SYLLABI

CHY100 CHEMISTRY 3 0 0 3

Unit 1

Water Technology: Hardness – units of hardness – alkalinity - dissolved oxygen. Boiler feed water – boiler compounds – boiler problems - internal conditioning - external conditioning – zeolite and ion exchange process. Municipal water treatment – desalination by RO and electro dialysis.

Phase rule: Phase rule – statement and explanation of terms–one component system – water-vapor-ice – thermal analysis – condensed phase rule - Two component system – Ag – Pb – simple Eutectic – compound formation - Cu – Au solid solution - Ellingham diagram and its application**.**

Unit 2

Spectroscopy: Significance of spectroscopy as analytical tool – Electromagnetic spectrum, intensities of spectral lines and the Beer-Lamberts law. Vibration of Diatomic molecules - Energy levels - Principles of selection rules - Introduction to IR spectrum – vibrational frequency – fundamental vibrations – IR instrumentation and its applications – Electronic spectra – types of electronic transition – chromophore concept – absorption and intensity shifts – conjugated dienes - solvent effects – UV Instrumentation and its applications. Principles of H-NMR – number of signals – chemical shift – splitting of the signals.

Chemistry of corrosion and its control: Chemical and electro chemical corrosion – Pilling Bed worth ratio – forms of corrosion.

Unit 3

Electrochemical series - galvanic series - corrosion potential – corrosion current – rate of corrosion – units of corrosion - rate determination – weight loss method. Corrosion control - cathodic and anodic protection.

Advanced Engineering Materials: Introduction to Nanoscience and Technology – significance of nano materials – methods of synthesis – Carbon Nanotubes - synthesis – properties and applications. Conducting polymers - mechanism of conduction - applications. Organic LEDs - their functioning - advantages and disadvantages over conventional LEDs - their commercial uses. Liquid crystals – positional and orientation order - classification of liquid crystals - requirement for substance to exhibit liquid crystalline state - chemical constitution - identification of liquid crystals - electro-optic effect in liquid crystals, application of liquid crystals.

TEXTBOOKS:

1. *Gordon M Barrow, "Physical Chemistry", 5th edition, Tata McGraw-Hill, (2007).*
2. *Jain P C & Monika Jain, "Engineering Chemistry", Dhanpatrai Publishing Co Ltd, New Delhi, (2005).*

REFERENCES:

1. *Fontana and Mars G, "Corrosion Engineering", 3rd edition, McGraw hill, (1987).*

2. *Robert M Silverstein and Francis X Webster, "Spectrometric Identification of Organic Compounds", 6th edition, Wiley & Sons, (2006).*
3. *Charles P Poole, Jr Franck J Owens, "Introduction to Nanotechnology", Wiley Interscience, (2003).*
4. *Chandrasekhar A, "Liquid crystals", Cambridge University Press, Cambridge, UK, (1992).*
5. *CNR Rao, "UV & Visible Spectroscopy – Chemical Application", Butter Worths.*
6. *CNR Rao, "IR Spectroscopy – Chemical Application", Academic Press*

CHY181 CHEMISTRY LAB. 0 0 3 1

1. Estimation of Hardness of sample water.
2. Estimation of alkalinity of sample water.
3. Estimation of Kinetics of Ion Exchange reactions.
4. Estimation of HCl and CH_3COOH by conductometric titration.
5. Estimation of Fe^{2+} by potentiometric titration.
6. Phase diagram of two component system.
7. Determination of Corrosion rate and Inhibitor efficiency by weight loss method.
8. One step preparation of simple organic/inorganic compound.
9. Determination of molecular weight of polymer by viscosity method.
10. Adsorption by Activated charcoal method.

(Any 9 experiments of the above list)

Experiments for Demonstration

11. Desalination by Reverse osmosis.
12. Estimation of Dissolved oxygen of sample water.
13. Spectrophotometric analysis of trace element (Fe) in water.

CHY250 CATALYTIC CHEMISTRY 3 0 0 3

Unit 1

Catalysis: Introduction, Industrial applications. Rates of reactions - equilibrium, energy of activation and the catalyst's role, Elementary reactions in catalytic transformations homogeneous and heterogeneous catalysis.

Catalysis in solutions: Acid-base catalysis - catalysis in the gas phase, catalysis in dilute aqueous solution, catalysis in concentrated strong acid solutions, catalysis by bases, catalysis by metal ions, catalysis by electron transfer, organometallic catalysis, catalysis in Ziegler Natta/Metallocene/Metathesis polymerization.

Unit 2

Catalysis by macromolecules, Phase transfer catalysis.

Catalysis by Enzymes: Introduction - kinetics of enzyme catalyzed reaction, catalysis through enzyme, organic catalysis, metalloenzyme catalysis, supported enzymes. Industrial applications of enzyme catalyst.

Catalysis by Polymers: Attachment of catalytic groups to polymer supports, Adsorption and the Kinetics of polymer-catalyzed reactions**.**

Unit 3

Catalysis in polymer gels, bifunctional and multifunctional catalysis, porous polymers, Applications of polymer catalysis.

Catalysis in Molecular scale cavities: Structures of crystalline solids, structure of Zeolites, catalysis by Zeolites, catalysis by Zeolites containing metal complexes and clusters. Catalysis on surfaces – surface catalysis, catalysis on metal surfaces**.**

TEXTBOOKS:

1. *Bruce C Gates, "Catalytic Chemistry", John Wiley & Sons, Inc. USA, (1992).*
2. *Viswanathan B, Sivasankar S, Ramaswamy A V, "Catalysis, Principles and Applications", CRC Press, (2006).*

REFERENCES:

1. *James E House, "Principles of Chemical Kinetics", Academic Press, (2007).*
2. *Kuriacose J C, "Catalysis", Macmillan India Limited, New Delhi, (1991).*

CHY251 CHEMISTRY OF ENGINEERING MATERIALS 3 0 0 3

Unit 1

Chemical materials in Electronics and Electrical Engineering: Structural correlation to behavior of conducting polymers, Semi-conducting polymers - properties of organic polymers containing metal groups such as poly ferrocene - optical fibers - definition, principle and structure - characteristics of optical fibre - photo resist optical fibre - advantages of optical fibre - liquid crystalline - peizo and pyroelectric polymers - magnetic materials, hard and soft magnets – sensors (voltametric).

Nanomaterials: Nanotubes and Nanowires, Carbon nanotubes, single walled and multiwalled, aligned carbon nanotubes, doping with boron – applications - Nanostructured polymers.

Unit 2

Chemical aspects in biotechnology - Enzymes and bio reactors - Biotechnological processes – Bio-sensors - glucose biosensors, bio-filters and bio-membranes – Bio-fertilizers, Bio-surfactants.

Chemistry of Engineering Plastics: Preparation, properties and applications of ABS, Polycarbonates, Epoxy resins - Polyamides - Nylon and Kevlar.

Photochemistry in Electronics: Photochemical reactions - laws of absorption (Grothers - Draper law - Stark - Einstein's law) - Quantum efficiency - photochemical decomposition of HI and HBr - and Quantum yield.

Unit 3

Florescence and Phosphorescence - chemiluminescence - photo sensitization.

Chemistry of Toxic Materials and Toxicology: Principles of Toxicology - Volatile poisons - Gases CO, hydrocyanic acid - H_2S - PH_3 - CO_2 - SO_x - NO_x - Heavy metals - lead, arsenic, mercury, antimony, barium, bismuth, selenium, zinc, thallium - Pesticides - Food poisoning - Drug poisoning - barbiturates - narcotics - ergot - LSD - alkaloids - Radioactive Toxicology - Radiation hazards.

TEXTBOOK:

Kuriacose J C, Rajaram, "Chemistry in Engineering and Technology, Systematic Organic and Inorganic Chemistry and Chemistry of Materials (Vol 1 & 2)", Tata McGraw-Hill Publishing Company Limited, 1999.

REFERENCE:

Van Vlack, Lawrence H, "Elements of Material Science and Engineering" (6th edition), New York Addison-Wesley, 1989.

CHY252 CHEMISTRY OF ADVANCED MATERIALS 3 0 0 3

Unit 1

Chemistry of Engineering Plastics: Preparation, properties and applications of ABS, polycarbonates, epoxy resins - polyamides - Nylon and Kevlar.

Chemistry of Carbon nanotubes: Introduction, carbon nanotubes - fabrication, structure, electrical properties - vibrational properties - mechanical properties - applications of carbon nanotubes.

Unit 2

Electron transfer studies in salt based conductors and magnets: Introduction - definitions and units - ferro magnets and ferrimagnets. One-dimensional conductors - quasi one and two-dimensional super conductor. Fullerides - paramagnetic conductors and superconductors. Electron transfer salt based ferro magnets: nitroxide, metallocene and ferric magnet-based ferro magnets - weak ferro magnets. Nanopore containment of magnetic particles - nanocarbon ferromagnets.

Unit 3

Functional electro active polymers: Conjugated polymers - synthesis, processing and doping of conjugated polymers: polyacetylene, polyaniline, polythiophene, poly (p-phenylenevinylene) - ionically conducting polymers - applications of conjugated polymers. Semi-conducting, poly ferrocene - photo resist optical fibers and sensors, photo chromic & thermo chromic materials.

Photochemistry in Electronics: Laws of absorption - quantum efficiency and quantum yield - florescence and phosphorescence – photosensitization.

High energy materials: Preparation, properties and application of ammonium nitrate (AN), NH_4NO_3, ammonium perchlorate (AP), NH_4ClO_4, ammonium dinitramide (AND), $NH_4N(NO_2)_2$, hydrazinium nitroformate (HNF), $N_2H_5C(NO_2)_3$ etc.

TEXTBOOKS:

1. *Van Vlack, Lawrence H, "Elements of Material Science and Engineering", 6th edition, New York Addison, Wesley, (1989).*
2. *Chawla S, "A Textbook of Engineering Chemistry", Dhanpatrai & Co, Delhi, (2001).*

REFERENCES:

1. *Mark Ratner and Daniel Ratner, 'Nano technology - A gently introduction to the next big idea', Pearson Education, (2003).*
2. *Interrante L. V. and Hampden Smith M.J, 'Chemistry of Advanced Materials', Wiley-VCH, (1988).*

CHY253 ADVANCED POLYMER CHEMISTRY 3 0 0 3

Unit 1

Newer Polymers and Polymerizations: Polymeric Liquid Crystals - Inorganic and Organometallic polymers - Synthesis and reactions of Phosphorus - Nitrogen polymers - Boron - Silicone polymers. Cyclisation versus Linear Polymerization - Molecular weight control in linear polymerization - Molecular weight distribution in linear polymerization - Molecular weight distributions in nonlinear polymerization - Multichain Polymerization - Metallocene Polymerization.

Unit 2

Solid-state irradiation polymerization - Atom transfer radical polymerization - Plasma Polymerization - Zwitterionic Polymerization - Isomerization polymerization - Polymer supported solid phase reactions - Merrifield method.

Polymer degradation and stabilization: Mechanism of different types of degradation - Commonly used antidegradants and the mechanism of their stabilization.

Unit 3

Polymer solutions: Criteria for solubility - Heat of Dissolution and Solubility parameters - Conformation of polymer chains in solutions - Nature of polymer molecules in solution - Size and shape of macromolecules in solution - Thermodynamics of polymer solutions - Phase equilibria - Entropy and heats of mixing of polymer solutions - Effect of molecular weight on solubility - Solubility of crystalline and amorphous polymers - Flory Huggins theory of polymer solution, Equation of state theory, Flory Krigbaum theory and cluster type theory - Viscosity of dilute polymer solutions.

TEXTBOOKS:

1. *George Odian, "Principles of Polymerization", John Wiley & Sons Inc., New York, (1991).*
2. *Malcolm P.Stevens, "Polymer Chemistry", Oxford University Press, New York, (1999).*

REFERENCES:

1. *Harry R Allcock and Frederick W Lampe, "Contemporary Polymer Chemistry", 2nd edition, Prentice Hall, Inc., New Jersey, (1990).*
2. *Charles E Carraher, Jr., "Polymer Chemistry", 5th edition, Marcel Dekker Inc., New York, (2000).*
3. *Jayadev Sreedhar and Govariker, "Polymer Chemistry".*

CHY254 POLYMERS FOR ELECTRONICS 3 0 0 3

Unit 1

Conducting polymers: Conducting mechanisms - Electron transport and bipolar polymers - electrodepositable resists, resins. Applications - Organic light emitting diodes, Sensors, EMI shielding, printed Circuit Boards, Artificial nerves, Rechargeable Batteries, Electromechanical Actuators and switches.

Unit 2

Photoconductive polymers: Charge carriers, charge injectors, charge transport, charge trapping. Polymers for optical data storage - principles of optical storage, polymers in recording layer.

Nonlinear optics: NLO properties and NLO effects, wave guide devices, polymer optical fibers - through plane modulators.

Unit 3

Thermosensitive polymers: Applications - Mechanical actuators and switches - Tissue culture, Drug delivery, Photo resists - Types - Chemically amplified photoresists - Applications. Magnetic polymers - structure and Applications.

Liquid crystalline polymers: Fundamentals and process, liquid crystalline displays - Applications.

TEXTBOOK:

Kiichi Takemoto, Raphael M. Ottenbrite, Mikiharu Kamachi, "Functional Monomers and Polymers", CRC Press, (1997).

REFERENCE:

1. *A B Kaiser, "Electronic properties of conjugated polymers - basics, models and applications", Springer Verlag, (1987).*
2. *J. A. Chilton and M T Goosy, "Special polymers for electronics and optoelectronics", Kluwer Academic Publishers, (1995).*

CHY255 CHEMISTRY OF TOXICOLOGY 3 0 0 3

Unit 1

Introduction to Toxicology: Definition - scope - history - relationship to other sciences - dose-response relationship - sources of toxic compounds - Classes of

Toxicants - broad overview of toxicant classes such as metals, agricultural chemicals, food additives - contaminants, toxins, solvents, drugs, and cosmetics - history, exposure route, and toxicity of the non-essential metals - cadmium, lead, and mercury - medical treatment of metal poisoning - classes of agricultural chemicals - Toxins - source, including microbial, fungal, algal, plant and animal - examples - Brief discussions - food additives and contaminants – solvents - therapeutic drugs - drugs of abuse - combustion products - cosmetics.

Unit 2

Exposure Classes, Toxicants in Air, Water, Soil, Domestic and Settings: Occupational Air, water and soil as primary media for human exposure to various classes of chemical toxicants in environmental, domestic, and occupational settings - historic and present status of air pollution and air quality - introduction to the major classes of soil and water pollutants - sources, exposure routes and potential adverse health effects - Classes of occupational toxicants - route of exposure and permissible levels - specific examples of concern.

Unit 3

Toxicant Analysis and Quality Assurance Principles: Introduction to procedures, principles and operation of analytical laboratories in toxicology. Summary of the general policies - analytical laboratory operation, analytical measurement systems, quality assurance (QA) - quality control (QC) procedures.
Environmental Risk Assessment: Environmental risk assessment procedures - particular environmental risk problem - appropriate endpoints - development of conceptual models, analyzing exposure – effects, information - characterizing exposure - ecological effects - management of risks.
Future Considerations for Environmental and Human Health: Changes in toxicology - evaluation of future risk assessment - more fundamental aspects of toxicology - in vivo and in vitro toxicity - biochemical toxicology - molecular toxicology - development of selective toxicants.

TEXTBOOK:

Ernest Hodgson, "Modern Toxicology", John Wiley & Sons, Inc., (2004).

REFERENCES:

1. *John Wright, "Environmental Chemistry", Routledge, (2003).*
2. *A K DE, "Environmental Chemistry", New Age International, (2003).*
3. *Fritz Helmet, "Environmental Chemistry", Sarup and sons (Delhi), (2003).*

CHY256 CHEMISTRY OF NANOMATERIALS 3 0 0 3

Unit 1

Introduction: Introduction to Nanomaterials: Size dependence of properties - Surface to volume ratio and Quantum confinement. Microscopic techniques to study nano structures - SEM, AFM - TEM and STM - Raman spectroscopy.
Synthesis of Nanomaterials: Synthetic approaches: Colloidal Self-Assembly (Self-assembled monolayers - SAMs) and electrostatic self-assembly, electrochemical methods, sol-gel deposition

Unit 2

Langmuir-Blodgett (LB) technique, chemical vapour deposition, plasma arcing and ball milling.
Carbon nanostructures: Carbon Clusters: Fullerenes, structure, synthesis, alkali doped C_{60} - superconductivity in $C_{60,}$ applications of fullerenes. Carbon nanotubes: Classification, properties, synthesis, characterization, and potential applications, growth mechanism of carbon nanotubes.
Other Nanostructures: Quantum Dots: Preparation, properties and applications of Au, CdS and CdSe quantum dots,

Unit 3

Fabrication and applications of conducting polymer nanotubes, TiO_2 and metallic nanotubes.
Molecular Electronics and Machines: Molecular electronics: Working of Molecular and supramolecular switches, transistors and wires. Molecular machines: Working of Molecular motors, rotors, cars, elevators and valves.

TEXTBOOKS:

1. *Charles P Poole Jr, Frank J Ovens, "Introduction to Nanotechnology", Wiley Interscience, (2003).*
2. *Alexei Nabok, "Organic and Inorganic Nanostructure", Artech House, Inc. (2005).*
3. *Peter J F Harris, "Carbon Nanotube Science: Synthesis, Properties and Applications", Cambridge University Press, (2009).*
4. *Balzani V, Credi A, Venturi M, "Molecular devices and machines - A journey in to the Nanoworld", Wiley VCH, (2003).*

REFERENCES:

1. *Rao C N R, Muller A, Cheetham A K (Eds.), "The Chemistry of Nanomaterials: Synthesis, Properties and Applications", WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, (2004).*
2. *Zhong Lin Wang, "Characterization of nanophase materials", Wiley VCH, (2000).*
3. *Massimiliano Di Ventra, Stephane Evoy, James R Heflin, "Introduction to nanoscale science and technology", Kluwer Academic Publishers, (2004).*
4. *William A Goddard, III, Donald W Brenner, Sergey Edward Lyshevski and Gerald J. Iafrate, "Handbook of Nanoscience, Engineering, and Technology", CRC Press, (2003).*
5. *Balzani V, Credi A, Venturi M, "Molecular devices and machines- A journey in to the Nanoworld" Wiley VCH (2003).*
6. *Bharat Bhushan, "Hand book of Nanotechnology", Springer, (2004).*

CHY257 BIOMATERIALS SCIENCE 3 0 0 3

Unit 1

Introduction: Bulk properties, Surface properties and characterization - polymers, silicone biomaterials, medical fibres and biotextiles - Smart polymers - bioresorbable and bioerodible materials - natural materials, metals and ceramics - physicochemical surface modification.

Biocompatibility concepts: Introduction to biocompatibility - cell material interaction – types of materials - toxic, inert, bioactive - long term effects of materials within the body - cell response.

Unit 2

Chemical and biochemical degradation of polymers - degradation of metals and ceramics - calcification of biomaterials.

Host reactions and their evaluation: Inflammation and foreign body response - adaptive immunity - systemic toxicity and hypersensitivity - blood coagulation and blood materials interactions - device related infections.

Unit 3

Biological testing of biomaterials: Invitro and invivo assessment of tissue compatibility - evaluation of blood materials interaction - microscopy in biomaterials.

Practical aspects of biomaterials: Bioelectrodes, biomedical sensors and biosensors - sterilization of implants - implant failure - implant retrieval and evaluation - legal aspects, ethical issues and regulation aspects.

TEXTBOOK:

Buddy D Ratner, Allan S Hoffman, "Biomaterials Science - An introduction to materials in Medicine", Elsevier academic press, (2004).

REFERENCES:

1. *Jonathan Black, "Biological Performance of Materials: Fundamentals of Biocompatibility", 4th edition, CRC Press, (2006).*
2. *John D. Enderle, Susan M. Blanchard, Joseph D. Bronzino, "Introduction to Biomedical Engineering", 2nd edition, Elsevier Academic Press, 2005.*

CHY258 ENVIRONMENTAL CHEMISTRY 3 0 0 3

Unit 1

Air and air pollution (earth's atmosphere): Regions - ozone - CFC and other chemicals - catalytic decomposition of ozone - 'ozone hole' formation - Air pollution due to gas emission from industries - Atmospheric aerosols – dust, combustion products, aerosol concentration and lifetimes - Automobile exhausts, smog and effects - Acid rain - chemistry of acid rain, roll of meteorology, greenhouse gases and global warming - air pollution due to jet engines.

Water and water pollution (hydrosphere): Physical and chemical properties of water- microbiological processes - carbon, nitrogen cycles - Water pollution - polluting agents - indices of pollution, heavy metal pollution and toxicity - BOD and COD determination - suspended solids - determination of other ions by photometric methods - Chemistry of anaerobic process, use of Effective Microorganisms.

Unit 2

Aerobic processes - wastewater treatment systems (brief description only) - anaerobic and aerobic - sewage treatment, primary, secondary and tertiary processes - water reuse and recycle. Eutrophication of lakes, nitrogen and phosphorus in effluents - Drinking water standards - sources - fluoride and arsenic in water, purification, sterilization - chemistry of chlorination - water purification for domestic use - reverse osmosis -nano filters and membranes.

Industrial Pollution and its control: Industrial pollution and waste waters from various types of industries - environmental pollution due to paper mills, textile mills etc., and its control. Solid waste disposal - methods - solid waste from mining and metal production and its disposal - Electrochemical treatment of pollution control, electro-coagulation and flocculation - Green chemical processes and green solvents-reaction conditions to control industrial pollution.

Unit 3

Other types of pollution: Soil pollution - agricultural pollution - use of chemical fertilizers - Organic chemicals and environment, dioxins and furans - chemistry of some of the pesticides, insecticides and herbicides, ill effects due to uncontrolled use - Bulk storage of hazardous chemicals and disasters, Radioactive pollution, radiation units, sources - exposure and damage - safety standards - radioactive wastes and their disposal - Toxicological substances, testing of toxic substance, enzyme inhibition and biochemical effects of toxic chemicals on humans.

Sampling and Measurements of Pollutants: Sampling and analysis techniques of air pollutants (brief outline only) - analysis of particulate matter and lead - Sampling and measurements of water pollutants - organic loadings, phosphates and nitrogen compounds - monitoring of water quality - water test kits, various analytical methods (brief outline only).

TEXTBOOKS:

1. *Gary W.VanLoon and Stephen J.Duffy, "Environmental Chemistry", Oxford University Press, (2000).*
2. *Ajay Kumar Bhagi and G.R.Chatwal, "Environmental Chemistry", Himalaya Publishing House, (2003).*

REFERENCES:

1. *John Wright, "Environmental Chemistry", Routledge, (2003).*
2. *A K De, "Environmental Chemistry", New Age International, (2003).*
3. *Fritz Helmet, "Environmental Chemistry", Sarup and sons (Delhi), (2003).*
4. *Clair N Sawyer, Perry L McCarty and Gene F Parkin, "Chemistry for Environmental Engineering", McGraw Hill, (1994).*

5. *Jack Barrett, "Chemistry in your Environment", Albion Publishing Ltd., (1994).*
6. *Thomas G Spiro and William M Stigliani, "Chemistry of the Environment", Prentice Hall, (2002).*
7. *Kudisia VP and Ritu, "Environmental Chemistry", Pragati Prakashan, Meerut, (2000).*

CHY259 INSTRUMENTAL METHODS OF ANALYSIS 3 0 0 3

Unit 1

Error Analysis and Sampling: Accuracy - Precision - Classification of Errors - Minimization of errors - Standard deviation - Coefficient of variance - F-test - t-test - Significant figures. Sampling - Basis of sampling, Sampling and physical state - Safety measures of sampling.

Separation Techniques: Brief out line of column, paper and thin layer chromatography - Ion exchange methods - principle and application – HPLC.

Unit 2

Gas chromatography - principle and applications – gel chromatography.

Electro analytical techniques: Potentiometry - Potentiometric titration - determination of equivalence point - acid base, complexometric, redox and precipitation titrations - merits and demerits. Voltammetry - Cyclic voltammetry - basic principle and application - Polarography - introduction - theoretical principles - migration current - residual current - half wave potential - instrumentation - analytical applications.

Unit 3

Spectro-chemical techniques: UV-VIS spetrophotometry - principle - Beer's Law application - photometric titration - single and double beam spectrophotometer - instrumentation of IR - sample handling - IR applications - H - NMR - Instrumentation and applications - principle - instrumentation - applications of atomic absorption spectroscopy.

Thermal and Diffraction techniques: Principles and applications of DTG - DTA - DSC - X-ray - Electron Diffraction Studies - SEM, TEM.

TEXTBOOKS:

1. *Willard H W, Merritt JR, "Instrumental Methods of Analysis", 6th edition, Prentice Hall, (1986).*
2. *Skoog Douglas A, West Donald, "Fundamentals of Analytical Chemistry", 7th edition, New York Addison, Wesley, (2001).*

REFERENCES:

1. *"Vogel's Textbook of Quantitative Chemical Analysis", 5th edition, ELBS, (1989).*
2. *Kaur.H, "Instrumental Methods of Chemical Analysis", Goel Publisher, (2001).*

CHY260 ORGANIC SYNTHESIS AND STEREOCHEMISTRY 3 0 0 3

Unit 1

Nomenclature of Organic compounds: Polyenes, Alkynes with and without functional groups by IUPAC nomenclature. Aromatic and Heteroaromatic systems - nomenclature of heterocycles having not more than two hetero atoms such as oxygen, sulphur, nitrogen.

Stereochemistry: Tacticity, R/S system of nomenclature of central and axial molecules.

Unit 2

Atropisomerism - isomerism of biphenyls - allenes and spiranes - ansa compounds - Geometrical isomerism, E, Z Isomerism. Asymmetric synthesis.

Conformational Analysis: Optical activity and chirality - Conformational Analysis of cyclic and acyclic system - Conformational effects on reactivity of acyclic systems only.

Unit 3

Asymmetric synthesis: Stereo selective - Stereo specific - Regioselective and Regiospecific reactions. Principle of protection of alcohol, amine, carboxyl and carbonyl groups - Functional group inter conversions - Disconnection approach - Reversal of polarity - reagents in synthesis.

TEXT BOOKS:

1. *E. L. Eliel, "Stereochemistry of Carbon Compounds", Mc Graw-Hill Book Co, (2000).*
2. *Jerry March, "Advanced Organic Chemistry", 4th edition, John Wiley & Sons, (1992).*

REFERENCES:

1. *S. Warren, "Designing Organic Synthesis", Wiley & Sons, (1998).*
2. *Finar I.L, "Organic Chemistry: Stereochemistry and the Chemistry of Natural Products", 5th edition, ELBS, (2000).*

CHY261 UNIT PROCESSES IN ORGANIC SYNTHESIS 3 0 0 3

Unit 1

Application of Thermodynamics in Organic Unit Processes: free energy, bond energies and entropy. Concepts of aromaticity - Huckel's rule - anisotropy. Intermediates - carbocations, carbanions, free radicals, carbenes and nitrenes. Reagents in organic synthesis: Grignard reagents, Organolithium reagents, selenium dioxide, chromium trioxide, lead tetraacetate, sodium borohydride, lithium borohydride, sulphur carbanions.

Unit 2

Organic reactions and mechanisms: Substitution reaction - aliphatic

nucleophilic, aromatic elecrophilic and nucleophilic substitution. Elimination and addition reaction - Halogenation .Nitration – aromatic nitration – mechanism – Technical nitration – mixed acid nitration. Hydrocarbon synthesis and Hydroformylation (Catalysis) Various catalysts used – technology of Fischer - Tropsch operation – methanation - Hydroformylation, Monsanto acetic acid, Wacker process and synthetic gasoline. Alkylation – types – alkylating agents – factors controlling alkylation – technical alkylation.

Unit 3

Sulphonation and sulfation: Sulphonating and sulphating agents – their principal applications – chemical and physical factors in sulphaonation and sulphation – kinetic, thermodynamics and mechanism – the desulphonation reaction.

Amination: Amination by reduction – methods of reduction – catalytic, metal and acid, sulphide and electrolytic reductions – amination by ammonolysis- aminating agents – catalysts used in amination reactions – technical manufacture of amino compounds – ammonia recovery system.

Catalysis by organometallic compounds: Synthesis gas (Ruthenium and Rhodium metal catalyst).

TEXTBOOK:

P.H.Groggins, "Unit Processes in Organic synthesis", Mc Graw Hill, (Fifth edition), 1952.

REFERENCES:

1. *B C Bhattacharya, C M Narayanan, "Unit Operations and Unit Processes", Mc Graw Hill, (1994).*
2. *Dryden, "Dryden's Outlines of Chemical Technology", East West, (1988).*
3. *Carey. F and Sundberg R, "Advanced Organic Chemistry, Part A & B", Kluwer, (2000).*

CHY262 MEDICINAL ORGANIC CHEMISTRY 3 0 0 3

Unit 1

Medicinal Chemistry: Introduction, drugs - classification of drugs - mechanism of drug action. Drug-receptor complex nomenclature - agonist, antagonist.

Physicochemical properties in relation to biological action: solubility, partition coefficient, dissociation constant, hydrogen bonding, ionization, drug shape, surface activity, complexation, protein binding, molar refractivity, bioisosterism - Stereo chemical aspects of drug action-stereo isomerism-optical isomerism.

Unit 2

Enzymes and hormones: Enzymes - nomenclature, classification and characteristics of enzymes - mechanism of enzyme action, factors affecting enzyme action, cofactors and co-enzymes, enzyme inhibition, enzymes in organic synthesis. Hormones and vitamins - representative cases.

Medicinal agents from natural products: Natural products as therapeutic

agents, medicinal plants, animal products as medicine, isolation methods of alkaloids, terpenes, anti-oxidants.

Unit 3

Medicinal agents: Medicinal agents belonging to steroids, polypeptides, modified nucleic acid bases, sulphonamide and sulpha drugs, antibiotics, antifungal, antiseptics and disinfectants, anesthetics, antihypertensive drugs, analgesics, histamine and anti-histamine agents.

TEXTBOOKS:

1. *Rama Rao Nadendla, "Principles of Organic Medicinal Chemistry", 1st edition, New age internationals (P) limited, (2005).*
2. *Thomas Nogrady and Donald F. Weaver, "Medicinal chemistry: A Molecular and Biochemical Approach", 3rd edition, Oxford university press, (2005).*

REFERENCES:

1. *Wilson C O, Gisvold O and Deorge R F, "Text book of organic, medicinal and Pharmaceutical chemistry", 7thedition, J.B.Lippincott company, Philadelphia, (1977).*
2. *Burger A, "Medicinal Chemistry", 3rdedition, Wiley Interscience, Newyork, (1970).*
3. *Graham L P, "An Introduction to Medicinal Chemistry", 3rdedition, Oxford university Press, (2005).*

CHY263 ORGANIC REACTION MECHANISMS 3 0 0 3

Unit 1

Introduction to organic chemistry: Lewis structure and formal charges of organic compounds - electro negativities and dipoles, resonances, aromaticity and anti aromaticity - equilibrium, tautomerism and hyper conjugation - acidity and basicity - pKa, nucleophiles and electrophiles - hydrogen bonding - different types of organic reaction - addition, substitution, elimination and rearrangement - oxidations and reductions - general principles of writing organic reaction mechanism - reactive intermediates.

Reaction of nucleophiles and bases: Nucleophilic substitution - S_N1 and S_N2 reactions, nucleophilic substitution at aliphatic sp2 carbon and aromatic carbon - nucleophilic addition to carbonyl compounds - addition of grignard and organo lithium reagents - reactions of nitrogen containing nucleophiles with aldehyde and ketones - aldol condensation.

Unit 2

Michael and 1,4-addition reaction - Favorskii rearrangement - benzilic acid rearrangement - reaction mechanism in basic media - Mannich reaction - enols and enolates.

Reaction involving acids and other eletrophiles: Carbocations - formation

and rearrangements - cationic rearrangement involving electron deficient nitrogen atom - Beckmann rearrangement - Curtius, Lossen and Schmidt rearrangement - electrophilic additions - acid catalyzed reaction of carbonyl compounds - hydrolysis of carbocyclic acid derivatives - electrophilic aromatic substitution - carbenes and benzynes - Baeyer-Villeger reactions - Dienone-phenol rearrangement - pinacol rearrangement.

Unit 3

Radical and radical ions: Formation of radicals, radical chain processes, radical addition, reaction with and without cyclisation - fragmentation reaction - rearrangement of radicals - S_{RN} 1 reaction - radical ions - Birch reduction - Hofmann-Loffler-Freytag reaction - Barton reaction - McMurry reaction.

Pericyclic reaction: Representative of molecular orbitals of ethylene, butadiene and hexatriene molecules - Woodward - Hofmann rules of symmetry - electrocyclic reaction, cycloadditions - diels-Alder reaction - other thermal cycloadditions - photochemical [2+2] cycloaddition - 1,3-dipolar cycloadditions - Sigmatropic reactions, notations and directions of [3,3] sigmatropic rearrangements - Cope and oxy-Cope rearrangement [2,3] sigmatropic reaction - ene reaction.

TEXTBOOK:

Jerry March, "Advanced Organic Chemistry", 4th edition, John Wiley & Sons, (1992).

REFERENCES:

1. *Carey F and Sundberg R, "Advanced Organic Chemistry - Part A & B", Kluwer, (2000).*
2. *Peter Sykes, "Organic reaction mechanism", 6th edition, Pearson education (Singapore) Pte. Ltd.,(2005).*
3. *Michael B.Smith, "Organic Synthesis", 2nd edition, Mc Graw Hill, (2004).*

CHY264 GREEN CHEMISTRY AND TECHNOLOGY 3 0 0 3

Unit 1

Our environment and its protection, chemical pollution and environmental regulations, environmental chemistry, pollution prevention strategies, challenges to the sustainability of chemical industry, Pollution Prevention Act 1990, USA, Green Chemistry and its 12 principles, toxicity of chemicals, material safety data sheet (MSDS), concept of zero pollution technologies, atom economy, functional toxicity vs non-functional toxicity, alternative solvents, energy minimization, microwave and sonochemical reactions, renewable feed stock, carbon dioxide as a feed stock,.

Unit 2

Greener strategies of the synthesis of ibuprofen synthesis, teriphthalic acid etc. phase behavior and solvent attributes of supercritical CO_2, use of supercritical carbon dioxide as a medium chemical industry, use of ionic liquids as a synthetic

medium, gas expanded solvents, superheated water, etc. Synthesis of various chemicals from bio mass, polycarbonate synthesis and CO_2 fixation, green plastics, green oxidations, etc.

Unit 3

Processes involving solid catalysts – zeolites, ion exchange resins, Nafion/silica nano composites and enhanced activity. Polymer supported reagents, green oxidations using TAML catalyst, membrane reactors. Green chemistry in material science, synthesis of porous polymers, green nanotechnology.

REFERENCES:

1. *Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell Publishing.*
2. *Anastas, P. T., Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press Inc., New York, 1998.*
3. *Matlack, A. S. Introduction to Green Chemistry Marcel Dekker: New York, NY, 2001.*

CHY270 CORROSION SCIENCE 3 0 0 3

Unit 1

Basic principles: Free energy concept of corrosion - different forms of corrosion - Thermodynamic & Kinetic aspects of corrosion: The free energy criterion of corrosion possibility - Mechanism of Electrochemical corrosion - Galvanic and Electrochemical series and their significance.

Corrosion Control: Materials selection - metals and alloys - metal purification - non metallic - changing medium.

Unit 2

Anodic and cathodic protection methods - Coatings - metallic and other inorganic coatings - organic coatings - stray current corrosion - cost of corrosion control methods.

Corrosion protection by surface treatment: CVD and PVD processes - Arc spray - Plasma spray - Flame spray.

Corrosion Inhibitors: Passivators - Vapour phase inhibitor.

Unit 3

Stress and fatigue corrosion at the design and in service condition - control of bacterial corrosion.

Corrosion protection: Automobile bodies – engines – building construction.

TEXTBOOKS:

1. *Fontana and Mars G, "Corrosion Engineering", 3rd edition, Mc Graw-Hill, (1987).*
2. *Uhlig H H and Reviees R W, "Corrosion and its Control", Wiley, (1985).*

REFERENCES:

1. *ASM Metals Handbook, "Surface Engineering", Vol 5, ASM Metals Park, Ohio, USA, (1994).*
2. *ASM Metals Handbook, "Corrosion", Vol 13, ASM Metals Park, Ohio, USA, (1994).*
3. *Brain Ralph, "Material Science and Technology", CRC Series, Boston, New York.*

CHY271 ELECTROCHEMICAL ENERGY SYSTEMS AND PROCESSES 3 0 0 3

Unit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air, zinc-silver oxide batteries; lithium primary cells - liquid cathode, solid cathode and polymer electrolyte types and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: ARM (alkaline rechargeable manganese) cells, Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultra thin lithium polymer cells (comparative account) Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Reserve batteries and Fuel cells: Reserve batteries - water activated, electrolyte activated and thermally activated batteries - remote activation - pyrotechnic materials. Fuel Cells: Principle, chemistry and functioning - carbon, hydrogen-oxygen, proton exchange membrane (PEM), direct methanol(DMFC), molten carbonate electrolyte (MCFC) fuel cells and outline of biochemical fuel cells.

Electrochemical Processes: Principle, process description, operating conditions, process sequence and applications of Electroforming – production of waveguide and plated through hole (PTH) printed circuit boards by electrodeposition; Electroless plating of nickel, copper and gold; Electropolishing of metals; Anodizing of aluminium; Electrochemical machining of metals and alloys.

TEXTBOOKS:

1. *Derek Pletcher and Frank C. Walsh, "Industrial Electrochemistry", Blackie Academic and Professional, (1993).*
2. *Dell, Ronald M Rand, David AJ, "Understanding Batteries", Royal Society of Chemistry, (2001).*

REFERENCES:

1. *Christopher M A, Brett, "Electrochemistry – Principles, Methods and Applications", Oxford University, (2004).*
2. *Watanabe T, "Nano-plating: microstructure control theory of plated film and data base of plated film microstructure", Elsevier, Oxford, UK (2004).*
3. *Kanani N, "Electroplating and electroless plating of copper and its alloy", ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Lindon David, "Handbook of Batteries", McGraw Hill, (2002).*
5. *Curtis, "Electroforming", London, (2004).*
6. *Rumyantsev E and Davydov A, "Electrochemical machining of metals", Mir, Moscow, (1989).*

CHY272 COMPUTATIONAL CHEMISTRY AND MOLECULAR MODELLING 3 0 0 3

Unit 1

Introduction: Stability, symmetry, homogeneity and quantization as the requirements of natural changes - Born - Haber cycle – Energetic – kinetics - Principles of spectra.

Computational techniques: Introduction to molecular descriptors, computational chemistry problems involving iterative methods, matrix algebra, Curve fitting.

Molecular mechanics: Basic theory - Harmonic oscillator – Parameterization - Energy equations - Principle of coupling - Matrix formalism for two masses - Hessian matrix - enthalpy of formation-enthalpy of reactions.

Introduction to Quantum mechanics - Schrodinger equation - Position and momentum - MO formation - Operators and the Hamiltonian operator - The quantum oscillator - Oscillator Eigen value problems - Quantum numbers - labeling of atomic electrons.

Unit 2

Molecular Symmetry: Elements of symmetry - Point groups - Determination of point groups of molecules.

Huckel's MO theory: Approximate and exact solution of Schrodinger equation - Expectation value of energy - Huckel's theory and the LCAO approximation - Homogeneous simultaneous equations - Secular matrix - Jacobi method - Eigen vectors: Matrix as operator - Huckel's coefficient matrix - Wheeland's method - Hoffmann's EHT method - Chemical applications such as bond length, bond energy, charge density, dipole moment, Resonance energy.

Unit 3

Self consistent fields: Elements of secular matrix - Variational calculations -

Semi empirical methods - PPP self consistent field calculation - Slater determinants - Hartree equation - Fock equation – Roothaan - Hall equation - Semi empirical models and approximations.

Ab-initio calculations: Gaussian implementations – Gamess - Thermodynamic functions - Koopman's theorem - Isodesmic reactions, DFT for larger molecules - Computer aided assignments/mini projects with softwares - Introduction to HPC in Chemical calculations.

Molecular modelling software engineering - Modeling of molecules and processes - Signals and signal processing in Chemistry - QSAR studies and generation of molecular descriptors - Applications of chemical data mining - Familiarization with open source softwares useful for molecular modeling - Introduction to molecular simulation - M.D. simulation.

TEXTBOOKS:

1. *Namboori P.K., Deepa Gopakumar and K.I. Ramachandran (In press) "Computational Chemistry and Molecular Modeling", Krishnan.*
2. *Donald W Rogers, "Computational Chemistry Using PC", Wiley, (2003).*
3. *Alan Hinchliffe, "Chemical Modeling from atoms to liquids", Wiley, (2005).*

REFERENCES:

1. *James B Forseman and Aeleen Frisch-Gaussian, "Exploring Chemistry with Electronic Structure Method", Inc., Pittsburgh, PA, 2nd edition, (2006).*
2. *A C Philips, "Introduction to Quantum mechanics", Wiley, (2003).*
3. *Wolfram Koch, Max C. Holthausen, "A Chemist's guide to Density Functional Theory", Wiley, VCH, 2nd edition, (2001).*

CHY273 FUEL CELLS - PRINCIPLES AND APPLICATIONS 3 0 0 3

Unit 1

Introduction: relevance, importance and classification of fuel cells.

Background Theory: Thermodynamic aspects of electrochemistry energy conversion and its efficiency - factors affecting the efficiency - electrode kinetics of electrochemical energy conversion.

Unit 2

Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Proton Exchange Membrane Fuel cells: basic aspects - working and high temperature operation – recent development in technology.

Unit 3

Hydrogen: sources of hydrogen and preparation - clean up and storage - use as fuel in cells.

Energy and Environment - future prospects: Renewable energy and efficiency of renewable fuels - economy of hydrogen energy - life cycle assessment of fuel cell systems.

TEXTBOOK:

M.Aulice Scibioh and B.Viswanathan? "Fuel Cells – principles and applications", University Press, India, (2006).

REFERENCES:

1. *F. Barbir, "PEM fuel cells: theory and practice", Elsevier, Burlington, MA, (2005).*
2. *J.S. Newman and K.E. Thomas-Alyea, "Electrochemical systems", 3rd edition, Wiley, Hoboken, (2004).*
3. *G. Hoogers, "Fuel cell handbook", CRC, Boca Raton, FL, (2003).*

CHY274 SOLID STATE CHEMISTRY 3 0 0 3

Unit 1

Symmetry in Crystal Systems: Types of symmetry, plane, axis and centre of symmetry, crystal systems and symmetry elements. Law of rational indices, miller indices, Weiss indices - plane systems, space lattices, unitcells - unitcell dimension, determination. Space lattice - definition and types Bravais lattice - kinds of bravais lattices, number of atoms in SC, BCC, FCC lattices, void space, Radius ratio rule and application. Crystal defects - types of defects in crystals - stoichiometric defect - schottky and frenkel defects - Non-stoichiometric defects - metal excess and metal deficiency defects, influence of defects on the properties of solids.

Unit 2

Electrical and Magnetic Properties: Development of free electron theory to band theory of solids - metals and their properties; semiconductors - extrinsic and intrinsic, Hall effect; Insulators - dielectric, ferroelectric, pyroelectric and peizoelectric properties and the relationship between them. Dia, para, ferro, ferri, antiferro and antiferri magnetic types - selected magnetic materials such as spinels, garnets and perovskites, superconductors.

Diffraction Methods: X-ray diffraction - various methods of X-ray analysis of structure-ray diffraction pattern, X-ray scattering factor. Results and uses of X-ray diffraction. Limitations of X-ray diffractions.

Unit 3

Neutron diffraction - principles, electron diffraction patterns, limitations - applications of electron diffraction - structural elucidation. Distinction between X-ray, Neutron and electron diffraction. Structure factor - definition, factors influencing structure factor. Uses of structure factor. Fourier synthesis - definition, applications of fourier synthesis in crystal structure analysis of S-Tetrazine. Structure of Rutile, Fluorite, Antifluorite, Zinc blende, Wurtzite, diamond and graphite.

REFERENCES:

1. *Cotton F.A, Wilkinson G and Gaus P, "Basic Inorganic Chemistry", 3rd edition, John Wiley and Sons, (2003).*
2. *Shriver D.F and Atkins P.W, "Inorganic Chemistry", 3rd edition, ELBS, Oxford University Press, Oxford, (2004).*
3. *Huheey J.E, Keiter E.A and Keiter R.L, "Inorganic Chemistry", 4th edition, Addison-Wesley Pub. London, (1993).*
4. *Cotton F.A, Wilkinson G, Murillo C.A and Bochmann M, "Advanced Inorganic Chemistry", 6th edition, John Wiley and Sons, New York, (2003).*
5. *Jolly W.L, "Modern Inorganic Chemistry", 2nd edition, McGraw-Hill, Inc., (1991).*
6. *Miessler G.L and Tarr D.A, "Inorganic Chemistry", 3rd edition, Pearson Education, Singapore, (2004).*

CSE100 COMPUTER PROGRAMMING 3 0 0 3

Unit 1

Introduction to problem solving - algorithm development, flowcharting. C fundamentals, datatypes, variables, constants, enumerations, operators, bitwise operators, expressions, type cast, data input and output statements - formatted & unformatted, control structures - if, if else, switch.. case, while loop, do.. while, for loop, continue, break, goto. Arrays – defining an array, processing an array, multidimensional arrays.

Unit 2

Strings, string handling functions. User defined functions - defining a function, function prototypes, calling a function, passing arguments to a function, recursion. Variable scope - auto, extern, static, register. Pointers - declarations, call by reference, functions returning pointer, pointer arithmetic. Pointer to pointer, pointers and arrays - pointer to array, array of pointers, dynamic memory allocation - malloc(), calloc(), free().

Unit 3

Structures - declaration, initialization, bitfields, operations on structures. Arrays, pointers and structures as members of structure. Array of structures, structures and functions, pointers to structures. Files - file operations for binary and text files, file I/O statements - fscanf, fprintf, fread, fwrite. Random file access - rewind, ftell, fseek. Command line arguments. Preprocessor - macros.

TEXTBOOK:

Byron S Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", Second Edition, TMH publishers, 1996.

REFERENCES:

1. *Herbert Schildt, "The Complete reference, C" Fourth Edition, Tata-McGraw-Hill, 2000.*

2. *Kernighan Brian W and Ritchie Dennis M, "C Programming language", Second Edition, TMH, 1992.*
3. *Yashavant Kanetkar, "Let us C", Second Edition, TMH, 1996.*
4. *Cooper Herbert,"Spirit of C: Introduction to modern Programming", TMH, 1983.*

CSE180 COMPUTER PROGRAMMING LAB. 0 0 3 1

1. Programs using various input/output statements (scanf, printf, getchar, gets, puts, putchar)
2. Programs using bitwise operators and enumerated data types
3. Programs using control structures (if, if else, switch, & loops)
4. Programs using numeric one dimensional array
5. Programs using numeric multidimensional array
6. Programs using strings & string handling functions
7. Functions using static, external and auto variables
8. Programs using recursive functions
9. Programs using call by reference and pointer arithmetic
10. Pointer to array & array of pointers using dynamic memory allocation
11. Structures – arrays, structure within structure
12. Array of structures, unions
13. Programs using text files
14. Programs using binary files
15. Programs using random access of files
16. Programs using command line arguments

CUL101 CULTURAL EDUCATION I 2 0 0 2

Unit 1

Introduction to Indian Culture; Introduction to Amma's life and Teachings; Symbols of Indian Culture;

Unit 2

Science and Technology in Ancient India; Education in Ancient India; Goals of Life – Purushurthas; Introduction to Vedanta and Bhagavad Gita;

Unit 3

Introduction to Yoga; Nature and Indian Culture; Values from Indian History; Life and work of Great Seers of India (1)

TEXTBOOKS:

1. *The Glory of India (in-house publication)*
2. *The Mother of Sweet Bliss, (Amma's Life & Teachings)*

CUL102 CULTURAL EDUCATION II 2 0 0 2

Unit 1

Bhagavad Gita and Life Management; Historicity of Ramayana and Mahabharata; Overview of Patanjali's Yoga Sutras;

Unit 2

Highlights of Indian Mythology; Indian Society: Its Strengths and Weaknesses; Role & Position of Women in Indian Society;

Unit 3

Indian Models of Economy, Business and Management; Health and Lifestyle related issues; Conservation of cultural heritage; Life and work of Great Seers of India (2)

TEXTBOOKS:

1. *The Glory of India (in-house publication)*
2. *Sanatana Dharma (A compilation of Amma's teachings on Indian Culture)*

CUL151 ACHIEVING EXCELLENCE IN LIFE - AN INDIAN PERSPECTIVE 1 0 2 2

Objectives: *The course offers to explore the seminal thoughts that influenced the Indian Mind on the study of human possibilities for manifesting excellence in life. This course presents to the students, an opportunity to study the Indian perspective of Personality Enrichment through pragmatic approach of self analysis and application.*

Unit 1

Goals of Life – Purusharthas

What are Purusharthas (Dharma, Artha, Kama, Moksha); Their relevance to Personal life; Family life; Social life; & Professional life; Followed by a Goal setting workshop;

Yogic way of Achieving Life Goals – (Stress Free & Focused Life)

Introduction to Yoga and main schools of Yoga; Yogic style of Life & Time Management (Work Shop);

Experiencing life through its Various Stages

Ashrama Dharma; Attitude towards life through its various stages (Teachings of Amma);

Unit 2

Personality Development

What is Personality – Five Dimensions – PanchaKosas (Physical/ Energy/Mental/ Intellectual/ Bliss); Stress Management &Personality; Self Control & personality; Fundamental Indian Values & Personality;

Learning Skills (Teachings of Amma)

Art of Relaxed Learning; Art of Listening; Developing 'Sraddha' – a basic qualification for obtaining Knowledge;

Communication Skills - An Indian Perspective;

Unit 3

Developing Positive Attitude & Friendliness- (Vedic Perspective);

Achieving Work Excellence (Karma Yoga by Swami Vivekananda & teachings based on Amma);

Leadership Qualities – (A few Indian Role models & Indian Philosophy of Leadership);

REFERENCE BOOKS:

1. *Awaken Children (Dialogues with Sri Mata Amritanandamayi) Volumes 1 to 9*
2. *Complete works of Swami Vivekananda (Volumes 1 to 9)*
3. *Mahabharata by M.N Dutt published by Parimal publications – New Delhi (Volumes 1 to 9)*
4. *Universal message of Bhagavad-Gita (An exposition of Gita in the light of modern thought and Modern needs) by Swami Ranganathananda. (Volumes 1 to 3)*
5. *Message of Upanishads, by Swami Ranaganathananda published by Bharatiya Vidya Bhavan, Bombay.*
6. *Personality Development – Swami Vivekananda published by Advaitha Ashram, Kolkatta.*
7. *Art of Man Making - Swami Chinmayananda published by Chinmaya Mission, Bombay*
8. *Will Power and its Development- Swami Budhananda published by Advaitha Ashram, Kolkatta*
9. *Ultimate Success - Swami Ramakrishnananada Puri published by Mata Amritanandamayi Math, Kollam*
10. *Yoga In Daily Life - Swami Sivananda – published by Divine LIife Society*
11. *Hindu Dharma - H.H. Sri Chandrasekharandra Saraswati published by Bharatiya Vidya Bhavan, Bombay*
12. *All about Hinduism – Swami Sivananda - Published by Divine Life Society*
13. *The Mind and its Control by Swami Budhananda published by Advaitha Ashram, Kolkatta*
14. *Krida Yoga - Vivekananda Kendra, Publication.*
15. *Valmiki Ramayana – Four volumes- published by Parimal Publications, Delhi*
16. *New perspectives in Stress Management - Dr H R Nagendra & Dr R Nagaratna published by Swami Vivekananda Yoga Prakashana, Bangalore.*
17. *Mind Sound Resonance Technique (MSRT) published by Swami Vivekananda Yoga Prakashana, Bangalore.*
18. *Yoga & Memory - Dr H R Nagendra & Dr.Shirley Telles, published by Swami Vivekananda Yoga Prakashana, Bangalore.*

CUL152 EXPLORING SCIENCE AND TECHNOLOGY IN ANCIENT INDIA 1 0 2 2

Objectives: *This course offers a journey of exploration through the early developments in India of astronomy, mathematics, technologies and perspectives of the physical world. With the help of many case studies, the students will be equipped to understand concepts as well as well as actual techniques.*

CUL152EXPLORING SCIENCE AND TECHNOLOGY IN ANCIENT INDIA 1 0 2 2

Unit 1
1. General introduction: principles followed and sources;
2. Astronomy & mathematics from the Neolithic to the Indus civilization;
3. Astronomy & mathematics in Vedic literature;
4. *Vedanga Jyotisha* and the first Indian calendars;
5. *Shulba Sutras* and the foundations of Indian geometry;

Unit 2
6. Astronomy & mathematics in Jain and Buddhist literature;
7. The transition to the Siddhantic period; Aryabhata and his time;
8. The *Aryabhatiya*: concepts, content, commentaries;
9. Brahmagupta and his advances;
10. Other great Siddhantic savants;
11. Bhaskara II and his advances;

Unit 3
12. The Kerala school of mathematics;
13. The Kerala school of astronomy;
14. Did Indian science die out?;
15. Overview of recent Indian scientists, from S. Ramanujan onward;
16. Conclusion: assessment and discussion;

TEXTBOOK:
Indian Mathematics and Astronomy: Some Landmarks, by S. Balachandra Rao
REFERENCE*:*
IFIH's interactive multimedia DVD on Science & Technology in Ancient India.

CUL153 EXCELLENCE IN DAILY LIFE 1 0 2 2

Unit 1
1 The anatomy of 'Excellence'. What is 'excellence'? Is it judged by external factors like wealth?
2 The Great Flaw. The subject-object relationship between individual and world. Promote subject enhance excellence.
3 To work towards excellence, one must know where he is. Our present state.. An introspective analysis. Our faculties within.

Unit 2
4 The play of the mind. Emotions – convert weakness into strength.
5 The indispensible role of the intellect. How to achieve and apply clear thinking?
6 The quagmire of thought.. the doctrine of Karma – Law of Deservance.
7 Increase Productivity, reduce stress.. work patterning.

Unit 3
8 The art of right contact with the world.. assessment, expectations.
9 Myths and Realities on key issues like richness, wisdom, spirituality.
10 Collect yourself, there is no time to waste. The blue-print of perfect action.

REFERENCES:
The Bhaja Govindam and the Bhagavad Gita.

CUL154 YOGA PSYCHOLOGY 1 0 2 2

Objectives: *This course offers the foundation necessary to understand Eastern approaches to psychology and spirituality. The course includes experiential components centering on meditation and spiritual practice.*

Unit 1
Introduction
Introduction to Modern Psychology
A short history of Modern Psychology - Major Schools of Modern Psychology - The three major forces in Western Psychology - Freudian Psychoanalysis; Behaviourism; Humanistic Psychology.
Introduction to Indian Psychology
What is Yoga? - Rise of Yoga Psychology tradition - Various schools of Yoga Psychology - Universal Goal of all Yoga-schools.
Patanjali Yoga Sutra – 1
Introduction to Rishi Patanjali - Bird view of Yoga-Sutra - Definition of Yoga – Vrittis.
Patanjali Yoga Sutra – 2
Five Kinds of Vrittis - Pramanam - sources of right knowledge - Viparyayah – unfolded belief - Vikalpah – Unfolded belief - Smriti – Memory.

Unit 2
Patanjali Yoga Sutra – 3
Two formulae - Necessity of Abhyasah and Vairagyah - Foundation of Abhyasah - Foundation of Vairagyah.
Patanjali Yoga Sutra – 4
Introduction to Samadhi - Samprajnata-Samadhi - Reasoning in Samprajnata-Samadhi - Reflection in Samprajnata-Samadhi - Bliss in Samprajnata-Samadhi - Sense of Individuality in Samprajnata-Samadhi.
Patanjali Yoga Sutra – 5
Main obstacles in the path of Yoga - other obstructions - removal of obstacles by one – pointedness; by controlling Prana - by observing sense experience - by inner illumination - by detachment from matter - by knowledge of dream and sleep

- by meditation as desired.

Patanjali Yoga Sutra – 6

How to make mind peaceful? - Cultivating opposite virtues: happiness – friendliness - misery – compassion - virtue – gladness - vice – indifference.

Patanjali Yoga Sutra – 7

Five causes of Pain - avidya – ignorance (Root Cause) - asmita – 'I-Feeling' - raga – attraction - dwesha – repulsion - abhinivesha – clinging to life.

Unit 3

Patanjali Yoga Sutra – 8

Necessity of Yoga practice - eight parts of Yoga practice - five Yamas: ahimsa – satya – asteya – brahmacharyam – aparigraha.

Patanjali Yoga Sutra – 9

Five Niyamas: Soucha – Santhosha – Tapas – Swadyah – Ishwara - Pranidhanam.

Patanjali Yoga Sutra – 10

Asanam – Pranayamah - various kinds of Pranayamah - Pratyaharah - Mastery over the senses.

Report review

Conclusion

REFERENCES:

- *The course book will be "The four chapters of Freedom" written by Swami Satyananda Saraswati of Bihar School of Yoga, Munger, India.*
- *"The message of Upanishads" written by Swami Ranganathananda. Published by Bharathiya Vidya Bhavan.*
- *Eight Upanishads with the commentary of Sankaracharya, Translated by Swami Gambhirananda, Published by Advaita Ashram, Uttaranjal.*
- *'Hatha Yoga Pradipika' Swami Muktibodhananda, Yoga Publications Trust, Munger, Bihar, India*

ECE100 ELECTRONICS ENGINEERING 3 0 0 3

Objective: *To understand the working of basic electronic devices such as diodes, BJTs and FETs; Introduce the student to the operation and design of fundamental building blocks of electronic systems like power supplies, amplifiers and oscillators; Develop skills to analyze specifications of simple electronic circuits and carry out their design.*

Unit 1

Physics of conductors and semiconductors: conductors, semiconductors, silicon crystals, intrinsic semiconductors, two types of flow, doping a semiconductor, two types of extrinsic semiconductors, unbiased diode, forward bias, reverse bias, breakdown, barrier potential and temperature, reverse biased diode, diode approximations.

Rectifiers and diodes: half wave, full wave and Bridge rectifiers. Filters, choke input filter, capacitor input filter, PIV and surge current, Zener diode, loaded Zener regulator, LED, photo diodes, Schottky diode, Varactor diode.

Unit 2

Basics of amplifiers: Introduction to BJT and FET, BJT characteristic curves and regions of operation, emitter and voltage divider bias of BJT, BJT as a switch, LED drivers, JFET characteristics, JFET biasing in Ohmic and active regions, transconductance, JFET amplifiers, depletion mode and enhancement mode MOSFET, CMOS.

Unit 3

Operational amplifiers and linear ICs: differential amplifier, introduction to Opamps, inverting and non-inverting amplifier, comparators, instrumentation amplifier, summing amplifier, voltage follower.

Oscillators: Theory of sinusoidal oscillations, Wein Bridge oscillator, Colpitts oscillator, Quartz Crystal oscillator, introduction to 555 Timer, astable and monostable operation.

TEXTBOOK:

A.P Malvino, "Electronic Principles", Seventh Edition, TMH, 2007

REFERENCES:

1. *J. Millman and C C Halkias, "Electronics Devices & Circuits", TMH Edition, 2005*
2. *David. A. Bell, "Electronics Devices and Circuits", Fifth Edition, Oxford University Press,2008*
3. *I. J. Nagrath, "Electronic Devices and Circuits", Prentice-Hall of India, 2007*

EEE100 ELECTRICAL ENGINEERING 3 0 0 3

Unit 1

Introduction to electrical engineering. System of units. Electric current, Coulomb's law, Ohm's law, Faraday's law of electromagnetic induction, Kirchoff's laws, Ampere's law.

Ideal independent current and voltage-sources; Reference directions and symbols, energy and power; R, L and C- parameters; Series and parallel combination of resistances, capacitances and inductances, series-parallel circuits, superposition theorem, conversion of a voltage source to current source and vice versa, voltage divider and current divider rule. Network reduction by star–delta transformation, analysis of dc circuits by Mesh-current and nodal methods.

Unit 2

Transient analysis with energy storage elements (for RC-, RL- circuits with DC excitations): Writing differential equations for first order circuits, steady state

solution of circuits containing inductors and capacitors, initial and final conditions, transient response of RL and RC circuits (rise and decay).
Sinusoidal steady state analysis: Generation of sinusoidal functions, average and effective values of periodic functions, instantaneous and average power, power factor, phasor representation of sinusoids, response of single elements (R, L and C) for sinusoidal excitation; phasor concept and phasor diagram; Impedance and Admittance concepts; The series RL, series RC and series RLC circuits, complex power and power triangle. Introduction to 3-phase systems; Balanced 3-phase systems (STAR and DELTA connections).

Unit 3
Magnetic circuits: MMF, magnetic flux, reluctance, flux density, analogy with electric circuits, analysis of magnetic circuits, self and mutual induced emfs, energy stored in a magnetic circuit.
Transformers; construction and principle of operation of transformers, Emf equation. Three phase Induction motor: Types, construction, rotating magnetic field, principle of operation, slip, rotor induced emf.
Measuring instruments, Different types of instruments to measure voltage, current power and energy.

TEXTBOOK:

Vincent Del Toro, 'Electrical Engineering Fundamentals', Second Edition, Prentice Hall of India Private Limited, 2003.

REFERENCES:

1. *Giorgio Rizzoni, 'Principles and Applications of Electrical Engineering', Fourth Edition, Tata McGraw-Hill Publishing Company Limited, 2003.*
2. *Hughes, 'Electrical Technology' Seventh edition, Pearson Education Asia, 2000.*

EEE180 WORKSHOP B 1 0 2 2

Electrical workshop:
Study of safety devices such as fuse, MCB, ELCB & earthing – electrical power distribution in domestic installations, study of tools and accessories used in electrical wiring – wiring practice for staircase circuit, fluorescent lamp, hospital wiring and godown lighting – study of domestic appliances like Mixie, fan, Electric iron, Air conditioner, Refrigerator – study of different types of electric lamps like Incandescent lamp, Fluorescent, CFL, Metal halide, Mercury vapour, Sodium vapour and halogen lamp.

Personal computer hardware workshop:
Study of basic components in a computer - study of basic components in a network – study of diagnostic tools for system and study of floppy disk controller – study of hard disk controller – drivers for different components – trouble shooting

in printer – communication between two computers with null modem – transferring characters from PC to LCD.
Electronics and basic microprocessor workshop:
Identification of electronic components and study of measuring instruments – PCB fabrication and soldering practice – study of intel 8085 microprocessor trainer kit concepts.
PIC microcontroller workshop:
Introduction to MP lab simulator. Simulating and burning simple programmes on PIC 16F877A.

EEE290 ELECTRICAL ENGINEERING AND ELECTRONICS LAB. 0 0 3 1

List of Experiments:
1. Load Test on single phase induction motor.
2. Load Test on three phase induction motor.
3. Implement & verify Boolean expressions using logic gates & universal gates.
4. Implementation of multiplexer, de multiplexer, encoder & decoder.
5. Implementation of shift registers.
6. Programming exercises using microprocessors.

ENG111 COMMUNICATIVE ENGLISH 2 0 2 3

Objectives:

To make the students communicate their thoughts, opinions, and ideas freely and naturally.
To make them understand the different styles in communication
To make the students understand the aesthetics of reading and writing
To bring in a spirit of enquiry
To motivate critical thinking and analysis
To help them ruminate on human values

Unit 1
Reading: Different styles of communication – reading comprehension - critical thinking and analysis – note-making.

Unit 2
Writing: Prewriting techniques - kinds of paragraphs - basics of continuous writing; Grammar and usage – topics including spelling and number rules (Workbook).

Unit 3
Practical sessions (listening & speaking)**:** Introduction to English pronunciation including minimal pairs and word stress – differences between British and American English – listening comprehension and note-taking.
Activities: Short speeches, seminars, quizzes, language games, debates, discussions and book reviews, etc.

TEXTBOOKS:

1. *Language through Reading: Anthology compiled by Amrita;*
2. *Language through practice: Work book compiled by Amrita*

REFERENCES:

1. *Raymond Murphy. "Murphy's English Grammar", Cambridge Univ. Press, 2004.*
2. *Michael Swan. "Practical English Usage", Oxford Univ. Press, 2000.*
3. *Daniel Jones. "Cambridge English Pronouncing Dictionary" Ed. Peter Roach, Jane Setter and James Hartman, Cambridge Univ Press, 2006.*

ENG112 TECHNICAL COMMUNICATION 2 0 2 3

Objectives:

To introduce the students to the elements of technical style
To introduce the basic elements of formal correspondence
To introduce technical paper writing skills and methods of documentation
To improve oral presentation skills in formal contexts

Unit 1

Mechanics of writing: Grammar rules – punctuation - spelling rules - tone and style - graphical representation.

Unit 2

Different kinds of written documents: Definitions – descriptions – instructions – recommendations - manuals - reports – proposals; Formal correspondence: Letter writing, including job applications with resume.

Unit 2

Technical paper writing: Library research skills - documentation style - document editing – proof reading – formatting.

Practice in oral communication: Group discussion, interviews and technical presentations.

REFERENCES:

1. *Hirish, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002*
2. *Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003*
3. *Strunk,William Jr. and White. EB. "The Elements of Style" New York. Alliyan & Bacon, 1999.*
4. *Riordan, G.Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.*

ENG250 PROFESSIONAL COMMUNICATION 1 0 2 2

Unit 1

Reading Comprehension: Focus will be on understanding of the given information, vocabulary, inference, logical thinking, and decision - making.

Unit 2

Work place Communication: Writing suggestions, recommendations - reports like, incident report, progress report, trip report, feasibility report – resume writing - formal and business letters – memos, circulars, notices - agenda, meetings, minutes.

Unit 3

Practical: Telephonic conversations, interviews, group and panel discussions, and oral presentations.

REFERENCES:

1. *Davis Homer & Peter Strutt. "Words at Work", CUP, 1996.*
2. *Simon Sweeney. "Communicating in Business", CUP, 2000.*
3. *Leo Jones & Richard Alexander. "New International Business English" CUP, 2003.*
4. *Raymond V Lesikar & Marie E. Flatley. "Basic Business Communication", Tata McGraw-Hill Pub. Co. New Delhi, 2005. Tenth Ed.*

ENG251 BUSINESS COMMUNICATION 1 0 2 2

OBJECTIVES:

To introduce business vocabulary
T o introduce business style in writing and speaking
To expose students to the cross-cultural aspects in a globalised world
To introduce the students to the art of persuasion and negotiation in business contexts.

Unit 1

Writing – English grammar & business vocabulary - drafting – notice – agenda – minutes – reports – proposals – memos – letters - writing press releases.

Unit 2

Reading – scanning – comprehension – inference - error detection - listening – pronunciation – information & reporting.

Unit 3

Speaking – conversational practice – telephonic conversations – addressing a gathering – conducting meetings - negotiation & persuasion techniques.

Activities - case studies & role-plays

BOOKS RECOMMENDED:

1. *Jones, Leo & Richard Alexander. New International Business English. CUP. 2003.*
2. *Horner, David & Peter Strutt. Words at Work. CUP. 1996.*

3. Owen, Roger. BBC Business English. BBC. 1996.
4. Henderson, Greta Lafollette & Price R Voiles. Business English Essentials. 7th Edition. Glencoe / McGraw Hill.
5. Sweeney, Simon. Communicating in Business. CUP. 2000.

ENG252 INDIAN THOUGHT THROUGH ENGLISH 1 0 2 2

Objectives:

To expose the students to the greatness of Indian Thought in English

To develop a sense of appreciation for the lofty Indian Thought

To develop an understanding of the eclectic Indian

Unit 1

Poems: Toru Dutt – The Casuarina Tree; Sri Aurobindo – The Tiger and the Deer; Nissim Ezekiel – Farewell Party to Miss Pushpa T S;
Rabindranath Tagore – Upagupta.

Unit 2

Essays and short stories: Jawaharlal Nehru – at Harrow; Swami Vivekananda – The Ideal of a Universal Religion; Dr. S. Radhakrishnan – Philosophy of life; Gita Hariharan – The Remains of the Feast;Anita Desai – The Winterscape; R.K Narayan – The Blind Dog; Jim Corbett – Lalaji; Ruskin Bond – The Night Train at Deoli; Tagore – The Postmaster.

Unit 3

Drama and Speech: Rabindranath Tagore – Chandalika; Mahashwetadevi – Bayen; Swami Vivekananda – Chicago Address; J.Krishnamurthy / C.N.R Rao - Audio speech.

Short Story:

REFERENCES:

1. *"The Golden Treasury of Indo-Anglian Poetry", Ed. V.K. Gokak (1923-1965)*
2. *"Ten Twentieth Century Indian Poets", by R. Parthasarathy, OUP, 1976.*
3. *"The Remains of the Feast" by Gita Haiharan from In Other Words; New Writing by Indian Women, ed. Urvashi Butalia and Ritu Menon, The Women's Press Limited, 34,Great Sutton Street, London.*
4. *"Three Plays of Rabindranath Tagore", OUP, Madras, 1979.*
5. *"An anthology of Popular Essays and Poems". Ed. A.G. Xavier, Macmillan India Ltd., 1988.*
6. *"Hymns of Darkness", 1976.*
7. *"Letters from a Father to His Daughter", Allahabad Law Journal Co. Ltd., Allahabad.*
8. *Vidya, intranet, Amrita Vishwa Vidyapeetham.*
9. *"Mashi" and Other Stories, Rupa and Co. Paperback – 2002.*

10. *"My India", Oxford University Press, New Delhi – 2000- paperback.*
11. *"Prison and Chocolate Cake", Victor Gollencz, London. Indian Edition, Jaico Publishing, Bombay*
12. *"Twelve Modern Short Stories", Macmillan Publication.*
13. *"Malgudi Days", R.K. Narayan, Indian Thought Publications, 1996, 23rd reprint 2007.*
14. *Diamond Dust and Other Stories, Anita Desai, Published by Vintage, 2001.*
15. *The Complete Works of Swami Vivekananda, Advaita Ashram, Calcutta.*

ENG253 INSIGHTS INTO LIFE THROUGH ENGLISH LITERATURE 1 0 2 2

(Pre-requisite: Nil;Equivalent course in 2007 curriculum: Nil)

Objectives -

· *to expose the students to different genres of Literature*
· *to inculcate reading skills*
· *to provide deeper critical and literary insights*
· *to enhance creative thinking*
· *to help the student develop critical and analytical skills*
· *to promote the aesthetic sense*

Unit 1

Poetry

Seamus Heaney – Digging; Philip Larkin – Ambulances; W.B.Yeats - Prayer for my daughter; W. H Auden - Miss Gee; Peter Porter - Your Attention Please; Rabindranath Tagore 's poems "Defamation" and "Playthings".

Unit 2

Drama

Oscar Wilde - Importance of Being Earnest; Anton Chekov – Proposal; Scenes from the great tragedies of Shakespeare.

Unit 3

Essays

Bibhuti Mishra "When I took over from her"; R.K.Narayan "Junk"; M K Naik " The Postman's Knock",

Practical:

Reviews of novels and short stories; Presentations, Review of Literature, Discussions, Role plays.

REFERENCES:

1. *Gupta, Balram. G. S. Srinath. C. S. ed. Indian Humorous Essays. Chennai: Emarald. 2008. Print.*
2. *Indira . C T. ed. The Pleasures of Poetry. Madras: 2001. Print.*
3. *Rabindranath Tagore et al. Collected Poems and Plays of Rabindranath Tagore. Macmillan India Ltd. 1999. Print.*

4. *Sachithanandan , V. ed. Six English Poets.Madras: Macmillan . 1994. Print.*
5. *Vishwanathan, R. ed . ViewlessWings. Calicut: CU. 1991. Print.*
6. *Wilde, Oscar. The Importance of Being Earnest. Ed. Dr S Sreenivasan. Kollam: Century.2005. Print.*

ENV200 ENVIRONMENTAL STUDIES 3 1 0 4

Unit 1
Overview of the global environmental crisis; Biogeochemical cycles; Climate change and related international conventions and treaties and regulations; Ozone hole and related international conventions and treaties and regulations; Overpopulation; Energy crisis; Water crisis, groundwater hydrogeology, surface water resource development.

Unit 2
Ecology, biodiversity loss and related international conventions, treaties and regulations; Deforestation and land degradation; Food crisis; Water pollution and related international and local conventions, treaties and regulations; Sewage domestic and industrial and effluent treatment; Air pollution and related international and local conventions, treaties and regulations; Other pollution (land, thermal, noise).

Unit 3
Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes); Environmental management, environmental accounting, green businesses, eco-labeling, environmental ethics, environmental impact assessment; Constitutional, legal and regulatory provisions; Sustainable development;

TEXTBOOK:

"Environmental Studies - From Crisis to Cure" by R. Rajagopalan, Oxford University Press.2005,ISBN 0-19-567393-X.

REFERENCE BOOKS:

1. *G.T. Miller Jr., "Environmental Science", 11th Edition, Cenage Learning India Pvt. Ltd., 2008.*
2. *Benny Joseph "Environmental Studies", Tata McGraw-Hill Publishing Company Limited, 2006.*

FRE201 PROFICIENCY IN FRENCH LANGUAGE (LOWER) 1 0 2 2

Unit 1 Population - Identity
How to introduce yourself (name, age, address, profession, nationality); Numbers; How to ask questions;
Grammar – Pronouns - subjects; Regular verbs of 1st group (er) in the present; Être (to be) and avoir (to have) in the present; Interrogative sentence; Gender of adjectives.

Unit 2 The suburbs - At the train station

Introduce someone; Buy a train ticket or a cinema ticket; Ask for information; Official time; Ask for a price; The city (church, town hall, post office…)
Grammar– Pronouns - subjects (continuation); Gender of adjectives (continuation); Plural of nouns and adjectives; Definite and indefinite articles; Interrogative adjectives; I would like (Je voudrais).

Unit 3 Paris and the districts - Looking for a room
Locate a room and indicate the way; Make an appointment; Give a price; Ordinal numbers; Usual time; Ask for the time.
Grammar - Imperative mode; Contracted articles (au, du, des); negation.

TEXTBOOK:

Metro St Michel - Publisher: CLE international

FRE202 PROFICIENCY IN FRENCH LANGUAGE (HIGHER) 1 0 2 2

Unit 1 The first room of a student
A party to celebrate the 1st room; Description of a room; furniture; Locate objects: prepositions (devant, derrière, dans…), Read advertisement; Appreciation (I like, I prefer,).
Grammar - Perfect past tense with *avoir;* Possessive adjectives (*mon, ton, son*…); Demonstrative adjectives (*ce, cet, cette*); Yes (*oui, si*).

Unit 2 Small jobs
Conversation on the phone; Give Time indications; Answer a job offer; Describe a job; Suggest a meeting time.
Grammar - Perfect past tense with *être* and *avoir* (continuation); Possessive adjectives (*notre, votre, leur*); Prepositions (*à, pour, avec* …); Pronoun as direct object (*le, la, l', les*).

Unit 3 University Restaurant
Inquiry; Express an opinion; Ask questions (continuation); Food, meals, taste, preferences; Nutrition, diet, choose a menu or diet, Expression of quantities (*beaucoup, peu*).
Grammar - Partitif (expressing quantity) (*du, de la, pas de*….); Comparison (plus ...que, moins….que, autant …que); Interrogation (continuation), inversion, *Est-ce que, qu'est-ce que ?.*

TEXTBOOK:

Metro St Michel - Publisher: CLE international

GER201 PROFICIENCY IN GERMAN LANGUAGE (LOWER) 1 0 2 2

To have an elementary exposure to German language; specifically
1. to have some ability to understand simple spoken German, and to be able to speak it so as to be able to carry on life in Germany without much difficulty (to be able to do shopping, etc.);
2. to be able to understand simple texts, and simple forms of written communication;
3. to have a basic knowledge of German grammar;
4. to acquire a basic vocabulary of 500 words;
5. to be able to translate simple letters with the use of a dictionary; and
6. to have some familiarity with the German life and culture.

(This will not be covered as part of the regular classroom teaching; this is to be acquired by self-study.)

Some useful websites will be given.

GER202 PROFICIENCY IN GERMAN LANGUAGE (HIGHER) 1 0 2 2

The basic vocabulary and grammar learned in the earlier course is mostly still passive knowledge. The endeavour of this course is to activate this knowledge and develop the skill of communication.

Topics are: Airport, railway station, travelling; shopping; invitations, meals, meeting people; around the house; the human body; colours; professions.

Past and future tenses will be introduced. Applying genitive, dative and accusative.

Some German culture. Films.

GER211 GERMAN FOR BEGINNERS I 1 0 2 2

Unit 1
Greetings; Introducing one-self (formal and informal context), saying their name, origin, living place, occupation.
Numbers 1-100; Saying the telephone number.
Countries and Languages.
Grammar: Structure – W - Questions and Yes/No questions and statements, personal pronouns, verb conjugations. Articles.
Vocabulary: Professions.

Unit 2
Giving the personal details. Name, age, marital status, year of birth, place of birth, etc. Numbers till 1000. Saying a year.

Alphabets – spelling a word.
Filling up an application form; In the restaurant – making an order.
Grammar: Definite, indefinite and negative article in nominative.
Accusative: indefinite and negative Article
Vocabulary: Food items

Unit 3
Number above 1000. Orientation in Shopping plazas: asking the price, where do I find what, saying the opinion.
Grammar: Accusative – definite article. Adjectives and plural forms.
Vocabulary: Furniture and currencies.

GER212 GERMAN FOR BEGINNERS II 1 0 2 2

Unit 1
Shopping and orientation in supermarket; Conversation between the customer and salesman; Where one finds what in supermarket; Asking for requests and suggestions.
Grammar: Dative of personal pronouns. Imperative form.
Vocabulary: Consumables and measurements;

Unit 2
Appointments; Work and leisure time activities; Time, weekdays, months and seasons; saying the date; fixing up an appointment.
Grammar: Model verbs; Prepositions with time and place; Ordinal numbers.
Vocabulary: Leisure activities, weekdays, months and seasons.

Unit 3
Family and household; Family and relations; household and daily routine.
Grammar: Possessive articles; Divisible and indivisible verbs.
Vocabulary: Family circle; Household articles.

HUM250 INDIAN CLASSICS FOR THE TWENTY-FIRST CENTURY 1 0 2 2

Unit 1
Introductory study of the Bhagavad Gita and the Upanishads

Unit 2
The relevance of these classics in a modern age –

Unit 3
Goals of human life-existential problems and their solutions in the light of these classics etc.

REFERENCE:

The Bhagavad Gita, Commentary by Swami Chinmayananda

HUM251 INTRODUCTION TO INDIA STUDIES 1 0 2 2

Preamble:

This paper will introduce the students to the multiple dimensions of the contribution of India to the fields of philosophy, art, literature, physical and social sciences. The paper intends to give an insight to the students about the far-reaching contributions of India to world culture and thought during the course of its long journey from the hoary antiquity to the present times. Every nation takes pride in its achievements and it is this sense of pride and reverence towards the achievements that lays the foundation for its all-round progress.

Unit 1

A brief outline of Indian history from prehistoric times to the present times.
Contributions of India to world culture and civilization:
Indian Philosophy and Religion; Art and Literature; Physical and Social Sciences.

Unit 2

Modern India: Challenges and Possibilities –
Scientific and technological progress in post-independence era; Socio-cultural and political movements after independence; Challenges before the nation today - unemployment – corruption – degradation of cultural and moral values - creation of a new system of education; Creation of a modern and vibrant society rooted in traditional values.

Unit 3

Modern Indian Writing in English: Trends in Contemporary Indian Literature in English

TEXTBOOK:

Material given by the Faculty

BACKGROUND LITERATURE:

1) *Selections from The Cultural Heritage of India, 6 volumes, Ramakrishna Mission Institute of Culture (Kolkata) publication.*
2) *Selections from the Complete Works of Swami Vivekananda, Advaita Ashrama publication.*
3) *Invitations to Indian Philosophy, T. M. P. Mahadevan, University of Madras, Chennai.*
4) *Outlines of Indian Philosophy, M. Hiriyanna, MLBD.*
5) *An Advanced History of India, R. C. Majumdar et al, Macmillan.*
6) *India Since 1526, V. D. Mahajan, S. Chand & Company*
7) *The Indian Renaissance, Sri Aurobindo.*
8) *India's Rebirth, Sri Aurobindo.*
9) *On Nationalism, Sri Aurobindo.*
10) *The Story of Civilization, Volume I: Our Oriental Heritage, Will Durant, Simon and Schuster, New York.*

11) *Eternal Values for a Changing Society, Swami Ranganathananda, Bharatiya Vidya Bhavan.*
12) *Universal Message of the Bhagavad Gita, Swami Ranganathananda, Advaita Ashrama.*
13) *Awaken Children: Conversations with Mata Amritanandamayi*
14) *Indian Aesthetics, V. S. Seturaman, Macmillan.*
15) *Indian Philosophy of Beauty, T. P. Ramachandran, University of Madras, Chennai.*
16) *Web of Indian Thought, Sister Nivedita*
17) *Essays on Indian Nationalism, Anand Kumaraswamy*
18) *Comparative Aesthetics, Volume 2, Kanti Chandra Pandey, Chowkhamba, Varanasi*
19) *The Invasion That Never Was, Michel Danino*
20) *Samskara, U. R. Ananthamurthy, OUP.*
21) *Hayavadana, Girish Karnard, OUP.*
22) *Naga-Mandala, Girish Karnard, OUP.*

HUM252 GLIMPSES OF ETERNAL INDIA 1 0 2 2

Unit 1

Introduction

A peep into India's glorious past

Ancient India – the vedas, the vedic society and the Sanatana Dharma – rajamandala and the Cakravartins – Ramarajya – Yudhisthira's ramarajya; Sarasvati - Sindhu Civilization and the myth of the Aryan Invasion; Classical India – Dharma as the bedrock of Indian society – Vaidika Brahmanya Dharma and the rise of Jainism and Buddhism – the sixteen Mahajanapadas and the beginning of Magadhan paramountcy – Kautilya and his Arthasastra – Chandragupta Maurya and the rise of the Mauryan empire – Gupta dynasty Indian art and architecture – classical sanskrit literature – Harsavardhana; Trade and commerce in classical and medieval India and the story of Indian supremacy in the Indian ocean region; The coming of Islam – dismantling of the traditional Indian polity – the Mughal empire – Vijayanagara samrajya and days of Maratha supremacy.

Unit 2

India's contribution to the world: spirituality, philosophy and sciences
Indian Philosophy – the orthodox (Vaidika) and the heterodox (atheistic) schools; Ramayana and Mahabharata; Bhagavad Gita; Saints and sages of India; Ancient Indian medicine: towards an unbiased perspective; Ancient Indian mathematics; Ancient Indian astronomy; Ancient Indian science and technology.
The arrival of Europeans, British paramountcy and colonization
What attracted the rest of the world to India?; India on the eve of the arrival of European merchants; The story of colonization and the havoc it wrecked on Indian culture and civilization; Macaulay and the start of the distortion of Indian education and history; Indian economy – before and after colonization: a brief survey; The emergence of modern India.

Unit 3

Women in Indian society

The role and position of women in Hindu civilization; Gleanings from the Vedas, Brihadarnyaka Upanishad, Saptasati Devi Mahatmyam, Ramayana, Mahabharata, Manusmriti, Kautilya's Arthasastra and Mrichchhakatikam of Sudraka;

The role and position of Indian women vis-a-vis Islam and European cultures; The great women of India.

Modern India

The national movement for freedom and social emancipation; Swami Vivekananda, Sri Aurobindo, Rabindranath Tagore; Understanding Mahatma Gandhi; A new nation is born as a republic – the pangs of birth and growth; India since Independence – the saga of socio-political movements; Problems facing the nation today; Globalization and Indian Economy; Bharatavarsha today and the way ahead: Regeneration of Indian National Resources.

Conclusion

The Wonder that was India; The 'politics' and 'purpose' of studying India

REFERENCES:

1. *Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.*
2. *Somayaji, D.A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.*
3. *Sen, S.N. & K.V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.*
4. *Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.*
5. *Bose, D.M. et. al. A Concise History of Science in India. New Delhi: 1971.*
6. *Bajaj, Jitendra & M.D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
7. *Bajaj, Jitendra & M.D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
8. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies,2008.*
9. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*
10. *Vivekananda, Swami. Selections from the Complete Works of Swami Vivekananda. Kolkata: Advaita Ashrama.*
11. *Mahadevan, T.M.P. Invitations to Indian Philosophy. Madras: University of Madras.*
12. *Hiriyanna, M. Outlines of Indian Philosophy. Motilal Banarsidass.*
13. *Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.*
14. *Majumdar, R.C. et. al. An Advanced History of India. Macmillan.*
15. *Mahajan, V.D. India Since 1526. New Delhi: S. Chand & Company.*
16. *Durant, Will. The Case for India. Bangalore: Strand Book Stall, 2008.*
17. *Aurobindo, Sri. The Indian Renaissance / India's Rebirth / On Nationalism.*
18. *Nivedita, Sister. The Web of Indian Life. Kolkata: Advaita Ashrama.*
19. *Durant, Will. The Story of Civilization. Volume 1 – Our Oriental Heritage. New York: Simon & Schuster.*
20. *Ranganathananda, Swami. Eternal Values for A Changing Society. Bombay: Bharatiya Vidya Bhavan.*

21. *Ranganathananda, Swami. Universal Message of the Bhagavad Gita. Kolkata: Advaita Ashrama.*
22. *Seturaman, V.S. Indian Aesthetics. Macmillan.*
23. *Coomaraswamy, Ananda K. The Dance of Shiva. New Delhi: Sagar Publications.*
24. *Coomaraswamy, Ananda K. Essays on Indian Idealism. New Delhi: Munshiram Manoharlal.*
25. *Danino, Michel. The Invasion That Never Was.*
26. *Kautilya. Arthasastra.*
27. *Altekar, A.S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
28. *Altekar, A.S. The Position of Women in Hindu Civilization. New Delhi: Motilal Banarsidass.*
29. *Sircar, D.C. Studies in the Religious Life of Ancient and Medieval India. New Delhi: Motilal Banarsidass.*
30. *Sircar, D.C. Studies in the Political and Administrative Systems in Ancient and Medieval Times.New Delhi: Motilal Banarsidass.*
31. *Madhavananda, Swami & R.C. Majumdar eds. The Great Women of India. Kolkata: Advaita Ashrama.*
32. *Dutt, R.C. The Economic History of India. London, 1902.*
33. *Dharampal. Collected Works.*
34. *Dharampal. Archival Compilations (unpublished)*

HUM253 GLIMPSES INTO THE INDIAN MIND: THE GROWTH OF MODERN INDIA 1 0 2 2

Unit 1

Introduction

General Introduction; 'His + Story' or 'History'?; The concepts of 'nation', 'national identity' and 'nationalism'; Texts and Textualities: Comparative Perspectives

Unit 2

Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:

Raja Ram Mohan Roy; Dayananda Saraswati; Bal Gangadhar Tilak; Rabindranath Tagore;

Unit 3

Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:

Swami Vivekananda; Sri Aurobindo; Ananda K. Coomaraswamy; Sister Nivedita; Mahatma Gandhi; Jawaharlal Nehru; B.R.Ambedkar; Sri Chandrasekharendra Saraswati, the Paramacharya of Kanchi; Dharampal; Raja Rao; V.S. Naipaul.

Conclusion

REFERENCES:

1. *Tilak, Bal Gangadhar. The Orion / Arctic Home in the Vedas.*
2. *Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.*

3. *Vivekananda, Swami. "Address at the Parliament of Religions"/"The Future of India"/"In Defence of Hinduism" from Selections from the Complete Works of Swami Vivekananda.*
4. *Aurobindo, Sri. The Renaissance in India / On Nationalism.*
5. *Coomaraswamy, Ananda K. Essays in Indian Idealism (any one essay) / Dance of Shiva.*
6. *Nivedita, Sister. "Noblesse Oblige: A Study of Indian Caste" / "The Eastern Mother" from The Web of Indian Life.*
7. *Gandhi, Mahatma. Hind Swaraj.*
8. *Nehru, Jawaharlal. "The Quest" from Discovery of India.*
9. *Ambedkar, B.R. "Buddha and His Dhamma" from Collected Works.*
10. *Saraswati, Chandrasekharendra. "The Sastras and Modern Life" from The Hindu Dharma.*
11. *Dharampal. Bharatiya Chitta, Manas and Kala / Understanding Gandhi.*
12. *Naipaul, V.S. India: A Wounded Civilization / India: A Million Mutinies Now.*

HUM254 GLIMPSES OF INDIAN ECONOMY AND POLITY 1 0 2 2

Unit 1

Introduction

General Introduction; Primitive man and his modes of exchange – barter system; Prehistoric and proto-historic polity and social organization.

Ancient India – up to 600 B.C.

Early India – the vedic society – the varnashramadharma – socio-political structure of the various institutions based on the four purusarthas; The structure of ancient Indian polity – Rajamandala and Cakravartins – Prajamandala; Socio-economic elements from the two great Epics – Ramayana and Mahabharata – the concept of the ideal King (Sri Rama) and the ideal state (Ramarajya) – Yudhisthira's ramarajya; Sarasvati - Sindhu civilization and India's trade links with other ancient civilizations; Towards chiefdoms and kingdoms – transformation of the polity: kingship – from gopati to bhupati; The mahajanapadas and the emergence of the srenis – states and cities of the Indo-Gangetic plain.

Unit 2

Classical India: 600B.C. – 1200 A.D.

The rise of Magadha, emergence of new religions – Buddhism and Jainism – and the resultant socio-economic impact; The emergence of the empire – the Mauryan Economy and Kautilya's *Arthasastra;* Of Politics and trade – the rise of the Mercantile Community; Elements from the age of the Kushanas and the Great Guptas; India's maritime trade; Dharma at the bedrock of Indian polity – the concept of Digvijaya: dharma-vijaya, lobha-vijaya and asura-vijaya; Glimpses into the south Indian economies: political economies of the peninsula – Chalukyas, Rashtrakutas and Cholas

Medieval India: 1200 A.D. – 1720 A.D.

Advent of Islam – changes in the social institutions; Medieval India – agrarian economy, non-agricultural production and urban economy, currency system; Vijayanagara samrajya and maritime trade – the story of Indian supremacy in the

Indian Ocean region; Aspects of Mughal administration and economy; The Maratha and other provincial economies.

Unit 3

Modern India: 1720 - 1947

the Indian market and economy before the arrival of the European traders; Colonisation and British supremacy (dismantling of everything that was 'traditional' or 'Indian') – British attitude towards Indian trade, commerce and economy and the resultant ruining of Indian economy and business – man-made famines – the signs of renaissance: banking and other business undertakings by the natives (the members of the early Tagore family, the merchants of Surat and Porbander, businessmen of Bombay, etc. may be referred to here) – the evolution of the modern banking system; Glimpses into British administration of India and administrative models; The National movement and nationalist undertakings in business and industry: the Tatas and the Birlas; Modern India: the growth of large-scale industry – irrigation and railways – money and credit – foreign trade; Towards partition – birth of two new nations – division of property; The writing of the Indian Constitution – India becomes a democratic republic – a new polity is in place.

Independent India – from 1947

India since Independence – the saga of socio-political movements; Indian economy since Independence – the fiscal system – the five year plans – liberalisation – the GATT and after; Globalisation and Indian economy; Impact of science and (new/ emerging) technology on Indian economy; Histories of select Indian business houses and business entrepreneurship.

Conclusion

REFERENCES:

1. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*
2. *Kautilya. Arthasastra.*
3. *Altekar, A.S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
4. *Sircar, D.C. Studies in the Political and Administrative Systems in Ancient and Medieval Times. New Delhi: Motilal Banarsidass.*
5. *Dutt, R.C. The Economic History of India. London,1902.*
6. *Dharampal. Collected Works (Volumes IV & V).*
7. *Dharampal. Archival Compilations (unpublished).*
8. *Bajaj, Jitendra & M.D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
9. *Bajaj, Jitendra & M.D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
10. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
11. *Tripathi, Dwijendra. The Oxford History of Indian Business. New Delhi: Oxford University Press, 2004.*
12. *McGuire, John, et al, eds. Evolution of World Economy, Precious Metals and India. New Delhi: Oxford University Press, 2001.*

13. Tripathi, Dwijendra and Jyoti Jumani. The Concise Oxford History of Indian Business. New Delhi: Oxford University Press, 2007.
14. Kudaisya, Medha M. The Life and Times of G.D. Birla. New Delhi: Oxford University Press, 2003.
15. Raychaudhuri, Tapan and Irfan Haib, eds. The Cambridge Economic History of India. Volume 1. New Delhi: Orient Longman, 2004.
16. Kumar, Dharma, ed. The Cambridge Economic History of India. Volume 2. New Delhi: Orient Longman, 2005.
17. Sabavala, S.A. and R.M. Lala, eds. J.R.D. Tata: Keynote. New Delhi: Rupa & Co., 2004.
18. Mambro, Arvind ed. J.R.D. Tata: Letters. New Delhi: Rupa & Co., 2004.
19. Lala, R.M., For the Love of India: The Life and Times of Jamsetji Tata. New Delhi: Penguin, 2006.
20. Thapar, Romila. The Penguin History of Early India: From the Origins to AD 1300. New Delhi Penguin, 2002.
21. Majumdar, R.C., et. al. An Advanced History of India. Macmillan.

HUM255 SCIENCE AND SOCIETY – AN INDIAN PERSPECTIVE* 1 0 2 2

Unit 1
Introduction
Western and Indian views of science and technology
Introduction; Francis Bacon: the first philosopher of modern science; The Indian tradition in science and technology: an overview.

Unit 2
Indian sciences
Introduction; Ancient Indian medicine: towards an unbiased perspective;
Indian approach to logic; The methodology of Indian mathematics; Revision of the traditional Indian planetary model by Nilakantha Somasutvan in circa 1500 AD
Science and technology under the British rule
Introduction; Indian agriculture before modernization; The story of modern forestry in India; The building of New Delhi

Unit 3
Science and technology in Independent India
Introduction; An assessment of traditional and modern energy resources; Green revolution: a historical perspective; Impact of modernisation on milk and oilseeds economy; Planning without the spirit and the determination.
Building upon the Indian tradition
Introduction; Regeneration of Indian national resources; *Annamahatmyam and Annam Bahu Kurvita:* recollecting the classical Indian discipline of growing and sharing food in plenty and regeneration of Indian agriculture to ensure food for all in plenty.
Conclusion

REFERENCES:

1. Joseph, George Gheverghese. The Crest of the Peacock: Non-European Roots of Mathematics. London: Penguin (UK),2003.
2. Iyengar, C.N. Srinivasa. History of Hindu Mathematics. Lahore: 1935, 1938 (2 Parts).
3. Amma, T.A. Saraswati. Geometry in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.
4. Bag, A.K. Mathematics in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.
5. Sarma K.V. & B.V. Subbarayappa. Indian Astronomy: A Source-Book. Bombay: Nehru Centre, 1985.
6. Sriram, M.S. et. al. eds. 500 Years of Tantrasangraha: A Landmark in the History of Astronomy. Shimla: Indian Institute of Advanced Study, 2002.
7. Bajaj, Jitendra & M.D. Srinivas. Restoring the Abundance: Regeneration of Indian Agriculture to Ensure Food for All in Plenty.Shimla: Indian Institute of Advanced Study, 2001.
8. Bajaj, Jitendra ed. Report of the Seminar on Food for All: The Classical Indian Discipline of Growing and Sharing Food in Plenty. Chennai: Centre for Policy Studies, 2001.
9. Bajaj, Jitendra & M.D. Srinivas. Annam Bahu Kurvita: Recollecting the Indian Discipline of Growing and Sharing Food in Plenty. Madras: Centre for Policy Studies, 1996.
10. Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.
11. Somayaji, D.A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.
12. Sen, S.N. & K.V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.
13. Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.
14. Bose, D.M. et. al. A Concise History of Science in India. New Delhi: 1971.
15. Bajaj, Jitendra & M.D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.
16. Bajaj, Jitendra & M.D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.
17. Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.
18. The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.

** The syllabus and the study material in use herein has been developed out of a 'summer programme' offered by the Centre for Policy Studies (CPS), Chennai at the Indian Institute of Advanced Study (IIAS), Rashtrapati Nivas, Shimla, sometime ago. The same has been very kindly made available to us by Professors Dr M.D. Srinivas (Chairman) and Dr J.K. Bajaj (Director) of the CPS.*

JAP201 PROFICIENCY IN JAPANESE LANGUAGE (LOWER) 1 0 2 2

This paper will introduce the basics of Japanese language. Students will be taught the language through various activities like writing, reading, singing songs, showing Japanese movies etc. Moreover this paper intends to give a thorough knowledge on Japanese scripts that is *Hiragana* and *Katakana.* Classes will be conducted throughout in Japanese class only. Students will be able to make conversations with each other in Japanese. Students can make self-introduction and will be able to write letters in Japanese. All the students will be given a text on Japanese verbs and tenses.

Students can know about the Japanese culture and the lifestyle. Calligraphy is also a part of this paper. Informal sessions will be conducted occasionally, in which students can sing Japanese songs, watch Japanese movies, do *Origami* – pattern making using paper.

JAP202 PROFICIENCY IN JAPANESE LANGUAGE (HIGHER) 1 0 2 2

Students will be taught the third and the most commonly used Japanese script, *Kanji*. Students will be taught to write as well as speak.

Students will be given detailed lectures on Calligraphy.

This version of the course includes a new project where the students should make a short movie in Japanese language selecting their own topics.

By the end of the semester they the students will master the subject in all means. They will be able to speak Japanese as fluently as they speak English. Students will be encouraged to write stories and songs in Japanese language themselves.

MAT111 CALCULUS, MATRIX ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS 3 1 0 4

Unit 1
Linear systems of equations, Gauss elimination, rank of a matrix, linear dependence. Solutions of linear systems: existence, uniqueness, general form, eigen values, eigen vectors, some applications of eigen value problems, symmetric, skew-symmetric and orthogonal matrices, complex matrices: Hermitian, Skew Hermitian, unitary, similarity of matrices, basis of eigen vectors, diagonalization. (Sections: 6.3, 6.4, 6.5, 7.1, 7.2, 7.3, 7.4, and 7.5)
Limits and continuity. (Sections (in textbook 1): 2.2, 2.3, 2.4, 2.5, 2.6)

Unit 2
Derivatives, curve sketching, improper integral. (Sections (in textbook 1): 3.1, 4.1, 4.3, 4.4, 8.8)
Basic concepts and ideas, exact differential equations, integrating factors, orthogonal trajectories of curves. (Sections: 1.1, 1.5, 1.8)

Unit 3
Reviewof linear differential equations and Bernoulli equation, modelling: mixing problem, electric circuits. Review of homogeneous linear equations of second order, Euler-Cauchy equations, solution by undetermined coefficients, solution by variation of parameters. System of linear equation, basic concepts and theory, homogeneous systems with constant coefficients, phase plane, critical points.

Criterion for critical points and stabilty. (Sections: 1.6, 1.7, 2.1, 2.2, 2.3, 2.6, 2.9, 2.10, 3.1, 3.2, 3.3, 3.4)

TEXTBOOKS:

1. 'Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.
2. 'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, 2002, Eighth Edition.

MAT112 VECTOR CALCULUS, FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS 3 1 0 4

Unit 1
Vector and scalar functions, derivatives, curves, tangents, arc Length, curves in mechanics, velocity and acceleration, gradient of a scalar field, directional derivative, divergence of a vector field, curl of a vector field. (Sections: 8.4, 8.5, 8.6, 8.9, 8.10, 8.11)
Line integral, line integrals independent of path (Sections: 9.1, 9.2)

Unit 2
Green's theorem in the plane, surfaces for surface integrals, surface integrals, triple integrals – Gauss divergence theorem, Stoke's theorem. (Sections: 9.4, 9.5, 9.6, 9.7, 9.9)

Unit 3
Periodic functions, trigonometric series, Fourier series, functions of any period p = 2L, even and odd functions, half range expansions (theorem statement only), complex Fourier series, applications of Parseval's identity. (Sections: 10.1 to 10.5)
Basic concepts, modeling; vibrating string, wave equation, separation of variables, use of Fourier series, d'Alembert's solution of the wave equation, heat equation; solution by Fourier series. (Sections: 11.1 to 11.5)

TEXTBOOK:

'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, 2002, Eighth Edition.

MAT211 INTEGRAL TRANSFORMS AND COMPLEX ANALYSIS 3 1 0 4

Unit 1
Complex numbers, complex plane, polar form of complex numbers. Powers and roots, derivative. Analytic functions, Cauchy-Riemann equations, Laplace equation, conformal mapping, exponential function, trigonometric functions, hyperbolic functions, logarthims, general power, linear fractional transformation. (Sections: 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8,12.9)

Unit 2

Complex line integral, Cauchy integral theorem, Cauchy integral formula, derivatives of analytic functions. (Sections: 13.1, 13.2, 13.3, 13.4,)

Power series, Taylor series and Maclaurin series. Laurent series, zeros and singularities, residues, Cauchy residue theorem, evaluation of real integrals using residue theorem. (Sections: 14.4, 15.1, 15.2, 15.3, 15.4)

Unit 3

Laplace transforms, inverse transforms, linearity, shifting, transforms of derivatives and Integrals, differential equations, unit step function, second shifting theorem, Dirac's delta function. Differentiation and integration of transforms. Convolution, integral equations, partial fractions, differential equations, systems of differential equations. (Sections: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7)

Fourier integrals (Fourier integral theorem statement only), Fourier cosine and sine transforms, Fourier transforms. (Sections: 10.8 to 10.10)

TEXTBOOK:

'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, 2002, Eighth Edition.

MAT212 MATHEMATICAL STATISTICS AND NUMERICAL METHODS 3 1 0 4

Unit 1

Probability, random variables, probability distributions (continuous and discrete), mean and variance of a distribution, expectation and moment generating functions, binomial, poisson and normal distributions, random sampling, estimation of parameters. (Sections: 22.3, 22.5, 22.6, 22.7, 22.8, 23.1, 23.2)

Unit 2

Confidence interval and central limit theorem, testing of hypothesis. (Sections: 23.3, 23.4)

Solution of equations by iterative methods, interpolation. (Sections: 17.2, 17.3)

Unit 3

Numerical integration and differentiation, solution of linear systems by iterative methods, Eigen values of matrices by iterative methods. Numerical solutions for ordinary differential equations and partial differential equations. (Sections: 17.5, 18.3, 18.8, 19.1, 19.4)

TEXTBOOK:

'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, 2002, Eighth Edition.

MEC100 ENGINEERING MECHANICS 3 1 0 4

Unit 1

Principles of statics: Introduction to vector approach – free body diagrams - forces in plane – forces in space - concurrent forces – resolution of forces - equilibrium of particle.

Statics of rigid bodies in two dimensions and three dimensions: Moment of a force about a point - moment of a force about an axis - moment of a couple – equivalent force - couple system - rigid body equilibrium – support reactions.

Unit 2

Applications of statics: Friction – ladder friction – wedge friction - analysis of trusses – method of joints – method of sections.

Centroid and centre of gravity: Centroids of lines, areas and volumes – composite bodies.

Second moment of area – polar moment of inertia - mass moment of inertia - radius of gyration.

Unit 3

Dynamics of particles: Kinematics of particles – rectilinear motion – relative motion - position, velocity and acceleration calculations in cylindrical coordinates.

Dynamics of rigid bodies: General plane motion - translation and rotation of rigid bodies – Chasle's theorem – velocity and acceleration calculations in moving frames of references – Coriolis acceleration.

TEXTBOOKS:

1. *Shames, I. H, "Engineering Mechanics - Statics and Dynamics", 4/e, Prentice-Hall of India Pvt. Ltd., 2003.*
2. *Beer, F.P. & Johnston, E.R., "Vector Mechanics for Engineers - Statics and Dynamics", 8/ e, McGraw Hill International Book Co., 2008.*

REFERENCES:

1. *Hibbeler, R.C., "Engineering Mechanics", 12/e, Pearson Education Pvt. Ltd., 2007.*
2. *Meriam, J.L., "Dynamics", 5/e, John Wiley & sons, 2003.*
3. *K. L. Kumar, "Engineering Mechanics", 3/e, Tata McGraw Hill, 2003.*

MEC180 WORKSHOP A 1 0 2 2

Product detailing workshop: (Study of simple mechanical and electromechanical system)

Disassemble the product or sub assembly – measure various dimensions using measuring instruments – free hand rough sketch of the assembly and components – name the components and indicate the various materials used – study the

functioning of the assembly and parts – study the assembly and components design for compactness, processing, ease of assembly and disassembly – assemble the product or subassembly.

Pneumatics and PLC workshop:

Study of pneumatic elements – design and assembly of simple circuits using basic pneumatic elements – design and assembly of simple circuits using electro-pneumatics. Study of PLC and its applications – simple programming using ladder diagrams.

Sheet metal workshop:

Study of tools and equipment – draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray, etc.) – fabrication of components using small shearing and bending machines – riveting and painting practice.

Welding workshop:

Study of tools and equipment – study of various welding methods – arc welding practice and demonstration of gas welding and cutting.

Demo and practice workshop:

Fitting: Study of tools, practice in chipping, filing and making joints.

Carpentry: Study of tools, planning practice and making joints.

REFERENCES:

Concerned Workshop Manual

MEC181 ENGINEERING DRAWING 1 0 3 2

Use of drawing instruments – drawing practice – lettering – dimensioning – sketching.

Orthographic projections – projection of points; projection of lines; projection of planes; projection of solids.

Section of solids; Intersection of solids; development of surfaces.

Orthographic views of three-dimensional solids.

Isometric projection.

TEXTBOOK:

John, K. C., Engineering Graphics for Degree, PHI Learning, 2010.

REFERENCES:

1. *Bhat N.D. and Panchal V.M. – Engineering Drawing – Plane and solid Geometry, 42e, Charoatar Publishing House, 2000*
2. *James D. Bethune, Engineering Graphics with AutoCAD, 2002, Pearson Education, First reprint, 2003*
3. *Narayana K.L. & Kannaiah P, Engineering Graphics, SciTech publications, Chennai, 2003*
4. *Waran J Luzadder and John M Duff, Fundamentals of Engineering Drawing, 11e, Prentice Hall of India, New Delhi, 1995*
5. *K. R. Gopalakrishna, Engineering Drawing, 2003, Subhas Publications*

MEC182 COMPUTER AIDED DRAWING 1 0 3 2

Introduction to CAD

Preparation of drawings using CAD Tools

Introduction to VBA / LISP

Introduction to 3D modeling and Surface Modeling

TEXTBOOKS:

1. *Sham Tickoo, AutoCAD 2011 – a Problem solving approach, Autodesk Press, 2011.*
2. *John, K. C., Engineering Graphics for Degree, PHI Learning, 2010.*

REFERENCES:

CADian Manual

MEC200 METALLURGY AND MATERIALS SCIENCE 4 0 0 4

Unit 1

Structure of crystalline solids - interatomic bonding - crystal systems - unit cells - metallic crystal structures - Miller indices - crystallographic planes and directions - linear and planar atomic densities - imperfections in solids: point – linear - interfacial defects.

Elastic, anelastic and plastic behaviour. Mechanical properties - stress-strain curves for ductile and brittle alloys. Ductility – resilience - toughness. Hardness testing. Dislocations and plastic deformation. Slip phenomenon. Slip in single crystals.

Unit 2

Strengthening mechanisms - grain boundary hardening, solution hardening, work hardening. Ductile and brittle fracture - fracture mechanics. Impact testing. Ductile - brittle transition. Fatigue and creep properties. S-N curves fatigue and creep testing. Constitution of alloys - solid solution, intermetallic compound, Hume-Rothery rule. Phase diagram - phase rule, lever principle, isomorphous, eutectic, peritectic and eutectoid reactions. Iron-carbon phase diagram, equilibrium and non-equilibrium cooling in solid state, isothermal transformation, martensite and bainite reactions.

Unit 3

Heat treatment of steels: annealing, normalizing, hardening and tempering. Heat treatment of tool and die steels. Hardenability, its testing and simple problems related to materials selection. Surface hardening of steels - carburizing, nitriding, carbo-nitriding, induction method.

Classification of cast iron and steels - properties, microstructures and uses of cast irons, plain carbon, alloy, stainless, heat resistant, tool and die steels. Composition, properties, microstructures and uses of non-ferrous alloys - brass, bronze, aluminium, magnesium, nickel and zinc alloys.

TEXTBOOK:

Calllister, W. D., 'Materials Science and Engineering', John Wiley & Sons, 2003.

REFERENCES:

1. *Avner, S. H., 'Physical Metallurgy', McGraw-Hill, 2000.*
2. *Shackelford, J.F., 'Introduction to Materials Science for Engineers', Prentice Hall, 2005*
3. *Smith, F.W., 'Foundations of Materials Science and Engineering', McGraw -Hill ISE, 2004.*
4. *Dieter, G.E., 'Mechanical Metallurgy', McGraw-Hill, 1988.*

MEC206 KINEMATICS OF MACHINERY 3 1 0 4

Unit 1

Basics of mechanisms - terminology and definitions - degree of freedom - mobility - Kutzbach criterion – Grashoff's law – kinematic Inversions of 4-bar chain and slider crank chains.

Kinematics - displacement, velocity and acceleration - analysis of simple mechanisms – introduction to graphical method - Coriolis acceleration. Analytical methods for velocity and acceleration - complex algebra method - the method of kinematic coefficients - Chace solution.

Unit 2

Introduction to kinematic synthesis of linkages - type, number and dimensional synthesis - two position synthesis of slider crank mechanism - basic features of dimensional synthesis.

Cams - types, drawing cam profiles. Gears – terminology - law of gearing, interference contact ratio. Gear trains - simple, compound, epicyclic and differentials gear trains.

Unit 3

Friction - surface contacts - sliding and rolling friction – bearings - friction in clutches & brakes.

Gyroscope - gyroscopic forces and torques - gyroscopic stabilization - gyroscopic effects in automobiles, ships and airplanes.

TEXTBOOK:

Shigley J E and Uicker J J, 'Theory of Machines and Mechanisms', McGraw-Hill, Inc., 1995.

REFERENCES:

1. *Ghosh A and Mallick A K, 'Theory of Mechanisms and Machines', Affiliated East-West, New Delhi, 1988.*
2. *Rattan S S, 'Theory of Machines', Tata McGraw-Hill Publishing Company Limited, New Delhi, 1994.*

MEC210 MECHANICS OF SOLIDS 3 1 0 4

Unit 1

Stresses and strains. Strains and deformations in axially loaded bars - normal

strain – stress-strain relationships - Hooke's law - Poisson's ratio - modulus of rigidity - bulk modulus - relationship between modulus of elasticity - analysis of varying sections - stepped sections - bars of composite sections - thermal strain and deformation. Elastic strain energy for uniaxial stress.

Torsion - torsion of a circular shaft - the torsion formula - design of circular members in torsion - combined bending and torsion - open coiled and close - coiled helical springs.

Unit 2

Bending moment and shear force – bending stresses - shear and bending moment diagrams - bending stresses in beams. Deflection of beams differential equation of the elastic line - deflection by integration - Macaulay's method - moment area method.

Unit 3

Complex stresses - principal stresses and planes - graphical construction - Mohr's circle of stresses. Thin cylinders and thick cylinders: thin cylindrical shells subjected to internal pressure - circumferential stress - longitudinal stress - change in diameter, length and volume - thick walled cylinders subjected to internal and external pressures - Lame's theory.

Columns - axially loaded columns - different end conditions - Euler's formula for long columns - Rankine's formula.

Theories of failure.

TEXTBOOK:

Beer, F.D. and Johnston, E.R. 'Mechanics of Materials' , 5e, McGraw-Hill, 2009.

REFERENCES:

1. *Gere, J.M., 'Mechanics of Materials', 5e, Brooks/Cole Publication,2001 .*
2. *Popov, E.P., 'Engineering Mechanics of Solids', 2e, Pearson education,2003.*
3. *Crandall, Lardner, S.H., Thomas, J., 'An Introduction to the Mechanics of Solids', McGraw-Hill Higher Education, Burr Ridge, USA, 1999.*

MEC220 ENGINEERING THERMODYNAMICS 3 1 0 4

Unit 1

Introduction and importance of thermodynamics, different approaches in the study of thermodynamics, SI units, basic concepts and definitions - system, surroundings, types of systems, properties. Pressure measurement, thermodynamic equilibrium, quasi-static process, cyclic process, thermodynamic energy interactions - evaluation of work type energy interaction, heat interaction, energy and forms of energy. History of laws of thermodynamics. First law for closed system, analysis of closed systems. Concept of zeroth law, thermometry, temperature scales. Perfect gas, equation of state, specific heats, characterisation of various thermodynamic processes. Real gas models - Van der Waals equation, Virial equation of state, compressibility chart.

Thermodynamic properties of fluids, pure substance, phase-change process of pure substance, p-v-T surface, T-v, p-v and other diagrams, specific internal energy and enthalpy and other properties, steam tables.
Open system - conservation of mass applied to a control volume, conservation of energy applied to a control volume, application of steady-state flow process for typical work transfer and heat transfer devices. Throttling process, application of throttling process.

Unit 2
Second law of thermodynamics, statement of Kelvin-Planck and Clausius, heat engine, heat pump, refrigerator, irreversible processes, reversible processes, Carnot cycle, Carnot engine, Carnot theorems.
Clausius inequality and thermodynamic temperature scale, concept of entropy, entropy change in different processes, principle of Increase in entropy for closed systems.

Unit 3
Thermodynamic property relations: Introduction, important mathematical relations, cyclic rule, Maxwell relations, enthalpy, entropy, internal energy, and specific heat relations; Clausius-Clapeyron equation, Joule-Thomson coefficient and Inversion line.
Introductory treatment of power and refrigeration cycles - air standard Otto and diesel cycles, Rankine cycle, reversed Carnot cycle as a refrigeration cycle, vapour compression cycle.

TEXTBOOK:

Cengel, Y.A. and Boles, M.A., 'Thermodynamics: An Engineering Approach', Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002.

REFERENCES:

1. *Borganakke, S. and Wylen V., 'Fundamentals of Thermodynamics', Wiley Publications, New York, 2003.*
2. *Saad, M.A., 'Thermodynamics: Principles and Practice', Prentice Hall, New Jersey, 1998.*
3. *John R. Howell and Richard D. Buckius., 'Fundamentals of Engineering Thermodynamics", McGraw –Hill,1987.*

MEC222 FLUID MECHANICS AND MACHINERY 3 1 0 4

Unit 1
Basic concepts & hydrostatics**:** Concept of a fluid, classifications of fluid flow, properties of fluids, pressure & its measurements, fluid statics, buoyancy & stability.
Fluid kinematics: System and control volume, Lagrangian and Eulerian descriptions of fluid flow, fundamentals of flow visualization, plots of fluid flow data, kinematic descriptions, the Reynold's transport theorem.

Unit 2
Governing equations of fluid flow**:** Derivation of governing equations for mass, linear and angular momentum, energy in the integral form, Bernoulli's equation. Practical applications of integral form such as propellers, pumps, turbines, etc.
Flow through pipes: Boundary layer concepts, laminar flow in pipes, Hagen poiseuille equation, entrance region, losses in pipes, pipes in series & parallel, equivalent pipe, flow rate measurement – venturimeter, orifice meter & Pitot tube, introduction to turbulent flow in pipes.

Unit 3
Dimensional analysis & modeling**:** Dimensions & units, dimensional homogeneity, Buckingham Pi theorem, similitude – models and model testing, types of similitude.
Fluid machinery**:** Centrifugal pump – working principle, types, performance characteristics, hydraulic turbines – Pelton, Kaplan, Francis - working principles, performance characteristics – cavitation.

TEXTBOOK:

Cengel, Y.A. and Cimbala, J.M., Fluid Mechanics (Fundamentals & Applications),Tata McGraw Hill, India, 2006

REFERENCES:

1. *White, F.M., 'Fluid Mechanics', 4 e, McGraw Hill International Edition, 2006.*
2. *Fox and McDonald, 'Fluid Mechanics', 6e, John Wiley, 2006.*
3. *Panton, R.L., 'Incompressible Flow', Wiley India, 2005*

MEC230 MANUFACTURING TECHNOLOGY I 4 0 0 4

Unit 1
Metal casting – melting furnaces and practices - pattern making - moulding & core sand properties and testing. Mould and core making processes. Casting processes - sand, die, gravity, centrifugal castings. Principles of gating and risering - simple problems. Casting defects.

Unit 2
Welding - fusion, resistance and solid state processes and their applications. Welding defects: causes and remedies. Welding parameter optimization – simple problems. Metal forming processes - rolling, forging, extrusion, drawing and sheet metal working - types of defects and remedies.

Unit 3
Powder metallurgy: definition and concept – production of metal powders - characteristics of metal powders - compaction - sintering – design consideration - process capability - applications.
Surface modification processes - diffusion coating – electroplating – anodizing - conversion coating - hot dipping - ceramic and diamond coating.

TEXTBOOKS:

1. *Kalpakjian, S. and Schmid, S.R., 'Manufacturing Engineering and Technology', 4e, Pearson Education Asia, 2000.*
2. *Amitabha Ghosh and Asok Kumar Mallik, Manufacturing Science, 2nd edition, EWP, 2010.*

REFERENCES:

1. *Dieter, G. E., 'Mechanical Metallurgy', McGraw-Hill, 2000*
2. *Lindberg, R.A., 'Processes and Materials for Manufacture', Prentice Hall of India, 2000.*
3. *Ghosh, A. and Mallik, A.K., 'Manufacturing Science', East-West Press, 2001.*

MEC290 MACHINE DRAWING 1 1 3 3

Unit 1

BIS codes for practice of machine drawing - dimensioning, sectional views, abbreviations and conventions, welding symbols, surface finish symbols, screws, bolts, nuts and rivets.

Introduction to sketch mode and 2D draft mode in a 3D software package – 2D sketching, relationship/constraints, dimensioning.

Fits and tolerances - geometric tolerances. Machine elements - keys, pin joints, fasteners, hexagonal and square head bolts and nuts, conventional representation of threads.

Introduction to solid modelling using 3D software package - reference planes. Protrusion, revolved protrusion, swept protrusion, round, cutout, revolved cutout, hole, pattern, mirror, thread, chamfer.

Unit 2

Joints - cotter joints - sleeve, spigot and socket, jib and cotter, knuckle joints, couplings - flange coupling, universal coupling, riveted joints - single and multiple rivets - chain, zigzag and structural riveted joints, welded joints.

Advanced feature creations using solid modelling package - rib, thin wall, lip, mounting boss, web etc - editing features, creation of views from 3D model and section views. Bearings - footstep bearing, plummer block, swivel bearing, machine parts - tailstock, tool head of a shaper, valves - stop valve, safety valve - Ramsbottom safety valve. Preparation of assembled views from the given part drawings.

Unit 3

Assembly modeling using relations/constraints and conversion of parts and assembly to drafting – creation of bill of material – calculation of mass properties – interference checks between solids.

Automated preparation of part drawings and assembly drawings from 3D of screw jack, connecting rod assembly, crossheads of steam engine.

TEXTBOOKS:

1. *Gopalakrishna, K. R., 'Machine Drawing', 16e, Subhas publishing House, 2002*

2. *Sidheswar, N., Kannaiah, P., and Sastri, V.V.S., 'Machine Drawing', TMH, 2006, New Delhi*

REFERENCES:

1. *John, K.C. and Verhese, P.I, 'Machine Drawing', Jovast Publishers, 2005.*
2. *'PSG Design Data Book', Kalaikathir Achchagam, 2009.*
3. *Bhatt, N.D., 'Machine Drawing', Charotar Publishing House, 1991.*

MEC291 METALLURGY AND MATERIALS TESTING LAB. 0 1 3 2

Metallurgy Lab.

1. Preparation of metallurgical specimen for microscopic examination
2. Microstructure studies of ferrous and non-ferrous alloys
3. Heat treatment of steels and study of their microstructures.
4. Determination of hardenability of steel by Jominy End Quench test
5. Study of the effect of quenching media on hardenability
6. Introduction to Non-destructive testing

Materials Testing Lab.

1. Tension test on metals
2. Double shear test
3. Static bending test on wood
4. Compression test on wood
5. Tensile test on thin wires
6. Deflection test on beams
7. Rockwell hardness test
8. Brinell hardness test
9. Spring test
10. Impact test – charpy
11. Impact test – izod

MEC292 MANUFACTURING PROCESS LAB. I 0 1 3 2

Lathe operations

Study of different types of lathes: Centre, capstan & turret and automatic lathes and their accessories - selection of cutting parameters: speed, feed, depth of cut based on work – tool combinations, coolant types - exercises on plain, step, taper turning & eccentric turning - thread machining: external & internal threads - knurling - drilling, boring & tapping.

Foundry

Study of various processes, tools and equipments used in foundry – exercises on mould preparation.

Press work

Study & demo of press operations in hydraulic and mechanical presses.

MEC301 HEAT POWER ENGINEERING 3 1 0 4

Unit 1

Combined first law and second law analysis for open system, reversible steady flow work, available energy, irreversibility, exergy, second law efficiency, exergy change of a system, exergy transfer by heat, work and mass, decrease of exergy principle and exergy destruction, exergy balance.

Combustion thermodynamics – energy and energy sources, stoichiometry, enthalpy of formation and enthalpy of combustion, adiabatic flame temperature.

Classification and working of I.C. engines - four and two stroke using gasoline and diesel - testing and performance of internal combustion engines.

Gas turbine - open and closed cycle - practical gas turbine cycle - regeneration, inter cooling and reheating.

Unit 2

Reciprocating air compressors - operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Multi-stage compressor, saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression.

Steam nozzles - flow of steam through nozzles, shape of nozzles, effect of friction, critical pressure ratio, supersaturated flow.

Steam turbines - impulse and reaction turbines - compounding principles – velocity diagrams.

Unit 3

Vapour compression refrigeration system - description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, refrigerants and their desirable properties. Air cycle refrigeration, reversed Brayton cycle.

Properties of atmospheric air, dry bulb temperature, wet bulb temperature, dew point temperature; partial pressures, specific and relative humidity and the relation between the two. Enthalpy and adiabatic saturation temperature. Psychrometric chart, human comfort and air-conditioning, basic air-conditioning processes.

TEXTBOOKS:

1. *Cengel, Y.A. and Boles, M.A., 'Thermodynamics: An Engineering Approach', Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002.*
2. *Kurt C. Rolle., 'Thermodynamics and Heat Power', Merrill Publishing Company-A.I.T.B.S Publishers & distributors, Delhi, 2001.*

REFERENCES:

1. *Borganakke, S., and Wylen, V., 'Fundamentals of Thermodynamics', Wiley Publications, New York, 2003.*
2. *Ganesan, V., 'Internal Combustion Engines', Tata Mc Graw Hill, New Delhi, 1998.*
3. *Stocker, W.F. and Jones, J.W., 'Refrigeration & Air Conditioning', McGraw-Hill, 1985.*

4. *Saravanamuttoo, HIH, Rogers, GFC, Cohen, H., 'Gas Turbine Theory', Pearson Education Asia, 2001.*
5. *Kearton W.J., 'Steam Turbine –Theory and practice', CBS Publishers and Distributors, Delhi, 1988.*

MEC302 DYNAMICS OF MACHINERY 3 0 0 3

Unit 1

Force analysis - applied and constraint forces - free body diagrams - static equilibrium conditions - two, three and four force members - static force analysis. Inertia force and inertia torque – D'Alembert's principle - principle of superposition. Dynamic analysis in reciprocating engines – gas forces - equivalent masses - bearing loads - crank shaft torque. Turning moment diagrams - fly wheels – engine shaking forces.

Unit 2

Balancing - static and dynamic balancing - balancing of rotating masses - balancing a single cylinder engine balancing - multi-cylinder engines - partial balancing in locomotive engines – balancing machines.

Vibrations - single degree of freedom system - equations of motion - Rayleigh method - undamped and damped free vibration of single degree of freedom system - logarithmic decrement.

Unit 3

Forced vibration of single degree of freedom system - magnification factor - rotating unbalance - support harmonic excitation - critical speed of shafts - vibration measuring instruments - types of damping - equivalent viscous damping.

Vibration of two degree of freedom system - formulation and solution of matrix eigen value problem - natural frequencies and normal modes.

TEXTBOOK:

Shigley J E and Uicker J J, 'Theory of Machines and Mechanisms', McGraw-Hill, Inc., 1995.

REFERENCES:

1. *Rattan S S, 'Theory of Machines', Tata McGraw-Hill Publishing Company Limited, New Delhi, 1994.*
2. *Ghosh A and Mallick A K, 'Theory of Mechanisms and Machines', Affiliated East-West, New Delhi, 1988.*
3. *Seto, 'Mechanical Vibrations', Schaum Series, McGraw-Hill.*
4. *J P Den Hartog, 'Mechanical Vibrations', McGraw-Hill, New York, 1985 (fourth edition).*
5. *L Meirovitch, 'Elements of Vibration Analysis', McGraw-Hill, New York, 1985 (second edition).*

MEC310 DESIGN OF MACHINE ELEMENTS I 3 1 0 4

Unit 1

Design principles: Design theories - strength, rigidity and wear considerations. Design for strength - static and dynamic loadings, theories of failure, factor of safety. Material selection, preferred numbers, design codes and standards, fits and tolerance, surface finish and stress concentration factors. Manufacturing and environment aspects of design.

Variable and cyclic loads: Fatigue strength and fatigue limit-S-N curve - combined cyclic stresses - design based on Soderberg and Goodman equations. Miner's rule.

Unit 2

Shafts and related parts: Design of shafts, design of keys, keyways and couplings. Mechanical joints: Design of riveted and welded joints. Design of bolted joints. Power screws - design of power screws and ball screws.

Unit 3

Springs: Design of springs for static and varying loads - helical and leaf springs. Design of IC engine parts: piston, connecting rod, crank shaft and flywheel.

Probabilistic and robust design: Concepts and theories of probability, application of probability to mechanical design, optimum design, reliability, concept of robust design, quality loss function, control of noise variables, design of experiments.

TEXTBOOKS:

1. *Norton, R.L., 'Machine Design- An integrated Approach', 2e, Pearson Education, 2003.*
2. *Bhandari, V.B., 'Design of Machine Elements', TMH, 2003.*

REFERENCES:

1. *Shigley, J.E. and Mische, C.R., 'Mechanical Engineering Design', McGraw-Hill, 2002.*
2. *Juvinall, R.C. and Marshek, K.M., 'Fundamentals of Machine Component Design', 44e, Wiley, 2005.*
3. *Hamrock, B.J. Jacobson, B., and Schmid, S.R., 'Fundamentals of Machine Elements', McGraw Hill Co., 2004.*

MEC311 INTRODUCTION TO FINITE ELEMENT METHOD 3 1 0 4

Unit 1

Basic concepts: Introduction to finite element method – element types and discretization procedure – interpolation models.

Finite element formulation and solution: Derivation of element stiffness matrices and load vectors: variation and weighted residual approaches - Rayliegh-Ritz and Galerkin methods – numerical integration - assembly of element stiffness matrices and application of boundary conditions – solution procedures.

Unit 2

Application to solid mechanics: Static analysis of one-dimensional problems – trusses, beams and frames – two-dimensional problems - plane stresses and plane strain – axisymmetric problems – introduction to three dimensional problems – dynamic analysis.

Unit 3

Application to heat transfer: Finite element formulations of heat transfer problems –1-1-D and 2-D steady state and transient heat transfer problems.

Introduction to finite element packages: Introduction to commercial FE packages - preprocessing, solution, and post-processing – simple solid mechanics and heat transfer problems.

TEXTBOOKS:

1. *Rao, S.S., 'The Finite Element Method in Engineering', 4e, Butterworth-Heinemann Publisher, 2005.*
2. *Chandrupatla, T.R., and Belegundu, A.D., 'Introduction to Finite Element in Engineering', Prentice Hall of India, New Delhi, 2002.*

REFERENCES:

1. *Logan, D.L., 'A First Course in the Finite Element Method', Thomson, 2002*
2. *Hutton, D.V., 'Fundamentals of Finite Element Analysis', McGraw-Hill, 2003*
3. *Cook, R.D., Malkus, D.S., and Plesha, M.E., 'Concepts and Application of Finite Element Analysis', John Wiley & Sons, 1995.*
4. *Moaveni, S., 'Theory and Application with Ansys', Prentice Hall, 1999.*
5. *Fish, J., and Belytschko, T.,'A first course in Finite Elements', Wiley Inter Science, 2007.*

MEC312 DESIGN OF MACHINE ELEMENTS II 3 1 0 4

Unit 1

Bearings: Theory of lubrication, design of hydrodynamic journal bearing - Sommerfeld number - dimensionless parameters - optimum bearings. Selection of antifriction bearings - applications to constant and varying loads.

Flexible transmission systems: Classifications – applications – limitations - speed reduction - simple and compound power drives. Selection of belts - flat belt and V belt. Design of chain and rope drives.

Unit 2

Gears: Gear tooth profile correction - concepts and application, gear materials. Basics of gear design, gear tooth failure modes - design of spur and helical gears. Nomenclature of straight, spiral bevel and worm gears.

Gearboxes: Gear tooth loads and bearing reactions - applications to spur, helical, bevel and worm gear drives. Design of single stage speed reducers – standard speed ratios - speed diagram - design of multi stage, multi speed gearboxes.

Unit 3

Cam drives - types of cams drives – pressure angle and under cutting, base circle determination - forces and surface stresses, design of cam drives for IC engines and machine tools.

Friction drives: Design of plate clutches – axial clutches - cone clutches - internal expanding rim clutches. Design of internal and external shoe brakes.

Engineering design: Product design process, need identification, concept generation and evaluation, embodiment design, cost evaluation, target costing and professional responsibilities and ethics.

TEXTBOOKS:

1. *Norton, R.L., 'Machine Design- An integrated Approach', Pearson Education, New Delhi 2003.*
2. *Bhandari, V. B., 'Design of Machine Elements', TMH, 2003*

REFERENCES:

1. *Juvinall, R.C., and Marshek, K.M., 'Fundamentals of Machine Component Design', 44e, Wiley, 2005.*
2. *Collins, J.A., 'Design of Machine Elements and Machines', Wiley-VCH Verlag, 2003.*
3. *Fisher, F.E., 'Probability Applications in Mechanical Design', CRC press, 2000.*
4. *Dieter, G.E., 'Engineering Design: A materials and processing approach', 3e, McGraw Hill Co, 2000.*

MEC320 HEAT TRANSFER 3 1 0 4

Unit 1

Steady state heat conduction: One dimensional heat conduction equation – general heat conduction – boundary and initial conditions - heat generation in solids - generalized thermal resistance network – extended surface heat transfer. Multidimensional steady conduction – analytical solutions, numerical method of analysis.

Unsteady heat conduction: Unsteady state conduction – lumped heat capacity system, plane wall with convection, infinite cylinder & sphere with convection, semi-infinite solid.

Unit 2

Convective heat transfer: Boundary layer theory – physical mechanism of convection - flow over flat plates, cylinders and spheres. Flow over tubes and bank of tubes - natural and forced convection – combined natural and forced convection.

Radiative heat transfer: Thermal radiation and basic laws of radiation – black body – radiation properties - atmospheric and solar radiation – view factor - diffuse and gray surfaces.

Unit 3

Design of heat exchangers: Types of heat exchangers - standard representation - classification – parallel flow and counter flow - LMTD, NTU methods - selection of heat exchangers – construction of heat exchangers.

Phase change heat transfer: Boiling and condensation heat transfer.

TEXTBOOK:

Cengel, Y. A., 'Heat Transfer- A Practical approach', McGraw-Hill, 1998

REFERENCES:

1. *Holman, J. P., 'Heat and Mass Transfer', Tata McGraw Hill, 2000.*
2. *Incropera, F.P. and DeWitt, D.P., 'Fundamentals of Heat and Mass Transfer', John Wiley and Sons, 1998.*
3. *Ozisik, M. N., 'Design of Heat exchangers, condensers and evaporators, John Wiley', New York, 1985.*
4. *Bejan, A., 'Heat Transfer', John Wiley and Sons, 1995.*
5. *Ozisik, M. N., 'Heat Transfer', McGraw Hill Book Co, 1994.*

MEC330 MANUFACTURING TECHNOLOGY II 4 0 0 4

Unit 1

Theory of metal cutting: Types of metal cutting processes, mechanism of chip formation - forces and temperature in metal cutting: Tool life - machinability and surface finish: Cutting tool materials and cutting fluids.

Cylindrical surface machining: Basics of turning process, lathe and its accessories: operations, process parameters. Turret and capstan lathes.

Unit 2

Drilling machines: Types, operations, process parameters. Boring machines: types, operations, process parameters. Design considerations for drilling, reaming and tapping. Flat and profile machining: Milling operations - milling machines: types, operations, process parameters. Planing and shaping machines - types, operations. Broaching machines - types, operations. Gear machining processes.

Unit 3

Finishing processes: Fundamentals of abrasives – grinding wheels - the theory of grinding process - grinding operations and machines - grinding fluids - design considerations for grinding: Finishing operations - super finishing processes - lapping and honing.

CNC machines: NC, CNC and DNC, types, construction, tool and work holding devices, part programming - manual and computer automated programming.

Modern machining processes: EDM, ECM, USM, abrasive and water jet machining, high energy beam machining, high speed machining.

TEXTBOOKS:

1. *Kalpakjian, S. and Schmid, S. R., 'Manufacturing Engineering and Technology', 4e, Pearson Education Asia, 2000.*
2. *Amitabha Ghosh and Asok Kumar Mallik, Manufacturing Science, 2nd edition, EWP, 2010.*

REFERENCES:

1. *Choudhory, H., 'Elements of workshop technology, Vol.II', Asia Publishing House, 1992.*
2. *Rand, R.K. and Gupta, S.C., 'Production Technology', Khanna Publishers, 2008.*
3. *'H.M.T. Production Technology – Hand book', Tata McGraw-Hill Publishing Company Limited , 1990.*

MEC350 THEORY OF ELASTICITY 3 0 0 3

(Pre-requisite: MEC210)

Unit 1

Analysis of stress and strain: stress at a point; stress tensor; stress transformations; principal stresses; octahedral stress; geometrical representation of stress at a point; equations of equilibrium.

Infinitesimal affine transformation for deformation; strain tensor; principal strains; strain-displacement relations for finite and infinitesimal strains; compatibility conditions. Constitutive equations: **g**eneral theory; generalized Hooke's law for anisotropic and isotropic materials.

Unit 2

Equations of elasticity: common equations of elasticity theory like Mitchel-Beltrami and Navier equations, formulation of the general elasticity problem; boundary conditions.

Unit 3

Solution of some special boundary value problems: simplifications; two-dimensional problems in rectangular and polar coordinates; Airy's stress function; a few problems like stress concentration around a circular hole and Boussinesq problem.

A few representative three-dimensional problems; torsion and bending of non-circular prismatic bars (Saint-Venant's solution); membrane analogy, simple plate bending.

TEXTBOOKS:

1. *Timoshenko, S. P. and Goodier J.N, 'Theory of Elasticity', 3e, McGraw - Hill International Editions, 1970.*
2. *Sokolnikoff, I.S., 'Mathematical Theory of Elasticity', 2e, McGraw – Hill International Editions, 1956.*

REFERENCES:

1. *Hartog, J.P.D., 'Advanced Strength of Materials', Dover Publications Inc, 1987.*
2. *Boresi, A. P., Schmidt, R. J. and Sidebottom, O. M., 'Advanced Mechanics of Materials', 5e, John Wiley & Sons Inc., 1993.*

3. *Durelli, A.J., Phillips, E.A. and Tsao, C.H., 'Introduction to the Theoretical and Experimental Analysis of Stress and Strain', McGraw – Hill, New York, 1958.*

MEC351 AUTOMOTIVE TECHNOLOGY 3 0 0 3

Unit 1

Vehicle and engine construction - chassis, frame and body construction, engine types, construction details and multi-cylinder engines, valve arrangements, valve drives, engine cooling and lubrication, air supply system, carburetors, electronic fuel injection systems, exhaust systems.

Power drive line: clutch - types and construction, fluid coupling, transmissions - manual, semi and automotive transmission, continuously variable transmission, overdrives, torque converter, propeller shaft, differential and axles, front and all wheel drive vehicles.

Unit 2

Running systems: Steering geometry and types, steering linkages, power and power assisted steering, types of front axle, suspension systems, suspension design consideration active suspension, braking systems - hydraulic, pneumatic brakes and power brakes, anti-lock brake system - wheels and tyres.

Electrical and electronic systems: electrical systems – storage, charging, starting and ignition and lighting systems, electronic controls for engine and vehicle body, electronic dashboard instruments, electronic and computer controlled transmissions, intelligent transportation systems. Onboard diagnosis system, safety and security systems.

Unit 3

Performance of automobiles: Design aspects - ergonomics, seating and packaging, vehicle body aerodynamics, forces and couples, traction and tractive effort, power for propulsion, cornering properties, stability of vehicle, dynamics of vehicles.

Future automobiles: automobile air pollution, pollution control norms, alternate power units for automobiles - use of natural gas, LPG and hydrogen in automobiles as fuels, fuel cells, electric and hybrid vehicles. Indian traffic rules.

TEXTBOOKS:

1. *Heisler, H., 'Advanced Engine Technology', SAE, 2006.*
2. *Heitener, J., 'Automotive Mechanics', Affiliated East West, 1995.*

REFERENCES:

1. *Crouse, W.H., and Anglin, D.L., 'Automobile Mechanics', 10e, McGraw Hill.1993.*
2. *Garrett, T. K., Newton, K., and Steeds, W., 'Motor Vehicles', Butterworth Heinemann, 2001.*
3. *Fenton, J., 'Handbook of Automotive Body and System Design', Professional Engineering Publishing, UK, 2005.*

4. Giri, N.K., 'Automobile Mechanics', 8e, Khanna Publishers, New Delhi, 2006.
5. Bishop, R., 'Intelligent Vehicle Technology and Trends', AR Tech House Inc., 1999.

MEC352 AUTOMOTIVE CHASSIS DESIGN 3 0 0 3

Unit 1

CLUTCH DESIGN CALCULATION: Design of single plate clutch, multi plate clutch, design of centrifugal clutch, cone clutch, energy dissipated, torque capacity of clutch, design of clutch components, design details of roller and sprag type of clutches.

GEAR BOX: Performance of vehicle, total resistance to motion, traction and tractive effort, acceleration, calculation of gear ratio, design of three speed gear box, design of four speed gear boxes.

Unit 2

VEHICLE FRAME AND SUSPENSION: Study of loads, moments and stresses on frame members, computer aided design of frame for passenger and commercial vehicles, computer aided design of leaf springs, coil springs and torsion bar springs.

Unit 3

FRONT AXLE AND STEERING SYSTEMS: Analysis of loads, moments and stresses at different sections of front axle, determination of loads at kingpin bearings, wheel spindle bearings, choice of bearings, determination of optimum dimensions and proportions for steering linkages ensuring minimum error in steering.

FINAL DRIVE AND REAR AXLE: Design of propeller shaft, design details of final drive gearing, design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings.

TEXTBOOK

Heldt, P. M., 'Automotive Chassis', Chilton Co., New York, 1992.

REFERENCES

1. *Steeds, W., 'Mechanics of Road Vehicles', Illiffe Books Ltd., London, 1990.*
2. *Giles, K. G. , 'Steering, Suspension and tyres', Illiffe Books Ltd., London, 1988.*
3. *Steeds, N. and Garret, 'Motor Vehicle', Illiffe Books Ltd., London, 2000.*
4. *Giri. N. K., 'Automobile Mechanics', Khanna Publisher, New Delhi, 2002.*
5. *Heldt. P.M., 'Torque converter', Chilton Book Co., New York, 1982.*
6. *Averns, D., 'Automobile Chassis Design', Illiffe Books Ltd 1992.*

MEC353 OPTIMIZATION TECHNIQUES IN ENGINEERING 3 0 0 3

Unit 1

Introduction to optimization: Engineering application of optimization – statement of

an optimization problem - optimal problem formulation - classification of optimization problem. Optimum design concepts: definition of global and local optima – optimality criteria - review of basic calculus concepts – global optimality.

Linear programming methods for optimum design: review of linear programming methods for optimum design – post optimality analysis - application of LPP models in design and manufacturing.

Unit 2

Optimization algorithms for solving unconstrained optimization problems – gradient based method: Cauchy's steepest descent method, Newton's method, conjugate gradient method.

Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method - engineering applications of constrained and unconstrained algorithms.

Unit 3

Modern methods of optimization: Genetic algorithms - simulated annealing - ant colony optimization - Tabu search – neural-network based optimization – fuzzy optimization techniques – a pplications. Use of Matlab to solve optimization problems.

TEXTBOOK:

Rao, S. S., 'Engineering Optimization, Theory and Practice", 4e, New Age International publishers, 2009.

REFERENCES:

1. *Deb, K., 'Optimization for Engineering Design Algorithms and Examples', PHI, 2000.*
2. *Arora, J., 'Introduction to Optimization Design', Elsevier Academic Press, New Delhi, 2004.*
3. *Saravanan, R, 'Manufacturing Optimization through intelligent techniques', Taylor & Fransis (CRC Press), 2006.*
4. *Hardley, G., 'Linear Programming', Narosa Book Distributors Private Ltd 2002.*

MEC354 CONDITION MONITORING AND DIAGNOSTIC MAINTENANCE 3 0 0 3

Unit 1

Basic concepts: Machinery failures, basic maintenance strategies, factors influencing maintenance strategies, machine condition monitoring, transducer selection and location, PC interfacing and virtual instrumentation. Vibration signatures of faults in rotating and reciprocating machines; detection and diagnosis of faults.

Unit 2

Instrumentation and signal processing: Types of sensors in condition monitoring: vibration, acoustics and noise, acoustic emission, temperature, ultrasonic and infra-red sensors - signal processing: basic signal and systems concepts, time

domain analysis, frequency domain analysis, time-frequency analysis, wavelets and wavelet packets.

Unit 3

Pattern recognition: Feature extraction and feature selection methods, feature reduction using PCA - discriminant functions and decision boundaries, decision trees, maximum likelihood and nearest neighbour classification - Bayesian theory, neural networks, fuzzy logic and support vector machines (SVM) in classification. Application and case studies of condition monitoring: Bearings, gear boxes, engines, structural health monitoring, machine tool condition monitoring etc.

TEXTBOOKS:

1. *Balageas, D., Fritzen, C-P., and Guemes, A., 'Structural Health Monitoring', Published by ISTE Ltd., USA, 2006.*
2. *Clarence de Silva, 'Vibration and Shock Handbook', CRC Taylor & Francis, 2005.*

REFERENCE BOOKS:

1. *Collacot, 'Mechanical Fault Diagnosis and Condition Monitoring', Chapman- Hall, 1987.*
2. *Davies, 'Handbook of Condition Monitoring - Techniques and Methodology', Springer, 1998.*
3. *Norton, M. and Karczub, D., 'Fundamentals of Noise and Vibration Analysis for Engineers', Cambridge University Press, 2e, 2003.*
4. *Duda, R.O., Peter, Hart, E., and Stork, D.E., 'Pattern Classification', 2e, Wiley India, 2007.*
5. *Strang, G. and Nguyen, T., 'Wavelets and Filter Banks', Wellesley-Cambridge Press, 1996.*

MEC355 MODELING AND SIMULATION OF ENGINEERING SYSTEMS 3 0 0 3

Unit 1

Fundamental concepts in mathematical modelling: Abstraction – linearity and superposition – balance and conservation laws and the system – boundary approach. Lumped – element modeling: Mechanical systems - translational, rotational. Hydraulic systems. Thermal systems. RLC electrical systems.

Modeling of first–order and second–order systems: **g**overning equations for free and forced responses – transient response specifications – experimental determination – laplace transform. Time domain, frequency domain and state space.

Unit 2

Frequency response of linear, time invariant systems – frequency response of first–order and second–order systems – state space formulations of systems problems relating frequency response to pole location – transient response - poles and frequency response.

Unit 3

Feedback systems: **s**ystems with feedback – block diagrams – properties of feedback systems – relative stability-phase and gain margins.

TEXTBOOK:

Cha, P.D., Rosenberg, J.J., and Dym, C.L., 'Fundamentals of Modeling and Analyzing Engineering Systems', Cambridge University, 2000.

REFERENCES:

1. *Woods, Robert, L., and Kent L., 'Modeling and Simulation of Dynamic Systems', Prentice Hall, 1997.*
2. *Mukherjee, A. and Karmakar, R., 'Modeling and Simulation of Engineering Systems through Bondgraphs', Narosa, 2000.*
3. *Frederick, C., 'Modeling and Analysis of Dynamic Systems', 3e, Wiley, 2001.*

MEC 356 MATERIALS SELECTION IN MECHANICAL DESIGN 3 0 0 3

Unit 1

Overview of materials properties - modulus, tensile. Fatigue, creep strengths, toughness, hardness, fracture toughness, damping capacity, thermal, oxidation, corrosion and wear resistances.

Materials property charts. Materials families and classes - metals, ceramics, glasses, polymers, elastomers, composites, foams, natural.

Unit 2

Basis of materials selection. Design of components - functions, constraints, objectives and free variables. Selection process - translation, screening, ranking, supporting information. Illustration of the principles with examples - heat sink, overhead electrical transmission line, tie rod, light stiff beam. Multiple constraints and objectives - case studies. Design of hybrid materials - case studies.

Unit 3

Case studies in materials selection for various applications - oar, table leg, flywheel, kiln walls, passive solar heating, heat exchangers, bearings, springs, pressure vessel.

Principles of process selection and classification - casting, forging, moulding, fabrication, welding, joining, machining, powder processing, composite processing. Illustration of the principles with case studies.

Multiple constraints and objectives - case studies. Design of hybrid materials - case studies.

TEXTBOOK:

Ashby, M. F., 'Materials selection in mechanical design', 3e, Elsevier, 2005.

REFERENCE:

ASM Handbook, 'Materials Selection and Design', 1996.

MEC357 AIRCRAFT SYSTEMS AND ENGINEERING 3 0 0 3

Unit 1

Aircraft industry overview: Evolution and history of light, types of aerospace industry, key players in aerospace Industry, aerospace manufacturing, industry supply chain, prime contractors, tier 1 suppliers, key challenges in industry supply chain, OEM supply chain strategies, mergers and acquisitions, aerospace industry trends, advances in engineering/CAD/CAM/CAE tools and materials technology, global and Indian aircraft scenario.

Introduction to aircrafts: Basic components of an aircraft, structural members, air craft axis system, aircraft motions, control surfaces and high lift devices.

Types of aircrafts - lighter than air/heavier than air aircrafts. Conventional design configurations based on power plant location, Wing vertical location, intake location, tail unit arrangements, landing gear arrangements. Unconventional configurations - biplane, variable sweep, Canard layout, twin boom layouts, span loaders, blended body wing layout, STOL and STOVL aircraft, stealth aircraft. Advantaged and disadvantages of this configuration.

Unit 2

Introduction to aircraft systems: types of aircrafts systems. Mechanical systems. Electrical and electronic system. Auxiliary systems. Mechanical system: Environmental control systems (ECS), pneumatic systems, hydraulic systems, fuel systems, landing gear systems, engine control systems, ice and rain protection systems, cabin pressurization and air conditioning systems, steering and break systems, auxiliary power unit. Mechanical systems: Avionics, flight controls, autopilots and flight management systems, navigation systems, communication, information systems, radar systems.

Unit 3

Basic principles of flight: Significance of speed of sound, air speed and ground speed, properties of atmosphere, Bernoullie‘s equation, forces on the air plane, air flow over the wing section, pressure distribution over a wing section, generation of lift, drag, pitching moments, types of drag, lift curve, drag curve, lift/drag ratio curve, factors affecting lift and drag, center of pressure and it’s effects. Aerofoil nomenclature, types of aerofoil, wing section - aerodynamic center, aspect ratio, effects of lift, drag, speed, air density on drag.

Basics of flight mechanics: Mach waves, mach angles, sonic and supersonic flight and its effects. Stability and control: Degree of stability – lateral, longitudinal and directional stability and controls of aircraft. Effects of flaps and slats on lift coefficients, control tabs, stalling, landing, gliding turning, speed of sound, mach numbers, shock waves. Aircraft performance and maneuvers: Power curves, maximum and minimum speeds of horizontal flight, effects of changes of engine

power, effects of altitude on power curve, forces acting on an aeroplane during a turn, loads during a turn, correct and incorrect angles of a bank, aerobatics, inverted maneuvers, maneuverability.

TEXTBOOKS:

1. Kermode, A.C., ‘Flight without Formulae’, Pearson Education, 10e, 1995.

2. Kermode, A.C., ‘Mechanics of Flight’ Pearson Education, 5e, 2006.

REFERENCES:

1. Shevell, ‘Fundamentals of Flight’, Pearson Education, 2e, 1988.

2. Anderson, D., ‘Introduction to Flight’, McGraw Hill, 2005.

3. Mior, L. and Seabridge, A., ‘Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration’, Wiley, 2008.

MEC358 MECHATRONICS 3 0 0 3

Unit 1

Introduction to mechatronics systems - measurement systems - control systems - micro processor based controllers. Sensors and transducers - displacement, position and proximity; velocity, motion, force, fluid pressure, liquid flow and liquid level temperature, light sensors - selection of sensors. Pneumatic and hydraulic actuation systems – directional control valves - rotary actuators. Mechanical actuation systems – cams – gear trains – ratchet and pawl – belt and chain drives – bearings.

Unit 2

Electrical actuation systems – mechanical switches – solid state switches – solenoids – D.C motors – A.C motors – stepper motors. Building blocks of mechanical, electrical, fluid and thermal systems, rotational – transnational systems, electromechanical systems – hydraulic – mechanical systems. Continuous and discrete process controllers – control mode – two–step mode – proportional mode – derivative mode – integral mode – PID controllers – digital controllers – velocity control – adaptive control – digital logic control – micro processors control.

Unit 3

Programmable logic controllers – basic structure – input/output processing – programming – mnemonics – timers, internal relays and counters – shift registers – master and jump controls – data handling – analogs input/output – selection of a PLC problem. Stages in designing mechatronics systems – traditional and mechatronic design - possible design solutions. Case studies of mechatronics systems, pick and place robot – automatic car park systems – engine management systems.

TEXTBOOK:

W. Bolton, ‘Mechatronics’, Pearson Education, 2e, 1999.

REFERENCES:

1. *Michael B. Histand and David G. Alciatore, ' Introduction to Mechatronics and Measurement Systems', McGraw-Hill International Editions, 2000.*
2. *Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, 'Mechatronics', Chapman and Hall, 1993.*
3. *Dan Necsulesu, 'Mechatronics', Pearson Education Asia, 2002.*
4. *Lawrence J. Kamm, 'Understanding Electro – Mechanical Engineering- An Introduction to Mechatronics', Prentice – Hall of India Pvt., Ltd., 2000.*
5. *Nitaigour Premchand Mahadik, 'Mechatronics', Tata McGraw-Hill publishing Company Ltd, 2003.*

MEC359 MICRO-ELECTRO MECHANICAL SYSTEMS 3 0 0 3

Unit 1

Definition of MEMS. MEMS devices. Silicon as a MEMS material - mechanical properties of silicon. Mechanical components in MEMS. Design concepts of mechanical components. Working principles of microsystems. Engineering science for microsystems design and fabrication. Scaling laws – scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, electricity-fluid mechanics and heat transfer.

Unit 2

Materials for MEMS and microsystems. Fabrication technologies – photolithography - ion implantation – diffusion – oxidation – CVD - physical vapor deposition – etching. Micro manufacturing - bulk and surface micro machining - LIGA.

Unit 3

Microsystems design - design considerations - process design - mechanical design – CAD - micro system packaging – levels – bonding – interfaces - assembly – selection of packaging materials.

TEXTBOOK:

Tai – Ran Hsu, 'MEMS & MICROSYSTEMS Design and Manufacturing', Tata McGraw- Hill Publishing Company Limited, 2002.

REFERENCES:

1. *Marc J Madou, 'Fundamentals of Microfabrication', 2e, CRC Press, 2002.*
2. *Mohamed Gad-el-Hak, 'The MEMS Handbook', CRC Press, 2002.*

MEC360 TOOL ENGINEERING DESIGN 3 0 0 3

Unit 1

Design of jigs: Introduction - location principles – six point location principle – locators – clamping principles – clamping devices – drill jigs – drill bushes – drill jig types – design and development of jigs for given components.

Unit 2

Design of fixtures: Milling fixtures – milling methods – milling fixture types – turning fixtures – broaching fixtures – grinding fixtures – assembly, inspection and welding fixtures – modular fixtures – design and development of fixtures for given components.

Unit 3

Design of dies: Power presses types and construction details, die cutting operation, cutting action in die and punch, center of pressure, clearance and its significance, cutting forces, methods of reducing cutting forces, methods of punch support, strippers, stock stops, guide pilots, knockout, design of blanking and piercing dies. Design concepts and description of the components of progressive dies. Design of progressive dies. Design of compound dies. Design of combination dies.

Drawing dies: Metal flow and factors affecting drawing, blank size calculations, drawing force, single and double acting drawing dies, design and development of drawing dies for different components.

Bending and forming dies: Spring back, bend allowance; calculation of development length, bending force calculations types of bending dies. Curling dies. Forging process and forging dies. (Introductory Treatment)

TEXTBOOKS:

1. *P. H. Joshi, Jigs and Fixtures Design Manual, McGraw Hill, 2002*
2. *Kempster M H A, "An Introduction to Jig and Tool Design", Viva Books Pvt. Ltd., 1998.*
3. *Paquin and Crowley, "Die Design Fundamentals", Industrial Press, New York, 1979.*

REFERENCE BOOKS:

1. *Fundamentals of Tool Design, John G Nee, Society of Manufacturing, 4th Edition, 1998.*
2. *Production Techno1ogy Hand Book, HMT , Tata McGraw Hill*
3. *E. K. Henriksen - "Jig and Fixture Design Manual", Industrial Press, New York, 1973*
4. *Donaldson, Lecain and Goold - "Tool Design", McGraw Hill, New York, 1976*

MEC361 FRACTURE MECHANICS 3 0 0 3

(Pre-requisite: MEC210)

Unit 1

Introduction to fracture mechanics: Failures in structures - types and causes, historical perspective, fracture mechanics approach to design - energy criterion, stress intensity approach, time dependent crack growth and damage tolerance, effect of material properties on fracture.

Linear Elastic Fracture Mechanics (LEFM): Stress concentration effect of flaws, Griffith energy balance, the energy release rate, instability and resistance curve(R-curve), stress analysis of cracks, relationship between stress intensity factor and energy release rate (K and G), crack tip plasticity, mixed mode crack initiation and propagation.

Unit 2

Elastic Plastic Fracture Mechanics (EPFM): Crack-Tip-Opening Displacement (CTOD), the J contour integral and its determination, relationships between J and CTOD, crack-growth resistance curves, J-controlled fracture.

Fracture mechanism in metals and non-metals: Ductile fracture, cleavage, the ductile-brittle transition, intergranular fracture, fracture in polymeric materials, and fracture in ceramic and ceramic composites.

Unit 3

Applications: Introduction to fracture toughness testing of metals and non-metals for determination of fracture parameters, application of fracture mechanics concepts in the analysis of fatigue crack growth.

Computational fracture mechanics: overview of numerical methods for fracture mechanics problems, traditional methods in computational fracture mechanics – point matching and energy methods, the energy domain integral, finite element implementation, design of finite element mesh, linear elastic convergence study, analysis of growing cracks.

TEXTBOOK:

Anderson, T. L., 'Fracture Mechanics: Fundamentals and Applications', 3e, CRC Press, 2005.

REFERENCES:

1. *Ramesh, K., 'E-book on Engineering Fracture Mechanics', IIT Madras, 2006.*
2. *Janssen, M., Zuidema and Wanhill, R. J. H., 'Fracture Mechanics', 2e, VSSD (Delft University of Technology), 2006.*
3. *Kumar, P., 'Elements of Fracture Mechanics', Wheeler Publishing, 1999.*
4. *Dahlberg, T. and Ekberg, S., 'Failure Fracture Fatigue: An Introduction', Overseas Press (India), 2006.*
5. *Suresh, S., 'Fatigue of Materials', 2e, Cambridge University Press, 1998.*

MEC362 COMPUTATIONAL METHODS IN ENGINEERING 3 0 0 3

Unit 1

Basic concepts: Approximations and round-off errors - truncation errors and the Taylor series – accuracy and precision - error propagation.

Basic applications: Interpolation and curve fitting - methods to solve nonlinear equations – roots of equations - numerical differentiation and integration techniques: Newton-Cotes integration and Gauss quadrature - optimization: constrained and unconstrained optimization methods.

Unit 2

Linear algebra: system of linear equations: Gauss elimination, Gauss Jordan, LU, QR and SVD - iterative methods of solution – Eigenvalues and eigenvectors,

physical meaning and methods of determining eigenvalues and eigenvectors.

Unit 3

Differential equations: ordinary differential equations: Euler, Runge-Kutta methods, multi-step methods, stiff equations - partial differential equations: finite difference methods for elliptic, parabolic and hyperbolic equations and implementation.

TEXTBOOKS:

1. *Chapra, S. C., 'Numerical Methods for Engineers', 5e, McGraw-Hill Higher Education, 2006.*
2. *Hoffman, J.D., 'Numerical Methods for Engineers and Scientists', 2e, CRC Press, 2001.*

REFERENCE BOOKS:

1. *Quarteroni, A., Sacco, R., and Saleri, F., 'Numerical Mathematics' , 2e, Springer, 2007.*
2. *Trefethen, L.N. and Bau, D., 'Numerical Linear Algebra', SIAM, 1997.*
3. *Iserles, A., 'A First Course in the Numerical Analysis of Differential Equations', Cambridge University Press, 1996.*
4. *Coleman, M.P., Chapman & Hall, 'An Introduction to Partial Differential Equations with MATLAB', CRC, 2004.*

MEC363 DESIGN FOR MANUFACTURE AND ASSEMBLY 3 0 0 3

Unit 1

Design impact on cost, design for "X" - DFM approach, DFM framework, material and process evaluation, general DFM guidelines, machining and casting guidelines and examples, minimize finishing requirements. Computer applications for DFMA. Design features to facilitate machining: datum features - functional and manufacturing. Component design - machining considerations, redesign for manufacture, examples. Form design of castings and weldments.

Unit 2

Tolerance analysis: Process capability, process capability metrics, tolerance-cost aspects, feature tolerances, geometric tolerances, relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances - sure fit law, normal law and truncated normal law.

Interchangeable part manufacture and selective assembly - control of axial play - introducing secondary machining operations, laminated shims - examples.

Unit 3

Datum systems: degrees of freedom, grouped datum systems - computation of translational and rotational accuracy - geometric analysis and applications.

True position theory: co-ordinate and conventional method of feature location, tolerance and true position tolerance, virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position

tolerance, functional gauges, paper layout gauging - examples.
Principles of design for assembly, minimize part count, standardization and minimize part variety, design guidelines for manual assembly, DFA analysis, DFA index, design for automated assembly. Introduction to usage of DFMA software.

TEXTBOOKS:

1. *Boothroyd, G., Dewhurst, P. and Knight, W., 'Product Design for Manufacture and Assembly', 2e, Marcel Dekker, New York, 2002.*
2. *Peck, H., 'Designing for Manufacture', Pitman Publications, 1983.*

REFERENCES:

1. *Spotts, M. F., 'Dimensioning and Tolerance for Quantity Production', Prentice Hall Inc., 1983.*
2. *Wade, O.R., 'Tolerance Control in Design and Manufacturing' Industrial Press Inc., New York, 1967.*
3. *Creveling, C.M., 'Tolerance Design - A Hand Book for Developing Optimal Specifications', Addison Wesley Longman, Inc, 1997.*

MEC364 PRESSURE VESSEL DESIGN 3 0 0 3

(Pre-requisite: MEC210)

Unit 1

Introduction to pressure vessels, design philosophy, structural integrity - failure modes and theories - working loads and allowable stresses - fatigue, fracture and buckling. Stress categorization - primary, secondary and peak.
Design of cylindrical shells - ASME equations - thin shell equations - thick shell equations - buckling of cylindrical shells.

Unit 2

End closures - ASME equations for various types of heads – hemispherical, flat, ellipsoidal, torispherical, and conical heads.
Discontinuity stresses - discontinuity stresses - beams on elastic foundation, cutouts and reinforcements – stress concentrations around a hole –reinforcements. Fatigue assessment - exemption from fatigue analysis - S-N curves - design curves - cumulative damage - fatigue evaluation.

Unit 3

Bolted flanges - RF and FF flanges - gasket loading behavior - application of ASME equations for flange analysis and bolt design.
Design of supports - lug support - support skirts - saddle support.

TEXTBOOKS:

1. *Harvey, J. F., 'Theory and Design of Pressure Vessels', Van Nostrand, 1991.*
2. *Chattopadhyaya, S., 'Pressure Vessels - Design and Practice', CRC Press, 2005.*

REFERENCES :

1. *Brownell and Young, 'Process Equipment Design', Wiley publishing Ltd,1959.*
2. *Ellenberger, P., 'Pressure Vessels – ASME Code Simplified', 8e, McGraw Hill Company, 2004.*

MEC365 THEORY OF VIBRATIONS 3 0 0 3

Unit 1

Introduction - derivation of equation of motion - free vibration of undamped single degree of freedom systems - free vibration of damped single degree of freedom systems. Forced response of single degree of freedom systems - rotating unbalance, support motion, whirling of shafts, different types of damping. Response of sdof systems to arbitrary excitation - convolution integral, Fourier transforms method.

Unit 2

Free vibration of undamped two degree of freedom systems - formulation and solution of matrix Eigen value problem, natural modes - elastic and mass coupling, orthogonality of modes, natural coordinates. Response of two degree of freedom systems to harmonic excitation - undamped vibration absorbers.
Matrix formulation for multi degree of freedom systems, influence coefficients - undamped free vibration of multi degree of freedom systems, formulation of eigen value problem - orthogonality of modal vectors, expansion theorem. Modal analysis – modal damping in forced vibration. Computation of fundamental natural frequency - Dunkerley's formula - Rayleigh's method.

Unit 3

Vibration of continuous systems - wave equation - longitudinal and torsional vibration of rods, lateral vibration of beams.
Vibration control - vibration isolation, vibration absorbers. Vibration measuring instruments, vibration exciters, free and forced vibration tests.

TEXTBOOKS:

1. *Rao, S. S., 'Mechanical Vibrations', Second Edition, Addison-Wesley, 1990.*
2. *Thomson. T., 'Theory of Vibration with Applications', 5e, Pearson Education, 2003.*

REFERENCES:

1. *Meirovitch, L., 'Elements of Vibration Analysis', 2e, McGraw Hill International Edition, 1986.*
2. *Meirovitch, L., 'Analytical Methods in Vibrations', The Macmillan company, New York, 1967.*

MEC366 REFRIGERATION AND AIR CONDITIONING 3 0 0 3

Unit 1

Refrigeration cycles: Vapour compression cycle - simple saturated vapour compression cycle. Thermodynamic analysis of cycles. Refrigerant classification

– designation - alternate refrigerants. Global warming potential & ozone depleting potential aspects, vapour absorption systems.
System components: Refrigerant compressors – reciprocating, open type & hermetic type, screw compressors and scroll compressors - construction and operation characteristics. Evaporators - DX coil, flooded type chillers.

Unit 2
Expansion devices - automatic expansion valves, capillary tuber & thermostatic expansion valves. Condensing units and cooling towers. Cycling controls and system balancing: Pressure and temperature controls. range and differential settings. Selection and balancing of system components - graphical method.
Psychrometry: Moist air behavior - psychrometric chart - different psychrometric process analysis.

Unit 3
Air conditioning: summer and winter air conditioning - cooling load calculations - air distribution patterns - dynamic and frictional losses in air ducts - equal friction method - fan characteristics in duct systems.

TEXTBOOK

Stocker, W.F. and Jones, J. W., 'Refrigeration & Air Conditioning', McGraw-Hill, 1985.

REFERENCES

1. *Dossat, R.J., 'Principles of Refrigeration', John Wiley, 1989.*
2. *Goshnay, W. B., 'Principles and Refrigeration', Cambridge, University Press, 1982.*
3. *Prasad, M., 'Refrigeration and Air Conditioning', Wiley Eastern, 1995.*

MEC367 DESIGN OF THERMAL SYSTEMS 3 0 0 3

Unit 1
System design fundamentals: Basic design principles - workable and optimal systems - matching of system components - economic analysis – depreciation - gradient present worth factor.
Mathematical modeling for simulation: Mathematical models, principles, types, equation fitting, information flow diagram, workable systems, optimal systems.

Unit 2
Modeling thermal equipment: Modeling of heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps - simulation studies - information flow diagram - solution procedures.

Unit 3
Thermal systems optimization: objective function formulation - constraint equations - mathematical formulation - calculus method - dynamic programming -geometric programming - linear programming methods - solution procedures.

Dynamic behaviour of thermal system: Steady state simulation - laplace transformation - feedback control loops - stability analysis - non-linearities.

TEXTBOOKS:

1. *Stoecker, W.F., 'Design of Thermal Systems', McGraw-Hill, 1980.*
2. *Stoecker, W. F., 'Refrigeration and Air conditioning', Tata McGraw-Hill Publishing Company Limited,1985.*

REFERENCES:

1. *'ASHRAE Guide & applications', ASHRAE, USA, 1985.*
2. *Fanger, P. O., 'Thermal Comfort', McGraw-Hill, USA, 1972.*
3. *Kapur, J.N., 'Mathematical Modelling', Wiley Eastern, New York, 1980.*
4. *McQuiston, F.C. and Parker, T.D., 'Heating, Ventilating and Air conditioning, Analysis and Design', John Wiley, USA, 1988.*

MEC 368 INTERNAL COMBUSTION ENGINES AND POLLUTION CONTROL 3 0 0 3

Unit 1
Spark ignition engines: mixture requirement - feedback control carburetors - fuel injection systems. Stochiometric combustion - combustion with excess air-equivalence ratio.
Stages of combustion: Normal and abnormal combustion - knock. Combustion chambers. Simple thermodynamic analysis of SI engine combustion.

Unit 2
Compression ignition engines: nature of combustion in IC engines - direct and indirect injection systems - air motion - combustion chambers - spray penetration and evaporation. Supercharging - turbo charging. Thermodynamic analysis of CI engine combustion. Wankel engine: operation & applications. Hybrid vehicles.
Thermo chemistry: Pollutant formation, instrumentation to measure pollutants - pollutant calculation - effect of air-fuel ratio.

Unit 3
Emission standards: EGR on engine emissions - emission standards - emission control devices. Thermal & catalytic exhaust clean-up – catalysts -automotive catalytic converters - engine modifications to reduce emissions. Heat release analysis of IC engines.
Alternate fuels: engine modifications for alternate fuels (liquid and gaseous fuels), homogenous charge compression ignition engines.

TEXTBOOKS:

1. *Heywood, J. B., 'Internal Combustion Engine Fundamentals', McGraw-Hill, 1993.*
2. *Obert, E. F., 'Internal Combustion Engines and Air pollution', Harper and Row, 1973.*

REFERENCES:

1. *Ferguson, C.R, 'Internal Combustion Engines', John Wiley, 1989.*
2. *Ganesan, V., 'Internal Combustion Engines', Tata McGraw-Hill Publishing Company Limited, New Delhi 1998.*
3. *Degobert, P., 'Automobiles and Air Pollution', SAE, 2002*
4. *Campbell, A. S., 'Thermodynamic Analysis of Combustion Engines', John Wiley, 1979.*

MEC369 TURBOMACHINERY 3 0 0 3

Unit 1

Definition and classification of turbomachines - specific work - T-s and h-s diagram - incompressible and compressible flow – losses - total – to – total efficiency - total-to-static efficiency - effect of reheat and preheat factor. Degree of reaction. Energy transfer - Euler's equation, velocity triangles.

Dimensional analysis, dimensionless parameters and their physical significance, specific speed, hydraulic pumps: Centrifugal pumps – some definitions - pump output and efficiencies - effect of Vane angle – cavitation - pump characteristics - multistage pumps.

Unit 2

Hydraulic turbines: Classification of hydraulic turbines - velocity triangles. Efficiencies of draft tubes - hydraulic turbine characteristics. Francis and Kaplan turbines - velocity triangles - efficiencies of draft tubes - turbine characteristics. Elementary cascade theory, cascade nomenclature, compressor cascade, turbine cascade, cascade efficiency. Dimensional analysis of compressible flow machines, stalling and surging.

Unit 3

Centrifugal compressors: constructional details - stage pressure rise - stage pressure coefficient - stage efficiency - degree of reaction - various slip factors - introduction to fans and blowers, working principle, fan laws, performance characteristics.

Axial flow compressors: general expression for degree of reaction; velocity triangles for different values of degree of reaction, blade loading and flow coefficient, static pressure rise, workdone factor.

Steam and gas turbines: axial turbine stages - stage velocity triangles – work - single stage impulse turbine - speed ratio - maximum utilization factor - compounding of turbines and its types, degree of reaction - reaction stages. Inward flow radial turbine stages (IFR) - working principle and performance characteristics.

TEXTBOOKS:

1. *Dixon, S. L., 'Fluid Mechanics & Thermodynamics of Turbomachinery', 5e, Elsevier, 2005.*
2. *Sayers A. T., 'Hydraulic and Compressible flow Turbomachines'., McGraw-Hill,1992.*

3. *Yahya, S.M., 'Turbines, Fans and Compressors', Tata McGraw-Hill Publishing Company Limited, 2002.*

REFERENCES:

1. *Douglas, J. F., Gasiorek, J.M., and Swaffield, J.A., 'Fluid Mechanics', Addison-Wesley, 1999.*
2. *Kadambi, V and Manohar Prasad, 'Energy Conversion-Vol.III: TurboMachinery, New Age International Publishers, 1999.*
3. *Church, A.H. and Lal, J., 'Centrifugal Pumps and Blowers', Metropolitan, 1995.*

MEC370 FLUID POWER DRIVES AND CONTROLS 3 0 0 3

Unit 1

Basic principles - hydraulic principles. Hydraulic actuators – linear, rotary - selection – characteristics.

Hydraulic valves: pressure, flow, direction controls - proportional control valve. Fluid power symbols. Hydraulic circuits: Reciprocating, quick return, sequencing, synchronizing and other industrial circuits etc.

Unit 2

Design of hydraulic circuits: selection and sizing of components - calculation of frictional head loss - equivalent length for various components - actuator load calculation - pump sizing.

Unit 3

Pneumatic system fundamentals: FRL, actuators and valves. Logic circuits - position - pressure sensing, switching, electro-pneumatic. Design of pneumatic circuits using – Karnaugh maps. Cascade-step counter. Combination methods.

PLC programming – microprocessors - principles of low cost automation - case studies.

TEXTBOOK:

Esposito, A., 'Fluid Power with Applications', 5e, Pearson Education, 2000.

REFERENCES:

1. *Michael, J., Pinches and Ashby, J.G., 'Power Hydraulics', Prentice Hall, 1989.*
2. *Parr, A., 'Hydraulics and Pneumatics', Jaico, 1999.*
3. *Pease, D.A., and Pippenger, J.A., 'Basic Fluid Power', Prentice Hall, 1987.*
4. *Majumdar, 'Oil hydraulics and Pneumatics', Tata McGraw-Hill Publishing Company Limited, 2005.*

MEC371 RENEWABLE SOURCES OF ENERGY 3 0 0 3

Unit 1

Solar energy: Solar radiation - empirical equations - solar chart - measurements of solar radiation and sunshine. Solar thermal collectors - flat plate and concentrating collectors. Solar thermal power plant. PV systems and applications. Applications: Solar desalination, Solar pond, solar driers, industrial process heat, etc.

Wind energy: principles of wind power, site characteristics, wind rows diagram, types of wind turbines – construction, working and performance characteristics, synchronization of wind energy with the grid.

Unit 2

Bio-energy: Methanation: Methanogenic bacteria, process of methanation, variables affecting the process, popular designs of bio gas plant – construction and working. Feed stock preparation. Application: Biomethanation of agro waste, animal waste and process industry waste – sugar industry, sago industry, etc.

Thermal: Pyrolysis, gasification process, variables affecting the process, types of gasifiers, construction and working of gasifiers. Application: Gasification of biomass, process industry waste, viz - paper mill, waste cotton mill, saw mill, etc.

Unit 3

Ocean energy: Tidal: Types of energy harnessing techniques, turbines – construction, working and performance characteristics. Ocean thermal: open cycle, closed cycle, components of ocean thermal power plant, working and challenges. Fuel cells: principle of working of hydrogen, carbon monoxide, fuel cell etc.

TEXTBOOKS:

1. *Wakil, M.M.E., 'Power Plant Technology', 5e, McGraw-Hill, 2010.*
2. *Rai, G. D., 'Non Conventional Energy Sources', Khanna, New Delhi, 1999.*

REFERENCES:

1. *Garg, H. P. and Prakash, J., 'Solar Energy, Fundamentals and Applications', Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.*
2. *Golding, E. W., 'The Generation of Electricity by Wind Power', John Wiley, NJ, USA, 1976.*

MEC372 ADVANCED FLUID MECHANICS 3 0 0 3

(Pre-requisite: MEC222)

Unit 1

Fundamentals of fluid dynamics: Differential approach - the material derivative, integral approach – RTT, path lines, streamlines and stream functions, stress, rates of deformation, vorticity and circulation, stream function equation, vorticity transport equation, conservation equations – mass, momentum, energy, boundary conditions, moving coordinate systems.

Exact solution of Navier Stokes equation: Couette (wall–driven) steady flow, Poiseuille (pressure driven) steady duct flow, Wind driven (Ekman) flow, unsteady duct flow.

Unit 2

Inviscid irrotational flow: Potential flow – uniform flow, source, sink, doublelet, vortex, Hele–shaw Rankine half body, Rankine oval, superposition principle.

Flow over bodies: Drag and lift: Drag and lift, friction and pressure drag, reducing drag by streamlining, flow separation, drag coefficients of common geometries,

parallel flow over flat plates, friction coefficient, flow over cylinders and spheres, D'Alembert's paradox. Effect of surface roughness lift-end effects of wing tips lift generated by spinning.

Unit 3

Boundary layer theory: Boundary layer concept, boundary layer equations for 2D flows, Blasius similarity solution, Karman momentum integral equation, boundary layer thicknesses, boundary separation with various pressure gradient, laminar and turbulent boundary layers.

Introduction to turbulence: Nature of turbulence, origin of turbulence, characterization of turbulence, Reynolds modification of Navier-Stokes equations, Reynolds stresses, turbulence models – Prandtl mixing length model.

TEXTBOOK:

1. *Yuan, S. W., 'Foundations of Fluid Mechanics', Prentice Hall of India Private Limited, New Delhi, 1988.*
2. *Muralidhar, K. and Biswas, G., 'Advanced Engineering Fluid Mechanics', Narora, 1996.*

REFERENCES:

1. *Cohen, I.M., 'Fluid Mechanics', Academic Press, USA, 2003.*
2. *Shames, I.H., 'Mechanics of Fluids', Mc Graw-Hill, 2003.*
3. *Schlichting, H. and Gersten, K., 'Boundary Layer Theory', Springer-Verlag, New York, 2000.*

MEC373 COMBUSTION ENGINEERING 3 0 0 3

(Pre-requisite: MEC221)

Unit 1

Thermodynamics of combustion: properties of mixtures - combustion stochiometry - heat of reaction and formation - adiabatic flame temperature - chemical equilibrium. Chemical kinetics: Elementary reactions: rate of reactions and their functional dependence - chain reactions, pre-ignition kinetics, global reactions, nitrogen oxide kinetics, soot kinetics.

Unit 2

Combustion of gaseous and vaporized fuels: Laminar premixed flames - laminar flame theory - turbulent premixed flames - mechanism of flame stabilization - explosion limits - mechanism of flame quenching - flammability and ignition - diffusion flames - flame propagation - gaseous combustion system.

Unit 3

Combustion of liquid fuels: Spray formation - size distribution - fuel injectors, spray dynamics - vapourisation of single droplets - spray combustion system.

Combustion of solid fuels: solid fuel combustion mechanism - drying of solid fuels

- devolitilisation of solid fuels - fuel-bed combustion – suspension burning - fluidized bed combustion.

TEXTBOOKS:

1. *Borman, G. L. and Ragland, K. W., 'Combustion Engineering', McGraw-Hill, 1998.*
2. *Turns, S.R., 'An Introduction to Combustion', Mc Graw-Hill, 1996.*

REFERENCES:

1. *Kuo, K. K., 'Principles of Combustion', John Wiley & Sons, 1984.*
2. *Sharma, S. P. and Chandramohan, 'Fuels and Combustion', Tata McGraw-Hill Publishing Company Limited, 1984.*
3. *Heywood, J. B., 'Internal Combustion Engine Fundamentals', McGraw-Hill, 1993.*

MEC374 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

(Pre-requisite: MAT212, MEC222)

Unit 1

Introduction & conservation laws of fluid motion: Models of the fluid flow, substantial derivative, divergence of the velocity, laws of conservation - continuity equation, momentum equation, energy equation, dimensionless forms of equations, simplified mathematical model, mathematical classification of flows, physical boundary conditions. Basics of numerics: components of the numerical solution methods – mathematical model, discretization method, co-ordinates and basic vector systems, numerical grid, finite approximations, solution method, convergence criteria. Properties of numerical solution methods – consistency, stability, convergence, conservations, boundedness, realizability. Discretization approaches – FEM, FDM, FVM.

Unit 2

Finite difference method: approximation of the first derivative – Taylor series expansion, polynomial fitting, compact schemes, non-uniform grids. Approximation of the second derivative, approximation of the mixed derivative, explicit and implicit approaches, errors and analysis of stability.

Spectral analysis and grid generation: Spectral analysis of numerical schemes, higher order methods, high accuracy compact schemes. General transformation of the equations, metrics and Jacobians, stretched grids, boundary fitted co-ordinate systems, elliptic grid generation, unstructured grids.

Unit 3

Computational heat transfer: steady one & two dimensional heat conduction, unsteady one dimensional heat conduction, overrelaxation and under relaxation. One dimensional steady convection and diffusion.

Computational fluid flow: Solution methods for incompressible flows - collocated and staggered grid, pressure correction equations, SIMPLE and SIMPLER algorithm.

Examples in simple geometries such as flow in channel, lid driven cavity flow and validation. Solution methods for compressible flows - importance of conservation and upwinding. Simple artificial dissipation methods, pressure-correction methods for arbitrary Mach numbers. Applications to inviscid compressible flows.

TEXTBOOKS:

1. *Ferziger, J.H. and Peric, M., 'Computational Methods for Fluid Mechanics', 3e, Springer, 2002.*
2. *Anderson, J.D., 'The Computational Fluid Dynamics – The Basics with applications', McGraw-hill,1995.*

REFERENCES:

1. *Sengupta, T.K., 'Fundamentals of Computational Fluid Dynamics', Universities Press, 2004.*
2. *Patankar, S.V., 'Numerical Heat transfer and Fluid Flow', Taylor & Francis Publications, 1980.*

MEC375 AUTOMOTIVE ELECTRONICS 3 0 0 3

Unit 1

Introduction: Automotive component operation - electrical wiring terminals and switching multiplexed wiring systems - circuit diagrams and symbols. Charging systems and starting systems: charging systems principles alternations and charging circuits - new developments requirements of the starting system - basic starting circuit.

Ignition systems: Ignition fundamental, electronic ignition systems. Programmed ignition distribution - less ignition direct ignition spark plugs. Electronic fuel control basics of combustion - engine fuelling and exhaust emissions - electronic control of carburetion - petrol fuel injection - diesel fuel injection.

Unit 2

Instrumentation systems: introduction to instrumentation systems - various sensors used for different parameters sensing - driver instrumentation systems - vehicle condition monitoring - trip computer different types of visual display.

Electronic control of braking and traction: Introduction - control elements and control methodology - electronic control of automatic transmission: introduction - control of gear shift and torque converter lockup - electric power steering - electronic clutch.

Unit 3

Engine management systems: Combined ignition and fuel management systems - exhaust emission control - digital control techniques - complete vehicle control systems - artificial intelligence and engine management – use of microprocessor in automotives. Lighting and security systems: vehicles lighting circuits - signaling circuit - central locking and electric windows security systems - airbags and seat belt tensioners - miscellaneous safety and comfort systems.

TEXTBOOK:

Denton, T., 'Automobile Electrical and Electronic Systems', Edward Arnold Publications., 1995.

REFERENCES:

1. *Knowles, D., 'Automotive Electronic and Computer controlled Ignition Systems', Don, Prentice Hall, Englewood Cliffs, New Jersey 1988.*
2. *William, T.M., 'Automotive Electronic Systems', Heiemann Ltd., London, 1978.*
3. *Ronald, K .J., 'Automotive Electronics Handbook', McGraw Hill, Inc, 1999.*

MEC376 FUNDAMENTALS OF NUCLEAR ENGINEERING 3 0 0 3

Unit 1

Principles of nuclear energy: Introduction - atomic structure - energy from nuclear reactions - nuclear fission and fusion – radioactivity - decay rates and half lives - neutron flux - reaction rates.

Neutron diffusion theory: Diffusion equation - solution of diffusion equation – thermal diffusion length – diffusion in multiplying systems - slowing down of neutrons - neutron transport equation and its approximation.

Unit 2

Components of nuclear reactors: Nuclear fuel rod – coolant - control rod – moderator - cladding – reflectors - shielding materials - reprocessing of spent fuels - nuclear waste treatment systems.

Power reactor systems: Pressurised water reactors - boiling water reactors - gas cooled and high temperature gas cooled reactors - pressurised heavy water reactors - fast breeder reactors - LMFBR & GCFBR

Unit 3

Fuel management and reactor safety: fuel burnup - core management - control management - conversion ratio - breeding ratio - doubling time - biological effects of radiation – radiation hazards - nuclear reactor safety.

TEXTBOOKS:

1. *Wakil, M. M., 'Power plant technology', Mc Graw,1984.*
2. *Glarstone, S., 'Principles of Nuclear reactor Engineering', D Van Nostrand, 1982.*

REFERENCE:

Stephenson, R., 'Introduction to Nuclear Engineering', McGraw-Hill, 1982.

MEC377 POWER PLANT ENGINEERING 3 0 0 3

Unit 1

Hydrological data - capacity and type - selection - general layout and types of hydro electric power plants.

General layout of diesel power plant and their components - types of plant layouts

- comparison of diesel plant with thermal plant.

Comparison and types of gas turbine power plants and their components, combined gas and steam power plants - advantages of gas turbine plant over diesel and thermal plants.

Unit 2

General components of nuclear reactors - types of reactors - location safety and economics of nuclear plants - comparison with thermal power plants.

Steam power plant layout and components - modern steam generators - types - functions of super heater - reheater - economizer and air heater.

Unit 3

Fuels and combustion - fuel preparation and burning, grates, burners draft, combustion calculations, boiler trial, fuel handling systems, ash handling methods, gas cleaning methods and dust collection.

Types of condensers - cooling towers - water treatment methods.

Economics of power plant operation - instrumentation and control - variable load operation and economics.

TEXTBOOK:

Nagpal, G.R, Power Plant Engineering, Khanna Publishers, 41998.

REFERENCES:

1. *Morse F.T, Power Plant Engineering,* ***D. Van Nostrand company, inc, 1989.***
2. *Joel Weisman and Roy Eckart, " Modern Power Plant Engineering ", Prentice hall, 2002*

MEC390 THERMAL ENGINEERING AND fLUID MECHANICS LAB. 0 1 3 2

a) THERMAL ENGINEERING LAB.

I.C. Engines Lab.

1. Study of I.C. engines, components and loading devices
2. Valve timing and port timing diagrams.
3. Performance test on 4-stroke diesel engine.
4. Heat balance test on 4-stroke diesel engine.
5. Morse test on multi cylinder petrol engine.
6. Retardation test to find frictional power of a diesel engine.

Steam Lab.

- Study of steam generators and turbines.
- Performance and energy balance test on a steam generator.
- Performance and energy balance test on steam turbine.

b) FLUID MECHANICS LAB.

Flow experiments: Calibration of orifice meter, venturimeter, V and rectangular notch, pipe friction.

Verification of Bernoulli's theorem, Reynolds number, metacentric height.

MEC391 MANUFACTURING PROCESS LABORATORY II 0 1 3 2

a) Study of special machines

Exercises on milling machines – plain & gang milling operations - shaping and planing operations - gear milling & gear hobbing - grinding machines: surface, cylindrical grinding operations.

Measurement of cutting force in drilling operation – measurement of shear plane angle: turning and shaping operation.

b) Modeling & simulation lab.: Modeling and simulation exercises using discrete & continuous simulation software packages (Arena & Matlab).

MEC392 HEAT TRANSFER AND DYNAMICS LAB. 0 1 3 2

a) Heat Transfer Lab.

Heat transfer studies in a pin fin apparatus, parallel flow & counter flow heat exchanger, determination of Stefan Boltzmann constant - heat transfer coefficient in natural convection - heat transfer coefficient in forced convection.

b) Dynamics Lab.

Measurements

Measurement of shaft speed, force, torque, pressure, strain, temperature, velocity, displacement, frequency, amplitude, acceleration, noise.

Kinematics

Study of Kinematics of four bar mechanisms - slider crank, crank rocker mechanism. Kinematics of universal joints: Kinematics of gears - spur, helical, bevel, worm. Kinematics of gear trains - simple, compound, epicyclic, differential.

Dynamics

Static and dynamic balancing. Balancing of wheels. Gyroscope. Cam analysis. Moment of inertia of connecting rod. Radius of gyration of compound pendulum. Bifilar suspension. Torsinal vibration. Equivalent spring mass system. Longitudinal vibration. Critical speed of shaft.

MEC393 FLUID POWER AND FLUID MACHINERY LAB. 0 1 3 2

a) FLUID POWER LAB

1. Familiarizing of elements of pneumatic and hydraulic systems.
2. Familiarizing of Automation studio – pneumatic/hydraulic circuit design and simulation software.
3. Speed control circuits in a pneumatic trainer.
4. Single and double acting cylinder circuits using different direction control valves.
5. Sequencing of pneumatic circuits.
6. Electro-pneumatic circuits.
7. Logic circuits - pneumatic and Electro-pneumatic.

8. Electro-pneumatic sequencing circuits.
9. Study of PLC.
10. PLC based Electro-pneumatic sequencing circuits.

The circuits to be simulated using Automation studio and then assembled to check the correctness of the circuit.

b) FLUID MACHINERY LAB

Performance test on centrifugal pump, reciprocating pump, jet pump, submersible pump, gear pump

Performance test on Francis turbine, Pelton wheel.

MEC400 INSTRUMENTATION AND CONTROL SYSTEMS 3 0 0 3

Unit 1

Introduction - generalized measurement systems - need for measurement - history of standards, base and derived units SI unit rules – static and dynamic. Characteristics of instruments - error analysis. Signal representation – signal conditioners, amplifiers - transistor based amplifier - operational amplifier, adder, subtractor, differentiator, integration amp. Diff. charge amplifier, modulator, demodulator, Wheatstone bridge, use of bridge circuits - filters, ADC, DAC.

Displacement measurement - potentiometer - LVDT, Piezo electric type - Syncropair resolver - micro syn - linear syn - nozzle flapper - LASER interferometer - Fotonic sensor - infra red sensor – encoder (digital transducer) - speed measurement.

Nature of vibration, quantities involved, seismic transducer - different types of accelerometers, mountings.

Unit 2

Strain measurement types, mechanical strain gauge optical and acoustical SG - electrical strain gauge, selection of strain gauge.

Temperature measurement - bimetallic thermometer - platinum resistance thermometers – thermocouples – pyrometers - pressure fundamentals, manometers - elastic transducers, Mcleod gauges - thermal conductivity gauges, dead weight tester, flow measurement - ultrasonic flow meter - turbine type meters - hot wire anemometers.

Unit 3

Classification of control systems, block diagram representation and reductions, mathematical background and mathematical model of physical systems. Time domain analysis - unit step response and time domain specifications - effects of adding poles and zeros to transfer functions - transient response and stability.

Frequency response methods - polar plot - Bode diagrams, Nyquist stability criteria and stability margins - the Bode plots - stability margins on the Bode plot - relative stability. Elements of proportional – integral - derivative (PID) control.

TEXTBOOKS:

1. *Kumar, D. S., 'Mechanical Measurements and Control', 4e, Metropolitan Publishers, New Delhi, 2006.*
2. *Ghosh, A. K., 'Introduction to Measurements and Instrumentation', 3e, PHI learning, 2009.*

REFERENCES:

1. *Padmanabhan, T.R., 'Industrial Instrumentation', Springer-Verlag, 2000*
2. *Doebelin, E.O., 'Measurement Systems', McGraw-Hill, 1990.*
3. *Figliola, R.S., and Beasley, D.E., 'Theory and Design for Mechanical Measurements', 3e, John Willey 2005.*

MEC401 OPERATIONS RESEARCH 3 0 0 3

Unit 1

Linear programming: Formulations - graphical solutions - simplex method - duality, dual simplex method.

Transportation model: Assignment model – travelling salesman problem.

Dynamic programming: concepts, Bellman's principle – solutions to simple problems.

Unit 2

Decision theory: Decision trees. Game theory - 2 person zero sum; mixed strategies; 2 x n and m x 2 games.

Network models - project networks - CPM/PERT - project scheduling – crashing networks and cost considerations - resource leveling and smoothing - shortest route problem, minimal spanning tree problem, maximal flow problem.

Unit 3

Sequencing model – 2 machines 'n' jobs, 'm' machines 'n' jobs – n jobs 2 machines. Inventory models: deterministic & probabilistic models. Quantity discounts. Selective inventory management.

Queuing models: Poisson arrival and exponential service times. Single server, multi-server. Queues - infinite and finite capacity queues.

Simulation – Monte Carlo simulation: simple problems.

TEXTBOOK:

Taha, H.A., 'Operations Research: an Introduction', 8e, Prentice Hall, New Delhi, 2008.

REFERENCES:

1. *Hillier, F .S. and Lieberman, G .J, 'Operations Research', 9e, McGraw Hill, 2010.*
2. *Ravindran, A., Phillips, D.J., and Solberg, J.J., 'Operations Research- Principles and Practice', John Wiley & Sons, 2005.*
3. *Wagner, H.M., 'Principles of Operations Research', Prentice Hall, New Delhi, 1998.*
4. *Hardley, G., 'Linear Programming', Narosa Book Distributors Private Ltd 2002.*

MEC402 GAS DYNAMICS AND JET PROPULSION 3 1 0 4

Unit 1

Basic concepts: Energy and momentum equations of compressible fluid flows - stagnation states - Mach waves and Mach cone - effect of Mach number on compressibility. Isentropic flows: isentropic flow through variable area ducts.

Isentropic flow: Nozzle and diffusers, compressors and turbines - use of gas tables. Flow through ducts: flow through constant area ducts with heat transfer (Rayleigh flow) and friction (Fanno flow) - variation of flow properties - use of tables and charts - generalized gas dynamics.

Unit 2

Normal and oblique shocks: Governing equations - variation of flow parameters across the normal and oblique shocks - Prandtl Meyer relations – expansion of supersonic flow, use of table and charts - applications.

Unit 3

Jet propulsion: theory of jet propulsion - thrust equation - thrust power and propulsive efficiency - operation principle - cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo-prop engines – aircraft combustors.

Space propulsion: types of rocket engines - propellants - ignition and combustion - theory of rocket propulsion – performance study - staging - terminal and characteristic velocity - applications - space flights.

TEXTBOOKS:

1. *John D. Anderson Jr., 'Modern Compressible Flow with historical perspective', 2 edition , McGraw Hill Publishing company-International Edition ,1990.*
2. *Yahya, S.M., 'Compressible Flow', Tata Mcgraw Hill India, 2009.*

REFERENCES:

1. *Balachandran P., 'Fundamentals of Compressible fluid dynamics', PHI Learning India Private Ltd.,2009.*
2. *Cohen, H., Rogers, G.E., and Saravanamuttoo, 'Gas Turbine Theory', Longman, 1980.*
3. *Sutton, G.P., 'Rocket Propulsion Elements', John Wiley, New York, 1986.*
4. *Shapiro, A.H., 'Dynamics and Thermodynamics of Compressible Fluid Flow Vol. I', John Wiley, New York, 1953.*
5. *Radhakrishnan, E., 'Gas dynamics', Prentice-Hall of India Pvt. Ltd, 2004.*

MEC450 METAL FORMING TECHNOLOGY 3 0 0 3

Unit 1

Fundamentals of metal forming: Theory of plasticity - stress tensor – invariants of stress strain - hydrostatic & deviator components of stress – flow curve – true

stress and true strain. Yielding criteria – yield locus – octahedral shear stress and shear strains. Plastic deformations of crystals - critical resolved shear stress. Metal working: mechanics of metal working – working temperature - strain rate effects – friction and lubrication – deformation zone geometry.

Unit 2

Forging and rolling processes: Forging process – classification – equipment – calculation of forging loads – forging defects – residual stresses. Rolling: classification - rolling mills - rolling of bars & shapes – rolling forces – analysis of rolling – defects in rolling - theories of hot & cold rolling – torque power estimation. Extrusion and drawing processes: Extrusion: classification - equipment – analysis of extrusion process - extrusion defects – hydrostatic extrusion – tube extrusion. Drawing: Classification - rod & wire drawing equipment – analysis. Deep drawing – tube drawing – analysis, residual stresses.

Unit 3

Sheet metal forming processes: methods – shearing and blanking – bending – stretch forming – deep drawing – forming limit criteria – defects.

Special forming methods: Stretch forming – press brake forming – explosive forming – electro hydraulic forming – magnetic pulse forming – super plastic forming – electro forming – fine blanking - isothermal forging – HERF.

TEXTBOOK:

Dieter, G. E., 'Mechanical Metallurgy', Tata McGraw-Hill Publishing Company Ltd., 1994.

REFERENCES:

1. *Altan, T., Oh, S.I., and Gegei, H. L., 'Metal Forming Fundamentals and appilications', ASM, USA 1983.*
2. *Hosford, W. F. and Caddel, R. M., 'Metal forming- Mechanics & Metallurgy', Prentice Hall Publishing Co., 1990.*
3. *SME, 'Tool and Manufacturing Engineers Hand Book', Vol2, McGraw Hill NY 1984.*

MEC451 COMPOSITE MATERIALS AND PROCESSING 3 0 0 3

Unit 1

Types of reinforcements, their mechanical properties and functions - ceramics, glass, carbon, boron. silicon carbide, metal, aramid. Forms of reinforcements - particulate, fibre, filaments, whiskers, flakes. Pre-fabricated forms - preforms, prepegs, fabrics, honeycomb.

Type of matrix, its mechanical properties and functions - polymers (thermosets and thermoplastics), metals, ceramics, glass and carbon. Basic principles in the design of composites and selection of matrix and reinforcement. Bonding mechanisms.

Unit 2

Anisotropic behaviour and relationship between structure - mechanical properties.

Mechanical testing - tensile, compressive, intra-laminar shear, inter-laminar shear and fracture.

Polymer matrix composites: Types of thermoset and thermoplastic resins. Principles in the selection of matrix and the reinforcements. Process selection criteria. Mould and tool making. Basic manufacturing steps - impregnation, lay-up, consolidation and solidification.

Unit 3

Manufacturing processes for polymer composites - lay-up, compression moulding, extrusion, injection moulding, sheet forming, pultrusion, hot press & autoclave techniques and filament winding. Applications - industrial, automotive and aerospace. Metal and ceramic matrix composites - wettability of reinforcement to matrix and bonding, methods of manufacturing reinforcements with intermediate wetting layer. Manufacturing processes for metal matrix composites: casting methods - gravity & low pressure die, investment, squeeze, spray forming, compression moulding and thixo-moulding. Manufacturing processes for ceramic matrix composites: reaction sintering, electro-deposition, spray forming, infiltration. Applications - industrial, automotive and aerospace.

TEXTBOOKS:

1. *Clyne, T.W. and Withers, P.J., 'An Introduction to Metal Matrix Composites', Cambridge Univ. Press 1993.*
2. *Matthews, F.L., and Rawlings, R.D., 'Composite Materials: Engineering and Science', Chapman & Hall, London 1994.*

REFERENCES:

1. *Suresh, S., Martensen, A., and Needleman, A., 'Fundamentals of Metal Matrix Composites', Butterworth, Heinemann, 1993.*
3. *Mallick, P. K., 'Fiber-reinforced Composites: Materials, Manufacturing and Design', Marcel Dekker, 1993.*
4. Mazumdar, S.K., 'Composites Manufacturing-Materials, Product, & Process Engineering', CRC Press, 2002.

MEC452 MODERN PRACTICES IN PRODUCT DESIGN AND MANUFACTURE 3 0 0 3

Unit 1

Creativity & innovation: Aesthetics – industrial design concepts – capturing customer voice – new product development – QFD.

Computer Aided Design (CAD): the design process - product cycle - sequential and simultaneous engineering, computer aided engineering, geometric modeling, parametric design. Design for manufacturability and assembly, features of CAD packages – assembly of parts – tolerance analysis – mass property calculations - data exchange formats – selection of alterative materials for engineering design.

Unit 2

Computer Aided Manufacturing (CAM): CNC technology - functions of CNC control in machine tools - classification of CNC systems - contouring system - interpolators, open loop and closed loop CNC systems - CNC controllers, hardware features - Direct Numerical Control (DNC Systems) - numerical control codes – standards - manual programming - canned cycles and subroutines - computer assisted programming – CAD/CAM approach to NC part programming. APT language - machining from 3D models - virtual manufacturing, NC verification.

Unit 3

Reverse Engineering & Rapid Prototyping (RP): Conventional vs Reverse Engineering process, Basic phases, cloud point generation - related hardware and software. Rapid product development - RP data formats and information workflow, characteristics of generative manufacturing processes, industrial rapid prototyping system - technical characteristics and technological capabilities of RP systems. Concept modellers. RP process optimization. Direct and indirect tooling. Application of RP and RT in industrial product development - medical models - engineering analysis models - art and architecture models, scope for research.

Recent advances in product development methods and strategies: Concurrent engineering - total approach to product development – collaborative design - product data management – PLM – CPC – understanding of various software application packages available in the market for various phases of the product life cycle – design for environment – product costing - design for Six sigma - design FMEA.

TEXTBOOKS:

1. *Zeid, I., 'CAD-CAM Theory and Practices', Tata McGraw-Hill, 2005.*
2. *Groover. M. and Zimmers, 'CAD-CAM, Computer Aided Design and Manufacturing', Prentice Hall of India, New Delhi, 1997.*

REFERENCES:

1. *Gebhardt, A., 'Rapid Prototyping', Hanser Publishers, Munich 2003.*
2. *Lii, L., Fuh, J.Y.H., and Wong, Y.S., 'Laser Induced materials and processes for Rapid Prototyping', Kluwer Academic Publishers, 2001.*

MEC453 NON-DESTRUCTIVE TESTING 3 0 0 3

Unit 1

Introduction: Non-destructive testing - relative merits and limitations - NDT vs mechanical testing. Dry technique and wet technique – principle – applications - advantages and limitations. Dyes - developers – cleaners. Fluorescent penetrant test. Liquid penetrant inspection.

Radiography: X-rays and gamma rays, properties of X-rays relevant to NDE - absorption of rays - scattering. Types and use of filters – screens - geometric factors, film type and processing. Characteristics of films graininess, density,

speed, contrast. Characteristic curves. Characteristics of gamma rays - fluoroscopy – X-ray – radiography. Safety with X-rays and gamma rays.

Unit 2

Ultrasonic testing: Types of ultrasonic waves - principles of wave propagation - characteristics of ultrasonic waves - attenuation. Production of ultrasonic waves - couplants. Inspection methods - pulse echo, transmission and resonance techniques. Thickness measurement. Types of scanning. Test block - reference blocks.

Unit 3

Techniques for specific purposes: Magnetic particle inspection – principles – applications - magnetization methods - magnetic particles, demagnetization. Eddy current testing - thermal inspection principle, application - instrumentation of thermal inspection. Holography. Acoustic emission. Pressure and leak testing. Chemical spot testing. Spark testing.

TEXTBOOKS:

1. *Cartz, L., 'Non-Destructive testing', ASM International, Metals Park Ohio, US, 1995.*
2. *Raj, B., Jayakumar, T., and Thavasimuthu, M., 'Practical Non-Destructive testing', Narosa, New Delhi, 1997.*

REFERENCE:

ASM Metals Hand Book, 'Non-Destructive Evaluation and Quality Control', American Society of Metals, Metals Park Ohio, USA, 1989.

MEC454 INDUSTRIAL ROBOTICS 3 0 0 3

Unit 1

Evolution of robotics. Robot anatomy - design and control issues. Manipulation and control - sensors and vision

Coordinate frames. Mapping: mapping between rotated frames - mapping between translated frames - mapping between rotated and translated frames - description of objects in space - transformation of vectors – rotation - translation combined with rotation - translation of vectors - composite transformation - inverting a homogenous transform - fundamental rotational matrices.

Unit 2

Direct kinematic model – mechanical structure and notations - description of links and joints - kinematic modeling of manipulator - Denavit-Hartenberg notation - kinematic relationship between adjacent links - manipulator transformation matrix. Inverse kinematic model – manipulator workspace – solvability - solution techniques - closed form solution.

Unit 3

Imaging components - image representation - picture coding - object recognition and categorization - visual inspection. Robot cell - design and control layouts. Industrial applications – material handling, process, assembly, inspection. Non-industrial applications.

TEXTBOOKS:

1. *Mittal, R. K. and Nagrath, I. J., 'Robotics and Control', Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.*
2. *Craig, J., 'Introduction to Robotics: Mechanics and Control', 2e, Addison-Wesley, Reading, MA, 1989 .*

REFERENCE:

Fu, K. S., Gonzalez, R. C., and Lee, C. S. G., 'Robotics: Control, Sensing, Vision, and Intelligence', McGraw-Hill, New York, NY, 1987.

MEC455 ADVANCED CASTING TECHNOLOGY 3 0 0 3

Unit 1

Melt processing techniques for ferrous and non-ferrous alloys such as stainless steels, nickel, titanium alloys. Vacuum melting equipment and practice.

Elementary aspects of pattern and mould design using CAD softwares. Resin-bonded mould and core making processes and machines. Special casting processes and their applications - low pressure die casting, investment casting, squeeze casting, thixo-forming. Illustrations of automotive and aerospace applications.

Unit 2

Gating and riser design - principles of fluid flow, governing equations, heat tranfer applied to casting solidification, governing equations, boundary conditions for different casting methods, concept of directional solidification, gating and risers, application of simulation methods. Use of casting software in solving practical problems.

Unit 3

Casting defects and remedies. Inspection methods - visual, penetrant, magnetic, metallurgical, X-ray and Gamma ray radiography and. Mechanization and automation.

TEXTBOOK:

Jain, P. L., 'Principles of Foundry Technology' 3e, Tata McGraw Hill, New Delhi, 1993.

REFERENCE BOOKS:

1. *Heine, R. W., Loper, C. R., and Rosenthal, P. C., 'Principles of Metal Castings', 2e, Tata McGraw Hill, New Delhi, 1997.*
2. *Beeley, P.R., 'Foundry Technology', Butterworth scientific, London, 2001.*

MEC456 MICRO-MANUFACTURING 3 0 0 3

Unit 1

Micromachining – definition - principle of mechanical micromachining - classification of micromachining and nanofinishing processes - molecular dynamics simulations of machining at atomic scale.

Diamond Turn Machining (DTM) - components of DTM – requirements of DTM - material removal mechanism – molecular dynamics - tool geometry. Abrasive jet micromachining - erosion mechanism - powder feeding - microstructure fabrication. Ultrasonic micromachining – basic elements - mechanism of material removal - micro-hole drilling, contour machining, micro-de-burring, machining of ceramic materials. Electrochemical micromachining.

Unit 2

Micro-electric discharge micromachining – principle - Micro EDM system development - process parameters - analytical modeling. Laser micromachining techniques and their applications. Focused ion beam machining. Electro chemical spark micromachining – mechanism - equipment. Electron beam micromachining – mechanism - process parameters - applications.

Unit 3

Microfabrication - materials for microsystems manufacture - substrates and wafers, active substrate materials, silicon and silicon components. Photolithography based micro fabrication processes - photo resist development. Additive and subtractive techniques – CVD – PVD – etching - chemical, plasma - resists removal. Large aspect ratio micro manufacturing - LIGA, Deep Reactive Ion Etching.

Micro metrology **- s**canning electron microscopy, optical microscopy, atomic force microscope, molecular measuring machine, micro-CMM, transmission electron microscope – principles - applications.

TEXTBOOKS:

1. *Madou, M. J., 'Fundamentals of Microfabrication', 2e, CRC Press, 2002.*
2. *Jain, V.K., 'Introduction to Micromachining', Narosa Publishing House, 2010.*

REFERENCES:

1. *Ran Hsu, T-R., 'MEMS & Microsystems: Design and Manufacturing', Tata McGraw- Hill, 2002.*
2. *Mohamed Gad-el-Hak, 'The MEMS Handbook', CRC Press, 2002.*

MEC457 ADVANCED WELDING TECHNOLOGY 3 0 0 3

Unit 1

Overview of welding processes and their classification, types of joints, edge preparation, weld symbols, weld nomenclature, bead geometry, power density,

heat sources - Gaussian distribution of heat flux, welding techniques - linear and orbital. Arc characteristics. Voltage-current characteristics. Types of welding manipulators and their applications.
Advanced welding processes: submerged arc, TIG, MIG, electro-slag, ultrasonic, electron beam and laser beam welding. Case studies and applications - industrial, automotive and aerospace.

Unit 2
Thermal modeling and simulation of welding processes - governing heat transfer equations and boundary conditions for various types of welding processes. Estimation of cooling rates. Prediction of mechanical properties, micro/macro-structures of weldments and heat-affected zone. Prediction of weld defects such a crack, segregation, lack of fusion. Modeling and simulation of pulsed arc processes. Use of softwares for simulation.
Solidification behaviour of fusion weld: structural zones, epitaxial growth, weld pool shape and columnar grain structures. Weldability of metals - steels, stainless steels, aluminium, copper, nickel and titanium alloys.

Unit 2
Microstructures of weldment. Segregation of alloying elements. Impact of micro/ macro-structures and segregation on mechanical properties. Pre- and post- treatment. Effects of heat flow on residual stresses and distortion. Weldability tests.
Welding defects - causes and remedies. Methods of testing weldments - mechanical, pressure and leak testing. Inspection methods - visual, penetrant, magnetic, ultrasonic, x-ray and gamma radiography. Use of imaging techniques for online monitoring.

TEXTBOOKS:

1. *Khanna, O. P., 'A Text Book on Welding Technology', Dhanpat Rai and Sons, New Delhi, 1990.*
2. *Parmar, R. S., 'Welding Process and Technology', Khanna Publishers, Delhi, 1992.*

REFERENCES:

1. *Little, R. L., 'Welding and Welding Technology', Tata McGraw-Hill Publishing Company Limited, New Delhi, 1989.*
2. *Grong, O, 'Metallurgical Modelling of Welding', 2e, The Institute of Materials, 1997.*
3. *Kou, S., 'Welding Metallurgy', 2e, John Wiley Publications, New York, 2003.*

MEC458 ADVANCED MANUFACTURING PROCESSES 3 0 0 3

Unit 1
Nontraditional manufacturing processes - chemical machining – electro chemical machining - ultrasonic machining - physical setup, metal removal rate, process parameters, process capabilities and applications.

Nontraditional manufacturing processes - electrical discharge machining - wire EDM - abrasive flow machining - physical setup, metal removal rate, process parameters, process capabilities and applications.

Unit 2
High-speed machining: high performance machining of components. Application of HSM, improved material removal rate, surface finish and integrity, accuracy, economic considerations.

Unit 3
Modern grinding technologies, high speed and high performance grinding. Hard machining using single point tools.
Laser applications in manufacture: Cutting, welding, surface treatment, automation and in-process sensing.

TEXTBOOK:

Kalpakjian, S. and Schmid, S., 'Manufacturing Processes for Engineering Materials', 4e,Prentice Hall,2003.

REFERENCE BOOKS:

1. *Benedict, G. F., 'Non-Traditional Manufacturing Processes', Marcell Dekker Inc., NY, 1987.*
2. *Krar, S.F. and Gill, A., 'Exploring advanced manufacturing technologies', Industrial Press, 2003.*

MEC459 ADVANCED MATERIALS AND PROCESSES 3 0 0 3

Unit 1
Composite materials: types of metal matrices and reinforcements and their properties, bonding mechanisms, structure-property relationships, preforms, design of composites. Physical and mechanical properties. Characterization of microstructures and macrostructures. Fabrication techniques - metal infiltration, pressure and vacuum casting methods. Case studies.

Unit 2
Aerospace alloys: High strength aluminium and magnesium alloys, nickel and cobalt based superalloys, titanium alloys, their structures, structure-property relationships, heat treatment. Directional solidification and single crystal turbine blades. Case studies.

Unit 3
Smart materials: concept of shape memory, crystal structure, phase transformation mechanism and characteristics, properties, classification, applications.
Nanomaterials: properties, classification, characterization, materials behaviour, fabrication and applications.

TEXTBOOKS:

1. *Clyne, T. W. and Withers, P. J., 'An Introduction to Metal Matrix Composites', Cambridge Univ. Press 1993.*
2. *Duerig, T. W, Melton, K.N., Stöckel, D., and Wayman, C. M, 'Engineering Aspects of Shape Memory alloys' Butterworth Heinemann, 1990.*

REFERENCES:

1. *'Handbook of Nanostructured Materials and Nanotechnology', Academic Press, 2000.*
2. *Wang, Z.I., Liu, Y., Zhang, Z., 'Handbook of Nanophase and Nanostructured Materials Vol 1. Synthesis', Kluwer Academic/Plenum Publishers. 2002.*
3. *Sinha, A. K., 'Physical Metallurgy Handbook', McGraw-Hill, 2002.*

MEC460 ADVANCED METROLOGY AND SENSING SYSTEMS 3 0 0 3

Unit 1

Computer aided inspection: High precision measurements – interfacing - software metrology - automated visual inspection in manufacturing, contact and non-contact type inspection methods, electrical field techniques, radiation techniques, ultrasonic - Atomic Force Microscopes (AFM), Talysurf instruments.

Laser metrology: Laser interferometer, alignment telescope, laser scanners. On-line and in-process measurements - diameter, surface roughness, micro holes, surface topography measurements, straightness and flatness measurement, speckle measurements.

Unit 2

Coordinate Measuring Machine: CMM types, applications - non-contact CMM using electro optical sensors for dimensional metrology - non-contact sensors for surface finish measurements - measurements/programming with CNC CMM – performance evaluations – measurement integration. Machine vision: image acquisition and processing - binary and gray level images, image segmentation and labelling, representation and interpretation of colours.

Unit 3

Edge detection techniques, normalization, grey scale correlation – reflectance map concepts; surface roughness and texture characterization - photogrammetry. Application of machine vision in inspection - measurement of length, diameters, surface roughness - automated visual inspection - 3D and dynamic feature extraction. On-line quality control: on-line feedback quality control variable characteristics - control with measurement interval, one unit, and multiple units control systems for lot and batch production.

TEXTBOOKS/ REFERENCES:

1. *Marshall, A. D. and Martin, R. R., "Computer Vision, Models and Inspection", World Scientific, 1992.*
2. *Nello Zuech, "Understanding and Applying Machine Vision", Second Edition, Marcel Dekker, 2000.*

3. *John A. Bosch, Giddings, and Lewis Dayton, "Coordinate Measuring Machines and Systems", Marcel Dekker, 1999.*
4. *ASTE, "Handbook on Industrial Metrology", Prentice Hall, 1992.*

MEC461 QUALITY CONTROL AND RELIABILITY ENGINEERING 3 0 0 3

Unit 1

Introduction: Review of statistics and probability. Quality related costs, contemporary quality engineering philosophy, quality systems and international standards and 6 sigma. Control charts for variables: X-bar and R charts, X-bar and S charts; control charts for individual measurements; exponentially Weighted Moving Average (EWMA) and Deviation (EWMD) charts.

Unit 2

Control charts for attributes: p, np, c, and u charts Interpretation of control charts. Average Run Length (ARL) study. Multivariate quality control. Control charts for short production runs, modified acceptance control charts. Sensitivity analysis - process capability analysis.

Introduction to reliability: concepts and definition of reliability – reliability mathematics – failure distributions.

Unit 3

Hazard models – hazard rate function – failure density function – conditional reliability – exponential, Rayleigh, Weibull, Normal and Lognormal distributions – two-parameter exponential and three-parameter Weibull distributions – MTTF, MTBF – design life.

Reliability of simple Systems – series and parallel configurations – reliability improvement – redundancy – combined series and parallel systems – high level and low level redundancy – k-out of n system – standby redundancy.

Maintainability – factors affecting maintainability of systems – design for maintainability - MTTR – maintenance – spare provisioning.

TEXTBOOKS:

1. *Montgomery, D.C., 'Introduction to Statistical Quality Control', John Wiley, 2004.*
2. *Ebeling, C., 'An introduction to reliability and maintainability Engineering', Tata McGraw Hill publishing Company Ltd., 2004.*

REFERENCES:

1. *Eugene, G.L., 'Statistical Quality Control', McGraw-Hill, 1996.*
2. *Srinath, L. S., 'Concept in reliability with an introduction to maintainability and availability', Associated East-West, 1998.*
3. *Lewis, E.E., 'Introduction to reliability Engineering', John Wiley & sons, 1987.*
4. *Rao, S. S., 'Reliability based Design', McGraw Hill, 1992.*

5. *Barlow, R.E., Proselan, R.E., and Hunter, L. C., 'Mathematical Theory of Reliability', John Wiley, New York, 1965.*
6. *Halpern, S., 'The Assurance services, an Introduction to Reality control and Reliability' Prentice Hall, New Jersey, 1977.*
7. *O'cconer, P.D.T., 'Practical Reliability Engineering', John Wiley & Sons Ltd., 2003*

MEC462 SIMULATION MODELING OF MANUFACTURING SYSTEMS 3 0 0 3

Unit 1

Introduction: Introduction to manufacturing systems – introduction to simulation – applications – system and system environment – types of simulation - simulation procedure – examples of simulation – introduction to simulation softwares.
Probability distributions: review of basic probability and statistics – probability distributions – random number generators – testing of random numbers.

Unit 2

Analysis of simulation input data: data collection – statistical analysis of numerical data – tests for Independence and Identically distributed data - distribution fitting – selecting a distribution in the absence of data – modelling discrete probabilities – demonstration of input modelling using arena simulation package.
Model building of discrete systems: Modelling paradigms - modelling of structural elements and operational elements – modelling issues – model verification and validation.

Unit 3

Applications of simulation in manufacturing – manufacturing modelling techniques – modelling material handling system – model building exercises using arena - case study. Simulation output analysis: design of simulation experiments: determination of warm up period, run length, number of replications - statistical analysis of simulation output – terminating and non-terminating simulations – comparing alternative system designs – variance reduction techniques – simulation optimization.

TEXTBOOKS:

1. *Law, A. W., and Kelton, D. W., 'Simulation Modeling and Analysis', 3e, McGraw Hill, 2000.*
2. *Kelton, D. W., Sadowski, R. P., and Sasowski, D.A., 'Simulation with ARENA', McGraw Hill, 2009.*

REFERENCE BOOKS:

1. *Banks, J., Carson, J. S., Nelson, B.L., and Nicol, D.M., 'Discrete Event System simulation', 3e, Pearson Education, 2001.*
2. *Viswanathan, N. and Narahari, Y., 'Performance Modeling of Automated Manufacturing Systems', Prentice Hall, 1998.*

MEC480 OPERATIONS MANAGEMENT 3 0 0 3

Unit 1

Process management: Process design - process reengineering - job design. Work standards – work measurement - work sampling.
Facility location: Plant location - factors affecting location – globalization. Layout planning – types - designing of process layout and product layout.

Unit 2

Supply chain management: Overview – purchasing and distribution – measures of supply chain performance - supply chain dynamics.
Quality engineering: TQM, Six sigma concepts - lean manufacturing, ISO standards.

Unit 3

Forecasting: Forecasting system - judgment methods, time series methods.
Capacity planning: aggregate planning: Importance – planning process. Material requirements planning - inputs, factors, outputs. Master production scheduling. Scheduling – Gantt charts.

TEXTBOOKS:

1. *Krajewski, L. J. and Ritzman, L. P., 'Operations Management: Strategy and Analysis', Addison – Wesley Pearson Education Asia, 2000.*
2. *Chase, B. R. and Aquilano, N. J., 'Production and operations management', 7e, McGraw-Hill ,2006.*

REFERENCES:

1. *Hopp, W. J. and Spearman, M. L., 'Factory Physics', 2e, McGraw-Hill 2000.*
2. *Buffa, E .S. and Sariss, R .K., 'Modern Production/Operations Management', 8e, John Wiley, 1994 .*

MEC481 TOTAL QUALITY MANAGEMENT 3 0 0 3

Unit 1

Definition of quality - dimensions of quality. Quality planning - quality costs. Total quality management: historical review and principles – leadership - quality council - quality statements - strategic planning - deming philosophy. Barriers to TQM implementation.

Unit 2

Customer satisfaction – customer retention - employee involvement - performance appraisal - continuous process improvement - supplier partnership - performance measures. Seven tools of quality.
Statistical fundamentals - control charts for variables and attributes - process capability - concept of six-sigma - new seven management tools – benchmarking.

Unit 3

Quality function deployment (QFD) - Taguchi quality loss function - Total Productive

Maintenance (TPM) - FMEA.
Need for quality systems - ISO 9000:2000 – elements of quality systems (such as ISO 9000:2000). Implementation of quality system – documentation - quality auditing, QS 9000-ISO 14000.

TEXTBOOK:

Besterfiled, D, H., 'Total Quality Management', Pearson Education Asia, 1999.

REFERENCES:

1. *Evans, J. R, and Lidsay, W. M., 'The Management and Control of Quality', 5e, Southwestern (Thomson Learning), 2002 .*
2. *Feigenbaum, A. V., 'Total Quality Management- vol I&II ', McGraw-Hill, 1991.*

MEC482 FINANCIAL MANAGEMENT 3 0 0 3

Unit 1
Introduction: Financial management an overview – financial decisions in a firm – goal of FM – function of the financial system.
Fundamental valuation concepts: Time value of money – risk and return.

Unit 2
Capital budgeting: techniques of capital budgeting investment criteria – NPV – benefit cost ratio – IRR – payback period – ARR – investment appraisal in practice – estimation of project cost flows.

Unit 3
Working capital management: Current assets – financing ruling – profit criterion. Cash and liquidity management. Working capital financing.
Financial analysis and planning**:** Analyzing financial performance – break – even analysis and Leverages – financial planning and budgeting.
Mergers and takeovers - international trade.

TEXTBOOK:

Chandra, P., 'Financial Management: Theory and Practice', 5e, TMH, 2001.

REFERENCES:

1. *Denzil Watson & Antony Head, 'Corporate Finance- Principles and Practice', 2e, Pearson Education Asia, 2002.*
2. *Terry S. Maness, 'Introduction to Corporate Finance', McGraw Hill Book Company, 1988.*
3. *Eugene F. Brigham & Louis C. Gapenski, 'Financial Management – Theory and Practice', 12e, 2010.*

MEC483 MANAGERIAL STATISTICS 3 0 0 3

Unit 1
Quantitative methods: basic terminology in probability, probability rules, conditions of statistical dependence and independence, Bayes theorem, discrete random variables review of probability distributions, measure of central tendency.
Sampling and sampling distributions: Introduction to sampling, random sampling, design of experiments, introduction to sampling distributions.
Estimation: point estimates, interval estimates and confidence intervals, calculating interval estimates of mean from large samples, using t test, sample size estimation.

Unit 2
Testing hypothesis: Introduction, basic concepts, testing hypothesis, testing when population standard deviation is known and not known, two sample tests.
Chi- square and analysis of variance: introduction, goodness of fit, analysis of variance, inferences about a population variation.

Unit 3
Regression and correlation: Estimation using regression line, correlation analysis, finding multiple regression equation, modelling techniques,
Non parametric methods and time series and forecasting: sign test for paired data, rank sum test, rank correlation, Kolmogrov – smirnov test, variations in time series, trend analysis, cyclic variation, seasonal variation and irregular variation. Decision theory: decisions tree analysis.

TEXTBOOKS:

1. *Levin, R. I. and Rubin, D. S., 'Statistics for management' Pearson education, 5e, 2007.*
2. *Montgomery, D. C. and Runger, G. C., 'Applied Statistics and Probability for Engineers', 3e, John Wiley & Sons. 2002.*

REFERENCES:

1. *Bain .L.J. and Engelhardt, M., 'Introduction to probability and mathematical statistics', Duxbury Press, 2e, March 2000.*
2. *Hinkelmann, K. and Kempthorne, O, 'Design and Analysis of Experiments – Volume I', John Wiley & Sons, Inc., 2e, December 2007.*
3. *Johnson, R. A. and Wichern, D. W., 'Applied Multivariate Statistical Analysis', Prentice-Hall, Inc., 5e, December 2001.*
4. *Myers, R. H., 'Classical and Modern Regression with Applications', PWS-Kent Publishing Company, 2 e, March 2000.*
5. *Devore, J. L., 'Probability and Statistics for Engineering and the Sciences', Brooks/Cole Publishing Company, 5e, December 1999.*
6. *Freund. J. E. and Walpole, R. E., 'Mathematical Statistics', Prentice-Hall Inc., 4e, October 1986.*

MEC484 PROJECT MANAGEMENT 3 0 0 3

Unit 1

Foundations of project management: Project life cycle - project environment - project selection - project proposal - project scope - work breakdown structure.

Network scheduling: Critical path method, program evaluation & review technique - planning and scheduling of activity networks - assumptions in PERT modelling - time-cost trade-offs - linear programming and network flow formulations - PERT/CPM.

Unit 2

Scheduling with limited resources: resource planning - resource allocation - project schedule compression - project scheduling software. Precedence diagrams - decision CPM - generalized activity networks - GERT.

Unit 3

Estimation of project costs: **e**arned value analysis. Monitoring project progress. Project appraisal and selection - recent trends in project management.

TEXTBOOK:

Meredith, Jack, R., and Samuel, J., Mantel Jr., 'Project Management - A Managerial Approach', John Wiley, 1995.

REFERENCES:

1. *Ted, K., 'Project Management, Tools, and Trade-offs', John Wiley, 2004.*
2. *Samuel, J. M. and Meredith, J. R., 'Core Concepts of Project Management', John Wiley, 2001.*

MEC485 SUPPLY CHAIN MANAGEMENT 3 0 0 3

Unit 1

Introduction: introduction to SCM - the complexity and key issues in SCM – location strategy – facility location decisions – single facility and multiple location models. Logistics: logistics network configuration – data collection - model and data validation - solution techniques - network configuration DSS – transport strategy – service choices: single service and inter modal services – vehicle routing and scheduling models – travelling salesman problems – exact and heuristic methods.

Unit 2

Inventory: Inventory management and risk pooling - managing inventory in the SC. Value of information - bullwhip effect - lead time reduction.

Supply chain integration: supply chain integration - distributed strategies - push versus pull systems. Distribution requirements planning – DRP and demand forecasting, DRP and master production scheduling. DRP techniques – time-phased order point – managing variations in DRP – safety stock determination - strategic alliances - third party logistics - distribution integration.

Unit 3

Issues in SCM**:** Procurement and outsourcing strategies – framework of e-procurement. International issues in SCM - regional differences in logistics. Coordinated product and supply chain design - customer value and SCM.

TEXTBOOKS:

1. *Simchi, D. and Levi, 'Designing and Managing the Supply Chain: Concepts, Strategies, and Cases', McGraw Hill, 2002.*
2. *Christopher, M., 'Logistics and Supply Chain Management: Strategies for reducing Cost and Improving Service', PH, 1999.*

REFERENCES:

1. *Ballou, M., 'Business logistics / Supply chain management', Pearson Education, 2003.*
2. *Vollmann, T.E., 'Manufacturing Planning and Control for Supply Chain Management', 5e, McGraw Hill, 2005.*

MEC486 ENGINEERING ECONOMIC ANALYSIS 3 0 0 3

Unit 1

Economics: nature and scope of managerial economics. Economic theory and managerial economics.

Cost concepts: types of costs - cost functions. Cost controls: reduction – tools & areas. Pricing policies - methods. Capital budgeting - cost of capital. Appraising project profitability.

Unit 2

The essentials of demand and supply: The law of demand. Market demand curve. Other determinants of market demand. The law of supply. Determinants of market supply. The market mechanism. Price elasticity of demand.

Profit and revenue maximization: Optimal input combination. Total revenue maximization.

Unit 3

Market structure: Perfect competition and monopoly. Characteristics of monopolistic competition. Oligopoly.

Operations research techniques in managerial economics: inventory models. Theory of games. Decision theory, risk and uncertainty, measuring risk, consumer behavior and risk aversion, decision making under uncertainty with complete ignorance.

TEXTBOOK:

Webster, T. J., 'Managerial Economics - Theory and Practice', Elsevier 2004.

REFERENCE BOOKS:

1. *Panneerselvam, R., 'Engineering Economics' PHI, 2001.*
2. *Varshney, R. L., and Maheshwari, K. L., 'Managerial Economics', 13 e, S. Chand & Sons, 1997 .*
3. *Harrison B, Smith. C., and Davis B. 'Introductory Economics', Macmillan, 1992.*

MEC487 INDUSTRIAL ENGINEERING 3 0 0 3

Unit 1

Work system: elements of work, maintenance of machines, interaction, effect of working conditions and environment, physical and mental fatigue.

Productivity: productivity, factors affecting production, measurement of productivity.

Work study: definition and scope of work study; Areas of application of work study in industry; Human aspects of work study.

Method study: Information collection, recording techniques, and processing aids; critical examination; development, installation and maintenance of improved methods.

Unit 2

Motion economy and analysis: principles of motion economy; motion analysis; Micromotion and Memomotion study; Therbligs and SIMO charts; normal work area and design of work places; basic parameters and principles of work design.

Work measurement: work measurement techniques; calculation of standard time, work sampling and predetermined motion time systems.

Wages and incentive schemes: introduction, wage payment of direct and indirect labour, wage payment plans and incentives, various incentive plans, incentives for indirect labour.

Unit 3

Plant layout: concept of plant layout, types of layout; factors affecting plant layout, work station design, factors considered in designing a work station.

Material handling: introduction and functions of material handling equipment, selection of material handling equipment for different requirements, safety requirements.

Ergonomics: ergonomic design of equipment and work place. Ergonomic design standards - study of development of stress in human body and their consequences. Case studies.

TEXTBOOKS:

1. *Barnes, R, "Motion and Time Study" - Design and Measurement of Work. NY: John Wiley and Sons, 8th Edition, 1985.*
2. *"Introduction to Work Study", 4ed, International Labor Office, Geneva, 1992*

REFERENCE BOOKS:

1. *Khanna O. P., "Industrial Engineering and Management", Dhanpat Rai and sons, 2007.*
2. *Mahajan M., "Industrial Engineering and Production Management" Dhanpat rai and Sons Publishers, 2005.*

MEC488 MARKETING MANAGEMENT 3 0 0 3

Unit 1

Marketing process: definition, marketing process, dynamics, needs, wants and demands, value and satisfaction, marketing concepts, environment, mix. Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy.

Buying behaviour and market segmentation: Major factors influencing buying behaviour, buying decision process, business buying behaviour. Segmenting consumer and business markets, market targeting.

Unit 2

Product pricing and marketing research: objectives, pricing, decisions and pricing methods, pricing management. Introduction, uses, process of marketing research.

Unit 3

Marketing planning and strategy formulation: components of marketing plan - strategy formulations and the marketing process, implementations, portfolio analysis, BCG, GEC grids.

Advertising sales promotion and distribution: characteristics, impact, goals, types, and sales promotions - point of purchase - unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing.

TEXTBOOKS:

1. *Kolter, P., 'Marketing Management', Pearson Education 2001.*
2. *Ramasamy and Namakumari, 'Marketing Environment: Planning, implementation and control the Indian context', 1990.*

REFERENCES:

1. *Paul, G.E. and Tull, D., 'Research for marketing decisions', Prentice Hall of India, 1975.*
2. *Tull, D.S. and Hawkins, 'Marketing Research', Prentice Hall of Inida-1997.*
3. *Kotler, P. and Armstrong, G., 'Principles of Marketing' Prentice Hall of India, 2000.*
4. *Skinner, S.J., 'Marketing', All India Publishers and Distributes Ltd. 1998.*
5. *Govindarajan, M., 'Industrial marketing management', Vikas Publishing Pvt. Ltd, 2003.*

MEC489 LEAN MANUFACTURING 3 0 0 3

Unit 1

Introduction to lean and factory simulation: history of lean and comparison to other methods - the 7 wastes, their causes and the effects - an overview of lean principles/concepts/tools - stockless production.

The tools of lean manufacturing: continuous flow - continuous flow manufacturing and standard work flow - 5S and Pull systems (Kanban and ConWIP systems) - error proofing and set-up reduction – Total Productive Maintenance (TPM) - Kaizen event examples. Toyota production systems, Ford production systems.

Unit 2

Value stream mapping – current state: preparation for building a current state

value stream map - building a current state map (principles, concepts, loops, and methodology) - application to the factory. Simulation scenario.

Unit 3

Value stream mapping – future state: Key issues in building the future state map - process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop - example of completed future state maps - application to factory simulation – implementation of lean practices - best practices in lean manufacturing.

TEXTBOOKS:

1. *Womack, J. P., Jones, D. T., and Roos, D., 'The Machine that Changed the World: the Story of Lean Production', Simon & Schuster, New York, 1996.*
2. *Liker, J. K., 'Becoming Lean', Industrial Engineering and Management Press, 1998.*

REFERENCES:

1. *Womack, J.P. and Jones, D. T., 'Lean thinking', Simon & Schuster, USA, 1996.*
2. *Rother, M. and Shook, J., 'Learning to see', The Lean Enterprise Institute, Brookline, USA, 2003.*

MEC490 ENTERPRISE MANAGEMENT 3 0 0 3

Unit 1

Engineering economics: cost concepts - types of costs - cost functions. Cost controls: reduction – tools & applications. Pricing policies – methods – problems. Process design and improvement – process capacity – process layout – process reengineering – job design. Work standards – work measurement – work sampling – problems.

Unit 2

Supply chain management – basic concepts, SC dynamics, push-pull boundary, integrated supply chain, logistics, customer relationship, supplier relationship – selection, rating and development, procurement, SC metrics and performance measurement - problems. Lean manufacturing – concepts, wastes – tools viz., pull system, standardized work, takt time, kanban system, JIT, kaizen, SMED, 5S, value stream mapping, benefits of lean and implementation issues. Introduction to Six Sigma. Plant location – globalization, factors affecting location decisions, facility location - break-even method, rectilinear, factor-rating and centre of gravity – problems. Plant layout – types, process layout, product layout, systematic layout planning (SLP), line balancing problems. Capacity planning – aggregate planning – importance, planning process, methods – problems.

Unit 3

Role of IT in business performance improvement – e-commerce – e-purchasing – master production schedule, inventory lot sizing strategies, MRP basics – MRP

explosion, Available To Promise(ATP) inventory – MRP calculations – MRP II – scheduling – Gantt chart – introduction to ERP – ERP software – ERP modules – ERP implementation.

TEXTBOOKS:

1. *L. J. Krajewski and L. P. Ritzman, 'Operations Management: Processes and Value chain, PHI Pvt. Limited, 2006.*
2. *R. L. Varshney and K. L. Maheshwari, 'Managerial Economics', S Chand & Sons, 1997(thirteenth edition).*

REFERENCES:

1. *W. J. Hopp and M. L. Spearman, 'Factory Physics', McGraw-Hill 2000 (2nd ed.).*
2. *E. S. Buffa and R. K. Sariss, 'Modern Production/Operations Management', John Wiley, 1994 (eighth ed).*
3. *B. Harrison, C. Smith and B. Davis, 'Introductory Economics', Macmillan, 1992.*

MEC491 CAE / CAM LAB. 0 0 3 1

1. Part modeling with dimensions and constraints.
2. Assembly modelling and creation of bill of materials.
3. Drafting and detailing of assembly and components.
4. Application programming and customization of CAD package.
5. Modeling, meshing and analysis of a simple machine element.
6. Kinematic analysis of simple mechanism.
7. Manual part programming of milled and turned components.
8. Computer aided generation of NC codes using CAM software.
9. Robot programming for pick and place of objects.

MEC492 INSTRUMENTATION CONTROL AND METROLOGY LAB. 0 1 3 2

a) INSTRUMENTATION AND CONTROL LAB

Control system exercises

1. Level control using relay
2. Control using PC: Stepper motor, DC motor, flow, level

Instrumentation exercises

Basic circuit building exercises for given specification:

1. Amplifier using transistor
2. Instrumentation Amplifier using op-amp
3. Power supply
4. Amplifier using transistor

Calibration exercises

1. Dead weight pressure gage tester
2. Dead weight vacuum gage tester

Measurement Experiments

1. Torque
2. Power – using dynamometer
3. Speed - using stroboscope (optical type) and magnetic pickup.
4. Temperature - using thermocouple, RTD and thermistor.
5. Force - using proving ring.
6. Vibration - using Piezo-electric accelerometer.
7. Strain - one arm, two arms and four arms conditions.
8. Digital counter.

b) METROLOGY LAB.

Basics of measurements and measuring instruments.

Calibration of instruments: Micrometer, Vernier Caliper, Dial Indicator.

Linear measurements: Comparison of accuracies of various instruments.

Angle measurements: Sine Bar, Bevel Protractor.

Linear, angle and radius measurements: Profile Projector, Tool Maker's Microscope-

Comparative measurements: Electronic Comparator, Pneumatic Comparator.

Bore measurements: Bore Gauge.

Measurement of internal and external tapers: Standard sphere, Pin-Gear metrology: Gear Tooth Vernier, Disc Micrometer, Gear Roll Tester

Screw thread metrology: Floating Carriage Micrometer - Surface texture measurements

Micro hardness measurement

Measurement of geometric tolerances: Parallelism, Perpendicularity, Angularity, Cylindericity, Circularity, Straightness, Flatness and run-out

MEC497 SEMINAR 0 0 3 1

Each student is to prepare a seminar paper related to Mechanical Engineering in an approved format and present it at the end of the semester. No weekly slot to be allotted for presentation.

MEC499 PROJECT WORK 10 cr

The project shall be focused on the synthesis of the knowledge gained over the past seven semesters, by taking up a work of relevance to the area of specialization covering – design / development / realization / application / conceptual ideas / state-of-the-art technology. A report should be submitted in approved format before final examination.

The student is expected to work on a topic in the field of Mechanical engineering

which could involve theoretical and / or fabrication and / or experimental and or computational work. Evaluation will be done during the course of the project as well as at the end of the semester.

MNG400 PRINCIPLES OF MANAGEMENT 3 0 0 3

Unit 1

HISTORICAL DEVELOPMENT: definition of management – science or art – management and administration – development of management thought – contribution of Taylor and Fayol – functions of management – types of business organisations.

PLANNING: nature & purpose – steps involved in planning – objectives – setting objectives – process of managing by objectives – strategies, policies & planning premises - forecasting – decision-making.

Unit 2

ORGANISING: nature and purpose – formal and informal organization – organization chart – structure and process – departmentation by difference strategies – line and staff authority – benefits and limitations – de-centralization and delegation of authority – staffing – selection process - techniques – HRD – managerial effectiveness.

DIRECTING: scope – human factors – creativity and innovation – harmonizing objectives – leadership – types of leadership motivation – hierarchy of needs – motivation theories – motivational techniques – job enrichment.

Unit 3

Communication: process of communication – barriers and breakdown – effective communication – electronic media in communication.

CONTROLLING: system and process of controlling – requirements for effective control – the budget as control technique – information technology in controlling – use of computers in handling the information – productivity – problems and management – control of overall performance – direct and preventive control – reporting – the global environment – globalization and liberalization – international management and global theory of management.

TEXTBOOKS:

1. *Harold Kooritz & Heinz Weihrich "Essentials of Management", Tata McGraw-Hill, 1998*
2. *Joseph L Massie "Essentials of Management", Prentice Hall of India, (Pearson) Fourth Edition, 2003.*

REFERENCES BOOKS:

1. *Tripathy P C and Reddy P N, "Principles of Management", Tata McGraw-Hill, 1999.*
2. *Decenzo David, Robbin Stephen A, "Personnel and Human Reasons Management", Prentice Hall of India, 1996*

3. *JAF Stomer, Freeman R. E and Daniel R Gilbert, "Management", Pearson Education, Sixth Edition, 2004.*
4. *Fraidoon Mazda, "Engineering Management", Addison Wesley, 2000.*

PHY100 PHYSICS 3 0 0 3

Unit 1

Special theory of relativity: Frames of reference, postulates of special theory of relativity, time dilation, length contraction, relativistic mass, relativistic momentum, mass and energy, Lorentz transformation, velocity addition, Doppler effect.

Physical background for quantum mechanics: Black body radiation, photoelectric effect, Compton effect, X-ray diffraction, pair production, de-Broglie waves, uncertainty principle.

Unit 2

Quantum mechanics: Wave function, wave equation, Schrodinger equation (time dependent), expectation values-operators, eigen functions and eigen values, Schrodinger equation(steady state), particle in a box-finite potential, tunneling effect, quantum theory of hydrogen atom.

Unit 3

Classical and quantum statistics: Statistical distribution, Maxwell Boltzmann's statistics, molecular energies in an ideal gas, quantum statistics, Rayleigh Jean's formula, Planck's radiation law, free electron in a metal, electron energy distribution, specific heat of solids, evolution of stars.

Solid state physics: Crystalline and amorphous solids - ionic crystals - covalent crystals - Van der Walls bond - metallic bond - Band theory of solids - semiconductor devices.

TEXTBOOK:

Arthur Beiser, "Concepts of Modern Physics", Tata Mcgraw Hill, 2003 (6 th edition).

REFERENCES:

1. *T.Thornton and A.Rex, "Modern Physics for Scientists and Engineers", Fort Worth: Saunders, 2000 (2 nd edition).*
2. *P.A.Tipler and R. A. Llewellen, "Modern Physics", New York: Freeman, 1999 (3 rd edition).*
3. *S.H.Patil, "Elements of Modern Physics", Tata Mc Graw Hill, 1989.*
4. *F.K.Richtmyer, H.Kennard, John N.Copper, "Modern Physics", Tata Mc Graw Hill, 1995.*

PHY181 PHYSICS LAB. 0 0 3 1

Experiments on mechanics

1. Torsional pendulum.
2. Co-efficient of viscosity of liquid.

3. Young's modulus - non-uniform bending.

Experiments on optics

1. Determination of lycopodium powder particle size using laser.
2. Dispersive power of prism.
3. Newton's ring.

Experiments on electricity

1. Meter bridge / energy gap.
2. Frequency of AC current.
3. Temperature co-efficient of resistance.

TEXTBOOK:

The manual for experiments prepared by the Department of Physics, AVVP. Experiments will be renewed as an when feasible.

REFERENCE:

D.P.Khandelwal, "A Laboratory Manual of Physics", Vikas Publishing House Pvt LTd., New Delhi,1985.

PHY250 ELECTRICAL ENGINEERING MATERIALS 3 0 0 3

Unit 1

Conducting materials: The nature of chemical bond, crystal structure Ohm's law and the relaxation time, collision time, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.

Semiconducting materials: Classifying materials as semiconductors, chemical bonds in Si and Ge and it's consequences, density of carriers in intrinsic semiconductors, conductivity of intrinsic semiconductors, carrier densities in n type semiconductors, n type semiconductors, Hall effect and carrier density.

Unit 2

Magnetic materials: Classification of magnetic materials, diamagnetism, origin of permanent, magnetic dipoles in matter, paramagnetic spin systems, spontaneous magnetization and Curie Weiss law, ferromagnetic domains and coercive force, anti ferromagnetic materials, ferrites and it's applications.

Unit 3

Dielectric materials: Static dielectric constant, polarization and dielectric constant, internal field in solids and liquids, spontaneous polarization, piezoelectricity.

PN junction: Drift currents and diffusion currents, continuity equation for minority carriers, quantitative treatment of the p-n junction rectifier, the n-p-n transistor.

TEXTBOOK:

A J Decker, "Electrical Engineering materials", PHI, New Delhi, 1957.

REFERENCES:

1. *A J Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, N J 1957.*
2. *C Kittel, "Introduction to solid state Physics", Wieley, New York, 1956 (2 nd edition).*
3. *Allison, Electronic Engineering materials and Devices, Tata Mc Graw Hill*
4. *F K Richtmyer E H Kennard, John N Copper, "Modern Physics", Tata Mc Graw Hill, 1995 (5 th edition).*

PHY251 OPTOELECTRONIC DEVICES 3 0 0 3

Unit 1

Properties of semiconductors: Electron and photon distribution: density of states, effective mass and band structure, effect of temperature and pressure on band gap, recombination processes.

Basics of semiconductor optics: Dual nature of light, band structure of various semiconductors, light absorption and emission, photoluminescence. electro luminescence, radioactive and non-radiative recombination, wave trains.

Unit 2

Semiconductor light-emitting diodes: Structure and types of LEDs and their characteristics, guided waves and optical modes, optical gain, confinement factor, internal and external efficiency, semiconductor heterojunctions, double-heterostructure LEDs.

Semiconductor lasers: Spontaneous and stimulated emission, principles of a laser diode, threshold current, effect of temperature, design of an edge-emitting diode, emission spectrum of a laser diode, quantum wells, quantum-well laser diodes**.**

Unit 3

Semiconductor light modulators: Modulating light (direct modulation of laser diodes, electro-optic modulation, acousto-optic modulation), isolating light (magneto-optic isolators), inducing optical nonlinearity (frequency conversion, switching)

Semiconductor light detectors: I-V characteristics of a p-n diode under illumination, photovoltaic and photoconductive modes, load line, photocells and photodiodes, *p-i-n* photodiodes, responsivity, noise and sensitivity, photodiode materials, electric circuits with photodiodes, solar cells.

REFERENCES:

1. *Semiconductor Optoelectronics: Physics and Technology, Jasprit Singh, McGraw-Hill Companies, ISBN 0070576378*
2. *Optoelectronics, E. Rosencher and B. Vinter, Cambridge Univ. Press, ISBN 052177813.*
3. *Photonic Devices, J. Liu, Cambridge Univ. Press, ISBN 0521551951.*

4. *Semiconductor Optoelectronic Devices 2nd Edition", P. Bhattacharya, Prentice Hall, ISBN 0134956567.*
5. *Physics of Semiconductor Devices, by S.M. Size (2nd Edition, Wiley, New York, 1981).*

PHY252 PHYSICS OF SEMICONDUCTOR DEVICES 3 0 0 3

Unit 1

Introduction: Unit cell, Bravais lattices, crystal systems, crystal planes and Miller indices, symmetry elements. Defects and imperfections – point defects, line defects, surface defects and volume defects.

Electrical conductivity: Classical free electron theory – assumptions, drift velocity, mobility and conductivity, drawbacks. quantum free electron theory – Fermi energy, Fermi factor, carrier concentration. Band theory of solids – origin of energy bands, effective mass, distinction between metals, insulators and semiconductors**.**

Unit 2

Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors, carrier concentration in intrinsic and extrinsic semiconductors, electrical conductivity and conduction mechanism in semiconductors, Fermi level in intrinsic and extrinsic semiconductors and its dependence on temperature and carrier concentration. Carrier generation-recombination, mobility, drift-diffusion current. Hall effect.

Theory of p-n junctions – *diode and transistor*: p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, current, electric field, barrier potential. V-I characteristics, junction capacitance and voltage breakdown**.**

Unit 3

Bipolar junction transistor, p-n-p and n-p-n transistors: principle and modes of operation, current relations. V-I characteristics. Fundamentals of MOSFET, JFET. Heterojunctions – quantum wells.

Semiconducting devices: *Optical devices:* optical absorption in a semiconductor, e^--hole generation. Solar cells – p-n junction, conversion efficiency, heterojunction solar cells. Photo detectors – photo conductors, photodiode, p-i-n diode. Light emitting diode (LED) – generation of light, internal and external quantum efficiency. *Modern semiconducting devices*: CCD - introduction to nano devices, fundamentals of tunneling devices, design considerations, physics of tunneling devices.

TEXTBOOKS:

1. *C Kittel, "Introduction to Solid State Physics", Wiley, 7th Edn., 1995.*
2. *DA Neamen, "Semiconductor Physics and Devices", TMH, 3rd Edn., 2007.*

REFERENCES:

1. *SM Sze, "Physics of Semiconductor Devices", Wiley, 1996.*

2. P Bhattacharya, "Semiconductor Opto- Electronic Devices", Prentice Hall, 1996.
3. MK achuthan & KN Bhat, "Fundamentals of Semiconductor Devices", TMH, 2007.
4. J Allison, "Electronic Engineering Materials and Devices", TMH, 1990.

PHY253 ELECTROMAGNETIC FIELDS AND WAVES 3 0 0 3

Unit 1

Electrostatics: Coulombs law and electric field intensity, field due to a continuous volume charge distribution, field of a line charge, field of sheet of charge, electric flux density, Gauss's law, application of Gauss's law, Maxwell's first equation.

Poisson's and Laplace's equations: The potential field of a point charge, potential field of a system of charges :conservative property, potential gradient, the dipole.

Unit 2

Poisson's and Laplace's equations, uniqueness theorem, examples of the solution of Laplace's equation, solution of Poisson's equation.

Electromagnetics: Biot Savart law, magnetic flux and magnetic flux density, scalar and vector magnetic potentials, derivation of steady magnetic field laws, Faraday's laws, displacement current, Maxwells equations in point and integral form, retarded potentials

Unit 3

Electromagnetic waves: EM wave motion in free space, wave motion in perfect dielectrics, plane wave in lossy dielectrics, Poynting vector and power consideration, skin effect, reflection of uniform plane waves, standing wave ratio. Transmission line equations, line parameters-examples, dipole radiation, retarded potentials, electric dipole radiation.

TEXTBOOK:

William H Hayt , "Engineering Electromagnetics", Tata Mc Graw Hill , New Delhi, 2002 (5th edition).

REFRENCES:

1. *David J Griffiths, "Introduction to Electrodyanamics", Prentice-Hall of India, New Delhi, 1999 (2nd edition).*
2. *J D Jackson, "Classical Electrodynamics", Weiley Eastern, 2004 (2nd edition).*
3. *B.Chakraborty, "Principles of Electrodynamics", Books and Allied Publishers, 2002*

PHY254 MICROELECTRONIC FABRICATION 3 0 0 3

Unit 1

Introduction to semiconductor fabrication – scaling trends of semiconductor devices; crystal structure of semiconductor materials, crystal defects, phase diagrams and

solid solubility; physics of Czochralski growth of single crystal silicon, Bridgeman method for GaAs, float zone process; diffusion science: Ficks laws of diffusion, atomistic models of diffusion, dopant diffusion mechanisms; kinetics of thermal oxidation, Deal-Grove Model, nitridation of silicon, structure and characteristics of oxides, effect of dopants on oxidation kinetics, dopant redistribution;

Unit 2

Physics of ion implantation: Coulombic scattering and projected range, nuclear and electronic stopping, channeling, implantation damage removal, dopant activation by rapid thermal annealing; principles of optical lithography – optics and diffraction, light sources and spatial coherence, physics of pattern transfer, nodulation transfer function; chemistry of lithographic processes: organic and polymeric photoresists, developing and exposure, contrast; principles of non-optical lithography: electron beam, X-ray lithography, resists, sources; etching: Chemistry of wet etching, plasma physics, chemistry of plasma etching and reactive ion etching; chemical mechanical polishing.

Unit 3

Vacuum science: Kinetic theory of gases, gas flow and conductance, vacuum pumps and seals; deposition of thin films: physics of sputtering and evaporation, step coverage and morphology of deposited films, chemical vapor deposition: chemical equilibrium and law of mass action, gas flow and boundary layers, types of CVD, plasma assisted CVD; thermodynamics of epitaxial growth, types molecular beam epitaxy, isolation and contact formation – LOCOS and trench, silicides, metallization with Al and Cu; process Integration: CMOS, bipolar process flow.

TEXTBOOK:

Stephen Campbell, Science and Engineering of Microelectronic Fabrication, Oxford University Press, 2001

REFERENCE:

1. *S K Gandhi, VLSI Fabrication Principles, John Wiley & Sons, 1994*
2. *Gary S May and Simon M Sze, Fundamentals of Semiconductor Fabrication, John Wiley, 2003.*
3. *S Wolfe, Silicon Processing for the VLSI Era, Lattice Press, 1998.*

PHY255 ELECTRONIC MATERIALS SCIENCE 3 0 0 3

Unit 1

Types of bonding in solids, Crystallography and crystalline defects: Crystallography, Directions and planes, Crystalline defects, line defects, Planar defects, Volume defects; Binary and Ternary Phase Diagrams: Lever rule and phase rule, Eutectic, peretectic and Eutectoid systems, Applications of Phase diagrams; Basic Quantum Physics - atomic structure, Use of band theory and occupation statistics to explain existence and basic properties of metals and nonmetals. Working of Semiconductor

Devices using band diagrams and their electrical characteristics: pn junctions, BJT, MOSFET.

Unit 2

Use of band theory to explain optoelectronic properties of materials and optoelectronic devices: LEDs, Solar Cells, Lasers, pin diodes, photodiodes; Magnetic properties and Superconductivity: Magnetic moments and Magnetic Permeability, types of magnetism, saturation magnetization, magnetic domains, soft and hard magnetic materials, superconductivty and its origin, Giant Magneto Resistance, Josephson effect, Energy band diagrams and Magnetism, Applications of magnetic materials- Magnetic recording materials, etc.

Unit 3

Optical Properties of Materials: Reflection, Refraction, Dispersion, Refractive Index, Snells Law, Light Absorption and Emission, Light Scattering, Luminescence, Polarization, Anisotropy, Birefringerence; Dielectric Properties of Materials: Polarization and Permittivity, Mechanisms of polarization, dielectric properties-dielectric constant, dielectric loss, dielectric strength and breakdown, Piezoelectricity, Ferreoelectricity, and Pyroelectricity, Dielectric Materials

TEXTBOOK:

S.O. Kasap, Principles of Electronic Materials and Devices, 2006, 3rd edition, Tata McGraw Hill.

REFERENCE:

D. Jiles: Introduction to the Electronic Properties of Materials, Chapman & Hall. 1994.

PHY260 PHYSICS OF LASERS AND APPLICATIONS 3 0 0 3

Unit 1

Review of some basic concepts and principle of laser.

Introduction to light and its properties: Reflection, refraction, interference, diffraction and polarization. Photometry – calculation of solid angle. Brewster's law. Snell's law and, its analysis.

Introduction to LASERS: Interaction of radiation with matter - induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population inversion – concept and discussion about different techniques. Resonant cavity.

Unit 2

Properties of LASERS

Gain mechanism, threshold condition for PI (derivation), emission broadening - line width, derivation of Dw FWHM · natural emission line width as deduced by quantum mechanics - additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser

and broadening in gases due to isotope shifts. Saturation intensity of laser, condition to attain saturation intensity.

Properties – coherency, intensity, directionality, monochromaticity and focussibility. LASER transition – role of electrons in LASER transition, levels of LASER action: 2 level, 3 level and 4 level laser system.

Unit 3

Types of LASERS

Solid state LASER: (i) Ruby LASER – principle, construction, working and application. (ii) Neodymium (Nd) LASERS. gas LASER: (i) He-Ne LASER - principle, construction, working and application. (i) CO_2 LASER - principle, construction, working and application. Liquid chemical and dye LASERS. Semiconductor LASER: Principle, characteristics, semiconductor diode LASERS, homo-junction and hetero-junction LASERS, high power semi conductor diode LASERS.

Applications in Communication field:

LASER communications: Principle, construction, types, modes of propagation, degradation of signal, analogue communication system, digital transmission, fiber optic communication.

Applications of LASERS in other fields:

Holography: Principle, types, intensity distribution, applications. laser induced fusion. Harmonic generation. LASER spectroscopy. LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

REFERENCES:

1. *William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).*
2. *BB Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.*
3. *Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).*
4. *KR Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.*
5. *T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).*

PHY261 LASERS IN MATERIAL PROCESSING 3 0 0 3

Unit 1

Basic optical theory: Nature of electromagnetic radiation, interaction of radiation with matter, reflection, refraction, polarization, laser fundamentals, laser beam characteristics, beam quality (laser cavity modes),Q-switching, mode locking, continuous wave, types of lasers, energy and power.

Laser interaction with materials: Optical properties of materials, laser interaction with metals, insulators, semiconductors, polymers and biological materials.

Laser surface treatment: Introduction to laser surface hardening, laser surface melting, laser surface alloying, laser surface cladding, laser cleaning. Laser ablation:

mechanisms (photothermal, photophysical and photochemical), mask projection techniques, laser micro and nano structuring.

Unit 2

Laser cutting and drilling: Mechanism for inert gas and oxygen-assisted cutting, factors controlling cut quality and kerf width. Laser assisted drilling.

Laser welding: Introduction to laser keyhole welding and contrast with conduction limited welding, applications,

Direct laser fabrication (DLF): Laser sintering & laser rapid manufacturing, comparison with rapid prototyping. Main potential and limitations of DLF for direct fabrication and for the production of novel engineering materials and structures.

Unit 3

Laser forming: Mechanisms involved, including thermal temperature gradient, buckling, upsetting. Applications in alignment and straightening and in rapid production processes.

Scope of application of laser materials processing: focused on industrial application of laser in materials processing including laser welded tailored blanks.

Laser safety: Introduction to safety procedures in the use of lasers, including wavelength effects and laser safety standards.

REFERENCES:

1. *Steen, WM, Laser Material Processing (3rd Edition), Springer Verlag, 2003, ISBN 1852336986.*
2. *Silvast, WT, Laser Fundamentals, Cambridge University Press, 1998, ISBN 0521556171.*
3. *J. F. Ready, D.F. Farson. LIA Handbook of Laser Materials Processing Laser Institute of America, 2001.*
4. *M. von Allmen. Laser-Beam Interactions with Materials, Springer, 1987*
5. *D. Bauerle. Laser Processing and Chemistry, Springer, 2000*
6. *W.W. Duley, UV lasers : effects and applications in materials science, Cambridge University, Press, Cambridge ; New York, 1996.*
7. *J. Dutta Majumdar, and I. Manna, Laser Material Processing, Sadhana, Vol. 28, Year: 2003, 495-562.*

PHY262 NON-LINEAR DYNAMICS 3 0 0 3

Unit 1

Introduction: examples of dynamical systems, driven damped pendulum, ball on oscillating floor, dripping faucet, chaotic electrical circuits.

One-dimensional maps: the logistic map, bifurcations in the logistic map, fixed points and their stability, other one-dimensional maps.

Non-chaotic multidimensional flows: the logistic differential equation, driven damped harmonic oscillator, Van der Pol equation, numerical solution of differential equations.

Dynamical systems theory: two-dimensional equilibrium and their stability, saddle

points, are contraction and expansion, non-chaotic three-dimensional attractors, stability of two-dimensional maps, chaotic dissipative flows.

Unit 2

Lyapunov exponents: for one- and two-dimensional maps and flows, for three-dimensional flows, numerical calculation of largest Lyapunov exponent, Lyapunov exponent spectrum and general characteristics, Kaplan-Yorke dimension, numerical precautions.

Strange attractors: general properties, examples, search methods, probability of chaos and statistical properties of chaos, visualization methods, basins of attraction, structural stability.

Bifurcations: in one-dimensional maps and flows, Hopf bifurcations, homoclinic and heteroclinic bifurcations, crises.

Hamiltonian chaos: Hamilton's equations and properties of Hamiltonian systems, examples, three-dimensional conservative flows, symplectic maps.

Unit 3

Time-series properties: examples, conventional linear methods, a case study, time-delay embeddings.

Nonlinear prediction and noise-reduction: linear predictors, state-space prediction, noise reduction, Lyapunov exponents from experimental data, false nearest neighbors.

Fractals: Cantor sets, curves, trees, gaskets, sponges, landscapes.

Calculations of fractal dimension: similarity, capacity and correlation dimensions, entropy, BDS statistic, minimum mutual information, practical considerations.

Fractal measure and multifractals: convergence of the correlation dimension, multifractals, examples and numerical calculation of generalized dimensions.

Non-chaotic fractal sets: affine transformations, iterated functions systems, Mandelbrot and Julia sets.

Spatiotemporal chaos and complexity: examples, cellular automata, coupled map lattices, self-organized criticality**.**

TEXTBOOK:

Hilborn, R. C., Chaos and Nonlinear Dynamics, Second Edition, Oxford University Press, 2000

REFERENCES:

1. *Sprott, J. C., Chaos and Time Series Analysis, Oxford University Press, 2003*
2. *Strogatz, S. H., Nonlinear Dynamics and Chaos, Westview Press, 2001*
3. *Solari, H. G., Natiello, M. A., and Mindlin, G. B., Nonlinear Dynamics, Overseas Press (India) Private Limited, 2005*

PHY263 CONCEPTS OF NANOPHYSICS AND NANOTECHNOLOGY 3 0 0 3

Unit 1

Introduction

Introduction to nanotechnology, comparison of bulk and nanomaterials – change in band gap and large surface to volume ratio, classification of nanostructured materials. Synthesis of nanomaterials - classification of fabrication methods – top down and bottom up methods.

Concept of quantum confinement and phonon confinement

Basic concepts – excitons, effective mass, free electron theory and its features, band structure of solids. Bulk to nano transition – density of states, potential well - quantum confinement effect – weak and strong confinement regime. Electron confinement in infinitely deep square well, confinement in two and three dimension. Blue shift of band gap - effective mass approximation. Vibrational properties of solids - phonon confinement effect and presence of surface modes**.**

Unit 2

Tools for characterization:

Structural – X-ray diffraction, transmission electron microscope, scanning tunneling microscope, atomic force microscope. Optical - UV – visible absorption and photoluminescence techniques, Raman spectroscopy.

Nanoscale materials – properties and applications:

Carbon nanostructures – structure, electrical, vibration and mechanical properties. Applications of carbon nanotubes

Unit 3

Field emission and shielding – computers – fuel cells – chemical sensors – catalysis – mechanical reinforcement. Quantum dots and Magnetic nanomaterials – applications.

Nanoelectronics and nanodevices:

Impact of nanotechnology on conventional electronics. Nanoelectromechanical systems (NEMSs) – fabrication (lithography) and applications. Nanodevices - resonant tunneling diode, quantum cascade lasers, single electron transistors – operating principles and applications**.**

TEXTBOOKS:

1. *, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan ,Nanoscale Science and Technology, John Wiley and Sons Ltd 2004.*
2. *W. R. Fahrner (Ed.), Nanotechnology and Nanoelectronics, Springer 2006.*

PHY264 THIN FILM PHYSICS 3 0 0 3

Unit 1

Introduction and preparation of thin film: Difference between thin and thick film. Appreciation of thin film technology in modern era. Deposition technology: Physical methods, chemical methods, other new techniques, vacuum technology: Vacuum pumps & pressure gauges.

Defects in thin film: General concepts, nature of defect, microscopic defect and dislocation. Boundary defects. Defect and energy states - donar acceptor levels, trap and recombination centers, excitons, phonons**.**

Unit 2

Thin film analysis: Structural studies: XRD and electron diffraction. Surface studies: electron microscopy studies on film (SEM, TEM, AFM.) Film composition*:* X-ray photoelectron spectroscopy (XPS), Rutherford Back Scattering spectroscopy (RBS) and Secondary Ion Mass Spectroscopy (SIMS).

Properties of thin film: Optical behaviors*:* transmission, reflection, refractive index, photoconductivity, and photoluminescence.

Unit 3

Electrical behaviors: sheet resistivity, electron mobility and concentration, Hall effect, conduction in MIS structure.

Mechanical behaviors: stress, adhesion, hardness, stiffness.

Applications of thin films in various fields: Antireflection coating, FET, TFT, resistor, thermistor, capacitor, solar cell, and MEMs fabrication of silicon wafer: Introduction. preparation of the silicon wafer media, silicon wafer processing steps**.**

TEXTBOOK:

K.L. Chopra, "Thin Film Phenomena", McGraw-Hill, New York, 1969

REFERENCES:

1. *L.T. Meissel and R.Glang, "Hand book of thin film technology", McGraw Hill, 1978.*
1. *A.Goswami, "Thin Film Fundamentals ", New Age International, Pvt Ltd, New Delhi, 1996.*
2. *O.S.Heavens "optical Properties of Thin Films" by, Dover Publications, newyork 1991.*
3. *Milton Ohring "Materials science of thin films deposition and structures", Academic press, 2006.*
4. *Donald L.Smith "Thin Film deposition principle and Practice", McGraw –Hill international Edition, 1995.*

PHY270 MEDICAL PHYSICS 3 0 0 3

Unit 1

Ultrasonics - production methods and properties - acoustic impedance - Doppler velocimetry - echo cardiography – resolution – speckle - ultrasound imaging - therapeutic use of ultrasound - use in diagnostics of cardiac problems.

X-rays – production – intensity - hard and soft X-rays - characteristic and continuous X-ray spectrum - attenuation of x-rays by hard and soft tissues – resolution – contrast X-ray imaging - fluoroscopy modes of operation - image quality - fluoroscopy suites - radiation dose – computed-aided tomography (CAT)

Unit 2

Nuclear medicine - principles of nuclear physics – natural radioactivity, decay series, type of radiation and their applications, artificially produced isotopes and its application, accelerator principles; Nuclear Isomerism, internal conversion - ideal energy for radiotherapy based on interactions. Radionuclide used in medicine - radioisotope production – dosimetry – safety - radiation hazards – PET.

Nuclear magnetic resonance physics - magnetic moment – magnetization – relaxation - nuclear magnetic resonance spectroscopy.

Unit 3

Nuclear magnetic resonance imaging (MRI) – principle - chemical shift - magnetic resonance signal induction and relaxation - pulse sequencing and spatial encoding.

Laser physics – characteristics of laser radiation, mode locking - power of laser radiation - lasers as diagnostic tool - lasers in surgery - laser speckle, biological effects, laser safety management.

TEXTBOOK:

Hendee W R and Rittenour E E, "Medical Imaging Physics", John Wiley & Sons, Chicago, 2001.

REFERENCE BOOKS

1. *Glasser.O.Medical Physics Vol.1, 2, 3 Book Publisher Inc Chicago, 1980*
2. *Jerraold T Bush Berg etal, The essentials physics of medical imaging, Lippincott Williams and wilkins(2002)*

PHY271 ADVANCED CLASSICAL DYNAMICS 3 0 0 3

Unit 1

Introduction to Lagrangian dynamics

Survey of principles, mechanics of particles, mechanics of system of particles, constraints, D'Alembert's principle and Lagrange's equation, simple applications of the Lagrangian formulation, variational principles and Lagrange's equations, Hamilton's principles, derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

Unit 2

Central field problem

Two body central force problem, reduction to the equivalent one body problem, Kepler problem, inverse square law of force, motion in time in Kepler's problem,

scattering in central force field, transformation of the scattering to laboratory system, Rutherford scattering, the three body problem.

Rotational kinematics and dynamics

Kinematics of rigid body motion, orthogonal transformation, Euler's theorem on the motion of a rigid body.

Unit 3

Angular momentum and kinetic energy of motion about a point, Euler equations of motion, force free motion of rigid body.

Practical rigid body problems

Heavy symmetrical spinning top, satellite dynamics, torque-free motion, stability of torque-free motion - dual-spin spacecraft, satellite maneuvering and attitude control - coning maneuver - Yo-yo despin mechanism - gyroscopic attitude control, gravity-gradient stabilization.

TEXTBOOKS:

1. *H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 1980, (Second Edition)*
2. *H. Goldstein,Charles Poole, John Safko, Classical Mechanics, Pearson education, 2002 (Third Edition)*
3. *Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier, pp.475 — 543*
4. *Anderson.John.D, Modern Compressible flow, Mc Graw Hill.*

REFERENCE BOOKS:

1. *D. A. Walls, Lagrangian mechanics, Schaum Series, McGrawHill, 1967.*
2. *J. B. Marion and S. T. Thornton, Classical dynamics of particles and systems, Ft. Worth, TX: Saunders, 1995.*

PHY272 QUANTUM PHYSICS AND ITS APPLICATIONS 3 0 0 3

Unit 1

Review of Planck's relation, De-Broglie relation and uncertainty principle basic concepts - Schrodinger equation: probabilistic interpretation of wave function, one dimension problems – particle in a box, harmonic oscillator, potential barrier and tunneling. Hydrogen atom, electrons in a magnetic field - X-ray spectra - periodic table.

Unit 2

Bosons and Fermions - symmetric and antisymmetric wavefunctions - elements of statistical physics: density of states, fermi energy, Bose condensation - solid state physics: Free electron model of metals, elementary discussion of band theory and applications to semiconductor devices.

Einstein coefficients and light amplification - stimulated emission - optical pumping and laser action.

Unit 3

Operation of He-Ne laser and Ruby laser - laser in science and Industry - Raman

effect and applications.
Nuclear physics: nuclear properties - binding energy and mass formula - nuclear decay with applications - theory of alpha decay - nuclear forces – fission - principle of nuclear reactor - elementary particles - leptons, hadrons, quarks, field bosons - the standard model of elementary particles**.**

TEXTBOOK:

A Beiser, Perspectives in Modern Physics,Mc Graw Hill

REFERENCES;

1. *Arthur Beiser, Concepts of Modern Physics, 6th Edition Tata McGraw Hill*
2 *S H Patil,Elements of Modern Physics, Tata Mc Graw Hill, 1989*
3 *K Krane, Modern Physics, John Weiley, 1998.*
4 *K Thyagarajan, A K Ghatak, Lasers-Theory and Applications, Macmillan, 1991*

PHY273 COMPUTATIONAL PHYSICS 3 0 0 3

Unit 1

Differentiation: Numerical methods, forward difference and central difference methods, Lagrange's interpolation method.
Integration: Newton - cotes expression for integral, trapezoidal rule, Simpsons's rule, Gauss quadrature method.

Unit 2

Solution of differential equations: Taylor series method, Euler method, Runge Kutta method, predictor-corrector method.
Roots of equations: Polynomial equations, graphical methods, bisectional method, Newton-Raphson method, false position method.

Unit 3

Solution of simultaneous equations: Elimination method for solving simultaneous linear equations, Gauss elimination method, pivotal condensation method, Gauss-seidal iteration method, Gauss Jordan method, matrix inversion method.
Eigen values and Eigen vectors of matrix: Determinant of a matrix, characteristic equation of a matrix, eigen values and eigen vectors of a matrix, power method**.**

TEXTBOOK:

Rubin H Landau & Manuel Jose Paez Mejia, "Computational Physics", John Wiley & Sons

REFERENCES:

1. *Suresh Chandra, "Computer Applications in Physics", Narosa Publishing House, New Delhi*
1. *M Hijroth Jensen, Department of Physics, University of Oslo, 2003 (Available in the Web)*

PHY274 ASTROPHYSICS 3 0 0 3

Unit 1

Historical introduction: Old Indian and western – astronomy - Aryabhatta, Tycho Brahe, Copernicus, Galileo - Olbers paradox - solar system – satellites, planets, comets, meteorites, asteroids.
Practical astronomy - telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.
Celestial mechanics - Kepler's laws - and derivations from Newton's laws.
Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

Unit 2

Stellar astronomy: H-R diagram, color-magnitude diagram - main sequence - stellar evolution – red giants, white dwarfs, neutron stars, black holes - accretion disc - Schwartzchild radius - stellar masses Saha–Boltzman equation - derivation and interpretation.
Variable stars: Cepheid, RR Lyrae and Mira type variables - Novae and Super novae. Binary and multiple star system - measurement of relative masses and velocities. Interstellar clouds-Nebulae.

Unit 3

Galactic astronomy: Distance measurement - red shifts and Hubble's law – age of the universe, galaxies – morphology - Hubble's classification - gravitational lens, active galactic nuclei (AGNs), pulsars, quasars.
Relativity: Special theory of relativity - super-luminal velocity - Minkowski space - introduction to general theory of relativity – space - time metric, geodesics, space-time curvature. Advance of perihelion of Mercury, gravitational lens.
Cosmology: Comic principles, big bang and big crunch – cosmic background radiation - Nucleo-synthesis - plank length and time, different cosmic models - inflationary, steady state. Variation of G. anthropic principle**.**

REFERENCES:

1. *"Textbook of Astronomy and Astrophysics with elements of Cosmology", V.B.Bhatia, Narosa publishing 2001.*
2. *William Marshall Smart, Robin Michael Green "On Spherical Astronomy ",(Editor) Carroll, Bradley W Cambridge University Press ,1977*
3. *Bradley W.Carroll and Dale A. Ostlie.- "Introduction to modern Astrophysics" Addison- wesley, 1996.*
4. *BradleyW.Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison-Wesley Publishing Company, 1996'*
5. *'Stellar Astronomy' by K.D Abhayankar.*
6. *'Solar Physics' by K.D Abhayankar.*

SSK111 SOFT SKILLS I 0 0 3 1

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words. Listening skills: The importance of listening in communication and how to listen actively.

Prepositions, articles and puncuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level – I**:** Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;
Problem solving level – II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.
Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrithms.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Quantitative Aptitude by R.S. Aggarwal ,S. Chand*

6. *Quantitative Aptitude – Abijith Guha ,TMH.*
7. *Quantitative Aptitude for Cat- Arun Sharma. TMH.*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*
2. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

www.the grammarbook.com online teaching resources
www.englishpage.com online teaching resources and other useful websites.

SSK112 SOFT SKILLS II 0 0 3 1

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.
Problem solving level – III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Quick Maths – Tyra.*
6. *Quicker Arithmetic – Ashish Aggarwal*
7. *Test of reasoning for competitative examinations by Thorpe.E. TMH*
8. *Non-verbal reasoning by R.S. Aggarwal ,S. Chand*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova*
2. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

www.the grammarbook.com online teaching resources

www.englishpage.com online teaching resources and other useful websites.

SSK113 SOFT SKILLS III 0 0 3 1

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation/knowledge about the company, professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level – IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics). Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
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