

<b>15AVP201 /</b>	<b>AMRITA VALUES PROGRAMME I/</b>	<b>1 0 0 1</b>
<b>15AVP211</b>	<b>AMRITA VALUES PROGRAMME II</b>	<b>1 0 0 1</b>

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

#### ***Courses offered under the framework of Amrita Values Programmes I and II***

##### **Message from Amma's Life for the Modern World**

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

##### **Lessons from the Ramayana**

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

##### **Lessons from the Mahabharata**

Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

##### **Lessons from the Upanishads**

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The

Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, SatyakamaJabala, Aruni, Shvetaketu.

##### **Message of the Bhagavad Gita**

Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

##### **Life and Message of Swami Vivekananda**

Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

##### **Life and Teachings of Spiritual Masters India**

Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramakrishna Paramahansa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi.

##### **Insights into Indian Arts and Literature**

The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

##### **Yoga and Meditation**

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

##### **Kerala Mural Art and Painting**

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this

form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

### Course on Organic Farming and Sustainability

Organic farming is emerging as an important segment of human sustainability and healthy life. 'Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma's words "it is a big step in restoring the lost harmony of nature".

### Benefits of Indian Medicinal Systems

Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

### Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is "Unity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

### Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

## 15CHE111 INTRODUCTION TO CHEMICAL ENGINEERING 3 0 0 3

### Unit 1

Historical evolution of chemical engineering; what is chemical Engineering; the impact & role of chemical engineering; representing chemical processes using

process diagrams and flow sheets (introduction to unit operations and unit processes; batch vs. continuous operation); understanding prevalent symbols; chemical process industries: evolution, broad classification, characteristics, origin, growth, present scenario, & projections; opportunities and challenges; roles of the modern chemical engineer.

Physical quantities: units & dimensions, conversion & conversion factors; important process variables, making the connection between the variables and their measurements; conventions in methods of analysis and measurement, basis, chemical equations and stoichiometry, conversion, and yield; industrially important physical and chemical properties.

### Unit 2

Introduction to fluid flow (pressure-flow interaction, non-flowing fluids, pumps & turbines), heat transfer (applications of heat exchange in the industry), mass transfer (molecular vs. bulk transport), reaction engineering (important of describing reaction rate and design of reaction vessel), materials (important properties and their influence on selection of materials), and control (need for control and strategies); mathematical representation of process; types of chemical engineering problems (mainly rate, equilibrium and design).

### Unit 3

Computer aided calculations & spreadsheets; graphing (basic plots, interpreting trends, curve fitting, log-log & semi-log representation); relation between chemical engineering and physico – chemical sciences and other engineering disciplines; modern view of chemical engineering; economics (costs in industry, profitability considerations, analytical view of process and reporting of performance); safety-health-environment; ethics; case studies.

### TEXTBOOKS & REFERENCES:

1. K. A. Solen and J. N. Harb, "Introduction to Chemical Engineering – Tools for Today and Tomorrow", 5th Edition, Wiley, 2011.
2. S. Pushpavanam, "Introduction to Chemical Engineering", Prentice Hall India, 2012.

## 15CHE112 MATERIAL BALANCES 3 1 0 4

### Unit 1

Chemical engineer vs. Chemist, Careers in chemical engineering, Chemical engineering industries; Chemical engineering approach – Streams, Units and Processes; Unit operations and processes: Fluid and solid operations, Heat transfer operations, Mass transfer and separation operations, Chemical reactors, Control of processes, Costing and economics, Process flowsheets and components; Case studies.

Representing streams: Dimensions and unit conversions, Conversion factors, Dimensional consistency, Dimensionless numbers in chemical engineering; Representing compositions of mixtures and solutions: Binary and tertiary mixtures, Graphical representation, Compound stoichiometry; Representing gas phases: Ideal gas law, P-V-T calculations, Partial pressures and pure component volumes in mixtures; Representing reactions: Reaction stoichiometry, Conversion, Yield, Selectivity, Limiting and excess reactants; Dissociating gases; Representing moist gases: Humidity, Wet and dry bulb temperatures, Humidity chart.

**Unit 2**

Material balance – Control volume, Conservation of mass and species in a unit; Steady and unsteady state processes, Batch and continuous processes; Basis for calculation; Degrees of freedom; Steady and unsteady material balance in unit operations: Evaporation; Crystallization; Leaching; Adsorption; Drying; Liquid-Liquid Extraction; Absorption; Distillation; Recycle, Bypass, and Purge

**Unit 3**

Combustion: Orsat analysis, Proximate and ultimate analyses of coal; Single-pass and overall conversions; Oxidation of sulphur compounds; Reactions involving phosphorus; Reactions involving nitrogen; Reactions involving chlorine; Extraction of metals from ores; Hydrogenation, hydration, and oxidation; Electrochemical reactions; Recycle, Bypass, and Purge involving reactions

Representing processes: Creating Flowsheets; Degree of freedom analysis of flowsheets; Material balance involving multiple unit operations; Modular and overall equation-solving approaches; Case studies involving industrial flowsheets.

**TEXTBOOKS:**

1. Bhatt, B. L., and Vora, S. M., *Stoichiometry*, 3rd Edition, Tata McGraw Hill, New Delhi, 1996
2. Narayanan, K. V., and Lakshmiikutty, B., *Stoichiometry and Process Calculations*, Prentice Hall India, New Delhi, 2009
3. Murphy, R. M., *Introduction to Chemical Processes: Principles, Analysis, Synthesis*, McGraw Hill International Edition, New York, 2007

**REFERENCES:**

1. Himmelblau, D. M., *Basic Principles and Calculations in Chemical Engineering*, 6th Edition, Prentice Hall Inc., New York, 2003
2. Felder, R. M. and Rousseau, R. R., *Elementary Principles of Chemical Processes*, 3rd Edition, John Wiley & Sons, New York, 2000
3. Hougen, O. A., Watson, K. M., and Ragatz, R.A., *Chemical Process Principles Part I*, CBS Publishers, 1973
4. Lewis, W. K., Radash, A. H., and Lewis, H. C., *Industrial Stoichiometry*, McGraw Hill Book Inc., New York, 1995

**15CHE201 ENERGY BALANCE AND THERMODYNAMICS 3 0 2 4****Unit 1**

Systems, Properties, Processes, Cycles; State of a system and state postulate; State and path functions; Temperature and zeroth law of thermodynamics; Pressure and pressure measurement; Energy and its forms: Potential and Kinetic energy, Internal energy; Energy sources; Energy transfer – Heat, Work, Electricity; Mechanisms of heat transfer; Work: Moving boundary work, Flow work, Shaft, spring, elasticity, surface tension, and electrical work; Energy balance – First law for open and closed systems, steady and unsteady state processes.

Phases and phase diagrams of a pure substance, Saturation, Superheating, T-v, P-v, P-T diagrams and the P-v-T surface; Enthalpy; Property tables; Ideal and non-ideal gases: van der Waals, Soave-Redlich-Kwong, Peng-Robinson equations of state; Virial equation and its physical meaning; Compressibility factor.

**Unit 2**

Estimation of heat capacities: Solids, Liquids, Gases, Mixtures, Temperature dependence; Enthalpy changes: Mixing, Fusion, Vaporization – Clayperon equation, Clausius-Clayperon equation, Watson equation, Trouton's rule, Kistyakowsky equation; Energy analysis of gas cycles; Energy analysis using property tables.

Mechanical energy balance – Bernoulli equation; Energy transfer by mechanical work: Nozzles and diffusers, Turbines, compressors and pumps, Throttling valves, Pipe and duct flow; Energy transfer by heat: Heat exchangers, Boilers and Furnaces; Energy balance in unit operations: Mixers and splitters; Drying; Evaporation; Crystallization; Leaching; Adsorption; Liquid-Liquid Extraction; Absorption; Distillation; Recycle, Bypass, Purge.

**Unit 3**

Standard heat of reactions – Combustion and Formation; Hess's law; Effect of temperature and pressure; Adiabatic reaction temperature; Recycle in reactors; Combined material and energy balance in flowsheets – Degree of freedom analysis; Modular and overall equation-solving approaches.

Entropy and thermodynamic temperature; Combined first and second law for closed systems and cycles: Carnot cycle; Refrigerators, Heat pumps; Thermodynamic efficiency and coefficient of performance; Second law for open systems – Entropy balance; Statistical meaning of entropy.

**TEXTBOOKS:**

1. Narayanan, K. V., and Lakshmiikutty, B., *Stoichiometry and Process Calculations*, Prentice Hall India, New Delhi, 2009

2. Cengel, Y. A., and Boles, M. A., *Thermodynamics: An Engineering Approach, 7th Special Indian Edition*, McGraw Hill India, New Delhi, 2011
3. Rao, Y. V. C., *Chemical Engineering Thermodynamics*, Universities Press, 1997

**REFERENCES:**

1. Murphy, R. M., *Introduction to Chemical Processes: Principles, Analysis, Synthesis*, McGraw Hill International Edition, New York, 2007
2. O'Connell, J. P., and Haile, J. M., *Thermodynamics: Fundamentals for Applications*, Cambridge University Press, Cambridge, 2005

**15CHE202****FLUID MECHANICS****3 1 0 4****Unit 1**

Elementary concepts – density, specific weight, specific gravity, viscosity – dynamic and kinematic viscosity – surface tension, capillarity, vapour pressure, compressibility – Compressible and incompressible fluids; Concept of gauge and absolute pressure, measurement of pressure using manometers of different types. Hydrostatic force on plane and curved surfaces, center of pressure; buoyancy and stability of submerged and floating bodies;

Flow types - Unsteady, Steady and non-uniform, laminar and turbulent flows – Reynolds number; Ideal flow – rotational and irrotational, stream function, potential function – Velocity vectors; Path line, streak line and stream line; Derivation of continuity and momentum equation for steady three dimensional flows - Application of one dimensional steady flow; circulation and vorticity; Laminar flow between parallel plates – Taylor-Couette flow and Poiseuille flow; Flow in closed conduits Laminar flow through circular pipe – Shear stress and velocity profiles; pressure gradient, Hagen-Poiseuille's equation; Power required to overcome pressure drop; Velocity profile in turbulent flows;

Two dimensional flows - Boundary layer; Boundary layer equation; Blasius solution for boundary layer flow; boundary layer separation and its control.

**Unit 2**

Bernoulli's and Euler's equations; Application of Bernoulli's equations to flow meters - Pitot tube, Nozzle, Venturi meter and Orifice meter; Coefficient of discharge for flow meters and velocity measurement;

Concept of friction and friction factor from drag on a flat plate; Friction loss in laminar and turbulent flows, Darcy-Weisbach equation, Moody chart; Minor losses – Pipe fittings and pipe networks, equivalent length for pipe in pipe fittings;

Flow past immersed bodies – drag and lift, drag and lift coefficients, flow through beds of solids, one dimensional motion of particle through fluid, terminal velocity,

hindered settling, Fluidization – Conditions for onset of fluidization, Hydraulic radius of porous medium, Porous medium Reynolds number, minimum fluidization velocity; Pressure drop through porous media for spherical and non-spherical particles – Ergun equation; Types of fluidization;

**Unit 3**

Applications Transportation of fluids – pipes, fittings, valves; Pump terminology – Suction and Delivery heads, Suction lift, Cavitation, Net positive suction head and Power requirement; Positive displacement pumps – Reciprocating pump and gear pump; Rotary pumps - Centrifugal Volute pump, Pressure raise in centrifugal pump; Pump characteristics;

Significance of dimensionless numbers; Dimensional analysis and model testing – Buckingham pi-theorem; Application of dimensionless analysis - Flow through pipe, Settling of particles in a fluid, Centrifugal pump, Reynolds and Froude numbers and their use in model testing;

**TEXTBOOK AND REFERENCE BOOKS:**

1. Noel de Nevers, *Fluid Mechanics for Chemical Engineers*, McGraw Hill Inc., 1991
2. Cengel Y. A., and Cimbala J. H., *Fluid Mechanics: Fundamentals and Applications*, McGraw Hill Publishers, 3rd Ed., 2013
3. Holland F. A., and Bragg R., *Fluid Flow for Chemical Engineers*, Butterworth Heinmann, 2nd Ed., 2002
4. Ron Darby, *Chemical Engineering Fluid Mechanics*, Marcel Dekker Inc., 2nd Ed., 2001
5. Frank M. White, *Fluid Mechanics*, McGraw Hill Inc., 4th Ed., 2011

**15CHE203****MECHANICAL OPERATIONS****3 0 0 3****Unit 1**

Properties and handling of particulate solids- characteristics of solid particles, standard screen series, mixed particle size and screen analysis; Screening: Theory of screening, Effectiveness and Capacity of screens, Screening equipment: stationary screens and grizzlies, gyrating screens, vibrating screens and other industrial screens like trammels, etc. Transportation and storage of solids: bins, hoppers and silos, flow out of bins; conveyor selection, different types of conveyers and their performance characteristics.

Comminution of solids (Size Reduction): Factors affecting comminution, comminution laws: Kick's law, Rittinger's law and Bond's law and their limitations. Crushing efficiency & power consumption, Size reduction equipments: Primary crusher – Jaw crusher, Gyratory crusher, Secondary crusher – Roll crusher (both smooth roll & toothed roll) its selection and capacity, Grinder – Construction and operation

of Hammermill, Ball mill, Rod mill, Attrition mill, Agitated mill and their materials suitability, Ultra-fine grinder – Fluid energy mill, Cutting machines: knife cutters, Close circuit and Open circuit operation.

**Unit 2**

Separation of solids: gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, bowl classifier, super centrifuges, design of basket centrifuges; Industrial dust removing equipment - cyclones and hydro cyclones, with special reference to electrostatic and magnetic separators; Heavy media separations, floatation.

Mixing and Agitation: Mixing of liquids (with or without solids), mixing of liquids (with solids), mixing of liquids (with solids), mixing of powders, selection of suitable mixers, power requirement for mixing.

**Unit 3**

Filtration: Principle of Cake filtration, Pressure drop through filter media, compressible and incompressible filter cakes, Constant pressure and rate filtration, Continuous filtration, washing of filter cakes; Filtration – Theory, Filtration considerations, Batch and continuous filtration equipment (Pressure and Vacuum) – selection, operation and design of filters and optimum cycle of operation.

**TEXTBOOKS:**

1. W. L. McCabe, J. C. Smith, and P. Harriot, "Unit Operations in Chemical Engineering, 6th Edition, McGraw Hill, 2001.
2. W. L. Badger and J. T. Banchero, "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
3. A. S. Foust, L. A. Wenzel, C. W. Clump, L. Naus, and L. B. Anderson, "Principles of Unit Operations", 2nd Edition, John Wiley & Sons, 1994.

**REFERENCE:**

J. M. Coulson and J. F. Richardson, "Chemical Engineering Vol. I", 4th Edition, Asian Books Pvt Ltd., India, 1998.

**15CHE211 CHEMICAL ENGINEERING THERMODYNAMICS 3 0 0 3****Unit 1**

Pure gaseous substances – P-v-T behavior of pure substances, Calculation of work done, heat transferred, change in enthalpy in different processes – Ideal and Non-ideal gases; Equation of State, Compressibility factor.

Gas Mixtures – P-v-T behavior of gas mixtures, ideal and non-ideal mixtures, Mixture rules, Compressibility factors for mixtures.

Excess properties of mixtures – Temperature and Pressure dependence, Gibbs-Duhem equation;

**Unit 2**

Ideal and non-ideal solutions; vapor pressure of solutions; fugacity and activity coefficients and their estimation; Criterion for vapor liquid equilibrium (VLE); Binary VLE – Bubble and dew point calculations – Equation of State and Activity Coefficient models; Multi-component VLE – K-factor approach; Thermodynamic consistency of VLE data.

Criterion for liquid-liquid equilibrium; Estimation of distribution co-efficient from activity models; Composition estimation in problems related to extraction.

**Unit 3**

Criterion for chemical reaction equilibrium – feasibility of chemical processes, Equilibrium constant;

Conversion calculations in a reaction – Homogeneous gas phase reactions, Gas-Liquid reactions, effect of temperature and pressure on conversion.

**TEXTBOOK AND REFERENCE BOOKS:**

1. Y. V. C. Rao, *Chemical Engineering Thermodynamics, 1st Ed., 2001*
2. J. P. O'Connell and J. M. Haile, *Thermodynamics: Fundamentals for Applications, Cambridge University Press, 2005*
3. Yunus A. Cengel, *Thermodynamics: An Engineering Approach, 7th Ed., 2010*

**15CHE212****CHEMICAL TECHNOLOGY****4 0 0 4****Unit 1**

Chemical processing, the role of a chemical engineers in process industries, importance of block diagrams and flow charts, unit operations, unit processes, process utilities and economics, industrial safety and pollution, outline of plant and equipment design, process control and instrumentation; Chlor-Alkali: Definition of electrochemistry, manufacture of soda ash by solvay process, manufacture of chlorine & caustic soda by diaphragm cell, advantages & disadvantages of diaphragm & comparison with mercury cell. Cement: Definition of cement & portland cement, process description, raw material, flow sheet & major engineering problems associated with the dry processes for manufacturing of portland cement; Glass & Ceramics: Definition and general composition of glass, raw material, methods of manufacture, special glasses - fused silica and high silica glass; Ceramics – properties, classification, manufacturing process; Types of refractories and manufacturing processes; kilns. Inorganic Acids: Flow sheet, raw materials, industrial

applications, and engineering problems for Sulfuric acid (includes production of Sulfur) and Hydrochloric acid. Soap & Detergent industry: Continuous hydrolysis & saponification process, flow sheet for continuous process, for fatty acids, soap & glycerine; types of surface active agents, different constituents of detergent, manufacturing process of detergent (sulfonation and sulfation and compounding of detergent). Vegetable Oils: Extraction methods, hydrogenation of vegetable oils, general methods of production; Pulp & Paper Industry: Kraft process for pulp manufacture, Fourdrinier and Cylinder Machine processes for paper manufacture, and paper finishing;

**Unit 2**

Fertilizer Industry: mixed and direct-application fertilizers, NPK value, granulation, Haber process for Ammonia synthesis; Petroleum Refining Industry: Constituents of petroleum, products of refining, processing or refining; Petrochemicals Industry: Unit operations, chemical conversions, manufacture of petrochemicals, reactions producing petrochemicals; Paints & Varnishes: Brief description of requirements for surface coatings, simple flow sheet of paint coatings, simple flow sheets of paint manufacturing process, varnishes & their applications; Dyes and Intermediates: Raw materials, important cyclic intermediates, chemical conversions, structure and classification of dyes.

**Unit 3**

Polymers & Plastics Industries: Definitions, types of polymers, classifications, polymerization reactions, manufacture of PE, PP, PVC; Phenolic and epoxy resin. Rubber Industries: Natural and synthetic rubber, rubber compounding, rubber fabrication, latex compounds, and rubber derivatives; Pharmaceutical: Classification, alkylation, condensation and cyclization, dehydration, halogenations, oxidation, sulfonation, amination. Fermentation process; Manufacture of antibiotic - Penicillin, Streptomycin and Erythromycin; Biologicals. Food industry: Types of processing (refining & milling, canning, concentration, freezing, drying, pasteurization); Sugar: Manufacture and refining of cane sugar, decolorization, bagasse, beet sugar.

**TEXTBOOKS:**

1. C. E. Dryden, "Outlines of Chemicals Technology", 2nd Edition, Edited and Revised by M. Gopala Rao and M. Sittig, Affiliated East-West Press, 1993.
2. M. B. Hocking, "Handbook of Chemical Technology and Pollution Control", 3rd Edition, Academic Press, 2005.
3. G. I. Austin, "Shreve's Chemical Process Industries", 5th Edition, Tata McGraw Hill, Singapore, 1990.

**REFERENCES:**

1. Martin B. B. Hocking, "Handbook of Chemical Technology and Pollution", 3rd Edition, Academic Press, 2006.

2. M. Bickford, "Kirk-Othmer - Concise Encyclopedia of Chemical Technology", (2-volume set), 4th Edition, Wiley-Interscience, 1999.

**15CHE213****PROCESS HEAT TRANSFER****3 1 0 4****Unit 1**

Modes of heat transfer – Fourier's law of heat conduction and applications; Thermal conductivity measurement; Steady state conduction with variable area; Heat transfer coefficient & film theory; Heat transfer in extended surfaces; Heat Transfer to Fluids without phase change: Concepts of heat transfer by convection – Natural and forced convection; Correlations for the calculation of heat transfer coefficients.

**Unit 2**

Analogies between transfer of momentum and heat – Reynold's analogy, Prandtl and Colburn analogies; Heat Transfer to Fluids with Phase Change – heat transfer from condensing vapors, drop wise film wise condensation, film condensation on vertical surface and horizontal tube bank; Heat transfer to boiling liquids – mechanism of boiling of saturated liquids; Heat exchangers – shell & tube, double pipe, flow patterns, construction and operational features, theory & calculations, energy balances and effectiveness.

**Unit 3**

Heat exchanger design procedure – Effectiveness - NTU Method – Chart for different configurations; Theory of Evaporation; evaporator types; single effect and multiple effect evaporation; evaporator design considerations; Radiation heat transfer – Emissive power, Black body radiation, Emissivity, Stefan-Boltzman law, Planck's law, radiation between surfaces.

**TEXTBOOKS:**

1. Binay K. Dutta, "Heat Transfer – Principles and Applications", PHI Learning Pvt. Ltd., 2001.
2. W. L. McCabe, J. C. Smith and P. Harriot, "Unit Operations in Chemical Engineering", 6th Edition, McGraw Hill, 2001.
3. J. P. Holman, "Heat Transfer", 8th Edition, McGraw Hill, 1997.

**REFERENCES:**

1. F. P. Incropera, "Fundamentals of Heat and Mass Transfer", 6th Edition, Wiley, 2006.
2. J. M. Coulson, and J. F. Richardson, "Chemical Engineering Vol. 1", 4th Edition, Asian Books Private Limited, India, 1998.

**15CHE281****FLUID MECHANICS LAB.****0 0 2 1**

Bernoulli's equation for steady flow - verification of energy conservation principle; Determination of coefficient of discharge of flow measuring devices like

venturimeter, orificemeter, rotameter; Pipe friction studies- losses in fittings - friction factor; Flow through annular and helical coil pipes - coefficient of friction; Performance characteristics of centrifugal and reciprocating pumps; Flow through packed columns – fluidization - pressure drop in the column; Terminal settling velocity.

**15CHE282 MECHANICAL OPERATIONS LAB. 0 0 2 1**

Calculating Specific Surface Area and Particle Size using Sieve Analysis, Screen Effectiveness, Verifying crushing laws and energy consumption in Jaw Crusher, Ball mill and Drop weight Crusher, Determining reduction ratio in Roll Crusher, and Drop Weight Crusher, Solid Separation in Cyclone Separator, Calculation thickener area using batch sedimentation experiment, Determining Specific Cake resistance and filter medium Resistance in Filter Press, and Leaf Filter.

**15CHE285 CHEMICAL ENGINEERING INSTRUMENTATION LAB. 1 0 2 2**

Measurements – Units and Dimensions, Unit Conversions, Significant Figures, Uncertainty in Measurements: Standard Error, Standard Deviation, Sampling and Confidence Intervals; Rating an Instrument – Interval, Range, Resolution, Sensitivity, Detection Limit, Repeatability, Reproducibility, Accuracy and Precision; Graphical Representation of Data – Scatter Plots, Linear, Log-Linear and Log-Log Plots, 3D and Contour Plots, Bar Charts

Pressure Measurement (Two Experiments) – Atmospheric, Gauge, Differential, Vacuum, Barometric Pressure, Static vs. Dynamic Pressure; U-tube Manometer, Capsule Gauge, Thermal Gauge, Capacitive Gauge, Ion Gauge; Safety: Pressure Regulator, Relief Valves, Rupture Disks, Pressure Test and Leak Test;

Temperature Measurement (Two Experiments) – Wet Bulb, Dry Bulb Temperatures and Dew Point; Thermometers, Thermistors, Resistance Temperature Devices (RTD), Thermocouples, Thermopiles, Pyrometers;

Flow Measurement (Two Experiments) – Positive Displacement, Differential Pressure, Variable Area, Mass Flow, Oscillatory, Ultrasonic Flow Meters; Orifice Meters, Venturi Meters, Compressible Flow, Pitot Tubes, Rotameters, Hot Wire Anemometers, Coriolis Flow Meters;

Analysis of Solids and Powders (One Experiment) – Bulk and Particle Density; Particle Size and Size Distribution – Sieve Analysis, Diffraction, Microscopy;

Concentration and pH in Gases and Liquids (One Experiment) – pH Meters, Introduction to Chromatography, Mass Spectrometry, Refractometry, Spectroscopy

**TEXTBOOKS / REFERENCES:**

1. G. S. Patience, "Experimental Methods and Instrumentation for Chemical Engineers", Elsevier, 2013.
2. V. R. Radhakrishnan, "Instrumentation and Control for the Chemical, Mineral and Metallurgical Processes", Allied Publishers Pvt. Ltd., 1997.
3. AlokBarua, "Fundamentals of Industrial Instrumentation", Wiley India, 2011

**15CHE286 CHEMICAL TECHNOLOGY LAB. 0 0 2 1**

1. Estimation of the percentage of nitrogen in urea by Kjeldahl's method
2. Determination of the percentage of available chlorine in the given sample of bleaching powder.
3. Determination of acid value and iodine value of different oils (any two)
4. Estimation of saponification value of different oils (any two)
5. Determination of alkalinity and Total fatty matter by Soap analysis (any two)
6. Analysis of Flash point of a given oil (any two)
7. Determination of viscosity by red wood viscometer
8. Estimation of silica and moisture content in cement analysis.
9. Determination of sucrose content in the given sample of sugar
10. Analysis of the percentage of ash and lactose content in the given milk sample.

**15CHE301 CHEMICAL REACTION ENGINEERING I 3 0 0 3**

**Unit 1**

Elementary reactions - Rate equation and rate law, temperature dependency of rate of reaction (rate constant) – Arrhenius, Collision and Transition State theories.

Non-elementary reactions, mechanisms of non-elementary reactions – the pseudo steady state hypothesis (PSSH).

Analysis of Batch Reactor Data – Integral and Differential analysis of data, rate parameter estimation using least square analysis and curve fitting.

**Unit 2**

Design / performance equations for homogeneous and Isothermal systems – Batch, mixed flow and tubular reactors; size comparison of different reactors for single reactions; Rate parameter estimation using experimental data from various reactors.

Combination of reactors for a single reaction; Mixed Flow Reactors in Series; Combined Reactors in Series – Plug flow followed by mixed flow and vice versa. Parallel reactors – feed distribution in parallel reactor configuration; Auto catalytic reactions - Recycle reactors, Optimization of recycle ratio.

**Unit 3**

Multiple reactions – series, parallel and series-parallel reactions; Conversion and Selectivity; Reactor design for series reactions; Reactor design for parallel reactions; Reactor design for Series-parallel reactions;

Adiabatic reactions; heat of reaction as a function of temperature; Temperature as a function of Conversion and vice versa; Cooling / heating requirements in near-isothermal operation; Effect of temperature on conversion and selectivity in multiple reactions;

**TEXTBOOK AND REFERENCE BOOKS:**

1. Octave Levenspiel, *Chemical Reaction Engineering, 3rd Edition, John Wiley, 2004*
2. Scott H. Fogler, *Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall of India, 2000*
3. G. F. Froment and K. B. Bischoff, *Chemical Reactor Analysis and Design, 2nd Edition, John Wiley, 1990*

**15CHE302 DIFFUSIONAL MASS TRANSFER OPERATIONS 3 1 0 4****Unit 1**

Molecular diffusion in fluids, Fick's Law of diffusion, steady state diffusion under stagnant and laminar flow conditions. Diffusivity measurement and estimation, multi-component diffusion, diffusion in solids and its applications, eddy diffusion, mass transfer coefficients, theories of mass transfer, analogy equations, application of empirical correlations to known geometry such as flat plates, wetted wall columns. Concept of mass transfer coefficients, inter phase mass transfer, two film theory, relationship between individual and overall mass transfer coefficients. Mass transfer in fluidized bed, flow past solids and boundary layers. Equipments for countercurrent and concurrent mass transfer operations.

**Unit 2**

Absorption and stripping – Gas liquid equilibria, Raoult's and Henry's laws, Solubility of gases in liquid, choice of solvent; Material balance in countercurrent and concurrent absorption and stripping, L/G ratio, absorption factor; Equipment for absorption, Graphical and analytical methods for tray column, packed columns for absorption: rate based designs, HTU, NTU and HETP concepts, absorption with chemical reaction. Humidification and dehumidification: vapour liquid equilibria, theory of wet-bulb temperature and adiabatic saturation temperature, Lewis relation, Lewis relation, psychrometric chart, humidification and dehumidification equipments, enthalpy transfer concepts – temperature profiles in humidifier and dehumidifiers theory. Classification and design of cooling towers.

**Unit 3**

Drying: Solid-gas equilibria, mechanism of drying, drying curves, modes of drying operations, classification of dryers, industrial dryers for batch and continuous drying, time of drying in batch operation, estimation of size of rotary dryer based on rate concept. Crystallization: Equilibrium, theories of crystallization, purity, yield, energy requirements, kinetics of crystallization – nucleation and growth; population balance model, MSMPR crystallizer, crystallisation equipment.

**TEXTBOOKS:**

1. R. E. Treybal, *Mass Transfer Operations, 3rd Edn. McGraw Hill 1981.*
2. Binay K. Dutta, *Principles of Mass Transfer and Separation Processes, PHI Learning Private Ltd, 2013*

**REFERENCES:**

1. J. D. Seader, Ernest J. Henley, *Separation Process Principles, 2nd Edition, Wiley India, 2011*
2. Coulson, J. M. and Richardson, J. F. *Chemical Engineering Vol. II, 4th Edn., Asian Books Pvt. Ltd. India. 1998.*
3. McCabe, W. L. Smith, J. C. and Harriot, P. *Unit Operations in Chemical Engineering, 6th Edn, McGraw Hill Edn, 2001.*
3. J. R. Welty, C. E. Wicks, G. L. Rorrer and R. E. Wilson, *Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition, Wiley, 2000.*
4. Foust, A. S. Wenzel, L. A. Clump, C. W. Naus, L., and Anderson, L. B. *'Principles of Unit Operations', 2nd Edn. Wiley, 1980.*
5. Geankoplis, C. J., *"Transport Processes and Unit Operations", 4th Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2004.*

**15CHE303 STATICS AND STRENGTH OF MATERIALS 3 1 0 4****Unit 1**

Principles of statics: Introduction to vector approach - free body diagram - forces in plane and space - concurrent forces - resolution of forces - equilibrium of particle. Statics of rigid bodies in two and three dimensions - moment of force - rigid body equilibrium - support reactions. Centroid and centre of gravity; Centroids of lines, areas, volumes and composite bodies - Second moment of area - polar moment of inertia - mass moment of inertia.

**Unit 2**

Simple Stresses and Strains: Hooke's law - Elastic limit linear strain - lateral strain - Analysis of varying sections - bars of composite sections – Thermal stresses. Shear force and bending moment; Different types of support conditions and loads - Cantilever – simply supported – Over hanging beams, point loads, uniformly distributed loads - Theory of Simple bending; flexural formula.



**Unit 3**

Torsion of circular sections; Derivation of torsional formula – Assumptions made Power transmitted – Solid and hollow shafts. Complex stress; principal stresses and principal planes - principal strains – graphical method. Thin Shells; Thin cylindrical shells subjected to internal pressure – Circumferential stress – Longitudinal stress – change in diameter – length-volume – Thin spherical shells. Columns; Axially loaded Columns – Different end conditions – Euler's formula for long columns.

**TEXTBOOKS:**

1. R. C. Hibbeler, "Statics and Mechanics of Materials" Prentice Hall, 2013.
2. F. W. Cheng, "Statics and Strength of Materials", McGraw Hill India, 2013.

**REFERENCES:**

1. F. P. Beer, E. R. Johnston & D. Mazurek, "Vector Mechanics for Engineers: Statics", McGraw-Hill Higher Education, 2012.
2. J. M. Gere and B. J. Goodno, "Mechanics of Materials", CL Engineering, 2012.

**15CHE311 CHEMICAL REACTION ENGINEERING II 3 0 0 3****Unit 1**

Steps in heterogeneous reactions – bulk diffusion, internal diffusion, adsorption, desorption and surface reaction; Rate expressions for different steps in heterogeneous systems; Thiele modulus and effectiveness factor.

Flow regimes in Gas-Solid and Liquid-Solid systems; Estimation of overall mass transfer coefficient in heterogeneous systems; Design of packed-bed, fluidized bed, slurry and trickle bed reactors;

**Unit 2**

Relative rates of reaction and mass transfer in non-catalytic reactions in Gas-liquid reactions – Hatta number; Effect of gas solubility on rate of reaction;

Models for fluid-solid reactions: Progressive conversion model and Shrinking core model; Rate controlling steps in fluid-solid non-catalytic systems; Reactor design for non-catalytic reactions.

**Unit 3**

Non-ideal mixing in reactors; Estimation of mean residence time distribution and dispersion in mixing vessels using tracer studies; Dispersion model and Tanks-in Series model.

**TEXTBOOK AND REFERENCE BOOKS:**

1. Octave Levenspiel, *Chemical Reaction Engineering*, 3rd Edition, John-Wiley & Sons Inc., 1999
2. Scott H. Fogler, *Elements of Chemical Reaction Engineering*, 3rd Edition, PHI Limited, 2004

3. Peter Harriot, *Chemical Reactor Design*, Marcel and Dekker Inc., 2003
4. Froment, Bischoff and De Wilde, *Chemical Reactor Analysis and Design*, 3rd Edition, John-Wiley & Sons Inc., 2011
5. Hugo A. Jakobsen, *Chemical Reactor Modeling: Multiphase Reactive Flows*, Springer-Verlag, 2008

**15CHE312 EQUILIBRIUM STAGED OPERATIONS 3 1 0 4****Unit 1**

Design of mass transfer equipment based on the concept of equilibrium stage;

Distillation: vapor-liquid equilibria, Raoult's law and deviations from ideality, methods of distillation; Equilibrium and operating line concepts; Design calculations by McCabe-Thiele and Ponchon-Savarit methods; Continuous contact distillation (packed tower) design; Extractive and azeotropic distillation, low pressure distillation; Steam distillation; Tray tower equipment.

**Unit 2**

Absorption: Design of tray tower absorbers; Operating characteristics of stagewise and differential contactors; Design calculations for single stage, multistage concurrent and countercurrent absorbers.

Liquid-liquid extraction: Equilibrium in ternary systems; Design calculations for batch and continuous extractors, equipment – spray, packed and mechanically agitated contactors; Pulsed extractors, centrifugal extractors.

**Unit 3**

Leaching: Solid-liquid equilibria; Equipment – batch and continuous types; Calculation of number of stages.

Adsorption and Ion exchange: Theories of adsorption of gases and liquids; Principle of ion exchange; Equipment for batch and continuous operation; Design calculations for adsorption and for ion exchange resins.

Miscellaneous separation processes: Introduction to membrane separation process; Solid and liquid membranes; Reverse osmosis; Electrodialysis.

**TEXTBOOKS:**

1. R. E. Treybal, *Mass Transfer Operations*, 3rd Edition, McGraw Hill, 1981.
2. J. D. Seader and E. J. Henley, *Separation Process Principles*, 2nd Edition, Wiley, 2005.

**REFERENCES:**

1. J. M. Coulson and J. F. Richardson, "Chemical Engineering Vol. II", 4th Edition, Asian Books Pvt. Ltd, India, 1998.

2. W. L. McCabe, J. C. Smith and P. Harriot, "Unit operations of Chemical Engineering", 6th Edition, McGraw Hill, International Edition, 2001.

**15CHE313 MATERIALS TECHNOLOGY 3 0 0 3**

**Unit 1**

Basics of Materials Structure: crystal systems – space lattice – miller indices of atomic planes and directions – small problems in crystallography – crystal defects point, line and surface defects. Mechanical Behaviour of Materials: stress-strain curve – elastic deformation - characteristics of elastic deformation - atomic mechanism of elastic deformation - inelastic deformation - strain time curves – viscous deformation - plastic deformation - slip and twinning - Schmid's law - critical resolved shear stress – Strengthening mechanisms; work hardening - grain boundary hardening, dispersion hardening.

**Unit 2**

Mechanical Testing and Fracture of Materials: Tensile test - stress-strain curves for ductile and brittle materials – proof stress – Compression test – Hardness test – Impact test – Fatigue test – S-N curve – Creep; primary, secondary and tertiary creep - Fracture: Ideal fracture stress – brittle fracture – Griffith's theory cup and cone type fracture Phase Diagrams: solid solution – intermetallic compound, cooling, curves, non-equilibrium cooling - phase rule - Equilibrium diagrams – isomorphous - eutectic, peritectic and eutectoid reactions with examples - Iron-Iron carbide phase diagram.

**Unit 3**

Engineering materials: steels and cast irons - properties and applications - Heat treatment of steels: Annealing – Normalizing Hardening -Tempering matempering – Austempering – Hardenability and its testing – TTT diagram – Surface hardening of steels – carburising, nitriding, induction hardening. Effect of alloying elements on steel - Non-ferrous alloys – copper-aluminum – Magnesium, nickel and zinc-Composite materials – Ceramics.

**TEXTBOOKS:**

1. R. Balasubramaniam, "Callisters Materials Science and Engineering", Wiley, 2013.
2. W F Smith, J Hashemi, R Prakash, "Materials Science and Engineering", McGraw Hill 2008.

**REFERENCES:**

1. L H Van Vlack, Elements of Materials Science and Engineering, Pearson India 2008
2. D. R .Askeland, P. P Fulay, W. J .Wright, The Science and Engineering of Materials, CL Engineering 2012

**15CHE314 PROCESS DYNAMICS AND CONTROL 3 1 0 4**

**Unit 1**

Laplace transformation, transform of standard functions, derivatives and integrals; Open-Loop systems, first order systems: concept of transfer functions, transient response for standard input functions, physical examples of first order systems, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transportation lag.

**Unit 2**

Closed loop control systems, development of block diagram for feedback control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers; transient response of closed – loop control systems; stability of control systems:Routh-Hurwitz criterion, root locus diagrams.

**Unit 3**

Frequency response of closed – loop systems, control system design by frequency response techniques, bode diagram and stability criterion, tuning of controller settings. Introduction to advanced control systems - cascade control, Feed-forward control; Control of chemical processes.

**TEXTBOOKS:**

1. D. Coughanowr, "Process Systems Analysis and Control - 2nd Edn., McGraw Hill, New York, 1991.
2. G. Stephanopoulos, "Chemical Process Control", 8th Edn, Prentice Hall of India. 2009.

**REFERENCE BOOKS:**

1. Dale E. Seeborg, Thomas F. Edgar, Duncan A. Mellichamp, Francis J. Doyle, Process Dynamics and Control, 3rd Edition, John Wiley and Sons, 2011
2. Peter Harriot, Process Control, Tata McGraw Hill, 2008

**15CHE381 HEAT TRANSFER LAB. 0 0 2 1**

Thermal conductivity of solid materials, transient heat conduction, electrical analogies, natural convection, forced convection, heat transfer in pool boiling, condensation heat transfer, steady and un-steady state heat transfer through submerged coils in agitated vessels. Radiation heat transfer, characteristics and efficiency of heat transfer equipments such as heat exchangers, jacketed pans and evaporators.

**15CHE382 STRENGTH OF MATERIALS LAB. 0 0 2 1**

Tensile test on metals and wires - determination of tensile strength, modulus of elasticity, percentage elongation; Hardness tests - Rockwell, Brinell hardness

number; Impact test - Izod and Charpy - impact strength, energy and modulus estimation: Compression test; Torsion test on shafts - determination of Shear stress and modulus of rigidity; Static bending test – fibre stress at limit of proportionality, resilience, modulus of elasticity; Fatigue test - S-N curves; Deflection test on beams; Double shear test.

**15CHE385 CHEMICAL REACTION ENGINEERING LAB. 0 0 2 1**

Lecture on RTD studies; Study of kinetic expressions for first and second order reactions, kinetic studies in batch reactor, Semi batch reactor, Sono batch reactor, CSTR, PFR, Combined reactor in series, RTD study in CSTR in series, RTD study in a PFR.

**15CHE386 MASS TRANSFER LAB. 0 0 2 1**

Measurement of Diffusion coefficient, measurement of mass transfer coefficient, Concentration profile, Wetted wall column, Ternary Liquid-liquid Equilibrium, Leaching, Extraction in packed and plate columns. Steam distillation, Simple distillation, Distillation in packed columns. Absorption Isotherms Drying rate measurements. Characteristics and Efficiency of mass transfer equipments.

**15CHE390 / 15CHE490 LIVE-IN-LAB. 3 cr**

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

**15CHE391 PROJECT BASED LEARNING - PHASE I 1 cr**

Students will study a core Chemical engineering elective and discuss the theoretical (analytical and design) aspects of the subject matter. A minimum of two homework assignments will be given.

At the beginning of the semester, the instructor in consultation with the project group, will assign a project topic (from the elective selected) so that it covers the key concepts associated with the elective subject.

The projects could be based on design, process operational understanding, process optimization, mathematical representation of process, flowsheet simulations, or a research question aimed at developing new understanding on a topic or any other innovative topic.

By the end of the semester the student must submit a report with project objective(s), project plan, methodology, any special requirements (in terms of materials, equipment, and software), and key areas of learning - in consultation with the instructor.

**15CHE396 PROJECT BASED LEARNING - PHASE - II 2 cr**

Students will apply the concepts that they have studied in Project Based Learning - I, and proceed with executing the project as per plan. The instructor provides guidance through tutorial classes to help the students to master problem solving and analytical aspects. There will be requirement of literature review report, two mid-project reports and a final report, each of which will be used towards course evaluation.

**15CHE401 PROCESS DESIGN AND INTEGRATION 3 0 0 3**

**Unit 1**

Chemical process design process, Hierarchy of chemical process design and integration, Newdesign vs. retrofit, approaches, Heuristics for process design. Conceptual Process Synthesis – Diagrams for understanding chemical processes, Structure and hierarchical synthesis of flow sheets.

Reactor Network Synthesis - Reactor type and conditions for reaction systems, geometric techniques for synthesis of reactor networks.

**Unit 2**

Separation system Synthesis – Distillation column sequencing for ideal liquid mixtures, Separation system structure for non-ideal mixtures using distillation / residue curves. Reaction, Separation and recycle systems for batch and continuous processes.

**Unit 3**

Heat Exchanger Network: Synthesis using Pinch Technology – Targets for minimum utilities, area, total cost. Pinch design method for heat exchange network design, Evolutionary synthesis for minimum number of exchanges design. Heat integration of process equipments.

**TEXTBOOK:**

*Robin Smith, Chemical Process Design and Integration, John Wiley & Sons Ltd., New Delhi, 2014.*

**REFERENCES:**

1. Warren D. Seider, J. D. Seader, Daniel R. Lewin, Soemantri Widagdo, *Product and Process Design Principles: Synthesis, Analysis and Design*, 3rd Edn, Wiley, 2010
2. Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz, *Synthesis, and Design of Chemical Processes*, 3rd Edn, Pearson Education, 2008
3. Biegler, L. T., Grossmann, I. E., and Westerberg, A. W. "Systematic Methods for Chemical Process Design", Prentice-Hall, 1997.
4. Douglas, J. M. "Conceptual Design of Chemical Processes", McGraw Hill, 1988.
5. Harry Silla, *Chemical Process Engineering Design and Economics*, Marcel Dekker, Inc., New York, 2003

**15CHE402 PROCESS EQUIPMENT DESIGN AND DRAWING 2 0 2 3**

Design and drawing of chemical engineering equipments – hydrodynamic design, process design, mechanical design and drawing of the following equipments:

**Unit 1**

Pressure Vessels, Storage Tanks, Heat exchangers, Condensers.

**Unit 2**

Evaporators, Dryers, Cooling towers, Crystallizers.

**Unit 3**

Absorption columns, Distillation columns, Extraction columns, Reactors.

**TEXTBOOKS:**

1. M. V. Joshi and V. V. Mahajan, "Process Equipment Design", 3rd Edition, MacMillan India Ltd., 1996.
2. J. M. Coulson and J. F. Richardson, "Chemical Engineering Vol. 6", Asian Books Pvt Ltd, India, 1998.

**REFERENCES:**

1. R. H. Perry, D. W. Green and J. O. Maloney, "Perry's Chemical Engineers Handbook", 7th Edition, 1997.
2. S. D. Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.
3. "Indian Standard Specifications", IS: 2712-1998; IS: 2825-1969; IS: 3233-1965; IS: 4049-1996; IS: 4179-1967; IS: 4503-1967; IS: 4865-1968 Indian Standards Institution, New Delhi.
4. S. Tickoo, "AUTOCAD 2000", Galgotia Publications, New Delhi, 2001.
5. D. Kern, "Process Heat Transfer", McGraw Hill, 1999.

**15CHE403 TRANSPORT PHENOMENA 3 1 0 4****Unit 1**

Review of basic vector algebra and introduction to tensors, Macroscopic – Microscopic-Molecular views of phenomena; Momentum Transport: viscosity,

pressure and temperature effect on viscosity of gases and liquids, Newton's law of viscosity, mechanisms of momentum transport, non-Newtonian fluids & power-law models, derivation of velocity profile using shell balance method, velocity distributions in falling film and circular tube; equations of continuity, motion, and mechanical energy; use of equations of change to solve flow problems; unsteady viscous flow.

**Unit 2**

Energy Transport: Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanisms of energy transport, derivation of temperature profile using shell energy balance (with electrical, nuclear, viscous and chemical heat source); temperature distribution in solids and laminar flow, heat conduction through composite walls, and cylinders; Combined energy flux vector; equation of energy (alternate forms) - applications to specific systems (forced convection laminar flow in tube, tangential flow in annulus, transpiration cooling); unsteady heat conduction in solids.

**Unit 3**

Mass Transport: Diffusivity, mechanisms of mass transport, concentration distribution in solids and in laminar flow, Fick's law, temperature and pressure effect, theory of diffusion in gases and liquids, types of diffusion (ordinary, thermal, pressure, and forced), mass and moles transport, mass & molar average velocities; shell mass balances; concentration distribution through stagnant gas, diffusion in heterogeneous and homogeneous chemical reaction, falling film; Equations of change for multicomponent systems and concentration distribution in turbulent flows: derivation of equation of continuity for binary mixture.

**TEXTBOOK:**

R. B. Bird, W. E. Stewart and E. W. Lightfoot, "Transport Phenomena", 2nd edition, John Wiley, 2002.

**REFERENCES:**

1. R. S. Brodkey and H. C. Hershey, "Transport Phenomena", McGraw Hill, 1988.
2. J. R. Welty, R. W. Wilson and C. W.icks, "Fundamentals of Momentum, Heat, and Mass Transfer", 3rd Edition, John Wiley, 1984.
3. J. S. Slattery, "Advanced Transport Phenomena", Cambridge University Press, 1992.

**15CHE431 BIOCHEMICAL ENGINEERING 3 0 0 3****Unit 1**

Introduction: History and need for biochemical Engineering; Essential life sciences: Biomolecules; Microbial world; Metabolism and Bioenergetics; Cell and their function; Enzymes and enzyme kinetics: Enzymes fundamental concepts, Classification of enzymes; Industrial application of enzymes; Industrially important enzymes; Mechanism of enzymatic reactions; Kinetics: Michaelis-Menten and Briggs Haldane

equation; Evaluation of kinetic parameters; Enzymes inhibition; Factors affecting the reaction rates;

### Unit 2

Immobilized enzyme: Medical and analytical application of immobilized enzyme; Techniques; Immobilized Enzyme kinetics: Effect of mass transfer resistance. Microbial kinetics: Typical growth characteristics of microbial cells, factors affecting growth; Monod's equation; Transport in microbial system: Newtonian and Non-Newtonian behaviour of broths; Agitation and Mixing; Power consumption; Gas-Liquid transport in cells; Transfer resistances; Mass transfer coefficients and their role in scale-up of equipments.

### Unit 3

Bioreactors: Batch and continuous types; High performance bioreactors; Downstream processes and effluent treatment: Recovery and purification of products, different unit operations in down streaming with special reference to membrane separations; Extractive fermentation; Anaerobic treatment of effluents; Typical industrial examples for downstream processing and effluent disposal.

#### TEXTBOOK:

J. E Bailey and D. F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill, International Edition, 2nd Edition, New York, 1986.

#### REFERENCE BOOKS:

1. J. M. Lee, "Biochemical Engineering", 1st Edition, Prentice Hall, 1992
2. H. W. Blanch and D. S. Clark, "Biochemical Engineering", 2nd Edition, CRC Press, 1997.
3. M. L. Shuler and F. Kargi, "Bioprocess Engineering Basic Concepts", Prentice Hall of India, 2002.
4. D. Mukesh and N. G. Sathyanarayana, "Biochemical Engineering", PHI Learning Pvt. Ltd., 2007

## 15CHE432 CHEMICAL PROCESS MODELING AND SIMULATION 3 0 0 3

### Unit 1

Chemical engineering problems; Modeling – Steps involved; Variables – Stream, Unit, and Process variables; Constraints – Conservation relations, Sources and sinks, Material, Energy, Momentum balances; Equilibrium relations, Constitutive models; Common assumptions in modeling; Types of models – Lumped, Distributed, and Staged parameter models; Design variables – Characteristic length, time, velocity, temperature, mass, force; Change of variables; Dimensionless groups in modelling.

Filling and draining tanks: Steady and unsteady states, Varying inlets and outlets, Level and flow control; Mixing tanks: Two and multiple streams, Composition control; Heated tank: Jacketed kettle with steam condensation, Electrical heating, Phase change; Isothermal CSTR: 1st and 2nd order reactions, Enzyme kinetics; Non-isothermal CSTR; Centrifugal separation.

### Unit 2

Shell balances: Flow through a pipe, Continuity equation; Compressible fluid flow, Shock waves; Double-pipe heat exchanger: Steam condensing in shell/tube, Parallel vs counter flow; Pipeline flashing; Isothermal PFR: Component continuity equation, 1st and 2nd order reactions; Non-isothermal PFR: 1st and 2nd order reaction.

Triple effect evaporator; Binary distillation: continuous and batch columns; Multicomponent distillation: Underwood-Gilliland model; Gas absorption into a laminar liquid jet; Tray tower absorption: Kremser-Brown-Sauders equation, rigorous models; Reactive absorption in a wetted wall column; Multistage countercurrent liquid-liquid extraction.

### Unit 3

Selected Systems from the following: Multiple steady states and Stability: Isothermal and Non-isothermal CSTR; Temperature control in a non-isothermal PFR; Packed bed reactor; Polymerization: Bulk and Suspension polymerization; Membrane separation – Cross flow and reverse osmosis; Activated sludge process – secondary bioreactor; Pyrolysis of plastic; Chemical vapor deposition; Continuous, multicomponent distillation column; Dry flue gas desulfurization; Ball mill; Rotary kiln.

#### TEXTBOOK / REFERENCE:

1. W. L. Luyben, *Process Modeling, Simulation and Control for Chemical Engineers*, 2nd Edition, McGraw Hill, 1996.
2. C. L. Smith, R. W. Pike and P. W. Murrill, *Formulation and Optimization of Mathematical Models*, International Textbook Company, USA, 1970.
3. L. T. Biegler, E. I. Grossman and A. W. Westerberg, *Systematic Methods of Chemical Process Design*, Prentice Hall, 1997.

## 15CHE433 ENVIRONMENTAL ENGINEERING FOR PROCESS INDUSTRIES 3 0 0 3

### Unit 1

Water Pollution Control: wastewater characteristics: physical, chemical and bacteriological, Types of pollutants in waste water of chemical industries, Methods of sampling, preservation of samples and analysis. Methods for the treatment of liquid wastes: Physical, chemical and biological methods, Selection and design of equipments. Physical treatment: pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation. Chemical Treatment: Anaerobic with special reference to UASB and aerobic treatment biochemical kinetics, trickling filter, activated sludge process, lagoons, aeration systems, fluidized bed bioreactors; Disinfection, Ion exchange, Electro-dialysis, Reverse Osmosis.

Pollution control in selected process industries – fertilizer industries, petroleum refineries and petrochemical units, pulp and paper industries, Tanning industries, Sugar industries, Dairy, Alcohol industries, Electroplating and metal finishing industries, Radioactive wastes, ranking of wastewater treatment alternatives, Case Studies.

### Unit 2

Solid Wastes Management: Characterization of wastes-hazardous and non-hazardous wastes. Waste disposal and management laws and guidelines; Problems of collection and handling; various processing techniques used in solid waste management - treatment, disposal, utilization and management; value extraction from the wastes;

Industrial waste management and Pollution Prevention: Process modification, alternative raw material, recovery of by co-product, recycle and reuse of waste, energy recovery and waste utilization.

### Unit 3

Air Pollution Control: Sources and effects of air pollutants on physical environment and living systems, Methods of measuring and sampling of gaseous and particulate pollutants, meteorological aspects of air pollution, effects, Selection and Design of particulate and gaseous pollution control equipment; mechanical separation, Bag filter, cyclone separator, electrostatic precipitation, wet gas scrubbing, adsorption and absorption.

#### TEXTBOOKS / REFERENCES:

1. C. S. Rao, "Environmental Pollution Control Engineering," 2nd Edition, New Age International Publishers, 2006.
2. G. Kiely, "Environmental Engineering", Special Indian Edition, Tata McGraw-Hill, 2009.
3. G. Tchobanoglous, F. L. Burton, and H. D. Stensel, "Wastewater Engineering: Treatment and Reuse", 4th Edition, McGraw Hill Science, 2002.
4. S. P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill, 2001.
5. A. P. Sincero and G. A. Sincero, "Environmental Engineering: A Design Approach", Prentice Hall, 1995.
6. H. S. Peavy, D. R. Rowe, and G. Tchobanoglous, "Environmental Engineering", 7th Edition, McGraw Hill, 1987.
7. M. N. Rao and H. V. N. Rao, "Air Pollution", Tata McGraw Hill, 2001.
8. F. Kreith and G. Tchobanoglous, "Handbook of Solid Waste Management", 2nd Edition, McGraw Hill, 2002.

## 15CHE434 INTERFACIAL SCIENCE AND ENGINEERING 3 0 0 3

### Unit 1

Introduction – colloids, surfaces and interfaces, Colloids - classifications and characterizations. Colloids - preparation and purification methods - Surfaces and

interfaces – definitions, description of different surface and interfaces, applications of interfacial engineering - Surface, interfacial tensions and measurement of interfacial tension using different methods - Surface properties.

Attractive forces and van der Waals interactions - Columbic forces and ionic, dipole interactions. Van der Waals forces in polar and non-polar media - Electrostatic and Electrokinetic theories.

Source of interfacial formation and electrical double layer (EDL) - Helmholtz model, Gouy-Chapman model, Debye-Hückel theory on EDL, EDL thickness - Surface potential, Zeta potential, pH effects, calculations - Electroosmosis and Electrophoresis, types, applications.

### Unit 2

Capillary theories, Capillary driving forces in liquid-fluid systems, Solid-Liquid-Fluid Systems: The Effect of Contact Angle - Capillary Flow and Spreading Processes, coefficients, petroleum recovery, measurement of capillary driving forces - Surface tension gradients, marangoni flow, contact angle hysteresis, dynamic contact angles, Practical capillary systems – wetting in fibers, water proofing, wicking process and detergency.

Adsorption – Gibbs surface excess, adsorption equation for Solid-Fluid interfaces, Gibbs adsorption isotherm – Physisorption vs Chemisorption, Thermodynamic considerations, heterogeneous catalysis.

Catalytic poisons, promoters and adsorption isotherms at S-V interfaces, Langmuir, Freundlich, BET adsorption isotherms and surface area calculations, adsorption at S-L interfaces - Adsorption isotherms in solid-liquid systems, nature of the adsorbent surface, environmental effects - Colloidal stability – Coagulation, flocculation, mechanism for colloidal formation.

### Unit 3

Colloidal behaviour, Lennard-Jones 6-12 potential, attractive forces, sources of colloidal stability, critical coagulation concentration -Coagulation kinetics - fast and slow, Smoluchowski equation, DLVO theory, reversible flocculation.

Emulsions - formation, emulsification methods-Emulsifiers and Stabilizing agents, types, functions.

HLB number, PIT and Application of HLB and PIT in Emulsion Formulation - Association colloids - vesicles, micelles and membranes -Surfactant solubility, krafft temperature, and cloud point - Surfactant liquid crystals, micelles, micelle formation - Critical

micelle concentrations (CMC) - factors affecting CMC, additives - Vesicles and bilayer membranes – definitions, applications.

Optical properties - Light scattering, turbidity, light scattering theories - Scattering by small particles, large particles, Rayleigh, Debye and Mie scattering of particles - Foams, Aerosols, Foam stability and microfoams - Rheological properties of colloidal dispersions - viscosity, newtonian and non-newtonian fluids, Electroviscous effects.

**REFERENCE / TEXTBOOKS:**

- 1 Drew Myers, *Surfaces, Interfaces, and Colloids: Principles and Applications*. 2nd Ed., Wiley-VCH, 1999
- 2 D. J. Shaw, *Colloid & Surface Chemistry*, 4th Edition, Butterworth-Heinemann, 2003,
- 3 *Intermolecular and Surface Forces*, Jacob N. Israelachvili, Academic Press, 1992

**15CHE435 MATERIAL CHARACTERIZATION AND SPECTROSCOPIC METHODS 3 0 0 3**

**Unit 1**

Imaging microscopies and Image analysis: Optical Microscopy, Scanning electron microscopy, Scanning probe microscopy, X-ray microscopy and Transmission electron microscopy, Image analysis.

**Unit 2**

X-ray-diffraction, properties of x-rays, review of crystal systems and miller indices, stereographic projections, Laue conditions, bragg's conditions, diffraction methods, phase identifications, electron diffraction methods.

**Unit 3**

EDAX, XPS, scattering methods, Thermal and Thermomechanical analysis: differential scanning calorimetry and Differential thermal analysis. Thermogravimetric analysis, Dynamic mechanical analysis and TMA.

**REFERENCE / TEXTBOOKS:**

- 1 Yang Leng, *Materials Characterization: Introduction to Microscopic and Spectroscopic Methods* 2013, Wiley VCH; ISBN-10: 3527334637, ISBN-13: 978-3527334636.
- 2 B D Cullity and S R Stock, *Elements of X-ray diffraction*, 3rd Ed., Prentice Hall 2001
- 3 K P. Menard *Dynamic mechanical analysis: A practical introduction*, CRC press, 1999

**15CHE436 MODERN SEPARATION METHODS 3 0 0 3**

**Unit 1**

Introduction to binary distillation – The concept of K-factor; Multi-component distillation – Design, Models for multi-component design; Design of distillation columns for more than one feed stream; Pressure drop and tray-efficiency calculations.

**Unit 2**

Nature of Synthetic Membranes, General membrane Equation, Cross-Flow Microfiltration, Ultrafiltration, Reverse Osmosis, Membrane Modules and Plant Configuration, Membrane Fouling, Electrodialysis, Reverse Osmosis Water Treatment Plant, Pervaporation, Liquid Membranes.

Gas Separations - Chromatographic Separations: Elution Chromatography, Band Broadening and Separation Efficiency, Types of Chromatography, Large Scale Elution Chromatography, Selective Adsorption of Proteins, Simulated Countercurrent Techniques, Pressure Swing Adsorption.

**Unit 3**

Combined Reaction and Separation, Comparison with other Separation Techniques - Ionic Separations: Ion Exchange Resins, Resin Capacity, Equilibrium, Exchange Kinetics; Ion Exchange Equipments - Other Techniques: Supercritical Fluid Extraction, Oil Spill Management; Industrial Effluent Treatment by Modern Techniques. Reactive Extraction, Reactive Distillation.

**REFERENCES:**

- 1 J. D. Seader and E. J. Henley, "Separation Process Principles", 2nd Edition, Wiley, 2005.
- 2 R. W. Baker, "Membrane Technology and Applications", John Wiley & Sons Ltd, UK, 2004.
- 3 P. C. Wankat, "Separation Process Engineering", 2nd Edition, Prentice Hall, 2006.
- 4 R. W. Rousseau, "Handbook of Separation Process Technology", Wiley-Interscience, 1987.
- 5 J. M. Coulson and J. F. Richardson, "Chemical Engineering - Volume 2", 5th Edition, Butterworth-Heinemann, 2002.
- 6 Y. Osada and T. Nakagawa, "Membrane Science and Technology", Marcel Dekker, 1992.
- 7 Relevant journal publications.

**15CHE437 NANOSCIENCE AND NANOTECHNOLOGY 3 0 0 3**

**Unit 1**

Nanotechnology Fundamentals - Atomic structure, molecules and phases, surfaces, biosystems, metals, and other materials.

Molecular recognition, nanostructure preparation techniques, top-down and bottom up approach, self-assembly, nano manipulations – overview.

Familiar Nanostructures – SAMs, monolayer protected nanoparticles, quantum dots and core-shell nanoparticles, preparations, characterizations and applications.

**Unit 2**

Nano fabrication methods: Top-down approach – nanolithography techniques – dip pen, projection optical, e-beam, Extreme UV, proximity x-ray and MBE.

Bottom-up approach: self-assemblies – hydrogen bonded, biomimetic and dimensional nanoparticle arrays.

Carbon nanomaterials - Carbon nanotubes and fullerenes: Formation and properties of nanotubes, fullerenes, characterizations and their applications in electronics and energy storage.

Molecular switches – monomolecular in solutions, on surfaces (electron, pH and light driven switches).

### Unit 3

Micro/ Nanoelectronics (Nanowires: transistors, LEDs, Lasers, photodetectors).

Nano-Bio Technology (Lipid and lipid templates, selfassembled monolayers, biological computing, Protein Engineering, biosensors, drug delivery, PDT), Social implications of nanotechnology.

#### REFERENCE / TEXTBOOKS:

1. Massimiliano Di Ventra, Stephane Evoy and James R. Hefflin, Jr, "Introduction to Nanoscale Science and Technology" Kluwer Academic Publishers, 2004
2. T. Pradeep, Nano: The Essentials / Understanding Nanoscience and Nanotechnology, Tata Mcgraw Hill Publishing Company Limited, 2007
3. Cristian Contescu, Karol Putyera, Dekker Encyclopaedia of Nanoscience and Nanotechnology, 2nd Edition, CRC Press Publications, 2009, ISBN 978 0 8493 9639 7 (six volume set)

## 15CHE438 PETROLEUM REFINING AND PETROCHEMICAL TECHNOLOGY 3 0 0 3

### Unit 1

Petroleum refining: Crude oil distillation process – thermal conversion processes. Conventional thermal cracking – vis-breaking and design variables of vis-breaking – coking: Fluid coking, flexi coking, delayed coking and hardware considerations – catalytic conversion processes -fluid catalytic cracking with special reference to catalyst and reactor design configurations – hydro-treating, hydrodesulphurization and hydro-cracking – Reforming: process, catalyst, reactor design configuration – alkylation – isomerization – lube oil manufacturing process, solvent – de-asphalting, solvent de-waxing and hydro finishing – production of PET, waxes and bitumen.

### Unit 2

Petrochemical technology: Petrochemical industry overview, primary raw materials for petrochemicals, first generation petrochemicals – hydrocarbon intermediates and their production, non-hydrocarbon intermediates, olefin production, processing of olefins C4 & C5 cut from steam cracking and fluid cracking.

### Unit 3

Aromatics production, second generation petrochemicals from: methane and synthesis gas derivatives, ethylene and ethylene derivatives, propylene and propylene derivatives, C4 and C5 derivatives, aromatics – benzene, toluene and xylene derivatives – third generation petrochemicals – polymers, elastomers, polyurethanes and synthetic fiber.

#### TEXTBOOKS:

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers, Delhi, 2000.
2. J. H. Gary, G. H. Handwerk and M. J. Kaiser, "Petroleum Refining Technology and Economics", 5th Edition, CRC Press, New York, 2007.
3. G. D. Hobson and W. Pohl, "Modern Petroleum Technology", 6th Edition, Wiley, New York, 2000.
4. B. K. Bhaskara Rao, "A Text on Petrochemicals", Khanna Publishers, New Delhi, 2008.

#### REFERENCES:

1. R. A. Meyers, "Handbook of Petroleum Refining Processes", 2nd Edition, McGraw Hill, New York, 1996.
2. J. A. Moulijn, M. Makkee and A. Van Diepen, "Chemical Process Technology", Wiley, New York, 2001.
3. I. D. Mall, "Petrochemical Process Technology", Macmillan India Ltd, New Delhi, 2007.
4. Sami Matar and Lewis F Hatch, "Chemistry of Petrochemical Processes", Gulf Publishing Company, Houston, Texas, 2000.

## 15CHE439

## POLYMER COMPOSITES

3 0 0 3

### Unit 1

General introduction to composite materials: Concept and definition, classification of composites (CMC, MMC, PMC). Functional roles of reinforcement and matrix and importance of interface. Polymer matrix composites (PMCs): Fiber reinforced and particulate filled polymer composites. Reinforcements (glass, carbon/graphite, Kevlar), Matrices - Thermoset matrices - polyesters, epoxides, phenolics, vinyl esters, polyimides, cyanate esters - Thermoplastic matrices. Choice of reinforcements and matrices for different application needs.

### Unit 2

Fiber reinforced polymer composites (FRPs): Basic rule of mixtures, stress-strain relationships. Tailoring of structural properties through laminar-sequencing and choice of fiber fractions/fiber orientations, to meet design requirements. Effect of environmental conditions on properties. Mechanical behaviour of FRP composites: Fiber controlled and matrix dependent properties (tensile, compressive, shear). Experimental determination of composite properties by standard test methods. Composite constructions: Monolithic composite laminates: unidirectional and bidirectional, multi-axial, 3D, filament wound and braided types.



**Unit 3**

Composite precursors: SMCs, DMCs, BMCs prepreg materials and their choice in specific applications. Fabrication processes for FRP Composites: hand layup, spray up, vacuum bag moulding, compression moulding, filament winding, braiding, pultrusion, RTM, RIM, RRIM, RFI, autoclave moulding, injection moulding etc. Room temperature and hot curing of composites, Joining composite elements and repairs, Recycling of polymer composites.

**TEXTBOOKS:**

1. B. Astrom, "Manufacturing of Polymer Composites", CRC Press, 1997.
2. P K Mallick, "Fiber-Reinforced Composites: Materials, Manufacturing, and Design", CRC Press, 2007.

**REFERENCES:**

1. F. C. Campbell (Ed), Manufacturing processes for advanced composites, Elsevier, 2004.
2. S T Peters (Ed.), "Handbook of Composites", Springer, 1998.

**15CHE440 POLYMER MATERIALS - STRUCTURE 3 0 0 3**  
**PROPERTY RELATIONS**

**Unit 1**

Structure of polymers – thermoplastic – thermoset, rubber - Linear, branched, crosslinked, and network polymers - Homochain and hetero atomic chain polymers - Copolymers - Linear and cyclic arrangement - Prediction of polymer properties, group contribution techniques, topological techniques - Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

Mechanical properties - Stress-strain properties of polymers - Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness - Crazeing in glassy polymers - Ductile brittle transition. Effect of additives on mechanical properties of polymers - Creep, stress relaxation, and fatigue.

**Unit 2**

Thermodynamic and transition properties - Transition temperature in polymers, glass transition (T<sub>g</sub>), melt transition (T<sub>m</sub>), relationship between T<sub>g</sub> and T<sub>m</sub> - other transitions like β-transitions, upper and lower glass transition temperatures - Prediction of T<sub>g</sub> and T<sub>m</sub> of polymers by group contributions. Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy - Calculation of heat capacities of polymers.

Electrical and optical properties - Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor - effect of frequency of voltage

and temperature on dielectric properties - Prediction of molar polarization and effective dipole moment. Effect of additives on electrical properties of polymers.

**Unit 3**

Optical properties - Effect of polymer structure on optical properties - clarity, transparency, haze, transmittance, reflectance, and gloss - Prediction of refractive indices of polymers by group contributions.

Chemical Properties - Cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers - Prediction of solubility parameter - Effect of polymer structure on solubility in solvents and oils - Influence of structure in prediction of flame retardancy, water repellency - Chemical resistance of polymers - Polymer toxicity.

**TEXTBOOKS:**

1. J. A. Brydson, "Plastics Materials" Butterworth- Heinemann – Oxford, 7th Ed., London, 1999
2. Maurice Morton, "Rubber Technology", 3rd Ed, Kluwer Academic Pub, Dordrecht, Netherlands, 1999
3. Manas Chanda and Salil K. Roy, "Plastics Technology Handbook", CRC Press, Atlanta, 2007

**REFERENCE BOOKS:**

1. D. W. Van Krevelen and P. J. Hoftyzen, "Properties of Polymer", 3rd Edition Elsevier Scientific Publishing Company Amsterdam – Oxford – Newyork. 1990.
2. Jozef. Bicerano, "Prediction of Polymer Properties", Second Edition, Marcel Dekker Inc. New York, 1995.

**15CHE441 POLYMER PROCESSING 3 0 0 3**

**Unit 1**

Physical Basis of Polymer Processing – Mixing - distributive and dispersive mixing equipments. Extrusion - Features of a Single Screw Extruder, Analysis of Flow, Aspects of Screw Design, Operating Point. Twin Screw Extrusion - Processes – Pipe, Profile, Blown Film, Wire and Cable coating, Fibre, Film and sheet extrusion, Co extrusion - Melt Fracture – Sharskin-Die swell.

**Unit 2**

Injection Moulding – Principles - Moulding Cycle - Reciprocating Screw injection Moulding Machine - Types of Clamping Units - PVT diagram - Aspects of Product Quality - Hot Runner Moulding - Gas Assisted Injection Moulding. Blow Moulding – Principles - Injection Blow Moulding – Extrusion Blow Moulding – Stretch Blow Moulding - Trouble shooting – Thermoforming - Vacuum Forming - Pressure Forming - Material Stress and Orientation - Applications in Packaging.

**Unit 3**

Compression and Transfer Moulding - Types of Moulding Machines - Transfer Moulding - Trouble shooting – Comparison. Polymers in Rubbery State - Calendering process - Types of Calendars, Roll Deflection and Cambering - Rotational Moulding - Types of machines, Moulds, Materials. Fibre Reinforced Plastics – Materials - Layup processes - SMC, DMC - Resin Transfer Moulding - Pultrusion, Bag Moulding Processes - Filament Winding. Joining and machining of Plastics - Welding of Plastics - Ultrasonic, Induction, Hotplate, High Frequency. Solvent Cementing - Adhesive Bonding.

**TEXTBOOKS:**

1. B. Strong, "Plastics: Materials and Processing", Prentice Hall, 2012.
2. D. H. Morton-Jones, "Polymer Processing", Chapman & Hall, 1989.

**REFERENCES:**

1. C. A. Harper (Ed), "Handbook of Plastic Processes", John and Wiley 2006.
2. M. L. Berins (ed.), "Plastics Engineering Handbook of The Society of The Plastics Industry", Springer, 2012.

**15CHE442****PROCESS INSTRUMENTATION****3 0 0 3****Unit 1**

Introduction, general principles of measurement, classification of instruments, elements of an instrument, direct and inferential measurement; Static and dynamic characteristics of instruments, errors in measurements & error Analysis; Classification of sensors and transducers, amplifier signal conditioner, signal isolation, transmission, display, data acquisition modules, interfaces, recording. Control centre, instrumentation diagram.

Temperature measurement: Expansion thermometers - constant-volume gas thermometer, pressure spring thermometer, volumetric and pressure thermometers; Thermoelectric temperature measurement - Thermoelectricity, industrial thermocouples; Resistance thermometers - industrial resistance thermometers, null-bridge resistance thermometers, deflectional resistance thermometers; Radiation temperature measurement - radiation pyrometers, photoelectric pyrometers and optical pyrometers.

**Unit 2**

Measurement of pressure and vacuum: Pressure, vacuum and head; liquid column manometers - U-tube type, well type and inclined type, micromanometers; Low pressure measurement - keneometer, McLeod gage, thermal conductivity gauge; Barometer method for atmospheric pressure measurement; pressure measurement using bourdon tube, flat and corrugated diaphragms, and capsules; Measurement of pressure in corrosive fluids using liquid seal and diaphragm seal.

Hydrostatic type, Elastic Element type, Electrical Type and other type of instruments like Neleod Gauge, Thermocouple gauge, Knudson Gauge, Ionization Gauge.

Flow measurement: Variable area and variable head flow meters, volumetric and mass flow rate meters, linear velocity measurement systems, anemometers; Measurement of Head and Level: Density and specific gravity - constant volume hydrometer, air pressure balance method, gas density detector and gas specific gravity measuring system; Level measurement: pressure type, resistance & capacitance type, sonic & ultrasonic, thermal type level meters, level measurement in open vessels and in pressure vessels, solid level detectors.

**Unit 3**

Viscometers: Redwood, Saybolt, Engler, Cup and Cone type, Rheo & other types of viscometers; Composition analysis - Gas analysis by thermal conductivity, analysis of moisture in gases (humidity), psychrometer method, hygrometer method, dew-point method for moisture analysis in gases, measurement of moisture solids; pH measurement; Gas analysis by thermal conductivity, polarography & chromatography; Composition analysis using spectroscopic methods; On line instrumentation in modern plants.

**TEXTBOOK:**

1. Jain R. K., *Mechanical and Industrial Measurements*, Khanna

**REFERENCES:**

1. Ernest O. Doebelin, "Measurements systems Application & design", McGraw Hill Publishing, 1990.
2. T. G. Beckwith, R. D. Marangoni and J. H. Lienhard, "Mechanical Measurements", 6th Edn, Prentice Hall, 2006.
3. Eckman D. P., *Industrial Instrumentation*, Wiley Eastern.
4. Patranabis, D., "Principles of Industrial Instrumentation" 2nd ed. Tata McGraw Hill, New Delhi.

**15CHE443****PROCESS INTENSIFICATION****3 0 0 3****Unit 1**

Electrically Enhanced Processes; Microfluidics: Electrokinetics, Magnetohydrodynamics, Opto-microfluidics; Pressure-based Enhancement; Compact Heat Exchangers: Plate Heat Exchanger, Printed-Circuit Heat Exchanger, Spiral Heat Exchanger, Chart-Flo Heat Exchanger, Polymer-Film Heat Exchanger, Foam Heat Exchanger, Mesh Heat Exchanger; Micro-heat exchangers: Small Channels and Designs; Significance of dimensionless numbers.

**Unit 2**

Intensified Reactors: Spinning Disk Reactors; Oscillatory Baffled Reactors; Taylor-Couette Flow Reactor Microreactors: Basics & Applications; HEX Reactors; Induction

Heating, Sonochemistry, Microwave Enhancement, Plasma Enhancement, Laser-Induced Reactions; Choice of reactors based on reaction type; Operating regimes of reactors - Dimensionless Analysis.

Supercritical Operation; Intensified Separation: Distillation Columns – Divided Wall Columns, Compact Heat Exchangers; HiGee; Centrifuges; Membrane-based Separation; Intensified Mixing: In-line Mixers: Static Mixer, Mixing on a Spinning Disk, Induction-Heated Mixer;

### Unit 3

Reactive Separations: Reactive Distillation and Reactive Extraction; Membrane Reactors - Applications to dehydrogenation; Steam-methane reformation;

Case studies: Reaction separation of Plastic/Biomass pyrolysis; Petrochemicals and Fine Chemicals, Refineries, Bulk Chemicals, & Nuclear Industry.

#### TEXTBOOK / REFERENCES:

1. David Reay, Colin Ramshaw, and Adam Harvey, "Process Intensification: Engineering for Efficiency, Sustainability and Flexibility" Butterworth-Heinemann, 2008
2. Frerich J. Keil, "Modeling of Process Intensification", Wiley-VCH, 2007  
Relevant journal publications

## 15CHE444 SAFETY AND HAZARD MANAGEMENT IN CHEMICAL INDUSTRIES 3 0 0 3

### Unit 1

Hazard identification: General hazards of plant operation toxic hazards, fire and explosions – hazards. Transport of chemicals with safety unforeseen deviations, emergency management, planning for safety, selecting a basics of safety – preventive and protective measures, safety based on emergency, relief systems, safety based on containment operational safety procedural instructions – routine checks, process and product changes, safety checks, checklist for safety, leaks and detection.

### Unit 2

Hazards of plant operation: Toxic hazards, fire and explosion hazards, reaction hazards, literature calculations & explosions screening, normal reaction, gas evolution, characterizing runaway, control and mitigation of gas emanations, absorption with chemical reaction, health and environmental effects. Special problem of developing countries, safety gadgets, dispersions, degree of hazards, disposals, hierarchy of options, threshold limits, laws of safety, accident reporting.

### Unit 3

Storage, central handling safety, unintentional spills, runoff emits, containment economics, waste disposal and environmental protection, incineration, alternatives. Risk analysis, evaluation, mitigation, Hazop, Hazan, definition, probability quantification – risk, engineering, clean technology, initiatives, standards, emergency handling, accident investigation, legislation, nil-risk quantification methods. Case histories of accidents, examples of hazards assessment, examples of use of Hazan, explosion hazards in batch units, technical process, documentation for hazardous chemicals, format and methods.

#### TEXTBOOKS:

1. A. K. Rohatgi, "Safety handling of Hazardous Chemicals", J. K. Enterprises, Mumbai, 1986.
2. S. K. Shukla, "Enviro Hazards and Techno Legal Aspects", Shashi Publications, Jaipur, 1993.
3. G. L. Wells and R. M. C. Seagrave, "Flow sheeting for safety", Institution of Chemical Engineering, London, 1977.

#### REFERENCES:

1. T. Kletz, "Learning from Accidents", 3rd Edition, Gulf Professional Publishing, London, 1988.
2. J. Barton and R. Rogers, "Chemical Reaction Hazards – A Guide to Safety", Institution of Chemical Engineering, Gulf Professional Publishing, London, 1997.

## 15CHE445 SOLAR ENERGY 3 0 0 3

### Unit 1

Solar energy  
Solar radiation, its measurements and analysis. Solar angles, day length, angle of incidence on tilted surface, Sunpath diagrams, Shadow determination. Extraterrestrial characteristics, Effect of earth atmosphere, measurement & estimation on horizontal and tilted surfaces.

#### Solar cell physics

p-n junction, homo and hetro junctions, Metal-semiconductor interface, Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, efficiency measurements, high efficiency cells, Tandem structure.

### Unit 2

Solar cell fabrication technology  
Preparation of metallurgical, Electronic and Solar grade Silicon, Production of Single Crystal 'Si', Chocharlski (CZ) and Float Zone (FZ) method for preparation of silicon, procedure of masking, photolithography and etching, Design of a complete silicon, GaAs, InP solar cell. High efficiency III-V, II-VI multijunction solar cell, a-Si-H based solar cells, Quantum well solar cell, Thermophotovoltaics. Nanosolar cells. Thin film technologies.

**Solar Cell Characterization**

Characterization of solar cells: IV characteristics, impedance, incident photon-to-current conversion efficiency (IPCE), intensity modulated photovoltage spectroscopy (IMPV), lifetime measurements.

**Solar photovoltaic system design**

Solar cell arrays, system analysis and performance prediction, shadow analysis, reliability, solar cell array design concepts, PV system design, Design process and optimization, Detailed array design, storage autonomy, Voltage regulation, maximum tracking, Power electronic converters for interfacing with load and grid, use of computers in array design, Quick sizing method, Array protection and troubleshooting.

**Unit 3****Emerging Photovoltaic Technologies**

Working principle, characterization and applications of: organic solar cells, dye sensitized solar cells, quantum dot solar cells, bulk heterojunction solar cells

**SPV applications**

Centralized and decentralized SPV systems, stand alone, hybrid and grid connected systems, system installation, operation and maintenances, case studies and field experience, PV market analysis and Economics of SPV systems.

**TEXTBOOKS:**

1. John W Twidell and A D Weir, *Renewable Energy Resources*, ELBS
2. T Bhattacharya, *Terrestrial Solar Photovoltaic*, Narosa Publishers Ltd, New Delhi

**REFERENCE BOOKS:**

1. Garg H P., Prakash J., *Solar Energy: Fundamentals & Applications*, Tata McGraw Hill, New Delhi, 1997
2. S P Sukhatme, *Solar Energy*, Tata McGraw Hill
3. J F Kreider and Frank Kreith, *Solar Energy Handbook*, McGraw Hill
4. D Y Goswami, Frank Kreith and J F Kreider, *Principles of Solar Engineering*, Taylor & Francis.

**15CHE470****FUNDAMENTALS OF MANAGEMENT****3 0 0 3****Unit 1**

Introduction - Managers and Management. The historical roots of contemporary management practices - the pre-modern era, classical contributions, human resources approach, the quantitative approach. The Management Environment - A global market place, emphasis on technology, society and managers, entrepreneurship.

Foundations of Planning - Planning in uncertain environments, types of plans, management by objectives. The importance of organizational strategy, strategic framework, quality as a Strategic weapon. Foundations of Decision Making - The decision-making process, making decisions - the rational model, modifications of the rational model. Decision making - a contingency approach, decision-making styles, making decisions in groups.

**Unit 2**

Basic Organization Designs - The elements of structure, contingency variables affecting structure, organization design applications, learning organization, organization culture.

Managers and the Human resource management process - Employment planning, recruitment and selection, orientation, training, and development, performance management, compensation and benefits, managing change, stress and innovation, change process, organizational change and member resistance, making changes in the organization. Stress - the aftermath of organizational change, stimulating innovation.

**Unit 3**

Foundations of Individual and Group behaviour - Explaining and predicting behaviour, personality, perception, learning, foundations of group behaviour. Understanding work teams - types of work teams, characteristics of high-performance work teams. Motivating and rewarding employees - motivation and individual needs, early theories of motivation, contemporary theories of motivation. Leadership and Trust - Managers versus leaders, trait theories of leadership, behavioral theories of leadership, contingency theories of leadership, emerging approaches to leadership, contemporary leadership issues, building trust. Communication and Interpersonal skills - understanding communication, communication and Information Technology, developing interpersonal skills.

Foundations of Control - the importance of control, types of control, control implications for managers, the dysfunctional side of control.

**TEXTBOOK:**

Stephen P. Robbins, David A. DeCenzo, Sanghamitra Bhattacharya, Madhushree Nanda Agarwal. "Fundamentals of Management" – Pearson Prentice Hall, Sixth Edition

**15CHE471 MANAGERIAL ECONOMICS AND ACCOUNTING 3 0 0 3****Unit 1**

Introduction to Economics and managerial Decision Making, the Economics of a business, a brief review of important economic terms and concepts; Supply and

Demand - market demand, market supply, determinants of supply and demand, short run market changes and long run market analysis, comparative statics analysis, Demand Elasticity - the economic concept of elasticity, the price elasticity of demand, the cross-elasticity of demand, income elasticity, other elasticity measures, elasticity and total revenue; Elasticity of Supply. Applications of elasticity. Marginal utility, the law of diminishing marginal utility.

The theory and estimation of production - the production function, a short-run analysis of total, average, and marginal product, the three stages of production in the short run, long run and the law of diminishing returns, derived demand and the optimal level of variable input usage. Forms of production function.

### Unit 2

The Theory and Estimation of Cost - the importance of Cost in managerial decisions, the relationship between production and cost, the short-run cost function, the long-run cost function, economies of scale.

Pricing and output decisions - Competition and market types, pricing and output decisions in perfect competition, selecting optimum output level, competitive market in the long run; Pricing and output decisions in monopoly markets, implications for managerial decision making. Pricing and output decisions in monopolistic competition; oligopoly and market concentration, pricing in oligopolistic market.

### Unit 3

Management accounting: Balance Sheet and Profit and Loss account – financial statements, assets, liabilities, and owner's equity, relationship between assets, liabilities and owner's equity, forms of the balance sheet, profit and loss account, relation between balance sheet and profit and loss account. Cost classifications and allocation - nature of cost, historical and future costs, cost classifications in a manufacturing firm, cost concepts for planning and control, cost allocation; cost-volume-profit analysis and operating leverage; Break-even analysis, break-even point, operative leverage.

Capital expenditure planning - nature of investment decisions, investment evaluation criteria, time value of money, net present value method, internal rate of return method, profitability index, payback period, accounting rate of return method, cash flows for investment analysis. Capital budgeting process.

*Paul G. Keat, Philip K. Y. Young, Sreejata Banerjee "Managerial Economics" Economic Tools for Today's Decision Makers – Sixth Edition.*  
*I M Pandey, "Management Accounting", A Planning and Control Approach, Vikas Publishing House Pvt Ltd.,*

## 15CHE472 PROJECT ENGINEERING OF PROCESS PLANTS 3 0 0 3

### Unit 1

Scope of project engineering - the role of project engineer - R & D - TEFR - plant location and site selection - preliminary data for construction projects - process engineering – flowdiagrams - plot plans - engineering design and drafting. Planning and scheduling of projects - bar chart and network techniques.

### Unit 2

Business and legal procedures: Procurement operations, Organization and operation of procurement department, Procurement procedure, General purchaser-vendor practices, contracts and contractors, project financing, statutory sanctions.

Details of engineering design and equipment selection - design calculations excluded -Vessels, heat exchangers, process pumps, compressors and vacuum pumps, motors and Turbines, other process equipment

### Unit 3

Details of engineering design and equipment selection II - design calculations excluded - piping design, thermal insulation and buildings, safety in plant design, plant constructions, start up and commissioning.

Critical path method (CPM) and Programme evaluation and review technique (PERT) in project engineering.

### REFERENCE BOOKS

1. Peter Watermeyer, *Handbook for Process Plant Project Engineers*, Wiley, 2002
2. Howard F. Rase, M. H. Barrow, *Project engineering of process plants*, Wiley, 1957
3. Peter S. Max & Timmerhaus, *Plant design and economics for chemical engineers*, Mc Graw Hill, 2002.
4. B. C. Punmia & K. K. Khandelwal, *Project Planning and Control with PERT & CPM*, Firewall Media, 2002
5. Srinath L. S., *PERT AND CPM*, 3rd Edn Affiliated East Press Pvt. Ltd., New York, 2001.
6. Perry J. H., *"Chemical engineering handbook"* 7th ed. McGraw Hill, 1997.
7. Ernest E. Ludwig, *Applied project engineering and management*, Gulf Pub. Co, 1988.
8. R K Sinnott, *Chemical Engineering Design: Chemical Engineering Design, Chemical Engineering Technical Series*, Elsevier, 2014.

## 15CHE481 CHEMICAL PROCESS CONTROL LAB. 0 0 2 1

Calibration of temperature, pressure and flow measuring instruments, Dynamics of first order, second order, interacting and non-interacting systems, Control valve

characteristics, Study of control systems involving temperature, pressure, flow and level, Study advanced control strategies and Controller tuning.

**15CHE482 COMPUTER AIDED DESIGN OF CHEMICAL PROCESS LAB. 1 0 2 2**

Introduction to Aspen PLUS/ HYSYS; Thermodynamic property methods; Solution strategies; Simulation of pressure changing devices (Pumps, Compressors and Turbine); Simulation of two-phase and three phase separation units, Simulation of heat exchangers, Simulation of reactors (Plug Flow, Mixed Flow, Conversion, Gibbs, Equilibrium reactors and their combinations); Simulation of Distillation, Absorption and Extraction columns;

Case study set up and Sensitivity analysis.

**15CHE495 PROJECT PHASE I 2 cr**

Identification of the problem based on the current need gaps of the industry / knowledge / other academic / theoretical aspects; literature survey, identification of the project deliverables, identification of materials / equipment requirements, preparation of the methodology for the experimentation, and procurement of the materials. Presentation of project progress report to the department for evaluation at the end of the semester.

**15CHE499 PROJECT PHASE II 10 cr**

Setting up of the experimental work (hardware/software), carrying out the experimental work, carrying out material characterization if required, analysis of the results, discussion and interpretation of the results, validation of the hypothesis, and reporting project outcome in the approved format.

Presentation of the work / findings to the faculty for review and feedback three times during the semester. The final project will be evaluated by expert panel consisting of internal and external examiners.

**15CHY100 CHEMISTRY 3 0 0 3**

**Unit 1**

Chemical Bonding

Review of orbital concept and electronic configuration, electrovalency and ionic bond formation, ionic compounds and their properties, lattice energy, solvation enthalpy and solubility of ionic compounds, covalent bond, covalency, orbital theory of

covalency - sigma and pi bonds - formation of covalent compounds and their properties. Hybridization and geometry of covalent molecules - VSEPR theory - polar and non-polar covalent bonds, polarization of covalent bond - polarizing power, polarisability of ions and Fajan's rule, dipole moment, percentage ionic character from dipole moment, dipole moment and structure of molecules - co-ordinate covalent compounds and their characteristics, molecular orbital theory for H<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub> and CO, metallic bond - free electron, valence bond and band theories, weak chemical bonds – inter and intra molecular hydrogen bond - van der Waals forces.

**Unit 2**

Thermodynamic Parameters

Stoichiometry - mole concept, significance of balanced chemical equation - simple calculations - Conditions for occurrence of chemical reactions - enthalpy, entropy and free changes - spontaneity – Thermochemistry - heats of reactions - (formation, combustion, neutralization) - specific heats - variation of enthalpy change with temperature - Kirchhoff' relation (integrated form) - bond enthalpy and bond order - Problems based on the above.

Kinetics

Review of molecularity and order of a reaction, rate law expression and rate constant - first, second, third and zero order reactions, pseudo-first order reactions (pseudo-unimolecular reactions) - complex reactions - equilibrium and steady state approximations - mechanism of these reactions - effect of temperature on reaction rates - Arrhenius equation and its significance, Michaelis Menden kinetics-enzyme catalysis.

**Unit 3**

Electrochemistry

Electrolytes - strong and weak, dilution law, Debye-Huckel theory, faraday's laws, origin of potential, single electrode potential, electrochemical series, electrochemical cells, Nernst equation and its application, reference electrodes - SHE, Ag/AgCl, Calomel.

Photochemistry

Photochemistry, laws of photochemistry - Stark-Einstein law, Beer-Lamberts law, quantum efficiency-determination, photochemical processes - Jablonsky diagram, internal conversion, inter-system crossing, fluorescence, phosphorescence, chemiluminescence and photo sensitization, photo polymerization.

**REFERENCE BOOKS**

*Physical chemistry, Puri and Sharma*

*Inorganic chemistry, Puri and Sharma*

**15CHY181****CHEMISTRY LAB.****0 0 2 1**

1. Acid base titration (double titration)
2. Complexometric titration (double titration)
3. Redox (permanganometry) titration (double titration)
4. Conductometric titration
5. Potentiometric titration
6. Ester hydrolysis

**15CHY231****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".

**15CHY232****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.

**15CHY233****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).

**15CHY234****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 - ferromagnets and ferrimagnets. One-dimensional conductors - quasi one and two-dimensional super conductor. Fullerides - paramagnetic conductors and superconductors. Electron transfer salt based ferromagnets: nitroxide, metallocene and ferric magnet-based ferromagnets - 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<sub>4</sub>NO<sub>3</sub>, ammonium perchlorate (AP), NH<sub>4</sub>ClO<sub>4</sub>, ammonium dinitramide (AND), NH<sub>4</sub>N(NO<sub>2</sub>)<sub>2</sub>, hydrazinium nitroformate (HNF), N<sub>2</sub>H<sub>5</sub>C(NO<sub>2</sub>)<sub>3</sub> 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", Dhanpat Rai & 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).

**15CHY235****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 - piezo 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 (Grothters-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<sub>2</sub>S - PH<sub>3</sub> - CO<sub>2</sub> - SO<sub>x</sub> - NO<sub>x</sub> - 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.

15CHY236

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<sub>60</sub> - superconductivity in C<sub>60</sub>, 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<sub>2</sub> 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 Hefflin, "Introduction to nanoscale science and technology", Kluwer Academic Publishers, (2004).
4. William A Goddard, III, Donald W Brenner, Sergey Edward Lyshevski and Gerald J. Lafrate, "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).

**15CHY237****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).

**15CHY238****COLLOIDAL AND INTERFACIAL CHEMISTRY****3 0 0 3****Unit 1**

Introduction to surfaces, interfaces and colloids: Molecular origin, Surface phenomena and structure of interfaces, Surfactants structure, colloids in action - shapes and size distribution, Types of interaction forces - Physical and Chemical interaction, Classification of physical forces - Vander Waals force, electrostatic forces.

The Adsorption Phenomena - Structure and Properties of Adsorption Layers at the Liquid-Gas Interface, Principles of adsorption thermodynamics, The Gibbs equation, Structure and properties of the adsorption layers at the air-water interface.

**Unit 2**

Interfaces between Condensed Phases - Wetting, The interfaces between condensed phases in two-component systems, Adsorption at interfaces between condensed phases.

Thermodynamics - Adsorption, energy consideration of physical adsorption vs chemisorptions, Gibbs adsorption equation, Langmuir isotherm, BET isotherm, adsorption at solid-liquid interfaces. Emulsions - formation and stability, HLB number, PIT (Phase Inversion Temperature) foams, aerosols, Microemulsions, vesicles, micelles and membranes - applications of various colloidal systems.

**Unit 3**

Characterization of Colloids, Rheological properties - Classification, Interfacial rheology, Interfacial tension, Electrochemistry of interfaces - Electric double layer.

Stability of charge stabilized colloids, DLVO theory, Hamaker constant, Boltzmann distribution, Debye length, specific ion adsorption, stern layer, electrostatic, steric and electrosteric stabilization, zeta potential, surface tension, wetting and spreading, contact angle - Young's modulus, practical application - solid surfaces - surface mobility, characteristics and formation.

**TEXTBOOKS:**

1. D. Myers, "Surfaces, Interfaces and Colloids: Principles and Applications", 2nd Edition, Wiley-VCH, 1999.
2. T. Cosgrove, "Colloid Science: Principles, Methods and Applications", 2nd Edition, Wiley-Blackwell, 2010.

**REFERENCES:**

1. P. C. Hiemenz and R. Rajagopalan (Editors), "Principles of Colloid and Surface Chemistry", 3rd Edition, Academic Press, New York, 1997.
2. J. W. Goodwin, "Colloids and Interfaces with Surfactants and Polymers", John-Wiley and Sons Ltd, 2004
3. William Harde, "Colloids and Interfaces in Life Sciences", Marshall Dekker Inc. 2003

**15CHY239****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. K. I. Ramachandran, G Deepa and K Namboori, "Computational Chemistry and Molecular Modeling - Principles and Applications", Springer-Verlag, Berlin, Heidelberg, 2008, ISBN-13 978-3-540-77302-3.
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 Foresman 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).

**15CHY241****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 (MFC) 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 A J, "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. Rummyantsev E and Davydov A, "Electrochemical machining of metals", Mir, Moscow, (1989).

**15CHY242****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. Van Loon 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 V P and Ritu, "Environmental Chemistry", Pragati Prakashan, Meerut, (2000).

**15CHY243****FUELS AND COMBUSTION****3 0 0 3****Unit 1**

Fuels - Solid fuels - Classification, preparation, cleaning, analysis, ranking and properties - action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification.

Liquid fuels – Petroleum - origin, production, composition, classification, petroleum processing, properties, testing - flow test, smoke points, storage and handling.

Secondary liquid fuels - Gasoline, diesel, kerosene and lubricating oils. Liquid fuels - refining, cracking, fractional distillation, polymerization. Modified and synthetic liquid fuels. ASTM methods of testing the fuels.

**Unit 2**

Gaseous fuels - Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG - manufacture, cleaning, purification and analysis. Fuels for spark ignition engines, knocking and octane number, anti knock additives, fuels for compression, engines, octane number, fuels for jet engines and rockets.

Flue gas analysis by chromatography and sensor techniques.

**Unit 3**

Combustion: Stoichiometry, thermodynamics. Nature and types of combustion processes - Mechanism - ignition temperature, explosion range, flash and fire points, calorific value, calorific intensity, theoretical flame temperature. Combustion calculations, theoretical air requirements, flue gas analysis. combustion kinetics – hydrogen - oxygen reaction and hydrocarbon - oxygen reactions.

Rocket propellants and Explosives - classification, brief methods of preparation, characteristics; storage and handling.

**TEXTBOOK:**

*Fuels and Combustion, Samir Sarkar, Orient Longman Pvt. Ltd, 3rd edition, 2009.*

**REFERENCE:**

1. *Fuels - Solids, liquids and gases - Their analysis and valuation, H. Joshua Philips, Biobliflife Publisher, 2008.*
2. *An introduction to combustion: Concept and applications - Stephen R Turns, Tata Mc. Graw Hill, 3rd edition, 2012.*
3. *Fundamentals of Combustion, D P Mishra, 1st edition, University Press, 2010*
4. *Engineering Chemistry - R. Mukhopadhyay and Sriparna Datta, Newage International Pvt. Ltd, 2007.*

**15CHY244****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 behaviour and solvent attributes of supercritical CO<sub>2</sub>, 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<sub>2</sub> 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.*

**15CHY245****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.

Electroanalytical 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 spectrophotometry - 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 J R, "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).

**15CHY246****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, anaesthetics, antihypertensive drugs, analgesics, histamine and anti-histamine agents.

**TEXTBOOKS:**

1. Rama Rao Nadendla, "Principles of Organic Medicinal Chemistry", 1st edition, New age international (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", 7th edition, J. B. Lippincott company, Philadelphia, (1977).
2. Burger A, "Medicinal Chemistry", 3rd edition, Wiley Interscience, Newyork, (1970).
3. Graham L P, "An Introduction to Medicinal Chemistry", 3rd edition, Oxford university Press, (2005).

**15CHY247****MODERN POLYMER COMPOSITES****3 0 0 3****Unit 1**

General introduction to composite materials: Concept and definition, classification of composites (CMC, MMC, PMC). Functional roles of reinforcement and matrix and importance of interface. Polymer matrix composites (PMCs): Fiber reinforced and particulate filled polymer composites. Reinforcements (glass, carbon/graphite, Kevlar), Matrices - Thermoset matrices - polyesters, epoxides, phenolics, vinyl esters, polyimides, cyanate esters - Thermoplastic matrices. Choice of reinforcements and matrices for different application needs.

**Unit 2**

Fiber reinforced polymer composites (FRPs): Basic rule of mixtures, stress-strain relationships. Tailoring of structural properties through laminar-sequencing and choice of fiber fractions / fiber orientations, to meet design requirements. Mechanical behavior of FRP composites: Fiber controlled and matrix dependent properties. Fibre volume fraction, tensile, shear, compressive, flexural, thermo elastic and off – axis responses of lamina and laminates - notched strength – fracture toughness - nondestructive testing. Effect of environmental conditions on properties.

**Unit 3**

Composite precursors: SMCs, DMCs, BMCs prepreg materials and their choice in specific applications. Fabrication processes for FRP Composites: hand layup, spray up, vacuum bag moulding, compression moulding, filament winding, braiding, pultrusion, RTM, RIM, RRIM, RFI, autoclave moulding, injection moulding etc. Room temperature and hot curing of composites, Nanocomposites: Introduction; Nanoscale Fillers – Clay, POSS, CNT, nanoparticle fillers; Processing into nanocomposites; Modification of interfaces; Properties. Applications. Joining composite elements and repairs, Recycling of polymer composites.

**TEXTBOOKS:**

1. B. Astrom, "Manufacturing of Polymer Composites", CRC Press, 1997.
2. P K Mallick, "Fiber-Reinforced Composites: Materials, Manufacturing, and Design", CRC Press, 2007.

**REFERENCES**

1. F. C. Campbell (Ed), Manufacturing processes for advanced composites, Elsevier, 2004.
2. S T Peters (Ed.), "Handbook of Composites", Springer, 1998.

**15CHY248****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 - SN1 and SN2 reactions, nucleophilic substitution at aliphatic sp<sup>2</sup> 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 - benzylic acid rearrangement - reaction mechanism in basic media - Mannich reaction - enols and enolates.

Reaction involving acids and other electrophiles: 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 benzyne - Baeyer-Villiger 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 - SRN 1 reaction - radical ions - Birch reduction - Hofmann-Löffler-Freytag reaction - Barton reaction - McMurry reaction.

Pericyclic reaction: Representative of molecular orbitals of ethylene, butadiene and hexatriene molecules - Woodward - Hoffmann 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, McGraw Hill, (2004).

**15CHY249 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.

**TEXTBOOKS:**

1. E. L. Eliel, "Stereochemistry of Carbon Compounds", McGraw-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).

**15CHY250 POLYMER MATERIALS AND PROPERTIES 3 0 0 3****Unit 1**

Structure of polymers – thermoplastic, thermoset, rubber - Linear, branched, crosslinked, and network polymers – polymerization types – addition, condensation, mechanism, methods – bulk, solution, suspension and emulsion - crystalline, amorphous, orientation – molecular weight – intermolecular forces, solubility parameter- glass transition temperature.

**Unit 2**

Manufacturing, mechanical, thermal, electrical and chemical properties and applications of commodity plastics - PE,PP,PVC,PS, Engineering plastics - ABS, PC, PMMA, polyamide, polyacetal, PET, PBT, PTFE, High performance polymer - PES, PEI, PEEK, conducting polymer.

**Unit 3**

Thermoset materials - PF, UF, MF, epoxy and unsaturated polyester resin, Rubber - natural rubber, synthetic rubber - SBR, PB, nitrile, chloroprene, butyl, silicone - compounding and additives.

**TEXTBOOKS:**

1. J. A. Brydson, "Plastics Materials" Butterworth-Heinemann – Oxford, 7th Ed., London, 1999
2. Maurice Morton, "Rubber Technology", 3rd Ed, Kluwer Academic Pub, Dordrecht, Netherlands, 1999
3. ManasChanda and Salil K. Roy, "Plastics Technology Handbook", CRC Press, Atlanta, 2007

**REFERENCE BOOKS:**

1. D. W. Van Krevelena and P. J. Hoftyzen, "Properties of Polymer", 3rd Edition Elsevier Scientific Publishing Company Amsterdam – Oxford – Newyork. 1990.

2. Jozef Bicerano, "Prediction of Polymer Properties", Second Edition, Marcel Dekker Inc. New York, 1995.

**15CHY251 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).

**REFERENCES:**

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).

**15CHY252 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 piezoelectric 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).

## 15CHY331

## BATTERIES AND FUEL CELLS

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 batteries; Lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cells (comparative account).

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

### Unit 3

Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments.

Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen – clean up and storage of the fuels – use in cells, advantages and disadvantages of using hydrogen as fuel.

#### TEXTBOOKS:

1. Dell, Ronald M Rand, David A J, 'Understanding Batteries', Royal Society of Chemistry, (2001).
2. M. Aulice Scibioh and B. Viswanathan 'Fuel Cells – principles and applications', University Press, India (2006).

**REFERENCES:**

1. Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).
2. Curtis, 'Electroforming', London, (2004).
3. F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA, (2005).
4. G. Hoogers, 'Fuel cell handbook', CRC, Boca Raton, FL, (2003).

**15CHY332****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, McGraw-Hill, (1987).
2. Uhlig H H and Revie 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.

**15CSE100****COMPUTATIONAL THINKING AND  
PROBLEM SOLVING****3 0 2 4****Unit 1**

Basics: Introduction, Information and data, Data encoding. Logic: Boolean logic, Applications of propositional logic.

**Unit 2**

Problem Solving and Algorithmic Thinking: Problem definition, Logical reasoning, Problem decomposition, Abstraction. Flowcharting, Name binding, Selection, Repetition, Modularization. Data organization: List and Arrays. Simple algorithms, comparison of performance of algorithms.

**Unit 3**

Problem Solving Techniques: Factoring and Recursion Techniques, Search and Sort techniques, Text processing and Pattern matching.

**TEXTBOOKS:**

1. David Riley and Kenny Hunt, *Computational Thinking for Modern Solver*, Chapman & Hall / CRC, 2014
2. R. G. Dromey, "How to solve it by Computer", PHI, 2008

**15CSE102****COMPUTER PROGRAMMING****3 0 0 3****Unit 1**

Introduction to C language: Structure of a C program, comments, Data types, Variables, constants, Data input and output statements, input assertions, expressions and evaluation. Functions: inter function communication, standard functions, scope. Selection: two way selection, multi-way selection, repetition: concept of loop, loop invariant, pretest and post-test loops, initialization and updating, event and counter controlled loops. Recursion: recursive definition, recursive solution, designing recursive functions, limitations of recursion.

**Unit 2**

Files and streams, file input output. Arrays - 1D numeric, searching and sorting, 2D numeric arrays: problems with matrices. Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, array of pointers, pointer arithmetic.

**Unit 3**

Strings: fixed length and variable length strings, strings and characters, string input output, array of strings, string manipulation functions, sorting of strings. Enumerated types, Structures: Structure vs array comparison, complex structures, Structures and functions, Union, binary input output, Command line arguments.

**TEXTBOOK:**

Behrouz A. Forouzan and Richard F. Filberg, "Computer Science A structured programming approach using C", Third Edition, Cengage Learning, 2006.

**REFERENCES:**

1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language", Second Edition, Prentice Hall, 1988.
2. Eric S. Roberts, "Art and science of C", Addison Wesley, 1995.
3. Jeri Hanly and Elliot Koffman, "Problem solving and program design in C", Fifth Edition, Addison Wesley (Pearson), 2007.

**15CSE180 COMPUTER PROGRAMMING LAB. 0 0 2 1**

Solving simple problems with operators, programs on conditional control constructs, programs on loops (while, do-while, for), programs using user defined functions and library functions, programs on Files, arrays, matrices (single and multi-dimensional arrays), programs using DMA, programs on strings, structures.

**REFERENCE:**

Behrouz A. Forouzan and Richard F. Filberg, "Computer Science A structured programming approach using C", Third Edition, Cengage Learning, 2007.

**15CUL101 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 - Purusharthas; Introduction to Vendanta and Bhagavat Gita.

**Unit 3**

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

**TEXTBOOKS:**

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

**15CUL111 CULTURAL EDUCATION II 2 0 0 2**

**Unit 1**

1. Relevance of Sri Rama and Sri Krishna in this Scientific Age

2. Lessons from the Epics of India
3. Ramayana & Mahabharata

**Unit 2**

4. Who is a Wise Man?
5. A Ruler's Dharma
6. The Story of King Shibi

**Unit 3**

7. Introduction to the Bhagavad Gita
8. Bhagavad Gita – Action without Desire

**Unit 4**

9. Role and Position of Women in India
10. The Awakening of Universal Motherhood

**Unit 5**

11. Patanjali's Astanga - Yoga System for Personality Refinement
12. Examples of Heroism and Patriotism in Modern India

**TEXTBOOKS:**

Common Resource Material II (in-house publication)

Sanatana Dharma- The Eternal Truth (A compilation of Amma's teachings on Indian Culture)

**15CUL230 ACHIEVING EXCELLENCE IN LIFE - 2 0 0 2  
AN INDIAN PERSPECTIVE**

**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 'Shraddha' – 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. (Vol.s1 to 3)*
5. *Message of Upanishads, by Swami Ranaganathananda published by Bharatiya Vidya Bhavan, Bombay.*
6. *Personality Development – Swami Vivekananda published by Advaita Ashram, Kolkatta.*
7. *Art of Man Making - Swami Chinmayananda published by Chinmaya Mission, Bombay*
8. *Will Power and its Development- Swami Budhananda published by Advaita Ashram, Kolkatta*
9. *Ultimate Success - Swami Ramakrishnananada Puri published by Mata Amritanandamayi Math, Kollam*
10. *Yoga In Daily Life - Swami Sivananda – published by Divine Life 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 Advaita 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.*

**15CUL231****EXCELLENCE IN DAILY LIFE****2 0 0 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 indispensable 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.*

**15CUL232****EXPLORING SCIENCE AND TECHNOLOGY  
IN ANCIENT INDIA****2 0 0 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.

**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 Aryabhata: 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:**

*IFH's interactive multimedia DVD on Science & Technology in Ancient India.*

**15CUL233****YOGA PSYCHOLOGY****2 0 0 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

**15EEE180 WORKSHOP B 0 0 2 1**

**Part A - Electronics**

Identification of electronic components (Passive and Active)  
 Study of measuring instruments (Voltmeter, Ammeter and Multimeter)  
 Measurement and theoretical Verification of series and parallel combination of resistors and capacitors  
 Calibration of CRO and measurements of signal parameters (RMS, maximum value, peak value, time and frequency)  
 Calibration of function generator using CRO  
 Soldering practice

**Part B - Electrical**

1. Study on power supply and protective devices
2. Study on tools and electrical accessories
3. Study on sources of light
4. Study on energy efficiency
5. Study on water pump
6. Study on house hold appliances:
  - a. Iron box
  - b. Fan
  - c. Refrigerator
  - d. Air conditioner
7. House wiring I – Glow an incandescent lamp using SPST switch
8. House wiring II – Glow a fluorescent lamp using SPST switch
9. House wiring III – Operate a fan and an incandescent lamp using two independent SPST switch
10. House wiring IV – Operate a fluorescent lamp and a 3 pin socket using two independent SPST switch
11. House wiring V – Staircase wiring
12. House wiring VI – Godown wiring

**15ENG111 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 – Any two pieces from the text.

**Unit 2**

Writing: Prewriting techniques - Kinds of paragraphs - basics of continuous writing.

Grammar & Usage: Parts of Speech, Tenses, Concord, Phrasal Verbs, Modal Auxiliaries, Modifiers (Workbook) - Any two pieces from the text.

**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 - Any two pieces from the text.

Activities: Short speeches, seminars, quizzes, language games, debates, and discussions, Book Reviews, etc.

**TEXT:** *Language through Reading: Compilation by Amrita University for internal circulation*

Poems:

- i. The Poplar Field by William Cowper
- ii. Telephone Conversation by Wole Soyinka

Prose:

- i. Higher Mathematics by R. K. Narayan
- ii. Wings of Fire by Abdul Kalam (Part III.11)

Short Stories:

- i. Best Investment I Ever Made by A. J. Cronin
- ii. Death of an Indian by Krishna Charan Das

*Language through Practice: Compilation by Amrita University for internal circulation*

**15ENG230 BUSINESS COMMUNICATION 1 0 2 2**

**OBJECTIVES:** To introduce business vocabulary; to 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**

Business Vocabulary - Writing: Drafting Notices, Agenda, and Minutes - Reading: Business news, Business articles.

**Unit 2**

Writing: Style and vocabulary - Business Memorandum, letters, Press Releases, reports – proposals – Speaking: Conversational practice, telephonic conversations, addressing a gathering, conducting meetings.

**Unit 3**

Active Listening: Pronunciation – information gathering and reporting - Speaking: Cross-Cultural Issues, Group Dynamics, 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. Levi, Daniel. *Group Dynamics for Teams*. 3 ed. Sage Publications India Pvt. Ltd. New Delhi, 2011.
4. Owen, Roger. *BBC Business English*. BBC. 1996.
5. Henderson, Greta Lafollette & Price R Voiles. *Business English Essentials*. 7th Edition. Glencoe / McGraw Hill.
6. Sweeney, Simon. *Communicating in Business*. CUP. 2000.

**15ENG231****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 psyche; to develop an understanding about the societal changes in the recent past.

**Unit 1 Poems**

Rabindranath Tagore's Gitanjali (1-10); Nizzim Ezekiel's Enterprise; A. K. Ramanujam's Small-Scale Reflections on a Great House.

**Unit 2 Prose**

Khushwant Singh's The Portrait of a Lady; Jhumpa Lahiri's Short Story - Interpreter of Maladies.

**Unit 3 Drama and Speech**

Vijay Tendulkar's Silence, the Court is in Session; Motivational speeches by Jawaharlal Nehru / S. Radhakrishnan / A. P. J. Abdul Kalam's My Vision for India etc. (any speech).

**REFERENCES:**

1. Lahiri, Jhumpa. *Interpreter of Maladies*, Harper Collins Publications, 2000.

2. Ramanujan A. K. ed. K. M. George, *Modern Indian Literature: An Anthology*, Vol. I, Sahitya Akademi, 1992.
3. Singh, Khushwant. *The Portrait of a Lady: Collected Stories*, Penguin, 2009.
4. Tagore, Rabindranath. *Gitanjali*, Penguin Books India Pvt. Ltd, 2011.
5. Tendulkar, Vijay. *Five Plays*, Oxford University Press, 1996.

**15ENG232****INSIGHTS INTO LIFE THROUGH ENGLISH LITERATURE****1 0 2 2**

**OBJECTIVES:** To expose the students to different genres of Literature; to hone reading skills; to provide deeper critical and literary insights; to enhance creative thinking; to promote aesthetic sense.

**Unit 1 Poems**

1. W. H. Auden: Refugee Blues; 2. A. K. Ramanujan: Obituary; 3. William Blake: The Little Black Boy; 4. Gieve Patel: Grandparents at a Family Get-together.

**Unit 2 Short Stories**

1. Chinua Achebe: Marriage is a Private Affair; 2. Ruskin Bond: The Thief; 3. Isai Tobolsky: Not Just Oranges; 4. K A Abbas: The Refugee

**Unit 3 Prose**

1. A G Gardiner: On The Philosophy Of Hats; 2. Robert Lynd: Mispronunciation

## Practicals:

Role plays: The Proposal, Chekov / Remember Ceaser, Gordon Daviot / Final Solutions, Mahesh Dattani, Book reviews, Movie reviews.

**SUGGESTED READING:** *The Old Man and the Sea*, Hemingway / Any one of the novels of R. K. Narayan, etc.

**15ENG233****TECHNICAL COMMUNICATION****1 0 2 2**

**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 3

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

Practice in oral communication and Technical presentations

#### REFERENCES:

1. Hirsh, 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. E B. "The Elements of Style" New York. Alliyen & Bacon, 1999.
4. Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.

## 15ENG234 INDIAN SHORT STORIES IN ENGLISH 1 0 2 2

**OBJECTIVES:** To help the students learn the fine art of story writing; to help them learn the techniques of story telling; to help them study fiction relating it to the socio- cultural aspects of the age; to familiarize them with different strategies of reading short stories; to make them familiar with the morals and values held in high esteem by the ideals of Indianness.

### Unit 1

Introduction: Differences between novel and short stories – origin and development of short stories - Rabindranath Tagore: Kabuliwallah; Mulk Raj Anand: The Gold Watch.

### Unit 2

R. K. Narayan: Sweets for Angels; K. A. Abbas: The Refugee; Khushwant Singh: The Mark of Vishnu.

### Unit 3

Masti Venkatesha Iyengar: The Curds-Seller; Manohar Malgonkar: Upper Division Love; Romila Thapar: The Spell; Premchand: The Voice of God.

#### TEXT:

M. G. Narasimha Murthy (ed), Famous Indian Stories. Hyderabad: Orient Black Swan, 2014

#### REFERENCE;

Mohan Ramanan (Ed), English and the Indian Short Story: Essays in Criticism, Hyderabad, Orient Black Swan, 2000.

## 15ENV300 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY 3 0 0 3

### Unit 1

State of Environment and Unsustainability, Need for Sustainable Development, Traditional conservation systems in India, People in Environment, Need for an attitudinal change and ethics, Need for Environmental Education, Overview of International Treaties and Conventions, Overview of Legal and Regulatory Frameworks.

Environment: Abiotic and biotic factors, Segments of the Environment, Biogeochemical Cycles, Ecosystems (associations, community adaptations, ecological succession, Food webs, Food chain, ecological pyramids), Types of Ecosystems – Terrestrial ecosystems, Ecosystem Services, Economic value of ecosystem services, Threats to ecosystems and conservation strategies.

Biodiversity: Species, Genetic & Ecosystem Diversity, Origin of life and significance of biodiversity, Value of Biodiversity, Biodiversity at Global, National and Local Levels, India as a Mega-Diversity Nation (Hotspots) & Protected Area Network, Community Biodiversity Registers. Threats to Biodiversity, Red Data book, Rare, Endangered and Endemic Species of India. Conservation of Biodiversity. People's action.

Impacts, causes, effects, control measures, international, legal and regulatory frameworks of: Climate Change, Ozone depletion, Air pollution, Water pollution, Noise pollution, Soil/land degradation/pollution

### Unit 2

Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.

Discuss the interrelation of environmental issues with social issues such as: Population, Illiteracy, Poverty, Gender equality, Class discrimination, Social impacts of development on the poor and tribal communities, Conservation movements: people's movements and activism, Indigenous knowledge systems and traditions of conservation.

### Unit 3

Common goods and public goods, natural capital / tragedy of commons, Cost benefit analysis of development projects, Environment Impact Assessment (EIA), Environment Management Plan (EMP), Green business, Eco-labeling, Problems and solutions with case studies.



Global and national state of housing and shelter, Urbanization, Effects of unplanned development case studies, Impacts of the building and road construction industry on the environment, Eco-homes /Green buildings, Sustainable communities, Sustainable Cities.

Ethical issues related to resource consumption, Intergenerational ethics, Need for investigation and resolution of the root cause of unsustainability, Traditional value systems of India, Significance of holistic value-based education for true sustainability.

**TEXTBOOKS / REFERENCES:**

1. R. Rajagopalan, *Environmental Studies: From Crisis to Cure*. Oxford University Press, 2011, 358 pages. ISBN: 9780198072089.
2. Daniel D. Chiras, *Environmental Science*. Jones & Bartlett Publishers, 01-Feb-2012, 669 pages. ISBN: 9781449645311.
3. Andy Jones, Michel Pimbert and Janice Jiggins, 2011. *Virtuous Circles: Values, Systems, Sustainability*. IIED and IUCN CEESP, London. URL: <http://pubs.iied.org/pdfs/G03177.pdf>
4. Annenberg Learner, *The Habitable Planet*, Annenberg Foundation 2015. URL: <http://www.learner.org/courses/envsci/unit/pdfs/textbook.pdf>.

**15FRE230 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*

**15FRE231 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*

**15GER230 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

Numbers 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.

## **15GER231 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.

## **15GER232 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.

## **15GER233 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.

## **15HIN101 HINDI I 1 0 2 2**

**OBJECTIVES:** To teach Hindi for effective communication in different spheres of life - Social context, Education, governance, Media, Business, Profession and Mass communication.

### Unit 1

Introduction to Hindi Language, National Language, Official Language, link Language etc. Introduction to Hindi language, Devanagari script and Hindi alphabet.

Shabda Bhed, Roopantar ki Drishti se - Bhasha – Paribhasha aur Bhed - Sangya - Paribhasha Aur Bhed - Sangya ke Roopantar - kriya.

**Unit 2**

Common errors and error corrections in Parts of Speech with emphasis on use of pronouns, Adjective and verb in different tenses – Special usage of adverbs, changing voice and conjunctions in sentences, gender & number - General vocabulary for conversations in given context –understanding proper pronunciation – Conversations, Interviews, Short speeches.

**Unit 3**

Poems – Kabir 1st 8 Dohas, Surdas 1st 1 Pada; Tulsidas 1st 1 Pada; Meera 1st 1 Pada

**Unit 4**

Letter writing – personal and Formal – Translation from English to Hindi.

**Unit 5**

Kahani – Premchand: Kafan, Abhilasha, Vidroh, Poos ki rath, Juluos.

**BOOKS:**

1. Prem Chand Ki Sravshrestha Kahaniyam: Prem Chand; Diamond Pub Ltd. New Delhi
2. Vyavaharik Hindi Vyakaran, Anuvad thaha Rachana: Dr. H. Parameswaran, Radhakrishna publishing House, New Delhi
3. Kamtha Prasad Guru: Hindi Vyakaran, Best Book pub House, New Delhi
4. Poetry: Kavya Ras - Ed: T.V. Basker- Pachouri Press; Mathura

**15HIN111****HINDI II****1 0 2 2**

**OBJECTIVES:** Appreciation and assimilation of Hindi Literature both drisyā & shravyā using the best specimens provided as anthology.

**Unit 1**

Kavya Tarang; Dhumiil ke Anthim Kavitha [Poet-Dhumiil]; Dhabba [Poet-Kedarnath Singh]; Proxy [Poet-Venugopal]; Vakth [Poet-Arun Kamal]; Maachis [Poet-Suneeta Jain].

**Unit 2**

Communicative Hindi - Moukhik Abhivyakthi

**Unit 3**

Audio-Visual – Media in Hindi – Movies like Tare Zameen par, Paa, Black etc.,

appreciation and evaluation. News reading and presentations in Radio and TV channels in Hindi.

**Unit 4**

Gadya Manjusha – Budhapa, Kheesa, Sadachar ka Thavis

**Unit 5**

Translation: Theory and Practice - Letter writing: Formal and Personal – Introduction to Hindi Software.

**BOOKS:**

1. Kavya Tarang: Dr. Niranjan, Jawahar Pusthakalay, Mathura.
2. Gadya Manjusha: Editor: Govind, Jawahar Pusthakalay, Mathura

**15HUM230****EMOTIONAL INTELLIGENCE****2 0 0 2****Unit 1**

Emotional Intelligence: Concept of Emotional Intelligence, Understanding the history and origin of Emotional Intelligence, Contributors to Emotional Intelligence, Science of Emotional Intelligence, EQ and IQ, Scope of Emotional Intelligence.

**Unit 2**

Components of Emotional Intelligence: Self-awareness, Self-regulation, Motivation, Empathy, Social skills. Emotional Intelligence Competencies, Elements of Emotional Intelligence, Models of Emotional Intelligence: The Ability-based Model, The Trait Model of Emotional Intelligence, Mixed Models of Emotional Intelligence.

**Unit 3**

Emotional Intelligence at Work place: Importance of Emotional Intelligence at Work place? Cost –savings of Emotional Intelligence, Emotionally Intelligent Leaders, Case Studies Measuring Emotional Intelligence: Emotionally Intelligence Tests, Research on Emotional Intelligence, Developing Emotional Intelligence.

**REFERENCES:**

1. Daniel Goleman (1996). Emotional Intelligence - Why it can Matter More than IQ. Bantam Doubleday Dell Publishing Group
2. Daniel Goleman (2000). Working with Emotional Intelligence. Bantam Doubleday Dell Publishing Group
3. Liz Wilson, Stephen Neale & Lisa Spencer-Arnell (2012). Emotional Intelligence Coaching. Kogan Page India Private Limited

15HUM231

**GLIMPSES INTO THE INDIAN MIND:  
THE GROWTH OF MODERN INDIA**

2 0 0 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*.

15HUM232

**GLIMPSES OF ETERNAL INDIA**

2 0 0 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 – Yudhishthira'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 Arthashastra – 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 Arthashastra 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, Murlī 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. *Arthashastra*.
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)*

## 15HUM233 GLIMPSES OF INDIAN ECONOMY AND POLITY 2 0 0 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 varnashramadharmā – socio-political structure of the various institutions based on the four purusharthas; 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: 600 B.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 Arthashastra; 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: dharmā-vijaya, lobhā-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, Murlī 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 Jamssetji 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.

**15HUM234****HEALTH AND LIFE STYLE****1 0 2 2****Unit 1 Introduction to Health**

Health is wealth; Role of lifestyle habits on health; Importance of adolescence; Stages, Characteristics and changes during adolescence; Nutritional needs during adolescence why healthy lifestyle is important for adolescence. Eating Habits - eating disorders, skipping breakfast, junk food consumption.

*Practicals - Therapeutic Diets*

**Unit 2 Food and Nutritional Requirements during Adolescence**

Fluid intake; nutrition related problems; lifestyle related problems, Role of physical activity; resting pattern and postures, Personal habits – alcoholism, and other tobacco products, electronic addiction etc

*Practicals - Ethnic Foods*

**Unit 3 Need for a Positive Life Style Change**

Peer pressure & procrastination, Stress, depression, suicidal tendency, Mini project review and viva, Whole portions revision.

*Practical - Cooking without Fire or Wire-healthy Snacks*

**TEXTBOOKS:**

1. *B.Srilakshmi, "Dietetics", New age international (P) Ltd, publishers, 2010.*
2. *"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.*

**REFERENCE BOOKS:**

1. *K Park "Textbook of preventive and social medicine", 2010.*
- WHO Report on Adolescent Health: 2010*

**15HUM235****INDIAN CLASSICS FOR  
THE TWENTY-FIRST CENTURY****2 0 0 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***15HUM236****INTRODUCTION TO INDIA STUDIES****2 0 0 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, Simonand 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.*

**15HUM237 INTRODUCTION TO SANSKRIT LANGUAGE AND LITERATURE 2 0 0 2**

**OBJECTIVES:** *To familiarize students with Sanskrit language; to introduce students to various knowledge traditions in Sanskrit; to help students appreciate and imbibe India's ancient culture and values.*

**Unit 1**

Sanskrit Language – VakyaVyavahara (प्रथमादीक्षा) - Introduction to Sanskrit language - Devanagari script and Sanskrit alphabet - Vowels and Consonants – Pronunciation - Classification of Consonants – Samyukthakshara Words – Nouns and Verbs - Cases – Introduction to Numbers and Time – Verbs: Singular, Dual and Plural – SarvaNamas: First Person, Second Person, Third Person –Tenses: Past, Present and Future -Words for Communication – Selected Slokas – Moral Stories – Subhashithas– Riddles.

**Unit 2**

Language Studies - Role of Sanskrit in Indian & World Languages.

**Unit 3**

Introduction to Sanskrit Classical Literature – Kavya Tradition – Drama Tradition - Stotra Tradition – Panchatantra Stories.

**Unit 4**

Introduction to Sanskrit Technical Literature – Astronomy – Physics – Chemistry – Botany – Engineering – Aeronautics – Ayurveda – Mathematics – Medicine – Architecture - Tradition of Indian Art – Administration – Agriculture.

**Unit 5**

Indology Studies – Perspectives and Innovations.

**TEXTBOOKS AND REFERENCE BOOKS:**

1. *Vakya Vyavahara* - Prof. Vempaty Kutumba Sastri, Rashtriya Sanskrit Sansthan, New Delhi
2. *The Wonder that is Sanskrit* - Dr.Sampadananda Mishra, New Delhi
3. *Science in Sanskrit* – Samskritha Bharathi, New Delhi

**15HUM238****NATIONAL SERVICE SCHEME****2 0 0 2****Unit 1**

Introduction to Basic Concepts of NSS: History, philosophy, aims and objectives of NSS, Emblem, flag, motto, song, badge etc., Organisational structure, roles and responsibilities of various NSS functionaries.

NSS Programmes and Activities: Concept of regular activities, special campaigning, Day Camps, Basis of adoption of village / slums, methodology of conducting survey, financial pattern of the scheme, other youth programme/schemes of GOI, Coordination with different agencies, Maintenance of the Diary.

**Unit 2**

Volunteerism and Shramdan: Indian Tradition of volunteerism, Needs and importance of volunteerism, Motivation and Constraints of volunteerism, Shramdan as part of volunteerism, Amalabharatam Campaign, Swatch Bharath.

**Unit 3**

Understanding youth: Definition, profile and categories of youth, Issues, challenges and opportunities for youth, Youth as an agent of social change.

Youth and Yoga: History, philosophy and concept of Yoga, Myths and misconceptions about Yoga, Different Yoga traditions and their impacts, Yoga as a preventive and curative method, Yoga as a tool for healthy life style

**Unit 4**

Youth Development Programmes in India: National Youth Policy, Youth development programmes at the national level, state level and voluntary sector, youth-focused and youth-led organizations.

Youth and Crime: Sociological and psychological factors influencing youth crime, Peer mentoring in preventing crimes, Awareness about Anti-Ragging, Cyber Crime and its prevention, Juvenile Justice.

**Unit 5**

Environmental Issues: Environment conservation, enrichment and sustainability, climate change, waste management, rain water harvesting, energy conservation, waste land development.

Project Work / Practical

**15HUM239****PSYCHOLOGY FOR EFFECTIVE LIVING****2 0 0 2****Unit 1 Self-Awareness & Self-Motivation**

Self analysis through SWOT, Johari Window, Maslow's hierarchy of motivation, importance of self esteem and enhancement of self esteem.

**Unit 2 The Nature and Coping of Stress**

Conflict, Relationship issues, PTSD. Stress – stressors – eustress - distress, coping with stress, stress management techniques.

**Unit 3 Application of Health Psychology**

Health compromising behaviours, substance abuse and addiction.

**TEXTBOOKS:**

1. V. D. Swaminathan & K. V. Kaliappan "Psychology for effective living - An introduction to Health
2. Psychology. 2nd edition Robert J. Gatchel, Andrew Baum & David S. Krantz, McGraw Hill.

**REFERENCE BOOKS:**

1. S. Sunder, 'Textbook of Rehabilitation', 2nd edition, Jaypee Brothers, New Delhi.2002.
2. Weiben & Lloyd, 'Psychology applied to Modern Life', Thompson Learning, Asia Ltd.2004.

**15HUM240****PSYCHOLOGY FOR ENGINEERS****2 0 0 2****Unit 1**

Psychology of Adolescents: Adolescence and its characteristics.

**Unit 2**

Learning, Memory & Study Skills: Definitions, types, principles of reinforcement, techniques for improving study skills, Mnemonics.



**Unit 3**

Attention & Perception: Definition, types of attention, perception.

**TEXTBOOKS:**

1. S. K. Mangal, "General Psychology", Sterling Publishers Pvt. Ltd. 2007
2. Baron A. Robert, "Psychology", Prentice Hall of India. New Delhi 2001

**REFERENCE BOOKS:**

1. Elizabeth B. Hurlock, *Developmental Psychology-A life span approach*, 6th edition.
2. Feldman, *Understanding Psychology*, McGraw Hill, 2000.
3. Clifford Morgan, Richard King, John Scholper, "Introduction to Psychology", Tata McGraw Hill, Pvt Ltd 2004.

**15HUM241****SCIENCE AND SOCIETY –  
AN INDIAN PERSPECTIVE****2 0 0 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, Murlidhar 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.

**15HUM242****THE MESSAGE OF BHAGWAD GITA****2 0 0 2****Unit 1**

Introduction: Relevance of Bhagavad Gita today – Background of Mahabharatha.

ArjunaVishada Yoga: Arjuna's Anguish and Confusion – Symbolism of Arjuna's Chariot.

Sankhya Yoga: Importance of Self-knowledge – Deathlessness: Indestructibility of Consciousness – Being Established in Wisdom – Qualities of a Sthita-prajna.

**Unit 2**

Karma Yoga: Yoga of Action – Living in the Present – Dedicated Action without Anxiety over Results - Concept of Swadharma.

Dhyana Yoga: Tuning the Mind – Quantity, Quality and Direction of Thoughts – Reaching Inner Silence.

**Unit 3**

Bhakti Yoga: Yoga of Devotion – Form and Formless Aspects of the Divine – Inner Qualities of a True Devotee.

GunatrayaVibhaga Yoga: Dynamics of the Three Gunas: Tamas, Rajas, Sattva – Going Beyond the Three Gunas – Description of a Gunatheetha.

**TEXTBOOKS / REFERENCES:**

1. Swami Chinmayananda, "The Holy Geeta", Central Chinmaya Mission Trust, 2002.
2. Swami Chinmayananda, "A Manual of Self Unfoldment", Central Chinmaya Mission Trust, 2001.

**15HUM243 THE MESSAGE OF THE UPANISHADS 2 0 0 2**

**OBJECTIVES:** To give students an introduction to the basic ideas contained in the Upanishads; and explores how their message can be applied in daily life for achieving excellence.

**Unit 1**

An Introduction to the Principal Upanishads and the Bhagavad Gita - Inquiry into the mystery of nature - Sruti versus Smrti - Sanatana Dharma: its uniqueness - The Upanishads and Indian Culture - Upanishads and Modern Science.

**Unit 2**

The challenge of human experience & problems discussed in the Upanishads – the True nature of Man – the Moving power of the Spirit – The Message of Fearlessness – Universal Man - The central problems of the Upanishads – Ultimate reality – the nature of Atman - the different manifestations of consciousness.

**Unit 3**

Upanishad Personalities - episodes from their lives and essential teachings: Yajnavalkya, Aruni, Uddalaka, Pippalada, Satyakama Jabala, Svetaketu, Nachiketas, Upakosala, Chakrayana Ushasti, Raikva, Kapila and Janaka. Important verses from Upanishads - Discussion of Sage Pippalada's answers to the six questions in Prasnopanishad.

**REFERENCES:**

1. The Message of the Upanishads by Swami Ranganathananda, Bharatiya Vidya Bhavan
2. Eight Upanishads with the commentary of Sankaracharya, Advaita Ashrama
3. Indian Philosophy by Dr. S. Radhakrishnan, Oxford University Press
4. Essentials of Upanishads by R L Kashyap, SAKSI, Bangalore
5. Upanishads in Daily Life, Sri Ramakrishna Math, Mylapore.
6. Eternal stories of the Upanishads by Thomas Egenes and Kumuda Reddy
7. Upanishad Ganga series – Chinmaya Creations

**15HUM244 UNDERSTANDING SCIENCE OF FOOD AND NUTRITION 1 0 2 2****Unit 1 Food and Food Groups**

Introduction to foods, food groups, locally available foods, Nutrients, Cooking methods, Synergy between foods, Science behind foods, Food allergies, food poisoning, food safety standards.

*Cookery Practicals - Balanced Diet*

**Unit 2 Nutrients and Nutrition**

Nutrition through life cycle, RDA, Nutrition in disease, Adulteration of foods & Food additives, Packaging and labeling of foods.

*Practicals - Traditional Foods*

**Unit 3 Introduction to Food Biotechnology**

Future foods - Organic foods and genetically modified foods, Fortification of food value addition of foods, functional foods, Nutraceuticals, supplementary foods, Processing and preservation of foods, applications of food technology in daily life, and your prospects associated with food industry – Nanoparticles, biosensors, advanced research.

*Practicals - Value added foods*

**TEXTBOOKS:**

1. N. Shakuntalamananay, M. Shadaksharaswamy, "Food Facts and principles", New age international (P) Ltd, publishers, 2005.
2. B. Srilakshmi, "Dietetics", New age international (P) Ltd, publishers, 2010.

**REFERENCE BOOKS:**

1. B. Srilakshmi, "Food Science", New age international (P) Ltd, publishers, 2008.
2. "Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.

**15JAP230 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.

**15JAP231 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.

**15KAN101****KANNADA I****1 0 2 2**

**OBJECTIVES:** To enable the students to acquire basic skills in functional language; to develop independent reading skills and reading for appreciating literary works; to analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech.

**Unit 1**

Adalitha Kannada: bhashe, swaroopa, belavanigeya kiru parichaya  
Paaribhaashika padagalu  
Vocabulary Building

**Unit 2**

Prabhandha – Vyaaghra Geethe - A.N.Murthy Rao  
Prabhandha – Baredidi...baredidi, Baduku mugiyuvudilla allige... - Nemi Chandra

Paragraph writing – Development: comparison, definition, cause & effect  
Essay – Descriptive & Narrative

**Unit 3**

Mochi – Bharateepriya  
Mosarina Mangamma – Maasti Venkatesh Iyengar  
Kamalaapurada Hotelnalli – Panje Mangesh Rao  
Kaanike – B. M. Shree  
Geleyanobbanige bareda Kaagada – Dr. G. S. Shivarudrappa  
Moodala Mane – Da. Ra. Bendre  
Swathantryada Hanate – K. S. Nissaar Ahmed

**Unit 4**

Letter Writing - Personal: Congratulation, thanks giving, invitation, condolence

**Unit 5**

Reading Comprehension; nudigattu, gaadegalu

Speaking Skills: Prepared speech, pick and speak

**REFERENCES:**

1. H. S. Krishna Swami Iyengar – Adalitha Kannada – Chetana Publication, Mysuru
2. A. N. Murthy Rao – Aleyuva Mana – Kuvempu Kannada Adyayana Samsthe
3. Nemi Chandra – Badhuku Badalisabahudu – Navakarnataka Publication
4. Sanna Kathegalu - Prasaraanga, Mysuru University , Mysuru
5. B. M. Shree – Kannadada Bavuta – Kannada Sahitya Parishattu
6. K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna Book House (P) Ltd.
7. Dr. G. S. Shivarudrappa – Samagra Kavya – Kamadhenu Pustaka Bhavana

**15KAN111****KANNADA II****1 0 2 2**

**OBJECTIVES:** To enable the students to acquire basic skills in functional language; to develop independent reading skills and reading for appreciating literary works; to develop functional and creative skills in language; to enable the students to plan, draft, edit & present a piece of writing.

**Unit 1**

Official Correspondence: Adhikrutha patra, prakatane, manavi patra, vanijya patra

**Unit 2**

Nanna Hanate - Dr.G.S.Shivarudrappa  
Mankuthimmana Kaggada Ayda bhagagalu – D. V. Gundappa (Padya Sankhye 5, 20, 22, 23, 25, 44, 344, 345, 346, 601)

Ella Marethiruvaga - K. S. Nissaar Ahmed  
Saviraru Nadigalu – S Siddalingayya

**Unit 3**

Sayo Aata – Da. Ra. Bendre

**Unit 4**

Sarva Sollegala turtu Maha Samelana - Beechi  
Swarthakkaagi Tyaga - Beechi

**Unit 5**

Essay writing: Argumentative & Analytical

Précis writing

**REFERENCES:**

1. H. S. Krishnaswami Iyengar – Adalitha Kannada – Chetan Publication, Mysuru
2. Dr. G. S. Shivarudrappa – Samagra Kavya. - Kamadhenu Pustaka Bhavana
3. Shrikanth - Mankuthimmana Kagga – Taatparya – Sri Ranga Printers & Binders
4. K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna book house
5. Dr. Da. Ra. Bendre – Saayo Aata – Shri Maata Publication
6. Beechi – Sahukara Subbamma – Sahitya Prakashana

**15MAL101****MALAYALAM I****1 0 2 2**

**OBJECTIVES:** To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother-tongue; to learn our culture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; to create awareness that good language is the sign of complete personality.

**Unit 1**

Ancient poet trio: Adhyatmaramayanam,  
Lakshmana Swanthanam (valsa soumitre... mungikidakayal), Ezhuthachan -  
Medieval period classics – Jnanappana (kalaminnu... vilasangalingane), Poonthanam

**Unit 2**

Modern Poet trio: Ente Gurunathan, Vallathol Narayana Menon - Critical analysis of the poem.

**Unit 3**

Short stories from period 1/2/3, Poovanpazham - Vaikaom Muhammed Basheer -  
Literary & Cultural figures of Kerala and about their literary contributions.

**Unit 4**

Literary Criticism: Ithihasa studies - Bharatha Paryadanam - Vyasante Chiri -  
Kuttikrishna Mararu - Outline of literary Criticism in Malayalam Literature - Introduction  
to Kutti Krishna Mararu & his outlook towards literature & life.

**Unit 5**

Error-free Malayalam: 1.Language; 2.Clarity of expression; 3.Punctuation –  
Thettillatha Malayalam

Writing - a. Expansion of ideas; b. Precis Writing; c. Essay Writing; d. Letter writing;  
e. Radio Speech; f. Script / Feature / Script Writing; g. News Editing; h. Advertising;  
i. Editing; j. Editorial Writing; k. Critical appreciation of literary works (Any one or  
two as an assignment).

**REFERENCES:**

1. P. K. Balakrishnanan, Thunjan padhanagal, D. C.Books, 2007.
2. G. Balakrishnan Nair, Jnanappanayam Harinama Keerthanavum, N. B. S, 2005.
3. M. N. Karasseri, Basheerinte Poonkavanam, D. C.Books, 2008.
4. M. N. Vijayan, Marubhoomikal Pookkumbol, D. C.Books, 2010.
5. M. Thomas Mathew, Lavanyanubhavathinte Yukthisasthram, National Book Stall, 2009.
6. M. Leelavathy, Kavitha Sahityacharitam, National Book Stall, 1998.
7. Thayattu Sankaran, Vallathol Kavithapadhanam, D. C. Books, 2004.

**15MAL111****MALAYALAM II****1 0 2 2**

**OBJECTIVES:** To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother-tongue; to learn our culture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; to create awareness that good language is the sign of complete personality.

**Unit 1**

Ancient poet trio: Kalayanasougandhikam, (kallum marangalun... namukkennarika  
vrikodara) Kunjan Nambiar - Critical analysis of his poetry - Ancient Drama: Kerala  
Sakunthalam (Act 1), Kalidasa (Translited by Attor Krishna Pisharody).

**Unit 2**

Modern / romantic / contemporary poetry: Manaswini, Changampuzha Krishna  
Pillai – Romanticism – modernism.

**Unit 3**

Anthology of short stories from period 3/4/5: Ninte Ormmayku, M.T.Vasudevan Nair  
- literary contributions of his time

**Unit 4**

Part of an autobiography / travelogue: Kannerum Kinavum, V. T. Bhattathirippadu - Socio-cultural literature - historical importance.

**Unit 5**

Error-free Malayalam - 1. Language; 2. Clarity of expression; 3. Punctuation - Thettillatha Malayalam

Writing - a. Expansion of ideas; b. Précis Writing; c. Essay Writing; d. Letter writing; e. Radio Speech; f. Script / Feature / Script Writing; g. News Editing; h. Advertising; i. Editing; j. Editorial Writing; k. Critical appreciation of literary works (Any one or two as an assignment).

**REFERENCES:**

1. Narayana Pillai.P. K, *Sahitya Panchanan. Vimarsanathrayam, Kerala Sahitya Academy, 2000*
2. Sankunni Nair.M. P, *Chathravum Chamaravum, D. C. Books, 2010.*
3. Gupthan Nair.S, *Asthiyude Pookkal, D. C. Books. 2005*
4. Panmana Ramachandran Nair, *Thettillatha Malayalam, Saryyum thettum etc., D. C. Book, 2006.*
5. M. Achuthan, *Cherukatha-Innale, innu, National Book Stall, 1998.*
6. N. Krishna Pillai, *Kairaliyude Katha, National Book Stall, 2001.*

**15MAT111****CALCULUS AND MATRIX ALGEBRA****2 1 0 3****Unit 1 Calculus**

Graphs: Functions and their Graphs. Shifting and Scaling of Graphs.

Limit and Continuity: Limit (One-Sided and Two-Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity.

**Unit 2** Differentiation and its Applications: Derivative of a function, non differentiability, Intermediate Value Property, Mean Value Theorem, Extreme Values of Functions, Monotonic Functions, Concavity and Curve Sketching, Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques.

**Unit 3 Matrix Algebra**

Review: System of linear Equations, linear independence

Eigen values and Eigen vectors: Definitions and Properties, Positive definite, Negative Definite and Indefinite Matrices, Diagonalization and Orthogonal Diagonalization, Quadratic form, Transformation of Quadratic Form to Principal axes, Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian

Matrices and Orthogonal Matrices Iterative Methods for the Solution of Linear Systems, Power Method for Eigen Values and Eigen Vectors.

**TEXTBOOKS:**

1. 'Calculus', G. B. Thomas Pearson Education, 2009, Eleventh Edition.
2. 'Advanced Engineering Mathematics', Erwin Kreyszig, John Wiley and Sons, 2015, Tenth Edition.

**REFERENCE BOOKS:**

1. 'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002.
2. 'Advanced Engineering Mathematics', by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.

**15MAT121****VECTOR CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS****3 1 0 4****Unit 1**

Vector Differentiation: 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: 9.4, 9.5, 9.6, 9.9, 9.10, 9.11)

Vector Integration: Line Integral, Line Integrals Independent of Path. Green's Theorem in the Plane (Sections: 10.1, 10.2, 10.3, 10.4).

**Unit 2**

Surface Integral: Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem. (Sections: 10.5, 10.6, 10.7, 10.9)

First Order Differential Equations: First Order ODE, Exact Differential Equations and Integrating Factors (Sections 1.1 and 1.4).

**Unit 3**

Second Order Differential Equations: Homogeneous and non-homogeneous linear differential equations of second order (Review), Modelling: Free Oscillations,

Euler-Cauchy Equations, Solution by Undetermined Coefficients, Solution by the Method of Variation of Parameters (Sections 2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 2.10).

System of Order Differential Equations: Basic Concepts and Theory, Constant Coefficient systems – Phase Plane method, Criteria for Critical Points, Stability. (Sections 4.1 – 4.4).

**TEXTBOOK:**

'Advanced Engineering Mathematics', Erwin Kreyszig, John Wiley and Sons, Tenth Edition, 2015.

**REFERENCE BOOKS:**

1. 'Advanced Engineering Mathematics', Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.
2. 'Calculus', G. B. Thomas Pearson Education, 2009, Eleventh Edition.
3. 'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002.

**15MAT204****TRANSFORMS AND PARTIAL  
DIFFERENTIAL EQUATIONS****2 1 0 3****Unit 1**

Laplace Transform: 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.

**Unit 2**

Convolution, Integral Equations, Partial Fractions, Differential Equations, Systems of Differential Equations. (Sections: 6.1 to 6.7)

Fourier Series: Fourier series, Half range Expansions, Parseval's Identity, Fourier Integrals, Fourier integral theorem. Sine and Cosine Integrals. (Sections: 11.1 - 11.3)

**Unit 3**

Fourier Transforms: Sine and Cosine Transforms, Properties, Convolution theorem. (Sections: 11.1 -11.3, 11.7-11.9)

Partial Differential Equations: Basic Concepts, Modeling; Vibrating String, Wave Equation, Separation of Variables, Use of Fourier Series, Heat Equation; Solution by Fourier Series. (Sections: 12.1-12.5)

**TEXTBOOK:**

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.

**REFERENCE BOOKS:**

1. Advanced Engineering Mathematics by Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.
2. Larry C. Andrews and Bhimson. K. Shivamoggi, The Integral Transforms for Engineers, Spie Press, Washington, 1999.
3. J. L. Schiff, The Laplace Transform, Springer, 1999.

**15MAT214****PROBABILITY AND STATISTICS****2 1 0 3****Unit 1**

Probability Concepts: Review of probability concepts - Bayes' Theorem.

Random Variable and Distributions: Introduction to random variable – discrete and continuous distribution functions - mathematical expectations – moment generating functions and characteristic functions. Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions (MGF, mean, variance and simple problems) – Chebyshev's theorem

**Unit 2**

Sampling Distributions: Distributions of Sampling Statistics, Chi-square, t and F distributions (only definitions and use). Central Limit Theorem.

Theory of estimation: Point Estimation, Unbiased estimator - Maximum Likelihood Estimator - Interval Estimation.

**Unit 3**

Testing of Hypothesis: Large and small sample tests for mean and variance – Tests based on Chi-square distribution.

**TEXTBOOK:**

Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.

**REFERENCE BOOKS:**

1. J. Ravichandran, "Probability and Random Processes for Engineers", First Edition, IK International, 2015.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition (2007), Pearson Education Asia.
3. Sheldon M Ross, Introduction to Probability and Statistical Inference, 6th Edition, Pearson.
4. A. Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.

**15MAT302****NUMERICAL METHODS****2 0 2 3****Unit 1**

Review of Errors: Accuracy and Precision, round-off error and truncation error. (Sec. 2.2-2.4)

Roots of Transcendental and Polynomial Equations: Bisection method, Iteration methods based on first degree equation, Rate of convergence, System of nonlinear equations. (Sec. 4.2, 4.3, 5.1-5.3, 5.5)

Review of Matrix Algebra: Systems of Equations, Eigenvalues and Eigen vectors.

Solution of System of Linear Algebraic Equations: Gauss Elimination and Gauss Jordan Methods. Iteration Methods. Eigenvalues and Eigenvectors: Jacobi Method for symmetric matrices and Power Method for arbitrary matrices. (Sec. 8.2, 8.7, 10.2, 22.2)

### Unit 2

Interpolation and Approximation: Lagrange and Newton interpolation for unequal intervals, Finite difference operators, Interpolating polynomials using finite differences. (Sec. 13.1 – 13.4, 13.6)

### Unit 3

Review of Ordinary Differential Equations:

Solutions of Ordinary Differential Equations: Initial value problems - Single step methods - Taylor Series Method, Second, Third and Fourth order Runge Kutta Methods. (Sec.20.1 – 20.3, 21.2)

Lab-Implementation of these methods: MATLAB or EXCEL or Free and Open Source Software (FOSS) tools like R-programming and Scilab.

#### TEXTBOOK:

Steven Chapra and Raymond Canale, *Numerical Methods for Engineers*, McGraw Hill, 2007.

#### REFERENCE BOOKS:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical methods for Scientific and Engineering Computation*, New Age International Publishers, Fifth edition, 2007.
2. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, 7th edition, Addison Wesley, 2009.
3. Rizwan Butt, *Introduction to Numerical Analysis Using MATLAB*, Jones and Bartlett Publisher, 2010.
4. Abdelwahab Kharab, Ronald B, *An Introduction to Numerical Methods: A MATLAB Approach*, Third Edition, CRC Press, 2012.

**15MEC100**

**ENGINEERING DRAWING - CAD**

**2 0 2 3**

Introduction, Drawing Instruments and their uses, Layout of the Software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional environment. Selection of drawing size and scale. Commands and Dimensioning.

Orthographic Projections: Introduction, Planes of projection, reference line. Projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, and Projection of Solids in first angle projection system.

#### TEXTBOOK:

Bhat N. D. and Panchal V. M. , “ *Engineering Drawing Plane and Solid Geometry* ” , 42e, Charoatar Publishing House, 2010

#### REFERENCES:

1. James D. Bethune, “*Engineering Graphics with AutoCAD*”, Pearson Education, 2014
2. K. R. Gopalakrishna, “*Engineering Drawing*”, 2014, Subhas Publications
3. Narayan K. L. and Kannaiah P, *Engineering Drawing*, SciTech Publications, 2003

**15MEC180**

**WORKSHOP A**

**0 0 2 1**

### 1. Product Detailing Workshop

Disassemble the product of sub assembly - Measure various dimensions using measuring instruments - Free hand rough sketch of the assembly and components - Name of 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.

### 2. 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.

### 3. Sheet Metal Workshop

Study of tools and equipments - 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.

### 4. (a) Welding Workshop

Study of tools and equipments - Study of various welding methods - Arc welding practice and demonstration of gas welding and cutting.

(b) Demo and practice Workshop

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

Carpentry: Study of tools, planning practice and making joints

#### REFERENCE:

*Concerned Workshop Manual*

**15PHY100****PHYSICS****3 0 0 3****Unit 1 Review of Classical Physics and dual nature of Waves / particle**

Review of Kinematics, Force, Newton's Laws, Linear Momentum, Work, Energy, Power, Angular Motion- Kinematics and Mechanics, Angular momentum Torque, Conservation laws (linear and angular).

Particle properties of waves: Photoelectric effect, quantum theory of light, X-ray diffraction, Compton effect, pair production. Wave properties of particles: Waves, De Broglie waves, Group velocity and phase velocity, uncertainty principle.

**Unit 2 Atomic Structure and Quantum Mechanics**

Atomic Structure: Various models of atom, Atomic Spectra, Energy Levels, Correspondence Principle, Nuclear Motion, Atomic Excitation, and Rutherford Scattering.

Quantum Mechanics: Introduction - wave equation - Schrodinger's equation (time dependent and independent) - expectation values, operators, Eigen value (momentum and energy) – 1D potential box (finite and infinite) - tunnel effect - harmonic oscillator.

**Unit 3 Statistical Mechanics and Solid State Physics**

Statistical Mechanics: Classical Distribution - Maxwell's Boltzmann-Molecular energies of an ideal gas - most probable speed. Quantum Statistics - Bose-Einstein and Fermi-Dirac. Applications - Black Body Radiation, Specific heat of solids, free electrons in metals, Electron energy.

Solid State Physics: Types of solids, Crystallography, Bonds - Ionics, Covalent, and Van der Waals, Band Theory and energies, Semiconductor Devices, and Superconductivity.

**TEXTBOOK:**

"Concept of Modern Physics", Arthur Beiser, Tata-McGraw Hill, edition.

**REFERENCE BOOK:**

"Principles of Physics" by Halliday, Resnick and Walker, 9th edition

**15PHY181****PHYSICS LAB.****0 0 2 1**

Young's Modulus – Non Uniform Bending

Newton's Rings

Laser - Determination of Wavelength and Particle Size Determination

Spectrometer

Carey Foster's Bridge

Rigidity Modulus - Tensional Pendulum  
Viscosity of Liquid by Stokes's method  
Ultrasonic Interferometer  
Hysteresis – B H curve

**15PHY230****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*, McGraw 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.*

**15PHY233 BIOPHYSICS AND BIOMATERIALS 3 0 0 3**

**OBJECTIVE:** To equip the students with the knowledge on different kinds of biomaterials and other medical need, basic research, and to provide an over view of theory and practice of bio materials.

**Unit 1**

Quantum mechanics – Schrodinger's time dependent and independent equations – Pauli's exclusion principle – ionization energy – electron affinity – chemical binding – electro negativity and strong bonds - secondary bonds – inter atomic potential for strong bonds and weak bonds – bond energies – spring constants – free energy – internal energy – reaction kinetics.

Definition and classification of bio-materials, mechanical properties, visco-elasticity, wound-healing process, Application of biomaterial for the human body, body response to implants, blood compatibility. Implementation problems - inflammation, rejection, corrosion, structural failure. Surface modifications for improved compatibility.

**Unit 2**

Bioceramics, Biopolymers, Metals, ceramics and composites in medicine: Properties, applications, suitability & modifications required for certain applications.

X-ray diffraction and molecular structure – Nuclear Magnetic Resonance – scanning tunneling microscope – Atomic force microscopy – optical tweezers – patch clamping – molecular dynamics – potential energy contour tracing – SEM – TEM – spectroscopy methods differential thermal analysis, differential thermo gravimetric analysis – NDT methods.

**Unit 3**

Materials for bone and joint replacement – dental metals and alloys – ceramic – bioinert – bioactive ceramics – polymers - dental restorative materials – dental amalgams – cardiovascular materials – cardiac prosthesis; vascular graft materials – cardiac pacemakers – cardiac assist devices – materials for ophthalmology contact lens – intraocular materials – materials for drug delivery.

**TEXTBOOKS AND REFERENCES:**

1. Rodney M J Cotterill, *Biophysics an introduction, John Wiley & sons Ltd., NY, 2002*
2. Vasantha Pattabhi and N.Gautham, *Biophysics, Alpha science International Ltd. UK, 2002.*

3. Jonathan Black, *Biological Performance of Materials, Fundamentals of Biocompatibility, Marcel Dekker Inc., New York, 1992.*
4. D. F. Williams (ed.), *Material Science and Technology - A comprehensive treatment, Vol.14, Medical and Dental Materials, VCH Publishers Inc., New York, 1992.*
5. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, *Instrumental Methods of Analysis, CBS Publishers, New Delhi, 1986.*

**15PHY234 INTRODUCTION TO 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:**

Suresh Chandra, "Computer Applications in Physics", Narosa Publishing House, New Delhi  
M Hijroth Jensen, Department of Physics, University of Oslo, 2003 (Available in the Web)

**15PHY238 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 its 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 its 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", Wiley, New York, 1956 (2nd 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 (5th edition).

## 15PHY239 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).

#### REFERENCES:

1. David J Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India, New Delhi, 1999 (2nd edition).
2. J D Jackson, "Classical Electrodynamics", Wiley Eastern, 2004 (2nd edition).
3. B.Chakraborty, "Principles of Electrodynamics", Books and Allied Publishers, 2002

## 15PHY240 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, peritectic 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, superconductivity 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, Birefringence; Dielectric Properties of Materials: Polarization and Permittivity, Mechanisms of polarization, dielectric properties- dielectric constant, dielectric loss, dielectric strength and breakdown, Piezoelectricity, Ferroelectricity, 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.

**15PHY241 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, W M, *Laser Material Processing (3rd Edition)*, Springer Verlag, 2003, ISBN 1852336986.
2. Silvest, W T, *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.

**15PHY243 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.

**15PHY245 NUCLEAR ENERGY: PRINCIPLES AND APPLICATIONS 3 0 0 3****Unit 1**

Basics: Atomic theory, nuclear composition, sizes and masses of nuclei, binding energy, radioactive decay, radioactive chains. Nuclear reactions, transmutation of elements, conservation laws, neutron cross sections, interaction of charged particles and gamma radiation with matter.

Fission and fusion: The fission process, energetic of fission, byproducts of fission, energy from nuclear fuels. Fusion reactions, electrostatic and nuclear forces, thermo nuclear reactions in plasma. Energetics of fusion. Comparison of fusion and fission reactions.

**Unit 2**

Neutron chain reactions and nuclear power: Criticality and multiplication, factors governing the multiplication, neutron flux and reactor power, reactor types and reactor operations. Methods of heat transmission and removal, steam generation and electric power generation, waste heat disposal.

**Unit 3**

Breeder reactors and fusion reactors: The concept of breeding nuclear fuel, isotope production and consumption, fast breeder reactor, breeding and uranium sources. Technical problems in the functioning of fusion reactor, requirements for practical fusion reactors, magnetic confinement, inertial confinements and other fusion concepts. Prospects of fusion power.

Radiation protection and waste disposal: Biological effects of radiation, radiation dose units, protective measures, internal exposure, and radon problem. Nuclear fuel cycle and waste classification, spent fuel storage and transportation, high level waste disposal, low level waste disposal.

**TEXTBOOK:**

Raymond L Murray, *Nuclear Energy: An Introduction to the Concepts, Systems and Applications of Nuclear Processes*, Butterworth-Heimann-Elsevier Inc (2009)

**REFERENCES:**

1. David Bodansky, *Nuclear Energy: principles, practices and prospects*, Springer Verlag
2. S K Rajput, *Nuclear Energy*, Mahaveer & Sons (2009)

**15PHY247****PHOTOVOLTAICS****3 0 0 3****Unit 1**

Introduction to semiconductors: Semiconductors: concept of electron and holes, conduction in semiconductors and concentration of charge carriers in semiconductors. Direct and indirect band gap semiconductors (quantum mechanical treatment). Extrinsic semiconductors: n-type, p-type & compensation doping, carrier concentration; PN junction - concept of bands at PN junction, junction under forward and reverse biases (conceptual).

**Unit 2**

Optical Processes: Optical absorption, Photoelectric Effect, Beer-Lambert law (Qualitative). Wavelength to band gap relation. Generation of electron-hole pairs. Recombination processes - direct and indirect recombination, other recombination processes - Shockley Reed Hall recombination, Auger recombination.

Solar Cell – Principle: Introduction & history of Solar cells. Constituents of solar radiations (Solar Spectrum). Separation of electrons and holes. Transport of charge carriers - diffusion & drift of carriers, continuity equation, field current, diffusion current, total charge current.

**Unit 3**

Solar Cell – Properties: Measurement of solar cell parameters - short circuit current, open circuit voltage, fill factor, efficiency. Optical losses, electrical losses, surface recombination velocity, quantum efficiency - external and internal, I-V characteristics of Solar cells. Fabrication and design of Solar cells. Performance enhance: Enhance absorption, Reduce series resistance, surface recombination.

Advanced Solar cell technologies (III Generation): Alternatives to conventional Si based solar cells - Thin film solar cells, Hetero junction solar cells, Tandem solar

cells: material properties, fabrication and stability (includes nano scale devices). Organic solar cells.

**TEXTBOOK:**

Wenham S R, "Applied Photovoltaics", 2nd ed., Earthscan Publications Ltd., (2007).

**REFERENCES:**

1. Peter Wurfel, "Physics of Solar Cells", 2nd Ed., Wiley VCH (2005).
2. S O Kasap, "Principles of Electronic Materials and Devices", McGraw-Hill, New York (2005).

**15PHY248 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  $\Delta\omega$  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<sub>2</sub> 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. B B 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. K R Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.
5. T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).

**15PHY250 QUANTUM PHYSICS AND 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*, McGraw 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

**15PHY251****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 - donor 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.

**15PHY331****ASTRONOMY****3 0 0 3****Unit 1**

Astronomy, an Observational Science: Introduction - Indian and Western Astronomy – Aryabhata - Tycho Brahe's observations of the heavens - The laws of planetary motion - Measuring the astronomical unit - Isaac Newton and his Universal Law of Gravity - Derivation of Kepler's third law - The Sun-The formation of the solar system- Overall properties of the Sun- The Sun's total energy output - Black body radiation and the sun's surface temperature - The Fraunhofer lines in the solar spectrum and the composition of the sun - Nuclear fusion - The proton-proton cycle - The solar neutrino problem - The solar atmosphere: photosphere, chromosphere and corona - Coronium - The solar wind - The sunspot cycle - Solar The Planets - Planetary orbits - Orbital inclination - Secondary atmospheres - The evolution of the earth's atmosphere.

**Unit 2**

Observational Astronomy

Observing the Universe - The classic Newtonian telescope - The Cassegrain telescope - Catadioptric telescopes - The Schmidt camera - The Schmidt – Cassegrain telescope - The Maksutov-Cassegrain telescope - Active and adaptive optics - Some significant optical telescopes - Gemini North and South telescopes - The Keck telescopes - The South Africa Large Telescope (SALT) - The Very Large Telescope (VLT) - The Hubble Space Telescope (HST) - The future of optical astronomy - Radio telescopes - The feed and low noise amplifier system - Radio receivers - Telescope designs - Large fixed dishes - Telescope arrays - Very Long Baseline Interferometry (VLBI) - The future of radio astronomy - Observing in other wavebands – Infrared – Sub-millimetre wavelengths - The Spitzer space telescope - Ultraviolet, X-ray and gamma-ray observatories - Observing the universe without using electromagnetic radiation - Cosmic rays - Gravitational waves.

**Unit 3**

The Properties of Stars: Stellar luminosity - Stellar distances - The hydrogen spectrum - Spectral types - Spectroscopic parallax - The Hertzsprung – Russell Diagram - The

main sequence - The giant region - The white dwarf region - The stellar mass – luminosity relationship - Stellar lifetimes - Stellar Evolution – White dwarfs - The evolution of a sun-like star - Evolution in close binary systems – Neutron stars and black holes - The discovery of pulsars - Black holes: The Milky Way - Open star clusters - Globular clusters - Size, shape and structure of the Milky Way – observations of the hydrogen line - Other galaxies - Elliptical galaxies - Spiral galaxies - The Hubble classification of galaxies - The universe - The Cepheid variable distance scale - Starburst galaxies - Active galaxies - Groups and clusters of galaxies – Superclusters - The structure of the universe - Cosmology – the Origin and Evolution of the Universe - The expansion of the universe - The cosmic microwave background - The hidden universe: dark matter and dark energy - The Drake equation - The Search for Extra Terrestrial Intelligence (SETI) - The future of the universe.

**TEXTBOOK:**

*Introduction to Astronomy and Cosmology, Ian Morison, Wiley (UK), 2008*

**REFERENCE BOOK:**

*Astronomy: Principles and Practice, 4th Edition (Paperback), D. C. Clarke, A. E. RoyInstitute of Physics Publishing*

**15PHY333****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.*

**15PHY335****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. Jerrald T Bush Berg et al, The essentials physics of medical imaging, Lippincott Williams and Wilkins (2002)

**15PHY338 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. D A Neamen, "Semiconductor Physics and Devices", TMH, 3rd Edn., 2007.

**REFERENCES:**

1. S M Sze, "Physics of Semiconductor Devices", Wiley, 1996.
2. P Bhattacharya, "Semiconductor Opto- Electronic Devices", Prentice Hall, 1996.
3. M K Achuthan & K N Bhat, "Fundamentals of Semiconductor Devices", TMH, 2007.
4. J Allison, "Electronic Engineering Materials and Devices", TMH, 1990.

**15PHY532 ASTROPHYSICS 3 0 0 3****Unit 1**

Historical introduction: Old Indian and western – astronomy - Aryabhata, 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 - Schwarzschild 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: Cosmic 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. Bradley W. 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.

**15PHY535****EARTH'S ATMOSPHERE****3 0 0 3****Unit 1**

Earth's atmosphere: overview and vertical structure. Warming the earth and the atmosphere: temperature and heat transfer; absorption, emission, and equilibrium; incoming solar energy. Air temperature: daily variations, controls, data, human comfort, measurement. Humidity, condensation, and clouds: circulation of water in the atmosphere; evaporation, condensation, and saturation; dew and frost; fog.

**Unit 2**

Cloud development and precipitation: atmospheric stability & determining stability, cloud development and stability, precipitation processes, collision and coalescence, precipitation types, measuring precipitation. Air pressure and winds: atmospheric pressure, pressure measurement, surface and upper-air charts, surface winds, winds and vertical air motions, measuring and determining winds. Atmospheric circulations: scales of atmospheric motion, eddies, local wind systems, global winds, global wind patterns and the oceans.

**Unit 3**

Air masses, fronts, and mid-latitude cyclones. Weather forecasting: acquisition of weather information, forecasting methods and tools, forecasting using surface charts. Thunderstorms: ordinary (air-mass) thunderstorms, mesoscale convective complexes, floods and flash floods, distribution of thunderstorms, lightning and thunder. Tornadoes: severe weather and Doppler radar, waterspouts.

**Unit 4**

Hurricanes (cyclones, typhoons): tropical weather; anatomy, formation, dissipation and naming of hurricanes. Air pollution: a brief history, types and sources, factors that affect air pollution, the urban environment, acid deposition. Global climate: climatic classification; global pattern of climate.

**Unit 5**

Climate change: possible causes; carbon dioxide, the greenhouse effect, and recent global warming. Light, colour, and atmospheric optics: white and colours, white clouds and scattered light; blue skies and hazy days, red suns and blue moons; twinkling, twilight, and the green flash; the mirage; halos, sundogs, and sun pillars; rainbows; coronas and cloud iridescence.

**TEXTBOOK:**

C. Donald Ahrens: *Essentials of Meteorology: An Invitation to the Atmosphere* (6th edition), Brooks-Cole, 2010.

**REFERENCE:**

Frederick K. Lutgens & Edward J. Tarbuck: *The Atmosphere, An Introduction to Meteorology* (11th Edition), Prentice Hall, 19 January, 2009

**15PHY536****EARTH'S STRUCTURE AND EVOLUTION****3 0 0 3****Unit 1**

Introduction: geologic time; earth as a system, the rock cycle, early evolution, internal structure & face of earth, dynamic earth. Matter and minerals: atoms, isotopes and radioactive decay; physical properties & groups of minerals; silicates, important nonsilicate minerals, resources. Igneous rocks: magma, igneous processes, compositions & textures; naming igneous rocks; origin and evolution of magma, intrusive igneous activity, mineral resources and igneous processes.

**Unit 2**

Volcanoes and volcanic hazards: materials extruded, structures and eruptive styles, composite cones and other volcanic landforms, plate tectonics and volcanic activity. Weathering and soils: earth's external processes; mechanical & chemical weathering, rates; soils, controls of formation, profile, classification, human impact,

erosion, weathering and ore deposits. Sedimentary rocks: the importance and origins of sedimentary rocks; detrital & chemical sedimentary rocks, coal, converting sediment into sedimentary rock; classification & structures, nonmetallic mineral & energy resources. Metamorphism and metamorphic rocks: metamorphic textures, common metamorphic rocks, metamorphic environments & zones.

### Unit 3

Mass wasting: gravity, mass-wasting and landform development, controls and triggers, classification of mass-wasting processes, slump, rockslide, debris flow, earthflow, slow movements. Running water: hydrologic cycle, running water, streamflow, work of running water, stream channels, base level and graded streams, shaping stream valleys, depositional landforms, drainage patterns, floods and flood control. Groundwater: importance and distribution, water table, factors influencing storage and movement, springs, wells, artesian wells, environmental problems, hot springs and geysers, geothermal energy, geologic work. Glaciers and glaciation: formation and movement, erosion & landforms, deposits, other effects, causes. Deserts and wind: distribution and causes, geologic processes, basin and range, wind transport, erosion & deposits.

### Unit 4

Shorelines: coastal zone, waves & erosion, sand movement, shoreline features & stabilization; erosion problems along U.S. coasts, hurricanes, coastal classification, tides. Earthquakes and earth's interior: faults, seismology, locating the source of an earthquake, measuring intensity, belts and plate boundaries, destruction, damage east of the Rocky Mountains, earthquake prediction, earth's interior. Plate tectonics: continental drift, divergent boundaries, convergent boundaries, transform fault boundaries, testing the plate tectonics model, the breakup of Pangaea, measuring plate motion, what drives plate motions, plate tectonics in the future.

### Unit 5

Origin and evolution of the ocean floor: continental margins, features of deep-ocean basins, anatomy of oceanic ridge, oceanic ridges and seafloor spreading, nature of oceanic crust, continental rifting, destruction of oceanic lithosphere. Crustal deformation and mountain building: structures formed by ductile & brittle deformation, mountain building at subduction zones, collisional mountain belts, fault-block mountains, vertical movements of the crust. Geologic time: time scales, relative dating, correlation of rock layers; dating with radioactivity, the geologic time scale, difficulties in dating. Earth's evolution: birth of a planet, origin of the atmosphere and oceans, Precambrian (formation of continents); Phanerozoic (formation of modern continents & earth's first life); Paleozoic (life explodes); the Mesozoic (dinosaurs); Cenozoic era (mammals). Global climate change: climate & geology, climate system, detecting change; atmospheric basics & heating the

atmosphere; natural & human causes; carbon dioxide, trace gases, and climate change; climate-feedback mechanisms, aerosols, some possible consequences.

### TEXTBOOK:

Frederick K. Lutgens, Edward J. Tarbuck & Dennis G. Tasa: *Essentials of Geology* (11th edition), Prentice Hall, 8 March, 2012.

### REFERENCE:

Graham R. Thompson & Jonathan Turk: *Introduction to Physical Geology* (2nd Edition), Brooks Cole, 23 June, 1997.

## 15PHY540

## 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 neighbours.

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*

**15PHY542****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. electroluminescence, 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).*

**15SAN101****SANSKRIT I****1 0 2 2**

**OBJECTIVES:** To familiarize students with Sanskrit language and literature; to enable them to read and understand Sanskrit verses and sentences; to help them acquire expertise for self-study of Sanskrit texts and communication in Sanskrit; to help the students imbibe values of life and Indian culture as propounded in scriptures.

**Unit 1**

Introduction to Sanskrit language, Devanagari script - Vowels and consonants, pronunciation, classification of consonants, conjunct consonants, words – nouns and verbs, cases – introduction, numbers, Pronouns, communicating time in Sanskrit. Practical classes in spoken Sanskrit

**Unit 2**

Verbs - Singular, Dual and plural – First person, Second person, Third person.

Tenses – Past, Present and Future – Atmanepadi and Parasmaipadi-karthariprayoga

**Unit 3**

Words for communication, slokas, moral stories, subhashithas, riddles (from the books prescribed)

**Unit 4**

Selected slokas from Valmiki Ramayana, Kalidasa's works and Bhagavad Gita.

Ramayana – chapter VIII - verse 5, Mahabharata - chapter 174, verse-16, Bhagavad Gita –chapter -IV verse 8, Kalidasa's Sakuntalam Act IV –verse 4

**Unit 5**

Translation of simple sentences from Sanskrit to English and vice versa.

**ESSENTIAL READING:**

1. Pravesaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore -560 085
2. Sanskrit Reader I, II and III, R. S. Vadyar and Sons, Kalpathi, Palakkad
3. Prakriya Bhashyam written and published by Fr. John Kunnappally
4. Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston
5. Sabdamanjari, R. S. Vadyar and Sons, Kalpathi, Palakkad
6. Namalinganusasanam by Amarasimha published by Travancore Sanskrit series
7. Subhashita Ratna Bhandakara by Kashinath Sharma, published by Nirnayasagarpress

**15SAN111****SANSKRIT II****1 0 2 2**

**OBJECTIVES:** To familiarize students with Sanskrit language and literature; to enable them to read and understand Sanskrit verses and sentences; to help them acquire expertise for self-study of Sanskrit texts and communication in Sanskrit; to help the students imbibe values of life and Indian culture as propounded in scriptures.

**Unit 1**

Seven cases, indeclinables, sentence making with indeclinables, Saptha karakas.

**Unit 2**

Ktavatu Pratyaya, Upasargas, Ktvanta, Tumunnanta, Lyabanta.  
Three Lakaras – brief introduction, Lot lakara.

**Unit 3**

Words and sentences for advanced communication. Slokas, moral stories (Pancatantra) Subhashithas, riddles.

**Unit 4**

Introduction to classical literature, classification of Kavyas, classification of Dramas

- The five Mahakavyas, selected slokas from devotional kavyas - Bhagavad Gita – chapter - II verse 47, chapter - IV verse 7, chapter - VI verse 5, chapter - VIII verse 6, chapter - XVI verse 21, Kalidasa's Sakuntala act IV – verse 4, Isavasyopanishat 1st Mantra, Mahabharata chapter 149 verses 14 - 120, Neetisara chapter - III

**Unit 5**

Translation of paragraphs from Sanskrit to English and vice versa.

**ESSENTIAL READING:**

1. Pravesaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore -560 085
2. Sanskrit Reader I, II and III, R. S. Vadyar and Sons, Kalpathi, Palakkad
3. Prakriya Bhashyam written and published by Fr. John Kunnappally
4. Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston
5. Sabdamanjari, R. S. Vadyar and Sons, Kalpathi, Palakkad
6. Namalinganusasanam by Amarasimha published by Travancore Sanskrit series
7. Subhashita Ratna Bhandakara by Kashinath Sharma, published by Nirnayasagar Press.

**15SSK221****SOFT SKILLS I****1 0 2 2**

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 punctuation: 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; Cryptogrihms.

#### 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.thegrammarbook.com](http://www.thegrammarbook.com) - online teaching resources  
[www.englishpage.com](http://www.englishpage.com)- online teaching resources and other useful websites.

15SSK321

SOFT SKILLS II

1 0 2 2

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 competitive 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.thegrammarbook.com](http://www.thegrammarbook.com) - online teaching resources  
[www.englishpage.com](http://www.englishpage.com)- online teaching resources and other useful websites.

15SSK331

SOFT SKILLS III

1 0 2 2

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.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Data Interpretation by R. S. Aggarwal, S. Chand*
6. *Logical Reasoning and Data Interpretation – Niskit K Sinkha*
7. *Puzzles – Shakuntala Devi*
8. *Puzzles – George J. Summers.*

#### REFERENCES:

1. *Books on GRE by publishers like R. S. Aggarwal, 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.*

## 15SWK230 CORPORATE SOCIAL RESPONSIBILITY 2 0 0 2

### Unit 1

Understanding CSR - Evolution, importance, relevance and justification. CSR in the Indian context, corporate strategy. CSR and Indian corporate. Structure of CSR - In the Companies Act 2013 (Section 135); Rules under Section 13; CSR activities, CSR committees, CSR policy, CSR expenditure CSR reporting.

### Unit 2

CSR Practices & Policies - CSR practices in domestic and international area; Role and contributions of voluntary organizations to CSR initiatives. Policies; Preparation of CSR policy and process of policy formulation; Government expectations, roles and responsibilities. Role of implementation agency in Section 135 of the Companies Act, 2013. Effective CSR implementation.

### Unit 3

Project Management in CSR initiatives - Project and programme; Monitoring and evaluation of CSR Interventions. Reporting - CSR Documentation and report writing. Reporting framework, format and procedure.

#### REFERENCES:

1. *Corporate Governance, Ethics and Social Responsibility, V Bala Chandran and V Chandrasekaran, PHI learning Private Limited, New Delhi 2011.*
2. *White H. (2005) Challenges in evaluating development effectiveness: Working paper 242, Institute of Development Studies, Brighton.*
3. *UNDP (nd) Governance indicators: A users guide. Oslo: UNDP*
4. *Rao, Subbha (1996) Essentials of Human Resource Management and Industrial Relations, Mumbai, Himalaya*
5. *Rao, V. S. L. (2009) Human Resource Management, New Delhi, Excel Books,*

## 15SWK231 WORKPLACE MENTAL HEALTH 2 0 0 2

### Unit 1

Mental Health – concepts, definition, Bio-psycho-social model of mental health. Mental health and mental illness, characteristics of a mentally healthy individual, Signs and symptoms of mental health issues, presentation of a mentally ill person.

Work place – definition, concept, prevalence of mental health issues in the work place, why invest in workplace mental health, relationship between mental health and productivity, organizational culture and mental health. Case Study, Activity.

### Unit 2

Mental Health Issues in the Workplace: Emotions, Common emotions at the workplace, Mental Health issues - Anger, Anxiety, Stress & Burnout, Depression, Addictions – Substance and Behavioural, Psychotic Disorders- Schizophrenia, Bipolar Disorder, Personality disorders. Crisis Situations-Suicidal behavior, panic attacks, reactions to traumatic events. Stigma and exclusion of affected employees. Other issues –work-life balance, Presenteeism, Harassment, Bullying, Mobbing. Mental Health First Aid - Meaning. Case Study, Activity.

### Unit 3

Strategies of Help and Care: Positive impact of work on health, Characteristics of mentally healthy workplace, Employee and employer obligations, Promoting mental health and well being- corporate social responsibility (CSR), an inclusive work environment, Training and awareness raising, managing performance, inclusive recruitment, Supporting individuals - talking about mental health, making reasonable adjustments, Resources and support for employees - Employee Assistance Programme / Provider (EAP), in house counsellor, medical practitioners, online resources and telephone support, 24 hour crisis support, assistance for colleagues and care givers, Legislations. Case Study, Activity.

### REFERENCES:

1. American Psychiatric Association. "Diagnostic and statistical manual of mental disorders: DSM-IV 4th ed." [www.terapiacognitiva.eu/dwl/dsm5/DSM-IV.pdf](http://www.terapiacognitiva.eu/dwl/dsm5/DSM-IV.pdf)
2. American Psychiatric Association. (2000) [www.ccsa.ca/Eng/KnowledgeCentre/OurDatabases/Glossary/Pages/index.aspx](http://www.ccsa.ca/Eng/KnowledgeCentre/OurDatabases/Glossary/Pages/index.aspx).
3. Canadian Mental Health Association, Ontario "Workplace mental health promotion, A how to guide" [wmhp.cmhaontario.ca/](http://wmhp.cmhaontario.ca/)
4. Alberta Health Services Mental Health Promotion. (2012). *Minding the Workplace: Tips for employees and managers together*. Calgary: Alberta Health Services. <http://www.mentalhealthpromotion.net/resources/minding-the-workplace-tips-for-employees-and-managers-together.pdf>
5. Government of Western Australia, Mental Health Commission. (2014) "Supporting good mental health in the work place." [http://www.mentalhealth.wa.gov.au/Libraries/pdf\\_docs/supporting\\_good\\_mental\\_health\\_in\\_the\\_workplace\\_1.sflb.ashx](http://www.mentalhealth.wa.gov.au/Libraries/pdf_docs/supporting_good_mental_health_in_the_workplace_1.sflb.ashx)
6. Mental Health Act 1987 (India) [www.tnhealth.org/mha.htm](http://www.tnhealth.org/mha.htm)
7. Persons with disabilities Act 1995 (India) [socialjustice.nic.in](http://socialjustice.nic.in)
8. The Factories Act 1948 (India) [www.caaa.in/Image/19ulabourlawshb.pdf](http://www.caaa.in/Image/19ulabourlawshb.pdf)

## 15TAM101

## TAMIL I

## 1 0 2 2

**Objectives :** To introduce the students to different literature - Sangam literature, Epics, Bhakthi literature and modern literature. To improve their ability to communicate with creative concepts, and also to introduce them to the usefulness of basic grammatical components in Tamil.

### Unit 1

Sangam literature : Kuṟuntokai; (2, 6,8,40 pāṭalkaḷ) – puṛaṇāṅṁūru (74,112,184,192 pāṭalkaḷ) – tirukkūṟaḷ (iraṁmāṭci, amaiccu)

### Unit 2

Epic literature: cilappatikāram maturaik kāṇṭam (vaḷakkuṟaikkātai 50-55)

Spiritual Literature: tiruppāvai(3,4) – tēvāram (mācivīṇaiyumu)

Medieval Literature: bāratiyar kaṇṇaṅ pāṭṭu (eṅ viḷaiyāṭṭu piḷḷai) – bāratitacaṅ kuṭumpaviḷakku (tāyiṅ tālāṭṭu).

### Unit 3

Novel: Jeyakāntaṅ "kuru piṭam"

Essay: Aṅṅā "ē tāḷnta tamiḷakamē"

### Unit 4

Tiruṇāṅga campantar – iruṇāvukkaracar – cuntarar – māṅikka vācakar – āṅṭāḷ – tirumūlar – kulacēkara āḷvār – cīttalaic cāttanār toṭarpāṅga ceytikaḷ, mērkōḷkaḷ marrum ciṟappup peyarkaḷ

### Unit 5

Tamil Grammar: Col vakaikaḷ - vēṟṟumai urupukaḷ - valliṅgam mikumiṭam

mikāyiṭam - canti(puṇarcci) - ilakkaṅakkuṟippu.

Practical skills: Listening, speaking, writing and reading

### Textbooks:

- Aṅṅā "ē tāḷnta tamiḷakamē" nakkīraṅ paḷikēṣaṅs.
- Caktitācaṅ cupramaṇiyāṅ "nalla kuṟuntokai mūlamumuraiyumu" mullai patippakam, 2008.
- <http://www.Tamilvu.Org/library/libindex.Htm>.
- jeyakāntaṅ "kuru piṭam" mīṅṅāṭci puttaka nilaiyam, 1971.

- *Nā.Pārttacārati “puṛṇanānūṛṛuc ciṟukataikal” tamilḥ puttakālayam, 1978, 2001*
- *Poṇ maṇimāṛaṇ “aṭṭōṇ tamil ilakkaṇam “aṭṭōṇ papliṣiṇ kurūp, vañciyūr, tiruvaṇantapuram, 2007.*
- *puliyūrḥ kēcikaṇ “kuṟuntokai mūlamum uraiyum” cārāta patippakam, 2010.*
- *Puliyūrḥ kēcikaṇ “puṛṇanānūṛṛu” srīceṇpakā patippakam, 2010*

**15TAM111****TAMIL I I****1 0 2 2**

**Objectives:** To learn the history of Tamil literature. To analyze different styles, language training, to strengthen the creativity in communication, Tamil basic grammar, Computer and its use in Tamil language.

**Unit 1**

The history of Tamil literature: Nāṭṭupuraḥ pāṭalkaḥ, kataikkaḥ, paḷamolikaḥ - ciṟukataikaḥ tōṛramum valarcciyum,

ciṟṟilakkiyaḥkaḥ: Kaliḥkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ palḷu 35.

Kāppiyaḥkaḥ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu marṟum aimperum – aiñciṟuṇ kāppiyaḥkaḥ toṭarpāṇa ceytikaḥ.

**Unit 2**

tiṇai ilakkiyamum nītiyilakkiyamum - patiṇeṇkiḥkaṇakku nūlkaḥ toṭarpāṇa piṟa ceytikaḥ - tirukkuṟaḥ (aṇpu, paṇpu, kalvi, olukkam, naṭpu, vāymai, kēḷvi, ceynaṇṟi, periyāraittuṇakkōṭṭaḥ, viḷippuṇarvu pēṇṟa atikāratil uḷḷa ceytikaḥ.

Aṟanūlkaḥ: Ulakanīti (1-5) – ēlāti (1,3,6). - Cittarkaḥ: Kaṭuveḷi cittar pāṭalkaḥ (āṇantak kaḷippu –1,4,6,7,8), marṟum akappēy cittar pāṭalkaḥ(1-5).

**Unit 3**

tamil ilakkaṇam: Vākkiya vakaikaḥ – taṇviṇai piṟaviṇai – nērkūrū ayarkūrū

**Unit 4**

tamilaka aṟiṇarkaliṇ tamil toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṇ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṇ, na.Piccaimūrṭti, akilaṇ, kalki, jī.Yū.Pōp, vīramāmuṇivar, aṇṇā, paritimāṟ kalaiṇar, maṟaimalaiyaṭikaḥ.

**Unit 5**

tamil molī āyvil kaṇiṇi payaṇpāṭu. - Karuttu parimāṛram - viḷampara moliyamaippu – pēccu - nāṭakam paṭaiṟpu - ciṟukatai, katai, puṭiṇam paṭaiṟpu.

**Textbooks:**

- <http://Www.tamilvu.trg/libirary/libindex.htm>.
- [http://Www.tunathamizh.tom/2013/07/blog0post\\_24.html](http://Www.tunathamizh.tom/2013/07/blog0post_24.html)
- *Mu.Varatarācaṇ “tamil ilakkiya varalāṟu” cāhitya akāṭemi papliḥēṣaṇs, 2012*
- *nā.Vāṇamāmalai “paḷaṇkataikaḷum, paḷamolikaḷum” niyū ceṇcuri puttaka veliyiṭṭakam, 1980,2008*
- *nā.Vāṇamāmalai, “tamilar nāṭṭuppāṭalkaḥ” niyū ceṇcuri puttaka veliyiṭṭakam 1964,2006*
- *poṇ maṇimāṛaṇ “aṭṭōṇ tamil ilakkaṇam “aṭṭōṇ papliṣiṇ kurūp, vañciyūr, tiruvaṇantapuram, 2007.*