelevance, Principles of Working Capital Management.

#### References:

1. Brealey, R., Myers, S., Allen, F., & Mohanty, P. (2014). Principles of Corporate Finance (11e). New Delhi: Mc Graw Hill Education (India) Private Limited.
2. Pandey, I. M. (2014). Financial Management (10e). New Delhi: Vikas publishers.
3. Ross, S. A., Westerfield, R. W., Jaffe, J., & Kakani, R. K. (2014). Corporate Finance (10e). New Delhi: Mc Graw Hill Education (India) Private Limited.
4. Parasuraman, N. R. (2014). Financial Management - A Step-by-Step Approach (1e.). New Delhi: Cengage Learning India Private Limited.

### IIE 4305: INTERNATIONAL BUSINESS MANAGEMENT [3 0 0 3]

Historical perspective of international business, International business environment, Modes of entering international business, Cross-Culture and dynamic market understanding, Differences in Culture, Theories of international business, World Bank, World trade organization, Multinational Corporations and their involvement in International Business, Tariffs and quotas, Balance of Payment Account.

#### References:

1. Hill Charles, W. L., & Jain Arun, K. (2011). International Business: Competing in the Global Marketplace. (8e), Tata McGraw Hill.
2. Kumar, S. P., & Sanchari, S. (2012). International Business Management-AGlobal Perspective. New Delhi: Excel Books.

### IIE 4306: BRAND MANAGEMENT [3 0 0 3]

Introduction to brand management, Developing a brand strategy, Brand resonance and brand value chain, Designing and implementing brand marketing programs to build brand equity, Measuring and interpreting brand performance, Designing and implementing brand architecture strategies, Managing brands.

#### References:

1. Keller, K. L., Parameswaran, M. G., Jacob, I. (2015). Strategic Brand Management (4e). Noida, India: Pearson Prentice Hall Publication.
2. Rowles, D., (2014). Digital Branding (1e.). UK: Kogan Page Limited.
3. Kapferer, J. N., (2012). The New Strategic Brand Management: Advanced Insights and Strategic Thinking (5e). UK: Kogan Page Limited

## Centre for Integrative Medicine & Research (CIMR)

### IIE 4307: YOGA [3 0 0 3]

Aim, Objectives, Meanings and Definitions of Yoga, History of Yoga, Concepts and misconceptions of Yoga, Schools of Yoga, Ashtanga Yoga

## Subjects by Industry Experts

### IIE 4308: HEALTH ECONOMICS [3 0 0 3]

Economics: Understanding Economics, Efficiency, Rational decision making, Opportunity costs, Supply and demand, Price discovery, Health economics: Defining health, Human capital, what does supply and demand mean in the context of health? Arrow on the uncertainty and welfare economics, The Moral hazard, DALY and QALY, Efficiency: The Production possibility frontiers. The production function for health care. Health policy, Defining equity, Standards of healthcare provision Epidemiology, The Healthcare sector, The demand for health, Disease prevalence, The pharmaceuticals market, Cross country case studies.

#### References:

1. Sloan, Frank A., and Chee-Ruey Hsieh. Health economics. MIT Press, 2012
2. Annemans, L. Health economics for non-economists. An introduction to the concepts, methods and pitfalls of health economic evaluations. Academia Press, 2008
3. Jeffery, Roger. The politics of health in India. University of California Press, 1988.

### IIE 4309: DIGITAL MEDICINE [3 0 0 3]

Present day practice of medicine. Limitations of scalability in the present framework. Introduction to computing, algorithms, big data, semantic web, mobility. Communication-WAN/LAN, 3G/4G and 5G. Patient/Electronic Health records. Experience with these records elsewhere Wearables, the physics of data capture. Practical demonstration of wearables Genomics, an introduction. Computational genomics including the software. Imaging –an introduction-ionizing and non-ionizing. Imaging software and science of diagnosis. How all the four 4 pillars-PHR/EHR, Wearables, Genomics and Imaging come together with software as the glue to change the world of medicine.

#### References:

1. David Mount. Bioinformatics: Sequence and Genome Analysis. CSHL, 2001
2. Durbin, Richard, Sean Eddy, Anders Krogh, and Graeme. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1999

## Manipal College of Nursing Manipal

### IIE 4310: MEDICAL EMERGENCY AND FIRST AID [3 0 0 3]

Principles of First Aid, First aid kit and equipment, emergency drugs, scene assessment, safety and identifying hazards, patient assessment, Basic Life Support and AED, triage, extrication/stretchers, ambulance. Describe the causes, signs and symptoms and management of respiratory emergencies, acute gastro-intestinal emergencies, musculoskeletal emergencies, dental, ENT and eye emergencies, renal emergencies, nervous system emergencies, hematological emergencies, endocrine emergencies, toxicological emergencies, environmental emergencies, pediatric emergencies, psychiatric emergencies, obstetrical emergencies

#### References:

1. Pollak, A.N. (2005). Emergency care and transportation of the sick and injured. Massachusetts: Jones and Bartlett publishers.
2. Keen, J. H. (1996). Mosby's Critical Care and Emergency Drug Reference. Missouri: Mosby's year book.
3. Walsh, M. (1990). Accident and emergency nursing. A new approach. Oxford: Butterworth Heinemann Ltd.
4. Sbaih, L. (1992). Accident and emergency Nursing. A nursing model. London: Chapman and Hall.
5. Sbaih, L. (1994). Issues in accident and emergency Nursing. London: Chapman and Hall.
6. Bourg, P., & Rosen, S. P. (1986). Standardized nursing care plans for emergency departments. Missouri: The C. V. Mosby Company.
7. Howard, P.K., & Steinmann, R. A. (2010). Sheehy's Emergency Nursing principles and practice. Missouri: Mosby Elsevier.
8. Sira, S. (2017). First Aid Manual for Nurses (First ed.), New Delhi: CBS Publishers & Distributors Pvt. Ltd.

### IIE 4311: LIFE STYLE MODIFICATION AND COMPLEMENTARY AND ALTERNATIVE THERAPIES [3 0 0 3]

Principles and concepts of life style modification and various complementary and alternative therapies, Demonstrate skill in performing different yoga asanas, guided imagery/Progressive muscle relaxation, meditation & Pranayama, reflexology, massage therapy, aerobics, laughter therapy

#### References:

1. Bhat Krishna K. The power of yoga. Suyoga publications; DK, 2006
2. M.M.Gore. Anatomy & Physiology of yogic practices; (5e), New age book.
3. K N Udupa. Stress and its management by yoga. (2e). Motilal Banarsidas publishers Pvt. Ltd, Delhi, 2007.
4. Yoga and total health. A monthly journal on the yoga a way of life.
5. Swami Satyananda Saraswati. Dynamics of yoga. (2e), Bihar school of yoga, Bihar 1997.

## Welcomegroup Graduate School of Hotel Administration, Manipal

### IIE 4312: INDIAN CUISINE AND CULTURE PRACTICAL [3 0 0 3]

Introduction to Indian cuisine, Basic Indian gravies, Rice cooking, Preparation of various rice products, Tandoor Cooking, Indian sweets, Comfort Food, Regional and sub-regional cuisine.

### IIE 4313: FOUNDATION COURSE IN BAKING AND PATISSERIE PRACTICAL [3 0 0 3]

Introduction to Patisserie and Baking Principles, Special emphasis placed on the study of ingredient functions, Students will have the opportunity to apply basic baking techniques, Understanding fundamentals of yeast dough production, Emphasis on the application of ingredient functions, product identification and recipe interpretation occurs

throughout the course, Pastry Basics and Pie dough, The fundamental production of classical European pastry based desserts are included, Techniques of Cake Making, Techniques of Cookie making, The course emphasizes the preparation and makeup techniques of various cookies.

#### References:

1. Wayne Gisslen – Professional Baking, (5e), John Wiley USA.
2. Haneman L.J. Bakery: Flour Confectionery HEINMAN.
3. Mermaid Books The Book Of Ingredients DOWELL PHILIP.
4. John Wiley Understanding Baking AMENDOLA JOSEPH.
5. New Age International, A Professional Text to Bakery and Confectionery, KINGSLEE JOHN.
6. Virtue And Company Ltd., The New International Confectioner: WILFRED J. FRANCE.
7. Charrette Jacques, Great Cakes and Pastries, TEUBNER CHRISTIAN.
8. Joseph Amendola, Baker's Manual, (5e), NICOLE REES.
9. Joseph Amendola, Understanding Baking, (3e), NICOLE REES.
10. Culinary Institute Of America, Baking and Pastry: Mastering the Art and Craft, JOHN WILEY.

### IIE 4314: GLOBAL CUISINE & CULTURE- PRACTICAL [3 0 0 3]

European Cuisine: Familiarization of ingredients, recipes and preparation of different countries. North American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. South American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Asian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Australian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. African Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Molecular Gastronomy: Additives, Tools, and Recipes. Processed Food: Comparison and Critiquing. Mediterranean and European cuisine: Familiarization of ingredients, recipes and preparation of different countries.

#### References:

1. The Professional Chef - The Culinary Institute of America
2. Practical Cookery - Kinton, Ceserani and Foscett
3. Food Production Operation - Parvinder S. Bali
4. Professional Cooking - Wayne Gisslen
5. Cookery for the Hospitality Industry - Dodgshun Peters
6. Modern Cookery - Thangam E Phillips

## School of Communication, Manipal

### IIE 4315: REPORTING AND WRITING [3 0 0 3]

Introduction to news writing news in different media, news, definition of news, news values; types of news other theoretical issues relating to news writing. News Reporting Basic of news writing: structure of news reports; writing the lead; the changes in the composition of the lead; techniques of news gathering; sources of news. Reporting various types of reporting (Objective, Interpretative, Investigative.) General assignment reporting/working on a beat. Reporting for news agency, periodicals and magazines. Interviewing: doing the research, conducting the interview, types and formats of interviews, writing interviews

#### References:

1. Mencher, Melvin (2006): News Reporting and Writing, Mac-Graw Hill, Boston.
2. Scalnan, Christopher (2000): Reporting and Writing: Basics for the 21st Century, Harcourt College Publishers.
3. Harrington Walt (1997) Intimate Journalism: The Art and Craft of Reporting Everyday Life, Sage Publications.
4. Carole, Rich (2007), Writing and Reporting News: A Coaching Method, Thomson Learning Inc. Kamath, K.V. (1993): Journalists' Handbook, Vikas Publishing House.
5. Aggarwal, Vir Bala (2006): Essentials of Practical Journalism, Concept Publishing Company.



### **IIE 4316: INTRODUCTION TO ADVERTISING & PUBLIC RELATIONS [3 0 0 3]**

Introduction to advertising; Evolution and history of advertising; Influence of advertising on society and ethics. Advertising as part of marketing mix; Structure and types of ad agencies; Advertising planning; creative strategy and implementation (media strategy). The essentials of advertising on different media platforms – print, broadcast, internet and new media; discuss the difference in planning and execution using examples or campaign case studies. Public Relations-scope; definition; evolution; establish difference between PR and advertising; Identifying stakeholders and various Public Relation tools. Steps in developing a PR program/campaign-stating the problem, planning and programming, action and evaluation; Crisis communication; Ethical issues in Public Relations.

#### **References:**

1. Butterick, K (2012): Introducing Public Relations: Theory and Practice. New Delhi: SAGE Publications India Pvt. Ltd.
2. Cutlip, Center & Broom, (2000): Effective Public Relations.USA: Prentice Hall International.
3. Jaishri Jethwaney and Shruti Jain, (2012): Advertising Management. New Delhi: Oxford University Press
4. Reddi, C.V.N. (2009): Effective Public Relations and Media Strategy. New Delhi: PHI Learning Pvt. Ltd.
5. Sharma, S. & Singh, R. (2009): Advertising Planning and Implementation. New Delhi: PHI Learning Pvt. Ltd.

### **IIE 4317: BASIC PHOTOGRAPHY [3 0 0 3]**

Photo Journalism: History of Photography and Photo Journalism. Photo Journalism: Definition, Nature, Scope and Functions of Photo Journalism – Qualification and Responsibilities of Photo Journalists, News Photographers and News Value, Types and Sources. Selection, Criteria for News Photographs – Channels of News Pictures – viz., Wire, Satellite, Agency, Stock, Picture Library, Freelancer, Photo Editing, Caption Writing, Photo – Presentation. Legal and Ethical aspects of Photography – Professional Organizations – Camera – Components and Types of Camera – Types of Lens, Types of Films, Types of Filters – Importance of Light and Lighting Equipments – Camera Accessories – Picture appreciation. Digital Camera – Digital Technology and its future – Darkroom Infrastructure – Film developing and Printing

#### **References:**

1. Basic Photography – Newnes
2. The Hamlyn Basic Guide to Photography – Hamlyn
3. Hamlyn Encyclopedia of Photography – Hamlyn
4. Photographing People – Guglielmezei
5. History of Photography – Cyernshem G R
6. Photo Journalism – Rothsteline
7. Techniques of Photo Journalism – Milten Feinberg
8. Freelance Photography – Jechsend Gedsey
9. Picture Editing – Stanley E Kalish and Clifton C Edom
10. News Photography – Jack Price
11. 1000 Ideas for better News Picture – High Sidley and Rodney Fox

### **IIE 4318: MEDIA PRODUCTION TECHNIQUES [3 0 0 3]**

Print design elements – typography, colours, spacing, pictures, logos, graphics, principles of layout and design – basic writing skills. Photography – SLR camera, Lenses, Apertures and Shutter speeds, Exposure, Understanding light, Filters and accessories, composing a picture, developing and printing, creating special effects. Digital photography – digital camera – digital technology and its future. Television – Introduction to AV Media-pre-production, production, post-production. Show packaging-Camera-characteristics, parts and

functions; Mounting accessories and movements. Shots-Types and Uses; Basic composition. Practical video recording process. Radio – Introduction to Radio-Microphone types, characteristics and uses; Cables and Connectors. Recording device-Types and Characters, Audio editing, Programme formats-news, drama, feature and PSA's and Advertising.

#### **References:**

1. Gerald Millerson, "Effective TV production"
2. Peter Jarvis, "The Essential TV director's Handbook"
3. Hamlyn "Basic guide to photography"
4. Ralph Milton "Radio programming – a basic training manual"
5. Tomlinson Holman "Sound for film and television"
6. Reporting and writing by Melwin Mencher

### **IIE 4319: GRAPHIC & SKETCHING [3 0 0 3]**

Basic Art Principles: Element of Art & Design, Contour Drawing, Composition Principles, Pencil shading, creating geometry model and shading. Basic Perspective: Still life sketching & Drawing, Styles of shading, Introduction to colors, color still life painting, Layout Design, Creating concepts for Design. Skeleton System, Body Proportions, Upper Body, Lower Body, Back, Hands and Legs. Text: Human Anatomy by Victor Perard, Dynamic Anatomy by Burne Hogarth. Gesture Drawing Tips, Line of Action, Dynamic Poses, Body Weight and Gravity, Clothing. Text: Figure Drawing by Anthony Ryder.

#### **List of Practical's:**

- ▶ 10 Drawings of Human Anatomy Study In Pencil
- ▶ 50 Drawings of Gesture Drawing In Pencil
- ▶ 5 Contour Drawing
- ▶ 2 Still Life Pencil Shading
- ▶ 2 Color Still Life
- ▶ 2 Layout Design

#### **References:**

1. Mastering Composition: Techniques and Principles to Dramatically Improve Your Painting (Mastering (North Light Books)) Hardcover – 25 Jan 2008 by Ian Roberts
  2. Layout Essentials: 100 Design Principles for Using Grids (Design Essentials) Paperback – 1 by Beth Tondreau
  3. Pencil Drawing: Learn how to develop drawings from start to finish with techniques for shading, contrast, texture, and detail (Artist's Library) Paperback – 1 Jan 1988 by Gene Franks
  4. Drawing the Head and Figure – Jack Hamm
  5. Dynamic Anatomy – Burne Hogarth
  6. The artists complete guide to Human figure Drawing – Anthony Ryder
  7. Human Anatomy – Victor Perard
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