15AVP201 / 15AVP211 — AMRITA VALUES PROGRAMME I / AMRITA VALUES PROGRAMME II — 1 0 0 1 / 1 0 0 1

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, Satyakama Jabala, 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 Paramahamsa, 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 'Únity 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.

15CHY101 GENERAL CHEMISTRY I 3 1 0 4

Unit 1 Atomic Structure I

Dalton's atomic theory and its failure, sub atomic particles - e/m ratio of an electron - Thomson's experiment charge on electron - Millikan's Oil Drop Technique - atomic number - Chadwick's experiment and the neutron, Rutherford's and Bohr's model of atom - limitations of Rutherford's model - Maxwell's electromagnetic theory of radiation and s model, Bohr's model of hydrogen atom - Bohr's theory and Ritz combination principle, spectra – emission and absorption - Hydrogen spectrum, Bohr-Sommerfeld theory.

Unit 2 Atomic Structure II

Planck's quantum theory of radiation, dual character of electrons - de Broglie's equation and experiment-Heisenberg's uncertainty principle - photoelectric effect, Compton, Zeeman and Stark effects, Schrodinger wave equation, eigen values, significance of wave function (ψ and $\psi 2$) and quantum numbers, Schrodinger

wave equation for hydrogen and hydrogen-like systems (no derivations, only the final equation), probability distribution of electrons around the nucleus - distribution of 1s, 2s & 2p electrons or orbitals, shapes of atomic orbitals - s, p, d and f, aufbau principle, Hund's rule, Pauli's exclusion principle, electronic configuration of elements.

Unit 3 Chemical Bonding I

Electrovalency and ionic bond formation, ionic compounds and their properties, lattice energy Born equation and its application, Born-Haber cycle and its application, solvation enthalpy and solubility of ionic compounds, covalent bond, covalency, formation of H2 in terms of decrease of energy, orbital theory of covalency - sigma and pi bonds - formation of covalent compounds and their properties.

Unit 4 Chemical Bonding II

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, metallic bond - free electron, valence bond and band theories, weak chemical bonds – inter and intra molecular hydrogen bond - van der Waals forces.

Unit 5 Chemical analysis and stoichiometric calculation

Titrimetry - Fundamental concepts – Theory behind acid base, redox, precipitation and complexometric titrations – problems based on stoichiometry - gravimetry principle and model calculations involving estimation of barium, calcium and nickel - data analysis, significant figures, precision and accuracy – types of errors - mean and standard deviation.

TEXTBOOKS:

1. *B. R. Puri, L. R. Sharma, M. S. Pathania, 'Principles of Physical Chemistry', Vishal Publishing Co., 2008*
2. *Manas Chanda, 'Atomic Structure and Chemical Bond', 4th edition, Tata McGraw-Hill, New Delhi, 2000.*

REFERENCES:

1. *C. N. R. Rao, 'University General Chemistry', Macmillan, India, 2000.*
2. *F. A. Cotton, G. Wilkinson and P. L. Gaus, 'Basic Inorganic Chemistry', 5th edition, John Wiley, 1987.*
3. *Peter Atkins and Julio de Paula, 'Elements of Physical Chemistry', 5th edition, Oxford University Press. 2009.*

15CHY111 GENERAL CHEMISTRY II 3 1 0 4

Unit 1 Nuclear Chemistry

Size, structure and stability of the nucleus - n/p ratio, packing fraction, mass defect and binding energy - nuclear fission and fusion, hydrogen and atom bombs – radioactivity, alpha, beta particles and gamma radiation - Soddy-Fajan displacement

law, half and average life period - Geiger-Muller Counter and Wilson Cloud Chamber. applications of radioactivity - in medicine, agriculture, carbon and fossil dating - isotopes, isobars, isotones, isodiapheres and nuclear isomers - natural and artificial radioactivity, artificial transmutation of elements, induced radioactivity, preparation of transuranic elements, Q values, nuclear coulombic barrier.

Unit 2 Solid State

Crystalline and amorphous solids, isotropy and anisotropy, elements of symmetry in crystal systems indices - Miller indices, space lattice and unit cell, Bravais lattices, the seven crystal systems and their Bravais lattices, X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), types of crystals - molecular, covalent, metallic and ionic crystals - close packing of spheres – hexagonal, cubic and body centered cubic packing, interstices in packing - types of crystals – molecular, covalent, metallic crystals - defects in crystals – stoichiometric, non-stoichiometric, extrinsic and intrinsic defects - semi and super conductors - liquid crystals.

Unit 3 Acids, Bases and Non-aqueous solvents

Concepts of acids and bases – hard and soft acids and bases - Pearson's concept, HSAB principle and its application - basis for hard - hard and soft - soft interactions - non-aqueous solvents - general characteristics of non-aqueous solvent - melting point, boiling point, latent heat of fusion and vaporization, and dielectric constant - reactions such as complex formation, redox, precipitation and acid base type in non-aqueous solvents like liquid ammonia, liquid SO2 and liquid HF.

Unit 4 Introduction to nanostate of materials

Nanosize - surface to volume ratio and quantum confinement - size dependence of properties – optical – electrical – mechanical - magnetic properties. Zero, one and two dimensional nanomaterials.

Unit 5 Water Technology

Soft and hard water – Hardness – units of hardness – alkalinity - dissolved oxygen – water for various types of industries – treatment of water by ion exchange process - boiler feed water – boiler compounds – internal and external conditioning - water for drinking - municipal water treatment – desalination by RO and electro dialysis.

TEXTBOOKS:

1. *B. R. Puri, L. R. Sharma, Kalia, 'Principles of Inorganic Chemistry', Vishal Publishing Co., 2008*
2. *B. R. Puri, L. R. Sharma, M. S. Pathania, 'Principles of Physical Chemistry', Vishal Publishing Co., 2008*
3. *Gurdeep Raj, 'Advanced Inorganic Chemistry', 31st edition, Goel Publishing House, 2008.*

REFERENCES:

1. *H. S. Arnicker, 'Essentials of Nuclear Chemistry', 4th edition, New Age International Publishers, 2005.*
2. *L. V. Azaroff, "Introduction to Solids", Mc Graw Hill, New York, 2009*
3. *F. A. Cotton and G. Wilkinson, "Advanced Inorganic Chemistry", 5th edition, John Wiley and Sons, New York, 1987*

15CHY186 INORGANIC QUALITATIVE LAB. 0 0 2 1

I. Qualitative Analysis:

Analysis of mixtures containing two anions (one simple and one interfering) and two cations (of different groups) from the following:

Anions - HCO3-, CO32-, Cl-, F-, Br-, I-, NO3-, BO33-, SO42- and PO43-

Cations - Pb2+ Bi3+, Cd2+, Al3+, Fe2+, Fe3+, Mn2+, Zn2+, Ca2+, Sr2+, Ba2+, Mg2+, K+, Na+ and NH4+, Cu2+, Mn2+.

Note:

1. *Mixtures requiring elimination of phosphate and borate radicals should not be given (avoid cat ions like Ba2+, Sr2+, Ca2+ and Mn2+ when phosphate and borate are given).*
2. *Combinations like Cl- and Br-, I-and Cl- and NO3- and Br- shall be avoided.*
3. *Salts that yield SrSO4, BaSO4, CaSO4, PbSO4 and FeSO4 on double decomposition shall be avoided.*
4. *The two cations in the mixture should belong to different groups. However, combinations like Mg2+ and NH4+, K+ and NH4+ can be given.*

II. Preparations: (Any six from the following)

1. Ferrous ammonium sulphate
2. Tetrammine copper (II) sulphate
3. Potassium trisoxalato chromate
4. Prussian Blue
5. Hexammine Cobalt (II) chloride
6. Nickel dimethyl glyoximate
7. Potassium trisoxalato ferrate (III)
8. Tristhioureacopper (I) sulphate
9. Ferric alum
10. Potash alum
11. Mohr Salt from Kipp's waste.

TEXTBOOKS:

1. *A. I.Vogel, 'A text book of Qualitative Analyses', 4th edition, Longmans publications, 1985.*
2. *V. V. Ramanujam, 'Inorganic Semi Micro Qualitative Analysis', 3rd edition, The National Publishing Company, 1974.*

REFERENCES:

1. *G. Pass & H. Sutcliffe, 'Practical Inorganic Chemistry', 2nd edition, Chapman & Hill, 1974.*
2. *D. A.Skoog and D. M.West, 'Analytical Chemistry - An Introduction', 4th Edition, CBS Publishing Japan Ltd., 1986.*

15CHY201 PHYSICAL CHEMISTRY I 3 1 0 4

Unit 1 Kinetic Theory of Gases

Kinetic molecular model of gases – Maxwell distribution of velocities and its use in

calculating molecular velocities (average rms and most probable velocity and average kinetic energy) - Collision diameter, mean free path and viscosity of gases including their pressure and temperature dependence – Relation between mean free path and coefficient of viscosity – behaviour of real gases – deviation of gases from ideal behaviour – compressibility factor – van der Waal's equation of state - its derivation and application in explaining ideal gas behaviour – virial equation of state – van der Waals equation expressed in virial form and calculation of Boyle temperature – Isotherms of real gases and their comparison with van der Waal's isotherms – Determination of molecular mass by limiting density method – critical phenomena – critical constants and determination.

Unit 2 First law of thermodynamics and Thermo chemistry

System and surrounding – isolated, closed and open systems - state of the system - Intensive and extensive variables. Thermodynamic processes - reversible and irreversible, isothermal and adiabatic processes - state and path functions - exact and inexact differentials, concept of heat and work. First law of thermodynamics – statement. Relation between Cp and Cv, calculation of w, q, dE and dH for expansion of ideal and real gases under isothermal and adiabatic conditions of reversible and irreversible processes. Thermochemistry Enthalpy change of a reaction and different enthalpy changes - relation between enthalpy of reaction at constant volume (qv) and at constant pressure(qp) - temperature dependence of heat of reaction - Kirchoffs equation - of solution and dilution bond energy and its calculation from thermo chemical data - Integral and differential heats.

Unit 3 Second and Third laws of Thermodynamics

Second law of thermo dynamics - different statements of the law - Carnot's cycle and efficiency of heat engine - Carnot's theorem - thermodynamic scale of temperature - concept of entropy - definition and physical significance of entropy - entropy as a function of P, V and T - entropy changes during phase changes - entropy of mixing - entropy criterion for spontaneous and equilibrium processes in isolated system - Gibb's free energy (G) and Helmholtz free energy (A) - variation of A and G with P, V and T - Gibb's - Helmholtz equation and its applications - thermodynamic equation of state - Maxwell's relations. Introduction to Third Law of Thermodynamics and its applications, exceptions to the third law, chemical potential and its physical significance, Gibbs-Duhem equation, fugacity and fugacity coefficient, activity and activity coefficient.

Unit 4 Chemical equilibria

Law of mass action - equilibrium constant – Relation between Kp, Kc and Kx – Thermodynamic treatment of the law of mass action – vant Hoff reaction isotherm – Temperature dependence of the equilibrium constant – The van't Hoffs equation – Pressure dependence of the equilibrium constant Kp and Kc – Factors that change the state of equilibrium - Le-chatelier's principle and its application to chemical and physical equilibria.

Unit 5 Solutions

Mixture, homogeneous and heterogeneous mixtures, solution, solvent, solute - concentration of a solution, methods for expressing concentration - concept of activity and activity coefficients - completely miscible liquid systems - benzene and toluene. Duhem - Margules equation, azeotropes - HCl – water and ethanol - water systems - partially miscible liquid systems - phenol - water, triethanolamine - water and nicotine - water systems. Lower and upper CSTs - effect of impunities on CST - completely immiscible liquids - Nernst distribution law – derivation. Applications - determination of formula of a complex (KI + I2 = KI3).solvent extraction principle and derivation of a general formula of the amount unextracted - colligative properties - relative lowering of vapour pressure, elevation of boiling point, depression in freezing point and osmotic pressure (quantitative treatment), molecular weights from colligative properties.

TEXTBOOKS:

1. *Gurdeep Raj, 'Advanced Physical Chemistry', 35th edition, Goel Publishing House, 2009.*
2. *Puri, Sharma & Pathania, 'Principles of Physical Chemistry', 42nd edition, Vishal Publishing & Co, 2007.*

REFERENCES:

1. *R. Stephen Berry, Stuart A. Rice & John Ross, 'Physical Chemistry', 2nd edition, Oxford University press, 2000.*
2. *Levin, 'Physical Chemistry', 6th edition, Tata Mcgraw-Hill Education, 2011.*

15CHY202 INORGANIC CHEMISTRY I 3 1 0 4

Unit 1 s block elements

General characteristics – atomic and ionic radii – ionization energies – electropositive character – reducing properties – hydration of ions – flame coloration – lattice energies – chemical properties – extraction of alkali and alkaline earth metals – uses of alkali and alkaline earth metals – complexes of alkali and alkaline earth metals – compounds of alkali and alkaline earth metals and their applications.

Unit 2 p block elements

General characteristics – metallic and non-metallic character – diagonal relationship – extraction – Lewis acids – back bonding – boron compounds. Catenation – structure of graphite – intercalation compounds – metal carbonyls – carbides – silica, silicates, glass manufacturing – zeolites. Allotropy in P and S. compounds of N and P - hydrazine – hydrazoic acid – hydroxyl amine – phosphazines. Anomalous behavior of oxygen, structure of ozone. Hydrides, halides, oxides, oxoacids, persulfuric acids, nitrides of group VI and VII elements. Inter halogen compounds and their structure. Isolation of noble gases – preparation, properties, structure and uses of noble gas compounds.

Unit 3 d block elements

Transition metals: Transition metals – general characteristics – metallic character – oxidation states – size – density – melting and boiling points – ionization energy –

color – magnetic properties – reducing properties – catalytic properties – Non stoichiometric compounds – complex formation – alloy formation – difference between first row and other two rows. Chemistry of Zr, Ti, V and Mo compounds.

Unit 4 f block elements

Position in the Periodic Table - General characteristics of Lanthanides and Actinides - Lanthanide contraction and its consequences. Isolation of Lanthanides from Monazite including the Ion exchange resin method. Actinides - occurrence and preparation, comparison with lanthanides. Chemistry of Thorium and Uranium - Important compounds - preparation, properties and uses of Uranyl nitrate, Uranium hexafluoride, Thorium dioxide.

Unit 5 Metallurgy

Occurrence of metals based on standard electrode potential – concentration of ores – calcination, roasting and smelting – reduction using carbon and other reducing agents – electrolytic reduction – hydrometallurgy – Ellingham diagram. Refining of metals – electrolytic refining – oxidative refining – zone refining – Van Ankel method. Extractive metallurgy of Li, Ni – Ferrous metallurgy – manufacture of steel by open hearth process – Alloys – composition and uses of German silver, Brass, Bronze, Gunmetal, Alnico.

TEXTBOOKS:

1. *Puri B R, Sharma L R, Kalia K K, 'Principles of Inorganic Chemistry', 23rd edition, Shoban Lal Nagin Chand & Co, New Delhi, 1993.*
2. *Lee J. D., 'Concise Inorganic Chemistry', Black Well Science, UK. 2006*
3. *Soni P. L., 'Text Book of Inorganic Chemistry', S, Chand & Co, New Delhi, 2006.*

REFERENCE BOOKS:

1. *Madan R. D., Tuli G. D and Malik S. M., 'Selected Topics in Inorganic chemistry', S. Chand & Co, New Delhi, 2006.*
2. *S. F. A. Kettle, 'Physical Inorganic Chemistry', Spectrum, 1996.*
3. *B. E. Dogulas DH McDaniel's and Alexander, 'Concepts and Models of Inorganic Chemistry', Oxford IBH, 1983.*

15CHY211 PHYSICAL CHEMISTRY II 3 1 0 4

Unit 1 Phase Equilibria

Definition of terms: Phase, components and degrees of freedom – Derivation of Gibbs phase rule - application of phase rule to one component system: Water, carbondioxide and sulphur system – Reduced phase rule - Two component system: Simple eutectic system: Pb-Ag system, Pattinson's process. Thermal analysis and cooling curves, Compound formation with congruent melting point Zn – Mg, FeCl3 – Water system. Compound formation with incongruent melting point Na – K system. Metal systems forming continuous solid solutions and solid solutions with minimum and maximum melting points.

Unit 2 Chemical Kinetics

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 derivation, activation energy, characteristics of activated complex Theories of reaction rates – collision theory – derivation of rate constant of bimolecular gases reaction – failure of collision theory – Lindemann's theory of unimolecular reaction. Theory of absolete reaction rates – derivation of rate for a bimolecular reaction – significance of entropy and free energy of activation.

Unit 3 Catalysis

Catalysis – homogeneous and heterogeneous – homogeneous catalysis – kinetic of acid – ase reaction and mechanism - theory of homogeneous and heterogeneous catalysis. Heterogeneous catalysis – adsorption – types – chemical and physical, characteristics of adsorption. Different types of adsorption isotherms – Freundlich and Langmuir - enzyme catalysis, difference between enzyme catalysis and general heterogeneous catalysis, factors affecting the rate of enzyme catalyzed reactions.

Unit 4 Electrochemistry I

Electrolysis, Faraday's laws of electrolysis, strong and weak electrolytes specific, equivalent and molar conductance, equivalent conductance at infinite dilution and their measurement - Kohlrausch's law and its applications - calculation of equivalent conductance at infinite dilution for weak electrolytes, degree of dissociation of weak electrolytes - Modern theory of strong electrolytes (concept only) - Debye–Huckel Onsagar equation (no derivation) - solubility of sparingly soluble salts - applications of conductivity measurement - conductometric titrations - acid-base precipitation and complexometric titrations, Ostwald's dilution law and its limitations, common ion effect and its application, concept of pH, indicators, theories of indicators – buffers and their pH - Henderson equation, hydrolysis and example of hydrolysis - relation between Kh, Kb and Kw, transport number (Hittorf number) and its experimental determination - Hittorf's method and moving boundary method.

Unit 5 Electrochemistry II

Potential and its origin – electrical double layer and equilibrium – single electrode potential, standard hydrogen electrode - EMF series and its significance – Galvanic cells, IUPAC notation - reversible and irreversible cells, electrodes, calomel and Sg/AgCl reference electrodes - indicator and ion selective (pungor) electrodes and their applications, Computation of cell EMF, Calculation of thermodynamic quantities of cell reactions (?G, ?H and K) Concentration cell with and without transference, liquid junction potential and its elimination – variation of potential with concentration, Nernst equation and its applications, potentiometric titrations - acid-base, redox and precipitation titrations. Concept of overpotential - AOP, COP, IROP - Butler–Volmer equation - (derivation not required). Tafel experiment and Tafel plot and its significance.

TEXTBOOKS:

1. *Puri, Sharma & Pathania, 'Priniciples of Physical Chemistry', 42nd edition, Vishal Publishing Co, 2007.*
2. *Gurdeep Raj, 'Advanced Physical Chemistry', 35th edition, Goel Publishing House, 2009.*

REFERENCES:

1. *Glasstone and Lewis, 'Elements of Physical Chemistry', 2nd edition, Macmillan, 1982.*
2. *P. C.Rakhit, 'Physical Chemistry', 7th edition, Sarat Book House, 2001.*
3. *R. Stephen Berry, Stuart A. Rice & John Ross, 'Physical Chemistry', 2nd edition, Oxford University press, 2000.*

15CHY213 ORGANIC CHEMISTRY I 3 1 0 4

Unit 1 Basic concepts in Organic Chemistry

Composition of organic compounds – detection and estimation of elements – carbon, hydrogen, nitrogen, oxygen, sulphur, phosphorous, halogens – Calculation of empirical and molecular formula - determination of molecular weights – physical and chemical methods - empirical formula and molecular formula – Classification and Nomenclature of organic compounds.

Unit 2 Organic reactions and their mechanisms

Electron displacement effects – inductive, electromeric, mesomeric and hyperconjugative. Reactive intermediates – carbocations, carbanions, free radicals and carbenes – electrophiles and nucleophiles – hemolytic and heterolytic reactions – Substitution reactions (SN1 and SN2) – addition reaction – electrophilic and nucleophilic, elimination – E1 and E2 and rearrangement reactions – inter and intramolecular - condensation reactions – reduction and oxidation reactions.

Unit 3 Isomerism and Stereochemistry

Structural isomerism - chain, position, functional and metamerism, geometrical isomerism – determination of configuration, optical isomerism, Asymmetry, dissymmetry and chirality, enantiomers – Fischer projections – absolute and relative configurations – R and S systems – resolution of racemic mixtures – asymmetric synthesis.

Unit 4 Alkanes, cycloalkanes, alkenes and alkynes

Structure, nomenclature, isomerism in alkanes, alkenes and alkynes. General methods of preparation of alkanes, cycloalkanes, alkenes and alkynes. Physical and chemical properties alkanes, cycloalkanes, alkenes and alkynes. Conformation of alkanes.

Unit 5 Homocyclic Aromatic compounds and Aromaticity

Structure of benzene – nomenclature of aromatic compounds – general methods of preparation – physical chemical properties – Electrophilic and nucleophilic substitution reactions – orientation in aromatic disubstitution - Aromaticity – Huckel's rule – anisotropic ring current – aromatic – nonaromatic and antiaromatic compounds.

TEXTBOOKS:

1. *Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition, Prentice Hall, 1992.*
2. *K. S. Tewari and N. K. Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House, 2005.*
3. *D. Nasipuri 'Stereochemistry of Organic Compounds', 2nd Edition, New Age International (P) Ltd., Publishers, 1994.*

REFERENCES:

1. *Peter Sykes, 'A Guide book to Mechanism in Organic Chemistry', 6th Edition, Pearson Education, 2009.*
2. *P. S. Kalsi' 'Organic Reactions and their Mechanisms", New Age International Publishers, 2009.*
3. *J. Clayden, N. Greeves, S. Warren and P. Wothers, 'Organic Chemistry', 2nd edition, Oxford University Press, 2012.*

15CHY281 INORGANIC QUANTITATIVE LAB. – VOLUMETRIC ANALYSIS 0 0 2 1

Acid base titrations

1. Preparation of standard sodium carbonate solution, and standardization of hydrochloric acid (methyl orange indicator). Estimation of sodium hydroxide in solution using phenolphthalein indicator.
2. Preparation of standard oxalic acid solution and standardization of sodium hydroxide solution. Estimation of sulphuric acid in solution.
3. Estimation of sodium hydroxide and sodium carbonate in a mixture (analysis of commercial caustic soda) by double indicator method.

Redox titrations

Permanganometry

4. Preparation of standard oxalic acid solution and standardization of potassium permanganate solution. Estimation of ammonium Iron (11) sulphate in solution.
5. Preparation of standard oxalic acid solution and standardization of potassium permanganate solution. Estimation of hydrogen peroxide solution.
6. Estimation of calcium.
7. Estimation of Ferrous iron.

Dichrometry

8. Estimation of ferrous iron using external and internal indicators.
9. Estimation of ferric iron using external and internal indicators.

Iodimetry and Iodometry

10. Standardisation of sodium thiosulphate using potassium iodate, Electrolytic copper and potassium dichromate.
11. Estimation of As2O3 and arsenite
12. Estimation of copper sulphate.
13. Estimation of iron in the given sample of haematite by dichromate method.
14. Estimation of copper in bronze by iodometric method.
15. Estimation of tin in solder using EDTA.

TEXTBOOKS:

1. *A. I.Vogel, 'A text book of Qualitative Analyses', 4th edition, Longmans publications, 1985.*
2. *G. Pass & H. Sutcliffe, 'Practical Inorganic Chemistry', 2nd edition, Chapman & Hill, 1974.*

REFERENCES:

1. *G. S.Turpin, 'Practical Inorganic chemistry', MacMillan, 1895.*
2. *G. W. Parshall, 'Inorganic Synthesis', Vol. 15, Tata McGraw-Hill Education, 1974.*

15CHY286 BASIC ORGANIC QUALITATIVE LAB. 0 0 2 1

1. Basic idea on the preparation of reagents used in organic analysis. (Borshes reagent, Schiff's reagent, phenolphthalein, Neutral $FeCl_3$, Tollens reagent, Fehlings solution),
2. Determination of boiling point and melting point – capillary method,
3. Methods of re-crystallisation,
4. Tests for elements: Nitrogen, Halogens and Sulphur
5. Tests for unsaturation. Tests for aromatic character.
6. Study of the reactions of the following functional groups: alcohol, aldehyde, ketone, carboxylic acid, 1,2 dicarboxylic acid, ester, primary and secondary amines,
7. Systematic analysis of the following organic compounds containing one functional group and characterization with a derivative - alcohol, aldehyde, ketone, carboxylic acid, 1,2 dicarboxylic acid, ester, primary and secondary amines.

REFERENCES:

1. *F. G.Mann and B. C.Saunders, 'Practical Organic Chemistry' 4th edition, Pearson Education, 2009.*
2. *V. K.Ahluwalia and S. Dhingra 'Comprehensive Practical Organic Chemistry' Universities Press, 2000.*
3. *B. S.Furnis, A. J.Hannaford, P. W. G. Smith and T. R.Tatchell, 'Vogel's Text book of Practical Organic Chemistry', ELBS/Longman, 1989.*
4. *S. P. Bhettani & Aruna Chhikara, 'Practical organic chemistry (qualitative analysis)', Ane books (India) Pvt Ltd, 2008.*
5. *O. P. Pandey, D.N Bajpai, S. Gini, 'Practical Chemistry, for I, II & III BSc. Students', S. Chand & Company Ltd reprint, 2009.*
6. *V. K.Ahluwalia, Sunitha Dhingra, Adarsh Gulate, 'College Practical Chemistry', Universities Press (India) Pvt Ltd, 2008.*

15CHY301 PHYSICAL CHEMISTRY III 3 1 0 4

Unit 1 Introduction to Quantum Chemistry

Introduction to quantum mechanics, Planck's quantum theory of radiation, photoelectric effect - dual nature of radiation, de Broglie's hypothesis - dual character of matter, uncertainty principle, Schrodinger wave equation - time dependent and time independent (no derivation), wave function ψ and its physical meaning, application of Schrodinger equation - particle in a one-dimensional box with two infinite potential barriers (energy of the particle, quantum number and quantization, momentum of the particle, energy level diagram, zero point energy,

forms of the wave, node) and utility of this model, application of quantum mechanics to problems in chemistry - quantum chemistry (mention a few applications).

Unit 2 Basics of group theory

Symmetry elements and symmetry operation - group postulates and types of groups - Abelian and non Abelian-symmetry operation of H2O molecule - illustration of group postulates using symmetry operations of H2O molecule - construction of multiplication table for the operation of H2O molecule - point group - definition – elements (symmetry operations) of the following point groups: Cn (C2, C3) Sn (S1, S2), C1V (C2V, C3V) and C2R. group theory and optical activity.

Unit 3 Irreversible and Statistical Thermodynamics

Reversible and irreversible thermodynamics, examples for irreversible processes, postulate or assumption of local equilibrium, entropy production - entropy production in heat flow and in matter flow, forces and fluxes, introduction to statistical thermodynamics, system, assembly, ensemble, canonical and micro canonical ensemble, Boltzmann distribution law (no derivation), partition function, qualitative and basic ideas of Maxwell-Boltzmann statistics, Bose-Einstein statistics and Fermi-Dirac statistics, bosons and fermions.

Unit 4 Photochemistry

Photochemistry - Consequences of light absorption - The Jablonski diagram – non-radiative transitions - radiative transitions – laws of photochemistry - Lambert's law, Beer's law and Beer-Lambert law, deviation from Beer's law, Grotthus - Draper law - The Stark Einstein law of photochemical equivalence - Quantum efficiency (quantum yield). Energy transfer in photochemical reactions – photosensitisaiton - Photosynthesis in plants - Chemiluminescence - fluorescence and phosphorescence – lasers - uses of lasers. Photochemical reactions -Kinetics of hydrogen-bromine reaction - decomposition of HI - photoelectric cells, photosensitization and photosensitiser, photosynthesis.

Unit 5 Surface Chemistry and Colloids

Absorption – physical and chemical - adsorption isotherms, Freundlich and Langmuir isotherms, positive, negative and electrostatic adsorption, applications of adsorption, colloidal state, dispersed phase, dispersion medium, types of colloidal systems, sols, gels and foams - lyophobic and lyophilic colloids, preparation by mechanical and electrical dispersion and chemical methods, purification by electrodialysis, and ultrafiltration, properties - colour, optical and electrical properties, qualitative idea of electrical double layer (Helmholtz-Perrin theory, Gouy-Chapman theory, Stern's theory), stability of lyophobic and lyophilic sole, isoelectric point, protection of colloids - protective colloids, Gold Number, Hofmeister series, coagulation or flocculation - addition of electrolytes, continuous dialysis and salting out, Hardy-Schulze law, coacervation, sensitization, micelle and critical micellisation concentration, application of colloids.

TEXTBOOKS:

1. *R. K.Prasad, 'Quantum Chemistry', 3rd edition, New Age International Publishers, 2006.*
2. *Puri, Sharma & Pathania, 'Principles of Physical Chemistry', 42nd edition, Vishal Publishing Co, Delhi, 2007.*
3. *Gurdeep Raj, 'Advanced Physical Chemistry', 35th edition, Goel Publishing House, 2009.*

REFERENCES:

1. *Donald A McQuarrie, "Quantum Chemistry", Viva Books Private Ltd.*
2. *Glasstone and Lewis, 'Elements of Physical Chemistry', 2nd edition, Macmillan, 1982.*
3. *R. Stephen Berry, Stuart A. Rice & John Ross, 'Physical Chemistry', 2nd edition, Oxford University press, 2000.*

15CHY302 INORGANIC CHEMISTRY II 3 1 0 4

Unit 1 Coordination Chemistry I

Werner's theory – Electronic interpretation of co-ordination compounds - EAN rule – types of ligands – Nomenclature, isomerism – stability of complexes – factors influencing stability – Application of coordination compounds in qualitative and quantitative analysis. Theories of bonding in coordination compounds – VBT, CFT and MOT. VBT – merits and demerits – CFT – crystal field splitting in tetrahedral and octahedral complexes – factors affecting crystal field splitting – CFSE of complexes – spectrochemical series – Explanation of geometry, magnetism and colour on the basis of the above theories.

Unit 2 Coordination Chemistry II

Spectral and magnetic properties of metal complexes - Electronic absorption spectrum of [Ti H2O)6]3+ ion. Types of magnetic behavior, spin-only formula, calculation of magnetic moments. Reactivity of metal complexes - Labile and inert complexes, ligand substitution reactions – SN1 and SN2 substitution reactions of square planar complexes – Trans effect and applications of trans effect.

Unit 3 Organometallic compounds

Definition, classification and nomenclature of organometallic compounds, Ylides, classification on the basis of hapticity. Catalytic properties of organometallic compounds - alkene hydrogenation, synthesis of water gas – shift reaction, Zeigler-Natta polymerisation, Wilkinson catalyst - 18 electron rule, metal-alkene complexes, metal-alkyne complexes, carbene and carbyne complexes. Metal nitrosyls and dinitrogen complexes. Metallocenes – ferrocene (preparation and structure only). Dibenzene chromium. Zeise's salt – preparation, properties and structure.

Unit 4 Metal Carbonyls and Metal clusters

Preparation and properties of mononuclear carbonyls. Structures of Mo(CO)6, Fe(CO)5 and Ni(CO)4. Polynuclear carbonyls, bridged carbonyls and bonding in metal carbonyls. Preparation and properties of carbonyls of Fe and Ni. Metal clusters - carbonyl and halide clusters, low nuclearity carbonyl clusters and high nuclearity carbonyl clusters, electron counting schemes for Rh6(CO)16 and [Os6(CO)18]2- metal only clusters (Zintl ions).

Unit 5 Bioinorganic Chemistry

Essential and trace elements in biological systems, myoglobin and haemoglobin, role of myoglobin and haemoglobin in biological systems, mechanism of oxygen transport, cooperativity, Bohr effect. Vitamin B12 (structure not expected) Metalloenzymes of zinc, inhibition and poisoning of enzymes. Electron carriers – cytochromes. Role of alkali and alkaline earth metals in biological systems, Photosynthesis, Na/K pump. Biological function and toxicity of metals – Fe, Cu, Zn, Cr, Mn, Ni, Co, Cd, Hg and Pb, treatment of metal toxicity. Anti cancer drugs – cisplatin and carboplatin.

TEXTBOOKS:

1. *Puri B R, Sharma LR, Kalia K K., 'Principles of Inorganic Chemistry', 23rd Edition, Shoban Lal Nagin Chand & Co, New Delhi, 1993.*
2. *Lee J.D., 'Concise Inorganic Chemistry', Black Well Science, UK, 2006.*
3. *Soni P.L., 'Text Book of Inorganic Chemistry', S, Chand & Co, New Delhi, 2006.*

REFERENCE BOOKS:

1. *Madan R.D., Tuli G.D and Malik S.M., 'Selected Topics in Inorganic chemistry', S. Chand & Co, New Delhi, 2006.*
2. *S. F. A. Kettle, 'Physical Inorganic Chemistry', Spectrum, 1996.*

15CHY303 ORGANIC CHEMISTRY II 3 1 0 4

Unit 1 Alkyl Halides, aryl halides and Organometallic compounds

Structure, nomenclature, preparation of alkyl and aryl halides. Chemical and physical properties – SN1 and SN2 reactions – di, tri and tetra halogen derivatives – unsaturated halogen derivatives. Aryl halides – preparation, physical and chemical properties and uses - Addition halogen compounds – Chlorobenzene – DDT. Aralkyl halides – preparation and properties. Grignard reagents – preparation – chemical and physical properties – organolithium compounds.

Unit 2 Alcohols and Phenols

Alcohols: Nomenclature – preparation and properties. Conversion to tosylates – oxidation. Tests for hydroxyl groups. Industrial importance of various alcohols. Synthesis and properties of polyhydric alcohols.

Phenols: Preparation, properties, reactions (oxidation) to quinones, Riemer-Tiemann reaction – Bromination, Nitration, Liebermann's nitroso reaction, preparation of phenolphthalein, Kolbe's reaction – Pinacol–Pinacolone rearrangement. Industrial importance of picric acid, quinol and nitro phenols.

Ethers: Nomenclature, preparation and reactions - Claisen rearrangement, Zeisel's method – crown ether structure.

Thioalcohols - general physical and chemical characteristics.

Unit 3 Aldehydes and Ketones

Nomenclature, classification and preparation of aldehydes and ketones – reactivity of carbonyl groups – acidity of alpha H. Reactions – Oxidation, reduction, metal hydride reduction, nucleophilic addition, Wittig reaction, Grignard reagent, Michael addition, Cannizaro, Aldol, Perkin, Knoevenagel, Benzoin, Claisen, Reformatsky, Beckmann rearrangement, stobbe condensation (with mechanism).

Unit 4 Carboxylic acids, Acid derivatives and Active methylene compounds

Nomenclature. Classification of aliphatic and aromatic carboxylic acids. Preparation and reaction – acidity – reduction (mechanisms) substitution in alkyl/aryl group. Fischer esterification reaction. Decarboxylation reactions.

Dicarboxylic acids – preparation of oxalic, malonic, succinic, glutaric, adipic, phthalic acids and unsaturated acids (acrylic, crotonic and cinnamic, maleic and fumaric).

Active methylene compounds: Synthesis and application of ethyl acetoacetate, diethyl malonate and cyano aceto esters.

Acid derivatives: Preparation/reaction of acid chlorides, acid anhydrides, amides, esters, acid/alkaline hydrolysis of esters, trans-esterification.

Derivatives of carbonic acids: Preparation, properties and structure of urea, manufacture of urea and thiourea, preparation and basicity of guanidine.

Unit 5 Organic compounds containing Nitrogen

Nitro compounds – Nomenclature, preparation and properties of aliphatic and aromatic nitro compounds. Reduction of nitro benzene under various conditions. Di and tri substituted aromatic nitro compounds – synthesis of o-, m-, p- dinitrobenzenes and tri nitrobenzene. Amino compounds – nomenclature and classification. Carbylamine reaction, diazotization – comparison of aliphatic and aromatic amines. Reductive amination of aldehydic and ketonic compounds.

Diazonium salts – preparation and reactions. Diazoalkanes and azides Cyan compounds.

TEXTBOOKS:

1. *Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition, Prentice Hall, 1992.*
2. *K.S. Tewari and N.K. Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House, 2005.*
3. *T.H.Lowry, K.S.Richardson, 'Mechanism and Theory in Organic Chemistry', 3rd edition, Harper Colins, New York, 1987.*

REFERENCES:

1. *L.G. Wade, J.R., 'Organic Chemistry', 5th edition, Pearson Education, Singapore, 2004.*
2. *Solomons & Fryhle, 'Organic Chemistry', 7th edition, Wiley India Pvt. Ltd., 2004.*
3. *John McMurry, 'Fundamental of Organic Chemistry', 7th edition, Brook and Cole, 2011.*

15CHY311 BASICS OF ANALYTICAL CHEMISTRY 3 0 0 3

Unit 1 Theoretical principles of qualitative and quantitative analysis

Types of analytical methods - Importance of analytical methods in qualitative and quantitative analysis - chemical and instrumental methods - advantages and limitations of chemical and instrumental methods. Data Analysis - Types of errors, minimization of errors, propagation of errors, accuracy and precision, least square analysis, average standard deviation, coefficient of variance, significant figures.

Unit 2 Chromatographic Techniques

Theory of separation, chromatographic separation, chromatographic techniques - Column chromatography, thin layer chromatography, Paper chromatography, Ion-exchange chromatography, gas chromatography - principle, Significance of Rf-values. HPLC, GC-MS, bioseparation - electrophoresis, centrifugation, DNA/protein separation, purification, polymer separation, green separation process, separation using zeolite and polymer membranes.

Unit 3 Thermal Analysis

Principle of thermo gravimetry (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC) - Instrumentation and Characteristics of TGA and DTA curves, factors affecting TGA and DTA curves. Applications - TGA of calcium oxalate monohydrate, DTA of calcium acetatemonohydrate - determination of purity of pharmaceuticals by DSC, Thermometric titrations.

Unit 4 Electroanalytical Techniques

Conductometry - ion selective electrodes. Potentiometry, Amperometry, coulometry, polarography, voltametry - cyclic voltametry and anodic stripping voltametry - Principle and analysis of samples.

Unit 5 Crystallographic and Microscopic Techniques

XRD, X-ray crystallography, SAXD Optical microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Transmission Electron Microscopy, Atomic Force Microscopy.

TEXTBOOKS:

1. *Douglas A. Skoog and Donald M. West, F.J. Holler, 'Fundamentals of Analytical Chemistry', 7th edition, 7th edition, Suanders College publishers, 1995.*
2. *Usharani S., Analytical Chemistry, Macmillan, 2001.*

REFERENCES:

1. *Mendham J., Denney R.C., Barnes J.D., Thomas M., 'Vogel's Text book of Quantitative Chemical analysis', 7th edition, Pearson education, 2008.*
2. *Sharma, B.K., 'Instrumental Methods of Chemical Analysis', Goel Publishing House, Merrut, 1997.*
3. *Gopalan. R., Subramaniam P.S. and Rengarajan K., 'Elements of Analytical Chemistry', Sultan Chand and Sons, 2004.*

15CHY312 ORGANIC CHEMISTRY III 3 1 0 4

Unit 1 Polycyclic and Heterocyclic Aromatic Compounds

Classification – reactions and structure of naphthalene, anthracene and phenanthrene. Elementary idea of naphthyl amines, naphthols, naphthaquinone and anthraquinone. Five-membered heterocycles with one hetero atom – Nomenclature - Pyrroles – synthesis (knorr synthesis, Paal-Knorr synthesis etc), Furan – synthesis, Thiophene – synthesis. Six-membered heterocycles with one hetero atom - Pyridines – synthesis. Quinoline and isoquinolines – synthesis. Reaction mechanisms of electrophilic and nucleophilic substitutions, oxidation/reduction reactions. Resonance structures of heterocyclic compounds, applications. Fused ring heterocycles – Synthesis, Structure and reactivity.

Unit 2 Carbohydrates

Classification and nomenclature. Preparation, properties and structural elucidation. Glucose – structure and configuration of mono saccharide, interconversion, mutarotation, epimerization, cyclic structure. Disaccharide – sucrose, maltose – structure. Polysaccharide – starch, cellulose, glycogen – structure and utility. Reducing and non-reducing sugars.

Unit 3 Amino acids, Proteins, vitamins and Nucleic acids

Amino acids: Classification, structure and stereochemistry of amino acids, preparation and reactions of β, γ - amino acids. Essential and non essential amino acids, zwitter ion, isoelectric point. Peptides: structure and synthesis (Carbo benzoxy method, Sheehan method only). Proteins: - Structure of proteins, denaturation and colour reactions. Biosynthesis of protein. Nucleic acids: Classification and structure of DNA and RNA. Replication of DNA, Genetic Codes. Vitamins – Classification and important sources, physiological action and deficiency symptoms of vitamin A, B1, B2, and B12. C, D, E and K

Unit 4 Alkaloids, terpenes, enzymes and Photochemistry

Alkaloids – General properties and classification – Quinine – nicotine. Terpenes – isoprene rule – classification – examples – citral – geraniol. Enzymes: General nature and classification, specificity of enzymes. Photochemistry - Basic principles of photochemistry – jablonskii diagram, photochemical reactions of carbonyl compounds.

Unit 5 Synthetic polymers, oils, fats and detergents

Synthetic polymers: Addition polymerization – mechanism – condensation polymerization – terylene – nylon 6,6- phenolic resins – natural and synthetic rubbers. Colour dyes and pigments. Dyes: Theory of colour and constituents, classification of dyes, synthesis of methy orange, malachite green, phenolphthalein alizarin, indigo. Oils and fats – structure and composition – physical and chemical properties – analysis of fats and oils. Soaps and detergents - composition - mechanism of cleaning action of soap – soap manufacture – detergents – advantages – preparation.

TEXTBOOKS:

1. *Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition, Prentice Hall, 1992.*
2. *I.L. Finar, "Organic Chemistry", 7th edition Vol I & II, Longmann, 2009.*
3. *S M Mukherji & S P Singh, "Reactions, Mechanisms of Organic Chemistry", 3rd edition, Macmillan Publishers India Ltd., 2009.*

REFERENCES:

1. *L.G. Wade, J.R., 'Organic Chemistry', 5th edition, Pearson Education, Singapore, 2004.*
2. *Solomons and Fryhle, Organic Chemistry, 7th edition, Wiley India Pvt. Ltd., 2004.*
3. *John McMurry, 'Fundamental of Organic Chemistry', 7th edition, Brook and Cole, 2011.*

15CHY313 INORGANIC CHEMISTRY III 3 1 0 4

Unit 1 Inorganic Polymers

Properties of Inorganic polymers - silicones - composition, manufacture, structure properties and uses, silanes and their polymers, applications of phosphazenes, silicates and their polymers - classification into discrete anions - one, two and three dimensional structures with examples - composition, properties and uses of beryl, asbestos, talc, mica, zeolites and ultramarines.

Unit 2 Inorganic Nanomaterials

General introduction to nanomaterials and emergence of nanotechnology; Moore's law; synthesis of nanoparticles of gold, rhodium, palladium, platinum, iron and silver; Synthesis of nanoparticle semiconductors, nanowires and nanorods; Techniques of synthesis: electroplating and electrophoretic deposition, conversion through chemical reactions and lithography; Thin films:

Chemical vapor deposition and Atomic layer deposition techniques; Carbon fullerenes and Nanotubes - applications of nanoparticles.

Unit 3 Molecular Recognition

The concepts of Molecular Recognition, Host, Guest receptor systems. Forces involved in Molecular Recognition – Hydrogen bonding, ionic bonding, p-stacking, van der Waal's and hydrophobic interaction.

Unit 4 Supra molecular Chemistry

Supra molecular Chemistry - Introduction to molecular receptors - design principles - tweezers, cryptands and carcerands – cyclophanes - cyclo dextrins and calixarenes - typical examples for Molecular Recognition and catalysis - catalysis by cation receptor, anion receptor and cylophanes - Molecular Recognition in DNA and protein structure.

Unit 5 Chemical Aspects of Soil

Origin of soil - igneous - metamorphic and sedimentary rocks - rock systems – weathering of rocks and minerals - main components of soil - organic, inorganic, liquid and gaseous phase - Physical properties of soil - Factors affecting soil pH - Soil

pH and nutrient availability - Causes of soil degradation. Origin of problem soils, their properties - acid, alkali and saline soils - diagnosis - remediation of acid and salt affected soils - Quality of irrigation water – causes for poor quality waters for irrigation, their effects in soils and crops. Soil testing - concept, objectives and basis - soil sampling, collection processing, despatch of soil and water samples. soil organic matter - its decomposition and effect on soil fertility - source of organic matter in soil - maintenance and distribution - soil organism - their role - nitrification - denitrification, nitrogen fixation in soils - biological nitrogen fixation - microbial interrelationship in soil - microbes in pest and disease management - Bio-conversion of agricultural wastes.

TEXTBOOKS:

1. *F. A. Cotton, G. Wilkinson, C. A. Murillo & M. Bochmann, 'Advanced Inorganic Chemistry', 6th edition, John Wiley, 1999.*
2. *J.E. Huheey, 'Inorganic Chemistry - Principles, Structure and Reactivity', 4th edition, Harper Collins, New York, 1993.*
3. *Daji, A.J. 'A Textbook of Soil Science', Asia Publishing House, Madras, 1970.*

REFERENCE BOOKS:

1. *Jonathan W. Stead, David R. Turner andkarl. J. Wallace., 'Core concepts in Supramolecular Chemistry and Nanochemistry', John Wiley sons Ltd, 2007.*
2. *R. W. Hay, 'Bioinorganic chemistry', Halsted Press, 1984.*
3. *Tisdale, S.L., Nelson, W.L. and Beaton, J. D, 'Soil Fertility and Fertilizers', Macmillian Publishing Company, New York, 1990.*

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).

Unit 3 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 4 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.

Unit 5 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 AJ, '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 Introduction to corrosion

Mechanisms of Chemical corrosion, electrochemical corrosion, Concentration cell corrosion, Pitting corrosion, Intergranular corrosion, Waterline corrosion, Stress corrosion.

Unit 2 Cathodic protection

Basis of cathodic protection, working of cathodic protection, electrochemical theory of cathodic protection, design parameters in cathodic protection, cathodic protection interferences.

Unit 3 Corrosion kinetics

Faradays laws of electrolysis and its application in determining corrosion rates, The laws, Corrosion kinetics, Mixed potential theory and its application, Resistance polarization, Determination of corrosion rates by electrochemical measurements, Kinetics of passivity.

Unit 4 Corrosion prevention by design

Corrosive environment, Stages in design processes, Soldering and threading, crevices, flowing water systems, design for liquid containers, design in packaging, coating and design, storage of combat vehicles.

Unit 5 Selection of materials for corrosive environment

Factors affecting the performance of materials, Materials classification, materials and fluid corrossivity, Corrossion behavior of several materials.

TEXTBOOKS:

1. *Mars G.Fontana, 'Corrosion Engineering', 3rd edition, Tata Mcgraw-Hill, 2005.*
2. *P.E.Philip A.Schieitzer, 'Corrosion Engineering Handbook', 2nd edition, Inco alloys Internaional, 1996.*

REFERENCES:

1. *R.Winston Revie and Herbert H Uhlig, 'Corrosion and Corrosion Control', 4th edition, John Wiley & Sons, 2008.*
2. *Zaki Ahmad, 'Principles of Corrosion Engineering and corrosion', 3rd edition John Wiley & Sons, 2006.*

15CHY333 GREEN CHEMISTRY 3 0 0 3

Unit 1 Introduction to Green Chemistry

Introduction - inception and evolution of green chemistry - principles of green chemistry - the green chemistry expert systems - the measure of greenness - safety and risk indices - the hierarchial approach - green chemistry and sustainable development - pollution control to pollution prevention - Indian perspective on green chemistry - information technology and sustainable development.

Unit 2 Green reagents

Green reagents - safer solvents - green solvents - water as a solvent - solvent free conditions - supports reagents - ionic liquids and their applications - super critical systems (CO_2) as green solvents - hydrogen peroxide in green oxidation reactions - dimethyl carbonate, a green solvent and an ambient reagent.

Unit 3 Green chemical techniques I

Environmentally benign technologies by green chemistry (with examples) - microwave assisted synthesis - electro-organic synthesis - photochemical degradation as a green approach for waste treatment - catalysis and green chemistry - supported catalysts and reagents for green chemistry - heterogenized reactions for green chemistry - oxidation technology for waste water treatment - green chemistry using biocatalytic reactions.

Unit 4 Green chemical techniques II

Aqueous phase reactions, solid state reactions, enzymatic transformations, sonicated reactions - usual organic reactions (Benzoin condensation, Michael Addition, Heck Reaction, Darzen reaction, Heck reaction, Claisen arrangement) in a greener way.

Unit 5 Green industrial processes and operations

Cleaner production - industrial perspectives - reactions and reactor designs - micromixers - unit operations - reactions with separation processes alternate energy resources - inherent safety - green chemistry and industries - the pharmaceutical industries and green chemistry - the polymer industry - pesticides, antifoulants, and herbicides - solvents and green chemistry - the food and flavor industry - the maleic anhydride manufacturing process - chelants - the surfactant industry - industries in need of support to go green - the semiconductor manufacture industry - the dye industry - the textile industry - the tannery industry - the sugar and distillery industries - the paper and pulp industry - the paint industry - Green chemistry in future.

TEXTBOOKS:

1. *Mukesh Doble and Anilkumar Kruthiventi, 'Green Chemistry and Processes', reprint, Science Press, 2007.*
2. *Paul T. Anastas and Tracy C. Williamson, 'Green chemistry: frontiers in benign chemical syntheses and processes', Oxford University Press, 1998.*

REFERENCES:

1. *V. K.Ahluwallia, 'Green Chemistry - Environmentally Benign Reactions', 1st edition, Ane books Pvt Ltd, 2009.*
2. *M. M. Srivastava, Rashmi Sanghi, 'Green Chemistry - Environment Friendly Alternatives', 2nd edition, Narosa Publishing House, 2005.*

15CHY334 INDUSTRIAL CATALYSIS 3 0 0 3

Unit 1 Catalysis

An introduction, general principles of catalysis, activation energy plots for catalytic processes, classification for catalysis - heterogeneous and homogeneous catalysis, van't-Hoff's and Arrhenius treatment of homogeneous catalysis - kinetic aspects, adsorption and general principles of heterogeneous catalysis - kinetic aspects, determination of surface area and pore-structure of the catalyst, definition of performance criteria of catalysts, activity, selectivity, temperature response, catalyst life.

Unit 2 Catalysis in Solutions

Acid and base catalysis, catalysis in gas phase, catalysis in dilute aqueous solutions, catalysis in concentrated strong acid solutions, catalysis by bases, catalysis by metal ions, electron transfer catalysis, catalysis by co-ordination and organometallic compounds, catalysis in Ziegler-Natta, metallocene, metathesis, catalysis by enzymes.

Unit 3 Polymers and Zeolites in Catalysis

Catalysis by polymers, polymer supported catalysts, catalysis in polymer gels, phase transfer catalysis, catalysis in molecular scale cavities, zeolites - molecular sieves, shape selective and size selective catalysis

Unit 4 Catalysis by Metals, Metal Oxides and Supported Metals

Electronic factors in catalysis by metals, valence bond and electron band theories, electronic factors in catalysis by semiconductors, co-operative electronics interactions and catalysis, localized interactions and catalysis, surface states and catalysis, role of supports, preparation and structure of supports, silica, alumina, silica-alumina, carbon, monolithic supports, surface properties, catalyst manufacture, catalyst size and shape, pretreatments, deactivation processes, sintering, poisoning and catalyst fouling.

Unit 5 Industrially Important Catalytic Processes

Catalysis and green chemistry, catalysis by ionic liquids, catalytic reforming, catalytic cracking, hydrotreatment, steam cracking, Fisher Tropsch process, mobil process for conversion of methanol to gasoline hydrocarbons, catalysis for environmental protection, removal of pollutants from exhausts, mobile and static sources, effluent clean up analysis, applications in the production of fertilizers, acetic acid, formaldehyde, washing powder additives, pharmaceuticals.

TEXTBOOKS:

1. *Bruce G Gates, 'Catalytic Chemistry', John Wiley & Sons, 1992.*
2. *J. A. Jensen, K. B. Rider, Y. Chen, M. Salmeron and G. A. Somorjai and E. K. Rideal, 'Concepts in Catalysis', Academic Press, New York, 1968.*
3. *Alfred Clark, 'The Theory of Adsorption and Catalysis', Academic Press, 1970.*

REFERENCES:

1. *W.B.Innes, 'Experimental Methods in Catalytic Research', Volume 1, R.B.Anderson Academic Press, 1968.*
2. *J.M.Betty, 'Applied Industrial Catalysis', Volume 1, Academic Press, 1983.*
3. *Ronald Pearce, William R. Patterson, 'Catalysts and Chemical Processes', Wiley, 1981.*
4. *Michael Bowker, 'The Basis and Applications of Heterogeneous Catalysis', Oxford University Press, 1998.*
5. *J.C. Kuriacose, 'Catalysis', Macmillian India LTD, 1991.*

15CHY335 INTRODUCTION TO FOOD CHEMISTRY 3 0 0 3

Unit 1 Introduction

Introduction: Definition of Food, major components of food, Physical States of Food - Dispersions true solutions, colloidal, emulsions, foam and gel, factors affecting stable dispersion of food ingredients, functions of emulsifiers and stabilizers. Water - Functions of water in food systems, hydrogen bonds, permanent dipole moment dielectric constant, theories of solvent action, water activity and food stability, absorption isotherm curve, roles of water in physical properties and chemical reactions in food theories and applications of different moisture determination methods.

Unit 2 Proteins and Carbohydrates

Protein - Classifications, nomenclature, and structures of aminoacids, basic properties of protein, structure of proteins, protein functional groups and their

chemical, hydrophobic, and hydrophobic properties, isoelelctric point and solubility as a function of pH, protein denaturation and its effects on food systems, nutritional quality of protein, theories & applications of analytical methods for protein and amino acids determination. Carbohydrates - Classification, nomenclature, and structures of Carbohydrates, isomers and absolute configurations of Carbohydrates, physical – chemical properties of Carbohydrates, sweetness of Carbohydrates, functions of Carbohydrates in foods, chemical reactions of Carbohydrates, analytical methods for Carbohydrate determination.

Unit 3 Lipids and minerals

Lipids - Nomenclature and structures of fatty acids, classifications of lipids, physical and chemical characteristics of different fats, relationship between chemical structure and fat melting properties, analytical methods for determining different physical and chemical characteristics of fat, lipid oxidation mechanisms, principles and applications of analytical methods for the determination of fat content and fatty acid composotions of foods. Minerals - Ash determination methods, principles and applications of different methods for determining individual minerals – atomic absorption and flame spectrometry's, and chemical methods.

Unit 4 Vitamins

Vitamins - Water soluble and fat soluble vitamins, chemical reactions and losses of vitamins during processing and storage. Principles and techniques for the determination.

Unit 5

Pigments in food flavours, browing reaction in foods, Enzymes in foods, and food industry, bio-deterioration of foods, food contaminants, Food additives and toxin.

REFERENCE:

Fennema's Food Chemistry fourth edition,edited by S. Damodaran, K.L. Parkin, and O.R Fennema, 2007 published by CRC Press .

SUGGESTED READINGS

1. *Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport*
2. *Birch, G.G., Cameron, A.G. and Spencer, M.1986. Food Science, 3rd ED.Pergamon Press, New york.*
3. *Fennema O.R. Ed. 1976. Principles of Food Science: Part – I Food Chemistry. Marcel Dekker, New york.*
4. *Meyer, L.H. 1973. Food Chemistry. East – West Press Pvt. Ltd., New Delhi.*
5. *Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport*

15CHY336 POLYMER SCIENCE 3 0 0 3

Unit 1 Introduction to polymers and polymerization

History of polymer Science. Concept of macromolecules, Nomenclature and Classification. Polymer, monomer, oligomer, repeating unit, degree of polymerization, functionality, copolymer - random, alternating, graft, block, Tacticity. Polymerization

processes. Free radical addition polymerization. Kinetics and mechanism. Chain transfer. Mayo-walling equation of the steady state. Molecular weight distribution and molecular weight control. Radical Atom Transfer and Fragmentation – Addition mechanism. Free radical living polymers. Cationic and anionic polymerization. Kinetics and mechanism, Polymerization without termination. Living polymers. Step Growth polymerization. Kinetics and mechanism. Molecular weight distribution. Linear vs cyclic polymerization, other modes of polymerization. Group Transfer, metathesis and ring opening polymerization. Copolymerization. The copolymerization equation, Q-e scheme, Gelation and Cross linking. Copolymer composition drifts Polymerization techniques. Bulk Solution, melt, suspension, emulsion and dispersion techniques.

Unit 2 Polymer Stereochemistry and characterization

Organizational features of polymer chains. Configuration and conformation, Tacticity, Repeating units with more than one asymmetric center. Chiral polymers - main chain and side chain. Stereo regular polymers. Manipulation of polymerization processes. Zeigler-Natta and Kaminsky routes. Coordination polymerization. Metallocene and Metal oxide catalysts. Polymer Characterization. Molecular weights. Concept of average molecular weights, Molecular weight distribution. Methods for determining molecular weights. Static and dynamic methods, Light scattering and GPC. Crystalline and amorphous states. Glassy and Rubbery States. Glass transition and crystalline melting. Spherullites and Lamellar. Degree of Crystallinity, X-ray diffraction, Thermal analysis of polymers. TG/DTG, DTA/DSC, DMA/TMA/DMTA. Spectroscopy of polymers. Microstructure determination by IR, Raman, UV, NMR and MS techniques. Solid State NMR and polymer stereochemistry. Structure-property relationship. Elastomeric and Viscoelastic states. Rubber-like elasticity. Maxwell and Kinetic model of viscoelasticity.

Unit 3 Polymer Solutions

Treatment of dilute solution data. Thermodynamics. Flory-Huggins equation. Chain dimension - chain stiffness - End-to-end distance. Conformation-random coil, Solvation and Swelling. Flory-Reiner equation. Determination of degree of cross linking and molecular weight between crosslinks. Polymer structure - property relationship, crystalline and amorphous combinations.

Unit 4 Polymer additives, blends and composites

Introduction - General principles, use of additives to enhance and protect properties of polymer, Classes of polymer additives - Type, Structure, Chemistry, Mechanism and suitability: for antioxidant-heat stabilizers - UV Stabilizers - HAL-antistatic - Blowing agents - lubricants nucleating agents - cross linking agent - flame retardant-compatibiliser. Fillers - effect and type of fillers - surface treatment and coupling agent. Coloration of polymers – pigment - colour measurement. Plasticizer – function - mode of operation - types. Compounding Eqmain types of colorant – uipments - internal mixer, two roll mill, Banbury mixer, single screw extruder, twin screw extruder - co rotating - counter rotating - intermeshing. Fabrication methods, polymer blends, toughened plastics and phase separated blends, interpenetrating network, mechanical properties, composite fabrication.

Unit 5 Industrial and speciality polymers

Synthesis, Structure and applications of polyethylene, polypropylene, polystyrene. Homo and Copolymers. Diene rubbers. Vinyl and acrylic polymers. PVC, PVA, PAN, PA. Poly (vinyl carbazole), poly (vinylimidazole). PMMA and related polymers. Copolymers. EVA polymers. Flourine containing polymers. Polyacetals. Reaction polymers. Polyamides, polyesters. epoxides, polyurethanes, polycarbonates, phenolics, PEEK, Silicone polymers. Reactions of polymers. Polymers as aids in Organic Synthesis. Polymeric Reagents, Catalysts, Substrates, Liquid Crystalline polymers. Main chain and side chain liquid crystalline polymers. Phase morphology. Conducting polymers. Polymers with high bandwidth. Polyanilines, polypyrrols, polythiophines, poly (vinylene phenylene). Photoresponsive and photorefractive polymers. Polymers in optical lithography. Polymer photo resists. Electrical properties of Polymers, Polymers with NLO properties, second and third harmonic generation, and wave guide devises.

TEXTBOOKS:

1. *F.W. Billmayer, 'Textbook of Polymer Science', 3rd Edition, Wiley. N.Y. 1991.*
2. *J.M.G Cowie, 'Polymers: Physics and Chemistry of Modern Materials', 2nd edition, Blackie Academic and professional, 1991.*
3. *P.J. Flory, 'Principles of polymer chemistry', reprint, Cornell University Press, 1953.*

REFERENCES:

1. *F. Ullrich, 'Industrial Polymers', Kluwer, N.Y. 1993.*
2. *H.G.Elias, 'Macromolecules, Vol. I & II', Academic, 1991.*
3. *Harry A Allcock, Frederick W Lampe and James E Mark, 'Contemporary Polymer Chemistry', 3rd edition, Pearson Prentice Hall, 2003.*

15CHY337 SURFACE SCIENCE AND COATING TECHNOLOGY 3 0 0 3

Unit 1 Introduction to Paints and Paint Technology

General introduction to paint industry - definition of paints, varnishes and lacquers their constitution and functions, general classification of surface coatings - decorative and protective coatings - paint industries in India.

Unit 2 Pigments Dyes and Extenders

Definition and classification of pigments and dyes - properties and evaluation of pigments such as crystal structure particle size and shape, refractive index and Hiding power, oil absorption, colour, specific gravity and bulking value, UV and IR absorption, light fastness, resistance to heat water, alkali and acid, corrosion inhibition, toxicity, reducing power, tinting strength, flooding and floating, settling, volatile and water soluble matter, residue on sieve, bleeding - white pigments and colored pigments - organic and inorganic pigments - industrial manufacture of pigments - special effect pigments - Extenders - use and functions of extenders - examples for extenders.

Unit 3 Binding media, solvents and additives in paints

Fundamentals of film formers, chemical structure of monomers, functionality and its

determination, degree of polymerization and molecular weight, non-convertible and convertible film formers, linear, branched and cross linked film formers, homopolymers and copolymers - Manufacture, chemistry and applications of alkyd resins, Polyester resins, Phenolic Resins, amino resins, epoxy resins, polyamide resins, polyurethanes, silicone resins, vinyl and acrylic resins - emulsions - polystyrene and styrene-acrylic emulsions. Solvents, dryers, surfactants and other additives in paints.

Unit 4 Paint Formulation, Manufacture and application techniques

Principles of paint formulation, formulation elements, mathematics & steps: PVC, CM, P/B ratio, Sp gravity, etc; Typical formulations of primers, undercoats and finish coats - Steps in paint manufacturing, phenomenon of wetting, grinding and dispersion, important considerations in pigment dispersion and rheology - different miiling and mixing techniques - factors affecting effectiveness of milling such as size, speed and type of mill; volume, composition, size and shape of grinding medium - mill base. Surface preparation techniques - Physical and chemical surface treatment techniques - Common application techniques - packaging technology.

Unit 5 Colour Technology, Paint properties and Quality Control in Paint Industries

Colour science and technology - light spectrum, primary and complemenary colours, colour mixing, dimensions of colour and colour systems, colour measurements, computer colour matching - colour coding system - General properties of paints, classification of paint properties - adhesion and cohesion properties, factors affecting adhesion wetting power, optical properties; colour, gloss, hiding, etc, physical, chemical and mechanical properties of paint films - factors affecting coating properties - rheological properties - Newtonian and non-Newtonian liquids, thixo-tropy, factors affecting viscosity, objectives of paint testing - Quality control procedures, standard specifications and test methods - tests on liquid paints density, dispersion, viscosity and consistency, wet opacity and dry hiding, spreading capacity and spreading rim, wet and dry rim thickness, drying time, etc. - Tests of dried coatings, colour and colour fastness, light fastness, gloss, flexibility, adhesion impact test, hardness mar resistance, abrasion resistance water and moisture resistance; water vapour transmission, PAC and salt spray test resistance, resistance to chemicals and solvents, resistance to heat and fire, air permeability - evaluation of water based paints, biological effects on paint films. Analysis of paints and varnishes; volatile and nonvolatile matter pigment content, binder or solid vehicle content, water content, ash content, pigment binder and solvent analysis - Ageing properties of coatings, weatherometery, natural outdoor durability test accelerated outdoor weathering, artificial weathering tests, defects observed in paint film on exposure.

TEXTBOOKS:

1. *Australian OCCA, 'Surface Coating Technology Volume 1', Chapman and Hall, 1974.*
2. *W.M.Morgan, 'Outline of Paint Technology', John Wiley sons, 1990.*

REFERENCES:

1. *L. S. Pratt, 'Physics & Chemistry of Organic Pigments', Wiley, 1947.*
2. *H.Y. Payne, 'Organic Coating Technology Vol, 1 & 11', John Wiley & Sons, 1954.*

15CHY338 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), NH4NO3, ammonium perchlorate (AP), NH4ClO4, ammonium dinitramide (AND), NH4N(NO2)2, hydrazinium nitroformate (HNF), N2H5C(NO2)3 etc.

TEXTBOOKS:

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

15CHY381 BASIC PHYSICAL CHEMISTRY LAB. 0 0 5 2

1. Determination of CST of phenol-water system - effects of KCl/ NaCl salts on CST.

2. Phase diagram of simple eutectic system.
3. To determine the molecular weight of a high polymer by viscosity method.
4. To determine the molecular weight of a solute by Rast method using naphthalene or diphenyl as solvent using Beckmann thermometer.
5. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.
6. Determination of rate constant of acid catalyzed hydrolysis of an ester.
7. To study the adsorption of acetic acid from its aqueous solution by charcoal.
8. To determine the distribution coefficient of iodine between water and carbon tetra chloride.
9. Determination of transition temperature of the given salt hydrate.

TEXTBOOKS:

1. *R.C. Das and B.Behara, 'Experiments in Physical Chemistry', Tata McGraw-Hill, 1983.*
2. *Alexander Findly,' Practical Physical Chemistry', 9th edition, Wiley, 1972.*

REFERENCE BOOKS:

1. *Gilbert William Castellam,' Physical Chemistry', Addison-Wesley Publishing Company, 1964.*
2. *James Brierley Firth, 'Practical Physical Chemistry', D. Van Nostrand Company, 1916.*
3. *Dr.J.B.Yadav, 'Advanced Practical Physical Chemistry', Krishna Prakashan Media, 29th edition, 2010.*

15CHY382 ORGANIC SYNTHESIS AND ESTIMATION LAB. 0 0 2 1

1. Basic concepts on theoretical yield, practical yield, samples % conversion etc, Organic preparations including recrystallisation,
2. Synthesis of a) Acetanilide to p-nitroacetanilide b) Acetanilide to p-bromoacetanilide c) Benzyl chloride to Benzoic acid, d) Nitrobenzene to dinitrobenzene e) Ester hydrolysis f) Benzoylation (phenol to phenyl benzoate);
3. Separation Techniques: Thin Layer Chromatography, Column chromatography

REFERENCES:

1. *F. G.Mann and B. C.Saunders, 'Practical Organic Chemistry' 4th edition, Pearson Education, 2009.*
2. *V. K.Ahluwalia and S. Dhingra 'Comprehensive Practical Organic Chemistry' Universities Press, 2000.*
3. *B. S.Furnis, A. J.Hannaford, P. W. G. Smith and T. R.Tatchell, 'Vogel's Text book of Practical Organic Chemistry', ELBS/Longman, 1989.*
4. *O. P. Pandey, D.N Bajpai, S. Gini, 'Practical Chemistry, for I, II & III BSc. Students', S. Chand & Company Ltd reprint, 2009.*
5. *V. K.Ahluwalia, Sunitha Dhingra, Adarsh Gulate, 'College Practical Chemistry', Universities Press (India) Pvt Ltd, 2008.*

15CHY385 INORGANIC QUANTITATIVE LAB. – GRAVIMETRIC ANALYSIS 0 0 5 2

1. Gravimetric estimation of barium as barium sulphate.

2. Gravimetric estimation of iron as iron (III) oxide.
3. Estimation of sulphate as barium sulphate.
4. Gravimetric estimation of copper as copper (I) thiocyanate.
5. Gravimetric estimation of nickel as nickel dimethyglyoximate.
6. Gravimetric estimation of magnesium as magnesium 8-hydroxy quinolate.
7. Estimation of iron in the given sample of haematite by dichromate method.
9. Estimation of copper in bronze by iodometric method.
10. Estimation of tin in solder using EDTA.

TEXTBOOKS:

1. *G.H.Jeffery, J.Bassett, J.Mendham and R.C.Denny 'Vogel's Text Book of Quantitative Chemical Analysis', 5th Edition, ELBS, 1989.*
2. *D.A.Skoog and D.M.West 'Analytical Chemistry-An Introduction', 4th Edition, CBS Publishing Japan Ltd., 1986.*

REFERENCES:

1. *E.J.Meehan, S.Bruckenstein and I.M.Kolthoff and E.B.Sandell, 'Quantitative Chemical Analysis', 4th Edition, The Macmillan Company, 1969.*
2. *R.A.Day (Jr) and A.L.Underwood, 'Quantitative Analysis', 6th Edition, Prentice Hall of India, 1991.*

15CHY386 PHYSICAL CHEMISTRY LAB. – INSTRUMENTAL ANALYSIS 0 0 3 1

1. Determination of cell constant and equivalent conductivities of different electrolyte by conductometrically.
2. Determination of the strength of strong and weak acids in a given mixture conductometrically.
3. Determination of the velocity constant, order of the reaction and energy of activation for specification of acetate by sodium hydroxide conductometrically.
4. Determination of solubility and solubility product of sparingly soluble salt by (e.g. PbSO4, BaSO4) conductometrically.
5. Determination of the strength of strong and weak acids in a given mixture using a potentiometer.
6. Determination of the strength of strong and weak acids in a given mixture using a pH meter.
7. Determination of unknown concentration using photoelectric calorimeter.
8. Determination of pKa of acetic acid using pH meter.
9. Determination of concentration of an electrolyte by Nernst equation.
10. Determination of concentration of ions by Spectrophotometer.
11. Determination of concentration of potassium and sodium ion by flame photometry.
12. Determination of transport number of silver ion.

TEXTBOOKS:

1. *R.C. Das and B.Behara, 'Experiments in Physical Chemistry', Tata McGraw-Hill, 1983.*
2. *Alexander Findly,' Practical Physical Chemistry', 9th edition, Wiley, 1972.*

REFERENCE BOOKS:

1. *Gilbert William Castellam,' Physical Chemistry', Addison-Wesley Publishing Company, 1964.*
2. *James Brierley Firth, 'Practical Physical Chemistry', D. Van Nostrand Company, 1916.*
3. *Dr.J.B.Yadav, 'Advanced Practical Physical Chemistry', Krishna Prakashan Media, 29th edition, 2010.*

15CHY390 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with solutions for societal problems. The students shall visit villages or rural sites during the vacations (after second semester or fourth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth 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.

15CHY399 PROJECT *(for Exit-option students)* 6 cr

Students who want to exercise the exit option at the end of the sixth semester shall decide on it at the end of the fourth semester. These students shall execute a project and earn six credits.

The proposed project work shall get started at the beginning of the fifth semester and is to be credited during the sixth semester. The project work involves simple experimental techniques in chemistry for solving minor problems faced in various processing industries or on improving the existing experimental techniques followed at present in chemistry laboratories. The project work will be supervised by a faculty from chemistry department and periodical reviews of the work accomplished will be done by a panel involving a minimum of 3 chemistry faculty members. Also the student should give a presentation of the project at the end of the sixth semester to a panel of faculty members/ external experts.

15CHY501 GROUP THEORY AND QUANTUM CHEMISTRY 3 1 0 4

Unit 1 Quantum Chemistry I

Origin of quantum mechanics, de Broglie relationship, postulates of quantum mechanics, operators and eigen functions, operators for momentum, energy and angular momentum, expectation values, time dependent and independent Schrodinger equation, stationary states, the uncertainty principle (no derivation), application of Schrodinger wave equation to particle in one dimensional box and three dimensional box, degeneracy, application of Schrodinger wave equation to harmonic oscillator, free particles, quantum entanglement, quantum dots.

Unit 2 Quantum Chemistry II

Application of Schrödinger wave equation to rigid rotator and H atom, shapes of atomic orbitals from solutions of H atom, many electron atoms, approximation methods, independent particle model, variation methods, perturbation methods, application to the ground state of Helium atom, SCF method, the exclusion principle, chemical bonding: Hydrogen molecule ion and hydrogen molecule from molecular orbital and valence bond theory, homo and hetero nuclear diatomic molecules from VB and MO theory, the concept of directed valences and hybridization, HMO methods, pi bonds and treatment of delocalization.

Unit 3 Introduction to Computational Quantum Chemistry

Hartree Fock SCF method, electronic structure of molecules, the basis sets, STOs and GTOs, nomenclature of basis sets, semi empirical and ab-initio methods, calculations of molecular properties like atomic charges, dipole moments, electronic distributions, vibration frequencies, NMR chemical shift etc using Gaussian program, specification of molecular geometry using Cartesian coordinates and internal coordinates, Z-matrix, Z-matrix of some simple molecules, structure of a Gaussian input file.

Unit 4 Group Theory I

Symmetry in molecules, elements of symmetry, point groups, matrix representation of symmetry operations, character, application of group theory to symmetry properties of molecules, definition of a mathematical group, abelian group, cyclic group, symmetry operations as group elements, similarity transformation and classes, group multiplication table, symmetry classification of molecules into point groups (Schoenflies symbol), reducible and irreducible representations, great orthogonality theorem and its consequences, character tables, reduction formula, construction of character tables for point groups with order ≤ 6, interpretation of character tables.

Unit 5 Group Theory II

Wave functions as bases for irreducible representations, construction of hybrid orbitals for AB3 (planar), AB4 (Td), AB5 (D3h) and AB6 (Oh) type of molecules, symmetry adapted linear combinations, projection operators, application of projection operators to pi-bonding in ethylene, cyclopropenyl systems and benzene, application of symmetry to predict polar and chiral compounds, chemical applications of group theory for molecular vibrations, selection rules and applications to IR and Raman spectra, applications of group theory to electronic spectra.

TEXTBOOKS:

1. *V.Ramakrishnan and M.S.Gopinathan, 'Group Theory in Chemistry', 2nd reprint edition, Vishal Publications, 1996.*
2. *Ira N. Levin, 'Quantum Chemistry', 6th Edition, Prentice-Hall, 2008*
3. *F.Albert Cotton, 'Chemical Applications of Group Theory', 3rd Edition, John Wiley, 1990.*

REFERENCES:

1. *J.P.Lowe, "Quantum Chemistry", 2nd Edition, Academic Press Inc., 1993.*

2. L.Pauling and E.B.Wilson, "Introduction to Quantum Mechanics", McGraw Hill, 1935.
3. M.S.Pathania, "Quantum Chemistry and Spectroscopy (Problems & Solutions)", Vishal Publications, 1984.
4. P.H.Walton, "Beginning Group Theory for Chemistry", Oxford University Press Inc., New York, 1998.

15CHY502 CHEMICAL THERMODYNAMICS AND EQUILIBRIA 3 1 0 4

Unit 1 Chemical Thermodynamics

First and second laws of thermodynamics, thermodynamic functions, heat capacity, thermo chemistry, need for second law of thermodynamics, entropy and free energy functions, calculation of changes in thermodynamic function for ideal and non-ideal gases in isothermal and adiabatic process, relation between thermo dynamic functions - Maxwell relations, Joule Thomson effect, coefficient of thermal expansion and compressibility factor, applications of free energy function to physical and chemical changes, equilibrium in chemical reactions, third law of thermodynamics - need for third law, calculation of absolute entropy, unattainability of absolute zero, thermodynamic systems of variable composition - fugacity functions, partial molar quantities, thermodynamics of ideal solutions, real solutions and regular solutions, dilute solutions of nonelectrolytes, Henry's law, Raoult's law, Gibbs-Duhem equations, Gibbs-Duhem-Margules equations, and activity and standard states of non electrolytes.

Unit 2 Irreversible Thermodynamics

Examples for irreversible process, entropy production, non-equilibrium, steady state and near equilibrium conditions, linear relation, phenomenological coefficients, Onsagar reciprocal relations, one component systems with heat and matter transport, application of irreversible thermodynamics to thermal diffusion, thermal osmosis etc., electro kinetic effects, the Glansdorf-Pregogine equation.

Unit 3 Statistical Thermodynamics

Statistical concept, probability and thermodynamic states, entropy and probability, canonical ensemble, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein Statistics, electron gas concept, Bose-Einstein condensation, relation among MB, FD & BE Statistics, partition function, partition function for free linear motion, free motion in a shared space, linear harmonic vibration, translational, rotational and vibrational partition function, molecular partition functions, partition functions and thermodynamic properties, calculation of equilibrium constant, heat capacity of gases, mono atomic solids, Einstein's and Deby's theory.

Unit 4 Equilibrium

Gibb's free energy, direction of spontaneous change of a reaction, chemical potential, chemical potential and equilibrium, ?G in terms of K, equilibrium constants – real gases and real reactions, equilibrium respond to catalyst, temperature, pressure and PH, application of ΔG and K – extraction of metals from their oxides, Ellingham diagram, and thermodynamics of ATP & respiration, biological energy conversion.

Unit 5 Phase Equilibrium

Gibb's Phase rule, one component system, two component systems, vapor pressure diagrams and their interpretation, lever rule, temperature-composition diagrams, liquid-liquid phase diagrams, distillation of partially miscible liquids, azeotropes, liquid-solid phase diagrams, phase diagram for the system Na/K/Na2K, phase diagram - steel, alloys, Fe-C system, zone refining, three component system, triangular coordinates, three component system – partially miscible liquids - H2O/ CHCl3/CH3COOH, phase diagram - NH4Cl/(NH4)2SO4/H2O

TEXTBOOKS:

1. Samuel Glasstone, 'Thermodynamics for Chemists', Lightning Source Incorporated, 2007.
2. Francis Weston Sears and Gerhard L.Salinger, 'Thermodynamics, kinetic theory and statistical thermodynamics' 3rd edition, Addison-Wesley Publications, 1975.

REFERENCES:

1. Prigogine, 'Introduction to Thermodynamic Irreversible Processes', Interscience Publishers, 3rd edition, 1968.
2. R.P.Rastogi and R.R.Misra, 'An Introduction to Chemical Thermodynamics', 6th Revised edition, Vikas Publishing House Pvt. Ltd., 2006.
3. F.W.Sears, 'Introductions to Thermodynamics, Kinetic Theory of Gases and Statistical Mechanics', Addison Wesley Pub., Cambridge, 1972.

15CHY503 MOLECULAR SPECTROSCOPY 3 1 0 4

Unit 1 Rotational and Vibrational Spectroscopy

Introduction to spectroscopy, rotation spectra - diatomic and polyatomic molecules, selection rules, intensities of spectral lines, stark effect, instrumentation of micro wave spectroscopy, applications and structural determinations, vibration spectra of diatomic molecules, harmonic and anharmonic vibrations, diatomic vibrating rotor, selection rule, breakdown of Born Oppenheimer approximation, rotational character of vibration spectra, different modes of vibrations, vibration-rotation spectra, Fermi resonance, vibration spectra of polyatomic molecules, IR spectra of organic and inorganic compounds, phase, temperature and solvent dependence, FTIR technique, instrumentation, Raman spectra (including the use of laser) - theory, relation with IR spectroscopy, mutual exclusion principle, resonance Raman, stimulated hyper and inverse Raman effects, instrumentation and applications of Raman spectroscopy.

Unit 2 UV-Visible and Fluorescence Spectroscopy

Electronic spectra of atoms - single and multi electron systems, j-j and L-S coupling, electronic spectra of diatomic and polyatomic molecules, its relation to electronic arrangement and symmetry of molecules, application of group theory in electronic spectra, selection rules, nature of electronic excitation, principles of absorption spectroscopy, Beer-Lambert law, presentation of spectra, chromophores, forbidden transition, different types of electronic transitions, p-p*, n-p* etc transitions, nature of transitions in carbonyl compounds, the effect of conjugation, effect of conjugation

on alkenes, HOMOs and LUMOs, Woodward-Fieser rules for dienes, spectra of carbonyl compounds, enones, Woodward rule for enones, spectra of aromatic compounds, effect of substituents, structural information from electronic spectra, excited states of molecules, Jablonski diagram, florescence and phosphorescence, life time of excited state, quantum yield, photochemical and photo physical properties, application of UV-Visible and Fluorescence Spectroscopy for structural elucidation of organic compounds, diffuse reflectance spectra.

Unit 3 NMR Spectroscopy

Nuclear magnetic resonance phenomenon - theory, relaxation effects, NMR uses active nuclei, Fourier Transformation in NMR, measurement of relaxation time, chemical shift, magnetic anisotropic effect, multiplets in NMR, spin-spin splitting, n + 1 rule, Pascal's triangle, tree-diagram, spin-spin splitting constant, J, 2J and 3J and long-range coupling, measurement of J, Karplus relationship, first and second order spectra, AX, AB, AX2, AX3, A2X3, AMX type spectra, double resonance and spin tickling, chemical shift reagents, spectra in higher fields, spectra of conformational isomers, homotopic, enantiotopic and diastereotopic systems, C13 spectra, factors related to C13 spectra, H1 coupled C13 spectra, H1 decoupled C13 spectra, chemical shift values, nuclear Overhauser effect (NOE), cross-polarization, off-resonance resonance decoupling, application of H1 and C13 NMR spectroscopy for the structural elucidation of organic compounds, B11, N15, F19 and P31 NMR spectra, spectra of paramagnetic complexes, magnetic susceptibility, contact shift, fluxional molecules and their studies using NMR, solid state NMR.

Unit 4 ESR, NQR and Mossbauer Spectroscopy

ESR spectroscopy - theory, hyperfine and superfine splitting, ESR active simple organic systems, ESR of inorganic systems like Cu2+ and VO2+ complexes, 'g' markers like DPPH and TCNE, evaluation of spin Hamiltonian like A, g11, g-, covalency factor in Cu2+ complexes, analysis of ESR spectra of VO2+ complexes, NQR spectroscopy - theory, relationship between electric field gradient and molecular structure, quadrupole coupling constant and structural information of compounds, Mossbauer spectroscopy, principle, Doppler effect, isomer shift, Zeeman splitting, quadrupole splitting, application of Mossbauer spectroscopy for studying Fe and Sn compounds and phase transformation, application of ESR spectroscopy.

Unit 5 Mass Spectroscopy and PES

Mass spectroscopy, base peak and molecular ion peak, isotope ratio data, fragmentation patterns of alkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols, phenols, aldehydes, ketones, esters, carboxylic acids, amines, methods of desorption and ionization (EI, CI, LD, MALDI, PD, FAB, SIMS), MS/MS and determination of molecular formula, metastable ions and their significance, study of fragmentation pattern, application of MS in structural elucidation and other frontiers of science, application of MS for quantitative analysis, photoelectron spectroscopy (PES), principle, application of PES.

TEXTBOOKS:

1. *Colin N. Banwell and Elaine M. McCash, 'Fundamentals of Molecular Spectroscopy', 4th Edition, Tata McGraw Hill, 2007.*
2. *G.M.Barrow, 'Introduction to Molecular Spectroscopy', McGraw Hill, 1962.*

REFERENCE:

Douglas A. Skoog, F. James Holler and Stanley R. Crouch, 'Principles of Instrumental Analysis', 6th Edition, Thomson Brooks/Cole, 2007.

15CHY511 CONCEPTS IN INORGANIC CHEMISTRY 3 1 0 4

Unit 1 Nuclear Chemistry

Nuclear structure, mass and charge,mass defect, binding energy, semi empirical mass equation, stability rules, magic numbers, models of nucleus, equations of radioactive decay and growth, half-life, average life radioactive equilibrium - transient and secular equilibrium, determination of half-lives, nuclear reactions, energetics of nuclear reactions, types of nuclear reactions, spontaneous and induced fission, neutron capture cross sections and critical size principle and working of nuclear reactors, nuclear fission reactions.

Unit 2 Radiation Chemistry

Radiochemical methods - measurement of radioactivity, counting statistics, errors and corrections - measurement of radiations - ionization chamber, cloud chamber, Bubble chamber, proportional counter, the Geiger counter, scintillation counter, semiconductor detectors plus height analysis - isotope dilution analysis - activation analysis, radiometric titrations - applications, hot atom chemistry, interaction of high energy radiation with matter, radiolysis of water, hydrated electron, radiation dosimetry, relevance of aqueous radiation chemistry to radiation biology, radiation chemistry of organic compounds, radiation polymerization.

Unit 3 Inorganic materials I

Alkali and alkaline earth metals, their compounds, crown ethers and cryptands as complexing agents for alkali metal ions, Be and Mg compounds, boron cage compounds, boron hydrides, structure and bonding, 3-centre-2-electron bonds, styx numbers, the importance of icosahedral frame work of boron atoms in boron chemistry, closo, nido and arachno structure, carboranes, metallocene carboranes, B-N compounds, interstitial compounds, metal carbides, nitrides and hydrides, fullerenes, functionalized fullerenes, C-nanotubes

Unit 4 Inorganic materials II

Inorganic chains and polymers, rings, cages, and clusters, sulphur-nitrogen compounds, polymeric sulphur nitride, isopoly anions, heteropoly anions, Keggin and Dawson polyoxometallates, borazines, metal clusters, nature of Si-Si bonds, silicates, silicates with zero-, one-, two- and three-dimensional structures, structure of elemental P, phosphonitrilic compounds, polymers with P-N bonds, interhalogen and pseudo halogens, intercalation chemistry, intercalation in layered materials like graphite, xenon fluorides & other xenon compounds.

Unit 5 Chemistry of f-block elements

The lanthanides and actinides, stable oxidation states, the lanthanide and actinide contractions, the f-orbitals, spectral and magnetic properties - comparison with inner transition and transition metals, separation of lanthanides, use of lanthanide compounds as shift reagents, photo-emission of lanthanide compounds, organometallic compounds of lanthanides and actinides and their structural features, reactions of lanthanide and actinide compounds, mineral sands of south west India - Ilmenite, Monazite, etc.

TEXTBOOKS:

1. *N.N.Greenwood and A.Earnshaw, 'Chemistry of Elements', Butterworth and Heinemann, 2nd Edition, 2002*
2. *J.E.House, "Inorganic Chemistry", Academic Press, 2008.*
3. *P.Atkins, T.Overton, J.Rourke, M.Weller, F.Armstrong Shriver & Atkins, "Inorganic Chemistry", 4th Edition, Oxford University Press, 2008.*
4. *G.L.Miessler and D.A.Tarr, "Inorganic Chemistry", 3rd Edition, Pearson, 2009.*

REFERENCES:

1. *B.E.Douglas, D.H.McDanial and J.J.Alexander, "Concepts and Models of Inorganic Chemistry", 3rd Edition, John Wiley, 2001.*
2. *A.J.Swallow, 'Radiation Chemistry, an Introduction', John Wiley & Sons, 1973*
3 *D.F.Shriver and P.W.Atkins, "Inorganic Chemistry", 3rd Edition, Oxford University Press, 1999.*

15CHY512 REACTION STRATEGIES AND FUNCTIONAL GROUP INTERCONVERSIONS 3 1 0 4

Unit 1 Pericyclic Reactions

Pericyclic reactions, study of the principle of conservation of orbital symmetry, selection rules, electrocyclic reactions, cycloadditions, cheletropic reactions, sigmatropic rearrangements - Sommelet, Hauser Cope and Claisen rearaangements, ene-reaction, secondary orbital interactions in [4+2] cycloadditons, feasibility check by Hoffman rule [(4q + 2)s + (4r)a] concept.

Unit 2 Synthetic Strategies

Synthetic strategies: Introduction to retrosynthetic analysis, protecting groups, functional group equivalents, reversal of reactivity (Umpolung), Introduction to combinatorial chemistry.

Unit 3 Organometallic reagents

Reagents based on chromium, nickel, palladium, silicon, and boron, Gilman reagent, phase transfer catalysts, Gilmans reagent - Lithium dimethyl cuprate, lithium diisopropyl amide (LDA), 1,3- dithiane, trimethyl silyl iodide, tri-n- butyl tin hydride, phase transfer catalysis, crown ethers and Merrifield resin, Petersons olefination, Baker-yeast.

Unit 4 Reagents for oxidation and reduction

PCC, DDQ, osmium tetroxide, ruthenium tetroxide, selenium dioxide, peracids,

hydrogen peroxide, singlet oxygen, aluminum isopropoxide, periodic acid, lead tetraacetate. Swern oxidation, Oppeneur oxidation, Woodward and Prevost hydroxylation, Sharpless asymmetric epoxidation, catalytic hydrogenations (heterogeneous and homogeneous), Clemmenson, Wolff Kishner and MPV reductions, metal hydrides, Birch reduction, hydrazine and diimide reduction.

Unit 5 Base catalyzed reactions

Reactivity of carbonyl groups in aldehydes, ketones, carboxylic acids, esters, acyl halides, amides. Substitution at a-carbon, aldol and related reactions, Claisen, Darzen, Dieckmann, Perkin, Stobbe, Baeyer-Villiger reaction, Prins, Mannich, Stork-enamine reactions. Conjugate additions, Michael additions and Robinson annulations, Reformatsky and Grignard reactions, Reaction with phosphorus and sulfur ylides, Wittig and other ylide reactions.

TEXTBOOKS:

1. *I. Flemming, "Frontier Orbitals and Organic Chemical Reactions", John Wiley, 1998.*
2. *W. Carruthers, "Some Modern Methods of Organic Synthesis", Cambridge University Press, 2004.*
3. *S. Warren, "Organic Synthesis: The Disconnection Approach", John Wiley, 2004.*

REFERENCES:

1. *J. Clayden, N. Green, S. Warren and P. Wothers, "Organic Chemistry", Oxford University Press, 2001.*
2. *Mc Murry, "Organic Chemistry", Thomson Brooks/Cole, 1999.*
3. *Norman and Coxon, "Organic Synthesis", CRC Press, 3rd En, 1993.*

15CHY521 AROMATICITY, STEREOCHEMISTRY AND REACTION MECHANISM 3 1 0 4

Unit 1 Aromaticity and Structure Activity Relationship

Bronsted and Lewis acids and bases, pH and pKa, Huckel's rule and modern theories of aromaticity and anti-aromaticity with suitable examples, study of [n]annulenes, fullerenes, nonbenzenoid aromatics, catenanes and rotaxanes, structure activity relationships with special emphasis on the effect of structure on acidity and basicity, solvent effects, linear free energy relationships, mechanisms and methods of determining them (kinetic and nonkinetic methods), application of frontier orbital theory in organic reactions, molecular orbitals and frontier orbitals, application in studying radical and ionic reactions, HSAB concept, Mobius strip, aromaticity in transition state.

Unit 2 Stereochemistry

Optical and geometrical isomerism, absolute and relative configuration, Cahn-Ingold-Prelog system, prochirality, prochiral centre, atoms, groups and faces, designations, asymmetric synthesis, stereospecific and stereoselective synthesis, regioselective and regiospecific reactions, atropisomerism, optical isomerism in biphenyls, allenes, spirans and "ansa" compounds, compounds containing chiral nitrogen and sulfur atom, geometrical isomerism of cyclic compounds, cumulenes and oximes.

Unit 3 Conformational Analysis

Conformational analysis of cyclic and acyclic systems with special emphasis on six membered rings, conformational effects on the reactivity of acyclic and cyclic systems - elimination, substitution and addition, strain, structure and stability of small, medium, and large rings, anomeric effect - cycloalkenes and cycloalkynes, stereochemistry of SN1, SN2, SNi, E1 and E2 - kinetically and thermodynamically favoured products.

Unit 4 Active Reaction Intermediates and Mechanisms

Generation, structure and reactivity of carbocations (including non-classical carbocations), carbanions, carbon radicals, radical ions, Baldwin ring-closure rules, generation, structure and reactivity of carbenes, nitrenes, arynes, nitrelium ions, mechanism of nucleophilic, electrophilic and free radical substitutions on aliphatic carbons (saturated and unsaturated) and on aromatic carbon, benzyne mechanism, addition and elimination reactions and their mechanisms, ylide chemistry.

Unit 5 Rearrangements Involving Electron Deficient Carbon, Nitrogen & Oxygen

Wagner-Meerwein, Pinacol, Demyanov, dienone-phenol, Favorskii, Wolff, Hofmann, Curtius, Lossen, Schmidt, Beckmann, benzidine, and Hofmann-Loffler rearrangements and their mechanisms, olefin metathesis.

TEXTBOOKS:

1. *Francis A.Carey and Richard J. Sundberg, "Advanced Organic Chemistry - Part A: Structure and Mechanisms", 5th Edition, Springer, 2007.*
2. *Francis A.Carey and Richard J. Sundberg, "Advanced Organic Chemistry - Part B: Reactions and Synthesis", 5th Edition, Springer, 2007.*
3. *Peter Sykes, "Mechanism in Organic Chemistry", Pearson, 6th En, 2005.*
4. *E. L. Eliel and S. H. Wilen, "Stereochemistry in Organic Compounds", John Wiley, 2008.*

REFERENCES:

1. *P. S. Kalsi, "Stereochemistry, Conformation and Mechanism", New Age Publications, 2008.*
2. *D. Nasipuri, "Stereochemistry of Organic Compounds - Principles and Applications", Revised 2nd Edition, New Age International, 2007.*
3. *S. H. Pine, "Organic Chemistry", McGraw Hill, 5th En, 2007.*
4. *P.S.Kalsi,"Stereochemistry and Mechanism through Solved Problems', New Age International, 2nd En, 1996.*

15CHY522 COORDINATION CHEMISTRY AND ORGANOMETTALICS 3 1 0 4

Unit 1 Theories and Concepts

Introduction - ligands, nomenclature of coordination compounds, coordination compounds of transition metal ions with 2, 3, 4, 5, 6, 7 and 8 coordination numbers. Werner's theory, Valence bond theory (VBT), Crystal field theory (CFT), CFSE, effects of CFSE on hydration energies, types of ligands and spectro-chemical series, spectral and magnetic properties, spin-only magnetic moments, nephelauxetic effect,

crystal field splitting patterns in complexes having Oh, Td, square planar, square pyramidal and trigonal pyramid geometries, relative energies of d-orbital in low symmetry ligand fields, factors affecting the magnitude of crystal field splitting energy, Jahn-Teller (JT) distortion, manifestation of JT on spectral properties, Structure and bonding in co-ordination complexes, molecular orbital theory (MOT), ligand field theory (LFT) molecular orbital energy level diagram for octahedral complexes without pi-bonding, metal-ligand pi-bonding, application of group theory to coordination compounds.

Unit 2 Spectral and Magnetic properties

Stabilization of unusual oxidation states, electronic spectra of complexes, spectra of transition metal complexes, term symbols for various dn ions, Orgel diagrams for dn systems, ligand field parameters, Dq, Racah parameter B and nephelauxetic constant b, Tanabe-Sugano (TS) diagrams, evaluation of Dq and other parameters from electronic spectra using TS diagrams, charge-transfer transitions, MLCT and LMCT, selection rules and band intensities, Laporte- and spin- selection rules, symmetry, spin-orbit and vibronic coupling effects, magnetic properties of complexes - magnetic susceptibility, contribution of spin-orbit coupling on µeff, types of magnetic behavior - ferromagnetism and antiferro-magnetism, crystal field and molecular orbital interpretations, comparison of different theories in coordination compounds, Guoy and Faraday methods, effects of temperature on magnetic behavior, spin cross over systems, Kotani plots.

Unit 3 Reactions, Mechanisms, Stereochemistry and Photochemical properties

Complex equilibrium - formation constants, chelate and macrocyclic effects, factors affecting stability of complexes, methods of determination of stability constants, stability of complex ions in solutions, inert and labile complexes, mechanisms of ligand displacement and addition reactions in octahedral complexes and square planar complexes of platinum cis- and trans effect, substitution reactions, mechanisms of substitution, kinetic consequences of reaction pathways, dissociation, interchange, association, dissociation, linear free energy relationships, conjugate base mechanism, stereochemistry of reactions, substitution in trans-complexes, substitution in cis-complexes, isomerisation of chelate rings the trans-effect, sigma-bonding and pi-bonding effects, oxidation-reduction reactions, inner and outer sphere reactions, conditions for high and low oxidations numbers, reactions of coordinated ligands, hydrolysis of esters, amides and peptides, template reactions, electrophilic substitution, Photochemical reactions of coordination compounds.

Unit 4 Classification and Structural aspects of Organometallic Compounds

Historical development, classification, nomenclature, hapticity, electron counting scheme, capping rule, 18 and 16 electron rules, structure prediction based on 18-electron rule, bond energies, stability and classification of ligands, main group elements, methods of formation, reactions, compounds of alkali metals, alkaline earth metals and groups 12 to 15 metals, transition elements, electronic structure and classification, ligands with 2, 3, 4, 5, 6, 7 or 8 electron donors, compounds involving metal ligand s-bonds and p-bonds, metal carbonyls, synthesis of metal carbonyls, bonding in metal carbonyls, stabilization of metals in unusual oxidation

states, polynuclear carbonyls with and without bridging groups, IR spectra of terminally bound and bridging type CO's, carbonyl hydrides, metal nitrosyls, dinitrogen complexes, isocycnide, tertiary phosphines and tertianry arsene complexes of transition metals, metal dioxygen and dinitrogen complexes, structural features of the above compounds, co-ordination compounds containing SO2, CO2 and N-heterocycles, complexes with weakly co-ordinating anions, 7, 8 and 9 co-ordination complexes, organometallic compounds with metal-metal bonds and containing metal clusters, metal-carbon sigma-bond, complexes with chain pi-donor ligands, structures of olefines, acetylenes and pi-allyl complexes, complexes with cyclic pi-donors, cyclopentadiene, benzene, cycloheptatriene, cyclobutadiene and cyclooctatetraene.

Unit 5 Bonding and Structural features of Organometallic Compounds
Fragment molecular orbitals (FMO) of various organic moieties/fragments like CH3, CH2, CH, BH2, BH, NH2, NH, FMO's (p-orbitals) of C3H5, C4H4, C4H6, C5H5, C6H6, C8H8 etc and various inorganic of the type MLn, isolobal concept, iso-electronic and isolobal relationships between various organic and inorganic (MLn) fragments, setting up of MO level diagrams and discussion of structure and bonding in various organometallic compounds like metal-olefins, MLn-cyclobutadiene, MLn-carbene, MLn-carbyne, sandwich and half-sandwich compounds, stable metal carbonyls, low and high nuclearity clusters, stereochemically non-rigid molecules, fluxional nature of organometallic compounds, nature of non-rigidity and their characterization by NMR spectroscopy, activation of small molecules by metal ions.

TEXTBOOKS:

1. *F. A. Cotton and G. Wilkinson, 'Advanced Inorganic Chemistry', John Wiley & Sons, 2009.*
2. *James E. Huheey, Ellen A. Keiter and Richard L.Keiter, 'Inorganic Chemistry, Principles of Structure and Reactivity', Pearson education, 5th edition, 2009.*
3. *J. D. Lee, 'Concise Inorganic Chemistry', 5th edition, John Wiley & Sons, 2009.*
4. *B. Douglas, D. McDaniel and J. Alexander "Concepts and Models in Inorganic Chemistry", 3rd Edition, Wiley, 2006.*

REFERENCES:

1. *P Atkins, T. Overton, J. Rourke, M.Weller, F. Armstrong, "Shriver & Atkins Inorganic chemistry", 4th Edition, Oxford University Press, 2008.*
2. *N. N. Greenwood and A. Earnshaw, 'Chemistry of Elements', Butterworth and Heinemann, 2nd Edition, 2002*
3. *J. E. House, "Inorganic Chemistry", Academic Press, 2008.*

15CHY581 INORGANIC SEMI-MICRO QUALITATIVE ANALYSIS LAB. 0 0 6 2

Semi-micro analysis of mixtures
The mixture will include 4 cations including two common (eg. Cations of metals like Cu, Mn, Zn, Ni, Ca, Ba, Mg etc) and two less common cations (eg. Cations of metals like Ti, Zr, V, W, Li, Ce, Th etc).
(The student has to successfully analyze a minimum of 10 mixtures).

TEXTBOOKS:

1. *A.I.Vogel, 'A text book of Qualitative Analyses', 4th edition, Longmans publications, 1985.*
2. *V.V. Ramanujam, 'Inorganic Semi-Micro Qualitative Analysis', 3rd edition, The National Publishing Company, 1974.*

REFERENCES:

1. *G.H.Jeffery, J.Bassett, J.Mendham and R. C. Denney, 'Vogel's Text Book of Qualitative Chemical Analysis', 5th edition, John Wiley & Sons Inc, 1989.*
2. *G.W. Parshall, 'Inorganic Synthesis', Vol. 15, Tata McGraw-Hill Education, 1974.*

15CHY582 INORGANIC QUANTITATIVE ANALYSIS LAB. 0 0 6 2

1. Estimation of Calcium (Permanganometry)
2. Estimation of Barium (Iodometry)
3. Estimation of Calcium as Calcium Carbonate (Gravimetry)
4. Estimation of Zinc using oxine (Gravimetry)
5. Estimation of Iron as Ferric Oxide (Gravimetry)
6. Analysis of Brass
7. Estimation of Copper and Nickel in a Mixture
8. Estimation of Copper and Iron in a Mixture
9. Preparation and Determination of Ferrous Oxalate
10. Estimation of Different Types of Hardness in the Given Water Sample
11. Estimation of Different Types of Alkalinities in the Given Water Sample
12. Estimation of Dissolved Oxygen in the Given Water Sample
13. Complexometric Estimations

TEXTBOOKS:

1. *G. Svehla, 'Vogel's Qualitative Inorganic Analysis', 7th Edition', Prentice Hall, 1996.*
2. *D.A.Skoog and D.M.West, 'Analytical Chemistry - An Introduction', 4th Edition, CBS Publishing Japan Ltd., 1986.*

REFERENCES

1. *E.J.Meehan, S.Bruckenstein and I.M.Kolthoff and E.B.Sandell, 'Quantitative Chemical Analysis', 4th Edition, The Macmillan Company, 1969.*
2. *R.A.Day (Jr) and A.L.Underwood, 'Quantitative Analysis', 6th Edition, Prentice Hall of India, 1991.*

15CHY585 ORGANIC QUALITATIVE ANALYSIS LAB. 0 0 6 2

1. Separation of binary mixtures
Includes separation, preliminary investigations, determinations of saturation/ unsaturation, detection of elements by Lassaigne's test, functional group identification, derivative preparation, determination of melting points of the derivatives and calculation of Rf values from TLC
The following mixtures can be given:
(a) Acid and hydrocarbon
(b) Phenol and aldehyde

(c) Phenol and acid
(d) Phenol and amine
(e) Acid and ester
(f) Halo compound and aldehyde
(g) Acid and aldehyde
(h) Amine and aldehyde
(i) Amine and ketone
(j) Alcohol and hydrocarbon

2. Thin layer chromatography to determine Rf values of compounds
(a) 2-nitroaniline
(b) 4-nitroaniline
(c) Cinnamic acid and 2-nitroaniline
(d) Acetophenone
(e) Ethyl benzoate

3. Simple column chromatography to separate the components of binary mixtures
(a) Hydrocarbon and ester
(b) Aldehyde and amine

REFERENCES:

1. *P.W.G. Smith, A.J.Hannaford, B.S.Furnis and A.R. Tatchell, "Vogel's Textbook of Practical Organic Chemistry", ELBS/Longman, 1989.*
2. *Ralph L.Shriner, Christine K.F.Hermann, Terence C.Morrill, David Y.Curtin, Reynold C.Fuson, 'Systematic Identification of Organic Compounds', John Wiley & Sons, 2003.*
3. *Mann and Saunders, 'Practical Organic Chemistry', Pearson edition, 2009*

15CHY586 ORGANIC QUANTITATIVE ANALYSIS LAB. 0 0 6 2

A. Estimations:
1. Estimation of equivalent weight of an acid
2. Estimation of glucose
3. Estimation of phenol
4. Estimation of acetone
5. Estimation of acid value of an oil
6. Estimation of iodine value and sap value of an oil
7. Estimation of Nitrogen – Kjeldahl method
8. Estimation of formaldehyde
9. Estimation of aniline
10. Estimation of ester

B. Preparations of Organic Compounds
Double stage preparations
(a) m-nitro benzoic acid from ethyl benzoate

(b) p-bromobenzanilide from aniline
(c) p-nitro acetanilide from aniline

Single stage preparations
(a) Benzimidazole
(b) Benzophenone oxime
(c) Dibenzilidene acetone (chalcone)
(d) Benzalacetophenone
(e) Benzanilide
(f) Acetanilide
(g) Acetyl salicylic acid (aspirin)

Name Reactions
(a) Benzil-Benzilic acid rearrangement
(b) Cannizaro reaction
(c) Claisen condensation

For all preparations
1. TLC to be done and Rf values of each compound to be reported
2. Melting point of pure compounds to be found
3. A small portion should be recrystallised from suitable solvent
4. Purified products to be displayed
5. Mechanisms for each preparation should be suggested

REFERENCES:

1. *P.W.G. Smith, A.J.Hannaford, B.S.Furnis and A.R. Tatchell, "Vogel's Textbook of Practical Organic Chemistry", ELBS/Logman, 1989.*
2. *Ralph L. Shriner, Christine K. F. Hermann, Terence C. Morrill, David Y. Curtin, Reynold C. Fuson, 'Systematic Identification of Organic Compounds', John Wiley & Sons, 2003.*
3. *Mann and Saunders, 'Practical Organic Chemistry', Pearson edition, 2009*

15CHY601 PHYSICAL METHODS IN CHEMISTRY 3 1 0 4

Unit 1 Ultraviolet and Visible spectroscopy
Orbitals involved in electronic transition, effect of solvents on the absorption of molecules, applications of electronic spectroscopy to conjugated compounds, a, ß unsaturated carbonyl compounds, aromatic compounds and heterocyclic systems, effects of substituents on the electronic spectra of aromatic compounds, electron releasing and electron withdrawing effects, substituents capable of p-conjugation, disubstituted benzene derivatives, stereo chemical factors in electronic spectroscopy, model compound studies, the nature of structural information that can be obtained from electronic spectroscopy, application of UV-visible spectroscopy for structural characterization of organic compounds.

Unit 2 Infrared Spectroscopy

The IR absorption process, instrumentation details, dispersive IR spectrometer, FTIR spectrometer, sample preparations, stretching and bending modes of various groups and corresponding IR absorptions, combination bands, difference bands, bond properties and absorption trends, the effect of reduced mass on the IR absorptions, correlation charts, characteristic group absorption of organic molecules and identification of functional groups, C-H stretching mode, O-H vibrations, C-H bending, C=C stretching, conjugation effect, ring-size effect, IR spectra of compounds containing substituted double bonds, carbonyl compounds, factors influencing C=O stretching vibrations, study of the IR spectra of normal, branched and cyclic alkanes, alkenes, alkynes, aromatic compounds, alcohols, phenols, ethers, epoxides, peroxides, aldehydes, ketones, carboxylic acids and derivatives and compounds containing N, P and S, IR spectra of inorganic systems, IR of anions like NO3-, ClO4-, SO42- in ionic form and also in coordinated forms due to symmetry, application of IR spectra for structural characterization.

Unit 3 NMR and ESR spectroscopy

Instrumentation details, factors influencing chemical shift, integrals in proton NMR spectra, splitting of NMR signals, magnitude of coupling constants, AMX, ABX and ABC systems, factors influencing geminal and vicinal coupling, heteronuclear coupling, chemical and magnetic equivalence, deuterium exchange, lanthanide shift reagents, peak assignments in 13C NMR, 13C - 1H spin coupling, DEPT, 2D NMR - shift correlation spectra - COSY HETCOR and HMQC, structural applications of 1H and 13C NMR techniques, CIDNP, spectra of compounds containing other important nuclei like 19F, 31P, 15N, 17O and 29Si, ESR spectroscopy, derivative curves, g values, hyperfine (hf) and superfine (shf) splitting, hf and shf splitting constants, structure and bonding parameters from ESR spectra.

Unit 4 Mass Spectrometry

Instrumentation details, structure and recognition of the molecular ion, molecular formula from the molecular ion, nature of metastable ion, calculation of m/z values, significance of metastable ions, basic fragmentation types and rules, fragmentation associated with functional groups, nitrogen rule, nature of fragmentation patterns, nature of fragment ions for alkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols and phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, S and N compounds, nitro compounds, isotope substitution by mass spectrometry, time of flight, quadrupole and tandem mass spectrometry, GC-MS, HPLC-MS, application of MS for structural characterization of organic compounds. Conjoint IR, UV/VIS, NMR and MS problems, applications of spectroscopic techniques in organic and inorganic chemistry, structural elucidation by using several spectroscopic techniques, aliphatic compounds, aromatic compounds, distinguishing structural isomers from spectral techniques, CD spectra and its applications.

Unit 5 Analytical Chemistry

(a) Complexometric Titrations

Classical methods of analysis, titrimetic analysis, theory of indicators, acid-base equilibrium in non-aqueous solvents, buffers, titration curves, titration in non-

aqueous solvents, complexometry, factors favoring complexation, theory of complexometric titrations, metal-ion indicators, masking and demasking, applications of complexometric titrations, solubility product, gravimetric determination.

(b) Separation Techniques

Distribution law, liquid-liquid extractions, factors favoring solvent extraction, synergistic extraction, countercurrent extraction, super critical fluids, electrophoresis - theory and applications, chromatography, theory, instrumentation and applications of column, paper, TLC, HPLC, GPC and ion exchange chromatography, gas chromatography, CHN analysis by GC.

(c) Thermal, Diffraction and Electroanalytical Techniques

Theory, instrumentation and applications of TG, DTA, DSC, XRD, electron diffraction, and neutron diffraction, theory, instrumentation and applications of conductometry, potentiometry, amperometry, voltammetry, polarography, electrogravimetry, coulometry and ion selective electrodes.

(d) Miscellaneous Techniques

Refractometry and interferometry, polarimetry, CD and ORD, nephalometry and turbidimetry, atomic absorption and flame emission spectrometry, XRF, chemical analysis of surfaces - ISS, SIMS, AES, ESCA.

TEXTBOOKS:

1. *Hobart H. Willard, Lynne L. Merritt, John A. Dean, Frank A. Settle, 'Instrumental Methods of Analysis', 6th edition, Van Nostrand, 1981*
2. *C. N. Banwell and E.M. McCash, 'Fundamentals of Molecular Spectroscopy', 4th Edition, New Age International, 2004.*
3. *3. R. M. Silverstein and F. X. Webster, 'Spectrometric Identification of Organic Compounds', 6th Edition, John Wiley, 1997.*

REFERENCES:

1. *William Kemp, 'Organic Spectroscopy', 2nd edition, ELBS, 1987.*
2. *D. H. Williams and I. Flemming, 'Spectroscopic Methods in Organic Chemistry', 4th Edition, McGraw-Hill, 2007.*
3. *J. B. Lambert, H. F. Shruvell, D. A. Lightner and R. G. Cooks, 'Organic Structural Spectroscopy', Prentice Hall, 2010.*
4. *D.L. Pavia, G.M. Lampman and G.S. Kriz, 'Introduction to Spectroscopy', 3rd Edition, Brooks/ Cole, 2001.*
5. *J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas 'Vogel's text book for Quantitative Chemical Analysis', 6th edition, Pearson Education, 1999.*

15CHY602 ELECTROCHEMISTRY, ENERGY SYSTEMS AND KINETICS 3 1 0 4

Unit 1 Surface Chemistry

Different types of interfaces, molecular and atomic surface structure, surface chemical

reactions, surface tension of solutions, surface excess, thermodynamics of surfaces, Gibbs equation and its derivation, surface films, surface potential, adsorption by solids, Langmuir isotherm - its kinetic and statistical derivation, Freundlich equation, multilayer adsorption, BET isotherm - its kinetic derivation, measurement of surface area, colloids - their preparation, purification, stability & electro kinetic phenomena, Donnan membrane equilibrium, micro and nano emulsions, surface analysis using photoelectron spectroscopy, surface imaging techniques like SEM, TEM, AFM etc., sputter coating, ion beam principles, design of surfaces with novel properties.

Unit 2 Electrochemistry I

Faraday's law, conductivity of electrolytes, applications of conductivity measurements, ionic mobility, transference number, Debye-Huckel-Onsagar equation of conductivity and its validity for aqueous and nonaqueous solutions, deviations from the Onsagar equation, activity and activity coefficients in electrolytic solution, Debye-Huckel theory and its tests and improvements, Onsager equation, electrochemical potential, electric potential at interfaces,

Unit 3 (a) Electrochemistry II

Electrochemical cells, standard electrode potentials, reversible cell, concentration cells with and without transference, energetic of cell reactions, effect of ionic concentration, pressure and temperature on the energetic of cell reactions, applications of e.m.f. measurements, potentiometric measurement of pH, glass electrode and its structure, performance and limitations, double layer, charge transfer across interfaces, polarisation, concentration polarisation, decomposition potential, over potential (hydrogen, oxygen and metal decomposition over voltage), theories of over voltage, electrode kinetics - Butler Volnmer equation, Tafel equation, power generation, storage cells, theories of corrosion, fuel cells, diffusion potential, liquid junction potential, Henderson's equation, electron transfer kinetics - Marcus theory, electrochemical impedance spectroscopy, electro organic chemistry - electro oxidation, electro reduction, electro polymerisation.

Unit 3 (b) Batteries and Fuel Cells

Primary, secondary and reserve batteries, chemistry, fabrication, performance aspects, packing classification and rating of Zn-C, Mg, alkaline manganous dioxide, mercuric oxide, silver oxide batteries, Zn/air and Li button cells, solid electrolyte cells, secondary batteries - lead-acid, Ni-Cd, Ni-Zn, Li and Li+ batteries, rechargeable Zn-alkaline batteries, reserve batteries – zinc-silver oxide, lithium anode cell, thermal batteries, advanced batteries for electric vehicles – metal/air, Zn-Br, sodium-beta and lithium/iron sulpfide batteries, Fuel Cells – carbon, hydrogen-oxygen, methanol, molten carbonate, solid polymer electrolyte and biochemical fuel cells, alkaline fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, proton exchange membrane fuel cells, solar cells – photovoltaic and photo electrochemical cells, photo biochemical conversion cell.

Unit 4 Chemical Kinetics I

Reaction rates and order of reactions, determination of order of reactions, complex reactions, reversible, consecutive and concurrent reactions, reactions of variable order, steady state treatment, reaction mechanism and molecularity, theories of unimolecular reactions and termolecular reactions, Arrhenius equation, collision theory and transition state theory, comparative study of the theories of reaction rates, free energy of activation, effect of solvent on rate of reactions, ionic reactions and effect of ionic strength - salt effect, effect of pressure on velocity of gas reactions.

Unit 5 Chemical Kinetics II

Reaction dynamics, fast reactions, flash photolysis and relaxation methods, catalysis and inhibition, homogeneous catalysis, acid, base and enzyme catalysis, kinetics of enzyme catalyzed reaction - the Michaelis-Menten equation, photochemical kinetics, steady state treatment of photochemical reactions, Semenov-Hinshelwood theory of chain reactions and explosions, free radical reactions - the Rice-Herzfeld mechanism.

TEXTBOOKS:

1. *K. J. Laiddler, 'Chemical-Kinetics', 3rd Edition, McGraw Hill, New York, 2004.*
2. *Dell, Ronald M Rand and A.J David, 'Understanding Batteries', 1st edition, Royal Society of Chemistry, 2001.*

REFERENCES:

1. *M. Aulice Scibioh and B. Viswanathan, 'Fuel Cells-Principles and Applications', reprint, University Press, India, 2006.*
2. *Gilbert W. Castellan, "Physical Chemistry", 3rd Edition, Narosa Publishing House, 2004.*
3. *Lindon David, 'Handbook of Batteries', 3rd edition, McGraw Hill, 2002.*
4. *W. J. Moore and R. G. Pearson, 'Kinetics and Mechanism', 2nd edition, Wiley, 1981.*

15CHY611 COMPUTATIONAL CHEMISTRY 2 1 0 3

Unit 1

Models, Approximation and Reality - Fundamental principles - energy, electrostatics, atomic units, thermodynamics, quantum mechanics, statistical mechanics.

Unit 2

Computational methods - Ab initio techniques - semiempeical methods - density functional theory - molecular mechanics - molecular dynamics, montecarlo simulations.

Unit 3

Computing molecular geometries, potential energy surfaces, Z matrices - basis sets - molecular vibrations - population analysis - chemical properties by computational methods.

Unit 4

Computing the transition states, reaction co-ordinates, reaction rates, solvation,

electronic excited states, structure property relations, computing NMR chemical shifts, Band structures, Meso scale dynamics, synthesis route prediction.

Unit 5
Periodic table, Molecular modeling, modeling of biomolecules, simulating liquids, polymers, solids and surfaces the software packages.

TEXTBOOKS:

1. *David C.Young, 'Computational Chemistry', 1st edition, Wiley-Interscience, 2001.*
2. *Andrew R.Leach, 'Molecular Modeling – Principles and Applications,' 2nd edition, Pearson Education EMA, 2001.*

REFERENCES:

1. *Christopher J.Cramer, 'Essentials of Computational chemistry: Theory and models', 2nd edition, Wiley publications, 2004.*
2. *Frank Jensen, 'Introduction to computational chemistry', 2nd edition, Wiley publications, 2006.*
3. *Jan H.Jensen, 'Molecular Modeling Basics', 1st edition, CRC Press, 2010.*
4. *Alan Hinchliffe, 'Molecular Modelling for Beginners', 2nd edition, Wiley publications, 2008.*

15CHY612 HETEROCYCLIC AND NATURAL PRODUCTS CHEMISTRY 3 1 0 4

Unit 1 Photochemistry - Principles and Reactions
Introduction to unimolecular and bimolecular processes, Stern Volmer equation, Jablonski diagram, cis-trans isomerisation, Paterno-Buchi reaction, Norrish Type I and II reactions, photo reduction of ketones, di-pimethane rearrangement, photochemistry of arenes, Hoffmann Loffler Freytag reaction, Barton reaction, photochemistry of cyclohexadienones, determination of photochemical reaction mechanism.

Unit 2 Heterocyclic Compounds
Nomenclature and general characteristics of heterocyclic compounds, study of three and four-membered ring heterocyles containing one heteroatom, structure and synthesis of penicillin and cephalosporin-C, structure and synthesis of reserpine, heteroaromatic compounds (five and six-membered rings) containing one and two heteroatoms, fused ring compounds - indole, quinoline, isoquinoline, coumarin, flavones, purine and pyrimidine, bases present in nucleosides.

Unit 3 Carbohydrates
Structure of ribose, glucose, fructose, maltose, sucrose, lactose, starch, cellulose and cyclodextrins, preparation of alditols, glycosides (O, C and N), deoxysugars, synthesis of vitamin C from glucose, structure and synthesis of nucleic acids, genetic code, recombinant DNA, biosynthesis of shikimic acid.

Unit 4 Chemistry of Natural Products
Alkaloids - classification, structure elucidation based on degradative reactions (quinine

and atropine), Terpenoids - classification, structure elucidation and synthesis of abietic acid, Steroids - classification, structure of cholesterol, conversion of cholesterol to progesterone, androsterone and testosterone, classification, structure and synthesis of prostaglandins, biosynthesis of fatty acids, prostaglandins, terpenoids and steroids.

Unit 5 Amino acids, Peptides and Enzymes
Synthesis of amino acids - Strecker and azalactone synthesis, enantioselective synthesis of amino acids, reactions of amino acids, structure of proteins, introduction to enzymes and coenzymes with special reference to the function of chymotrypsin, NAD, thiamine, pyridoxal, in vitro and in vivo synthesis of peptides, solid phase synthesis, biosynthesis of quinine and papaverine.

TEXTBOOKS:

1. *I. L.Finar, "Organic Chemistry", Volume 1, Sixth Edition and Volume 2, Fifth Edition, Longman, 2001.*
2. *N.R.Krishnaswamy, "Chemistry of Natural Products - A Unified Approach", Universities Press, 2nd En, 2010.*
3. *T. L.Gilchrist, "Heterocyclic Chemistry", Pearson, Third En, 2005.*

REFERENCES:

1. *J. Clayden, N.Green, S.Warren and P.Wothers, "Organic Chemistry", Oxford University Press, 2001.*
2. *R.O.C.Norman, "Principles of Organic Synthesis", Chapman and Hall, 2nd En, 1995.*
3. *Norman and Coxon, "Organic Synthesis."*
4. *Jerry March, "Advanced Organic Chemistry", Wiley Interscience, 2001.*

15CHY613 SOLID STATE AND BIOINORGANIC CHEMISTRY 3 1 0 4

Unit 1 Introduction to Crystal Systems
Introduction to solids - solid state chemistry, close packing, hcp, fcc, density, coordination numbers, tetrahedral and octahedral holes, body centered and primitive structures, symmetry, proper rotation, mirror planes, inversion, improper axis symmetry elements, symmetry in crystals, Schoenflies and Hermann-Mauguin notations, unit cells, glide plane, screw axis, three-dimensional unit cells, seven crystal systems/classes, space groups, Miller indices, Bravais lattices, reciprocal lattice, inter-planar spacing in different crystal systems, fractional coordinates, ionic solids, structures of CsCl, NaCl, NiAs, zinc blende and wutzite structures, MX2 type solids, fluorite and antfluorite structures, CdCl2 and CdI2 structures, rutile and anti-rutile, ReO3, spinel and inverse spinel, pervoskite structures, ionic radii, crystal radii, radius ratio, Extended covalent array, diamond, graphite.

Unit 2 Bonding in Solids and Electronic properties
Bonding in crystals, metallic bonding, ionic bonding, covalent bonding, silicates, Born-Haber cycle, Hess's law, lattice energy (L) and calculation of L, free electron theory, density of states, electronic conductivity, molecular orbital theory, overlap and bonding, linear chain of H atoms, LCAO, Fermi Level, conductors, insulators and semiconductors, n- and p-type semiconductors, bands in compounds, electrical conductivity, photo-conductivity, bands in d-block compounds, band-gap measurements, conductivity, GaAs, magnetic and optical properties of solids.

Unit 3 Magnetic and Optical Properties of Solids

Behavior of substances in magnetic field, effects of temperature (Curie & Curie-Weiss laws); magnetic moments, mechanism of ferro- and ant ferromagnetic ordering, super exchange. luminescence and phosphorescence, phosphors, lasers, non-stoichiometry in solids, electronic properties of non-stoichiometric oxides, defects in solids, Schottky defects, Frenkel defects, doping in crystals and color features, ruby, diamond, conducting organics, organic conductors, preparation, mechanism of conduction in organic semiconductors, photoconductivity of polymers, high Tc superconductors.

Unit 4 Bioinorganic Chemistry I

Inorganic chemistry and biochemistry – fundamentals, essential chemical elements, metals in biological systems, biological metal ion complexation, thermodynamics and kinetics. Transport of ions across biological membranes, role of alkali and alkaline metal ions in biological systems, ionophores and passive transport, sodium-potassium pump and active transport, structural role of Ca, transport of Ca, electron transport in biology, oxygen carriers - myoglobin and hemoglobin structure of prosthetic group and functions, mechanism for reversible binding of dioxygen and co-operativity of oxygen binding, behaviour of dioxygen bound to metals, model compounds, cobalt containing model compounds, iron containing model compounds, binding of CO to hemoglobin and myoglobin.

Unit 5 Bioinorganic Chemistry II

Copper enzymes, introduction, occurance, structure, function, azurin, plastocyanin, superoxide dismutase, haemocyain, haemerythrin, model compounds, Type I, II and III copper enzyme models, nitrogenase enzyme, introduction, nitrogen fixation, detailed mechanistic studies, Fe-S clusters, Fe-protein structure, Mo-Fe protein structure - P-cluster - M-centre, nitrogenase model compounds. Structural and functional models, photosynthesis, PS-I and PS–II, uptake, transport and storage of iron, Fe-S and other non-heme iron proteins, ferredoxins, transferrin, ferritin. Metals in medicine – inorganic medicinal chemistry, metal toxicity and homeostasis, therapeutic complexes – superoxide dismutase mimics, Zn-proteins, vanadium based diabetes drugs, platinum containing anticancer agents, diagnostic agents, MRI, metal transport and metallochaperons.

TEXTBOOKS:

1. *James E.Huheey, Ellen A.Keiter and Richard L.Keiter, 'Inorganic Chemistry, Principles of Structure and Reactivity', Pearson education, 5th edition, 2009.*
2. *P.Atkins, T.Overton, J.Rourke, M.Weller, F.Armstrong,"Shriver & Atkins Inorganic Chemistry, 4th Edition, Oxford University Press, 2008.*
3. *B.Douglas, D.McDaniel and J.Alexander, "Concepts and Models if Inorganic Chemistry", 3rd Edition, Wiley, 1994.*

REFERENCES

1. *F.A.Cotton and G.Wilkinson, 'Advanced Inorganic Chemistry', John Wiley & Sons, 2009.*
2. *R.S.Drago, 'Physical Methods in Chemistry', W.B Saunders, Philadelphia, PA, 1977.*

3. *D.Jiles, "Magnetism and Magnetic Materials", Chapman and Hall, London, 1991.*
4. *R.E.Hummel, "Electronic Properties of Materials", 3rd ed., Springer-Verlag, New York, 2001.*

15CHY631 APPLIED ELECTROCHEMISTRY 3 0 0 3

Unit 1 Electrodics

Electron transfer under an interfacial electric field, A two-way traffic across the interference: equilibrium and exchange current density. Dependence of the electrochemical reaction rate on over potential - Quantitative version of the Butler-Volmer equation. Electrode kinetics involving the semiconductor/solution interface. Techniques of electrode kinetics - preparation of electrode surface. Microelectrodes –applications.

Unit 2 Quantum oriented electrochemistry

Chemical potentials and energy state of electronics in the solution potential energy surfaces and electrode kinetics. A quantum mechanical description of electron transfer. Electron transfer, the frank-Condon principle in electron transfer, the primacy of Tafel's law in experimental electrode kinetics.

Unit 3 Electrochemical energy systems

Electrochemical process, Primary, secondary and reserve batteries, fuel cells, solar cells.

Unit 4 Electrochemical sensors

Potentiometric sensors, solid state Potentiometric chemical sensors, polymeric membrane sensors, ion selective field effect transistor, application, Hydrovolumetric technique - hydrodynamic voltametry - application, voltametric sensors - electrode modification application, optical sensors - bioamperometric titration. Methods involving forced convection - hydrodynamic methods.

Unit 5 Biosensors

Response of Enzyme-based Biosensors, Examples of Biosensor Configuration, Ferrocene - Mediated Amperometric Glucose Sensor, Potentiometric Biosensor for Phenyl Acetate, Potentiometric Immunosensor for Digoxin, Optical Biosensor for Glucose Based on Fluorescence Energy Transfer, Piezoelectric Sensor for Nucleic Acid Detection, Enzyme Thermistors.

TEXTBOOKS:

1. *Allen J.Bard and Larry R.Faulkner, 'Text book for Electrochemical Methods', 2nd edition, Wiley, 2000.*
2. *John O.M.Bockris, Amulya K.N.Reddy and Maria Gamboa-Aldeco 'Modern Electro Chemistry 2A', 2nd edition, Springer, 2001.*

REFERENCES:

1. *Robert W. Cattrall, 'Chemical Sensors', Oxford University Press, 1997.*
2. *Rudolf holze, 'Experimental Electrochemistry', 1st edition, Wiley, 2009.*

15CHY632 BIOANALYTICAL CHEMISTRY 3 0 0 3

Unit 1 Enzymes
Enzyme nomenclature, Enzyme commission numbers, Enzymes in bioanalytical chemistry, Enzyme kinetics - Enzyme activators, Enzyme inhibitors.

Unit 2 Quantification of Enzymes and their substrates
Instrumental methods, Optical detection - Absorbance, Fluorescence, Luminescence, Nephlometry Electrochemical detection -Amperometry, Potentiometry, Conductometry, Other Detection Methods - Radiochemical, Manometry, Calorimetry.

Unit 3 Immobilized enzymes
Immobilization methods - nanopolymerizing covalent immobilization, Crosslinking with bifunctional reagents. Properties of immobilized enzymes, immobilized enzyme reactions, theoretical treatment of packed bed enzyme reactors.

Unit 4 Antibodies
Structural and functional properties of antibodies, Polyclonal and monoclonal antibodies Antibody-antigen interactions, analyrtical application of secondary antibody-antigen.

Unit 5 Biosensors
Response of Enzyme-based Biosensors, Examples of Biosensor Configuration, Ferrocene-mediated Amperometric Glucose Sensor, Potentiometric Biosensor for Phenyl Acetate, Potentiometric Immunosensor for Digoxin, Optical Biosensor for Glucose Based on Fluorescence Energy Transfer, Piezoelectric Sensor for Nucleic Acid Detection, Enzyme Thermistors.

TEXTBOOKS:

1. *Susan R. Mikkelsen, and Eduardo Corto´n 'Bioanalytical Chemistry', 1st edition, Wiley Interscience, 2003.*
2. *Andres Manz, Nicole Pamme and Dimitri Lossifidis, 'Bioanalytical Chemistry', World Scientific Publishing Company, 2004.*

REFERENCE:

Robert W. Cattrall, 'Chemical Sensors', Oxford University Press, 1997.

15CHY633 CHEMISTRY OF BIOMOLECULES 3 0 0 3

Unit 1 Amino acids, Proteins and Peptides
Classification, Stereochemical aspects, physical properties, Ionic properties, spectral properties, chemical reactions of amino acids, Industrial preparation and chemical synthesis of amino acids. Ionic properties of proteins, protein structure, protein purification, protein structure determination, proteomics and protein function, solid phase peptide synthesis, biologically important peptides.

Unit 2 Enzyme chemistry
Introduction to Enzymes, Classification of enzymes, mechanism of enzyme action, immobilized enzymes and enzyme technology, enzyme analog built polymers, design of molecular clefts, enzymes in synthetic organic chemistry.

Unit 3 Molecular biology and bioinformatics
Structure of nucleic acids, genes and genome complexity, functions of nucleic acids, isolation and separation of nucleic acids, molecular analysis of nucleic acid sequences, nucleotide sequencing of DNA.

Unit 4 Immunochemical techniques
Production of antibpodies, purification and fragmentation of immunoglobulins, immunoprecipitatipon, labeling antibodies, immunoblotting, immunoassays, immunohisto/cytochemistry.

Unit 5 Recombinant DNA and genetic analysis
Constructing gene libraries, cloning vectors, hybridization and gene probes, application of gene cloning, expression of foreign genes, pharmacogenomics.

REFERENCES:

1. *Hermann Dugas, 'Bioorganic Chemistry - A Chemical Approach to Enzyme Action', 3rd edition, Springer.*
2. *Keith Wilson and John Walker, 'Principles and Techniques of Biochemistry and Molecular Biology', 6th edition, Cambridge University Press.*

15CHY634 INDUSTRIAL CHEMISTRY 3 0 0 3

Unit 1 Water treatment
Softening of water, Ion exchange process, Lime soda process, Modified Lime soda process, Zeolite process, Chemical and physical method of sterilization, Desalination, Boiler problems. Corrosion of boiler units, industrial water treatment, water analysis.

Unit 2 Fuels
Calorific value, determination of Calorific value, classification of fuels, Solid fuels, Properties of fuels, classification of coal, coking and non-coking coals, advantages and disadvantages of solid fuels. Liquid fuels, gaseous fuels, analysis of fuel gases, Distillation of petroleum. Processing & purification of petroleum and petroleum products, Flash point, Fire point, Knocking, antiknocking, Cetane number, octane number, natural gasoline, cracking, polymerization, alkylation, isomerisation, rocket fules, fossil fules, nuclear fuels.

Unit 3 Energy resources
Renewable and non renewable sources of energy, conventional and non conventional sources of energy, solar energy, solar technology, solar photovoltaic cell - application, PV lantern system, Radiotelephone system, Application of solar

energy, Environmental implication, Nuclear energy, nuclear fuel cycle in India, Energy conservation and waste heat boilers, Fuel cells, hydrogen cells.

Unit 4 Paints and Pigments
White pigment, blue, green, yellow, black and red pigments - manufacture, physical properties, characteristics, Manufacture of paints, setting of paints, requirement for good paints, emulsion paint, latex paint, luminescent paint, fire retardant paints, heat resistant paints, varnishes, manufacture of varnishes, enamels, lacquers.

Unit 5 Explosives and Toxic Chemical Weapons
Introduction, Classification. Deflagrating or low explosives. Characteristics of explosives, nitrocellulose, PETN, DNB, TNB, TNT, Picric Acid, Nitroglkycerine, Dynamite, Cirdite, Gun powder, RDX, EDNA, HMX,Tetryl, Pentryl, Hexyl, Dinol. Toxic chemical weapons, screening smokes, Incendiaries, Pyrotechniques, Explosives in India.

TEXTBOOKS:

1. *B.K.Sharma, 'Industrial Chemistry', Goel publishing.*
2. *James A Kent, 'Riegels Hand book of Industrial chemistry', 10th edition, Kluwer Academic/ Plenum publishers, 2003.*

REFERENCES

1. *Alan Heaton, 'An Introduction to Industrial chemistry', 3rd edition, Blackie Academic and professional, 1996.*
2. *Chris A Clausen and Guy Mattson, 'Principles of industrial chemistry', 2nd edition Wiley, 1978.*
3. *Jonathan Steed, 'Core Concepts on supramolecular chemistry and nanochemistry', Wiley Eastern Publishers, 2006.*

15CHY635 INDUSTRIAL STOICHIOMETRY 3 0 0 3

Unit 1
Introduction to process calculation - dimensions and systems of units - fundamental quantities of units, derived quantities, definition and units of force, volume, pressure, work, energy, power, heat-unit conversions in FPS, MKS and SI systems.

Unit 2
Mixtures and solutions - methods of expressing compositions of mixture and solutions, wet and dry basis concept. Ideal and real gas laws – Gas constant – normal molal volume, calculations of pressure, volume and temperature using ideal gas law. Gas mixtures – Use of partial pressure and pure component volume in gas calculations. Dissociating gases. Relation between mole%, volume% and pressure% of ideal gases calculation of average molecular weight, density, mole%, weight% in gas mixture in SI/MKS systems – applications of real gas relationship in gas calculation.

Unit 3
Description and simple material balance calculation of physical processes such as drying, distillation, absorption, mixing, crystallization, Evaporation.

Unit 4
Single stage material balance calculation of leaching and extraction, calculations involving recycling and by passing operation - limiting reactant, excess reactant, conversion, yield and selectivity - simple numerical for finding yield, conversion and composition.

Unit 5
Calculation of material and energy balance based on reactions involving heat capacity and specific heat - mean heat capacity of gases - heat capacity of gas mixture and liquid mixture. Calculations of heat capacity by integral equation up to three terms - sensible and latent heats of fusion, sublimation, vaporization. Calculations of standard heat of formation from heat of combustion data. Calculations for heat of reaction from heat of formation and heat of combustion data – Fuels - calorific values proximate and ultimate analysis - air requirement and composition of flue gases.

TEXTBOOKS:

1. *Bhatt, B.L. Vora, S.M., "Stoichiometry", 3rd Edition, Tata McGraw-Hill (1996).*
2. *Felder, R.M. and Rousseau, R.R. "Elementary Principles of Chemical Processes" 3rd Edn., John Wiley & Sons, New York 2000.*

REFERENCE BOOKS:

1. *Hougen O.A., Watson K.M. and Ragatz R.A., "Chemical Process Principles" Part I, CBS Publishers (1973).*
2. *Warren. K Lewis, Arthur H. Radash & H.Clay Lewis, "Industrial Stiochiometry", McGraw Hill Book C., NY 1995.*

15CHY636 MATERIAL SCIENCE AND NANOCHEMISTRY 3 0 0 3

Unit 1 Introduction to Nanomaterials
Introduction to Material Science, Interdisciplinary nature, Structure of nanomaterials, Length scales, de-Broglie wavelength & exciton Bohr radius, Foundations of Quantum Mechanics: wave function, Schrödinger equation, uncertainty principle, quantum wells, quantum wires, quantum dots, articles.

Unit 2 Nanomaterials: Synthesis, Properties
Size effect and properties of Nanoparticles - Particle size - Particle shape - Particle density, Specific surface area and pore - Composite structure, Crystal structure - Functionality of nanostructures and their characteristic evaluation - Optical properties - Catalytic property; Synthesis - Methods and Strategies, Top-down and bottom-up approaches, Chemical vapor deposition, Laser ablation, Electric-arc, Sol-Gel Processing, Lithography - Surface modification of inorganic nanoparticles by organic functional groups.

Unit 3 Surface Science and Characterization of Nanomaterials
Electron Microscopy, MFM, SNOM, SEM, TEM, EDAX, X-ray Diffraction and Electron

diffraction, Atomic Force Microscopy, Scanning Tunneling Microscopy, Spectroscopy: UV-Visible spectroscopy, Photoluminescence spectroscopy, IR spectroscopy, FTIR and ATR, Raman spectroscopy, Self-Assembled Monolayers.

Unit 4 Nanotechnology: Applications and Devices
Nanoscale materials, Nano transfer printing, Biomaterials applications, MEMS and NEMS, selforganisation, nanoscale (opto) electronics, Fullerenes, Devices - Actuators and motors for nanodisplacements, Nanosensors, development of optical memory using semiconductor nanoparticles - Nozzle-free inkjet technology - Dendrimers and their application to organic electronics devices - Nanomedicines, Bio-imaging with quantum dots.

Unit 5 Environmental Issues in Nanotechnology
Nanoparticles and environment - Nanoparticles in atmosphere - Ground water, exhaust gases – wastewater and Indoor environments; Safety of nanoparticles - Problems caused by nanoparticles, Safety assessment for the nanoparticles; Removal of nanoparticles.

TEXTBOOKS:

1. *T.Pradeep, 'Nano - The Essentials Understanding Nanoscience and Technology', McGraw-Hill Professional Publishing, 2008.*
2. *Charles P. Pool and Frank J. Ovens, 'Introduction to Nanotechnology', John Wiley and sons, 2006.*

REFERENCES:

1. *Ozin, Geoffrey Alan, Arsenault, 'Nanochemistry: A Chemical Approach to Nanomaterials', Royal Society of Chemistry, 2008.*
2. *C.N.R. Rao, A.Muller, A.K.Cheetham, 'The Chemistry of Nanomaterials: Synthesis, Properties and Applications', Wiley-Vch Verlag Gmbh & Co., 2004.*
3. *Alexei Nabok, 'Organic and Inorganic Nanostructures', Artech House, 2005.*
4. *C. Richard Brundle, Charles A. Evans Jr., and Shaun Wilson, 'Encyclopedia of Materials Characterization', Butterworth-Heinemann Publishers, 1992.*
5. *Masuo Hosokawa, Kiyoshi Nogi, Makio Naito and Toyokazu Yokoyama, 'Nanoparticle Technology Handbook', Elsevier Publishers, 2007.*

15CHY637 MEDICINAL CHEMISTRY 3 0 0 3

Unit 1 Physicochemical properties of drugs in relation to biological action
Acid-Base Properties, Water solubility, Partition coefficient, drug administration, drug distribution, metabolism (Phase I and Phase II) and toxicity of drug receptor interaction, conformational flexibility and multiple mode of action, optical isomerism and biological activity, selected physico-chemical properties (Ionization, hydrogen bonding and biological action, chelation and biological action, oxidation - reduction potential and biological action, absorption and orientation at surfaces) Enzymes, hormones and Vitamins - representative cases, nomenclature, classification and characteristics of enzymes, mechanism of enzyme action, factors affecting enzyme action, co-factors and co-enzymes, enzymes in organic synthesis, mechanism of enzyme catalysis, enzyme inhibition.

Unit 2 Essentials of drug design
Molecular mimetics, drug-lead modification, drug design using QSAR and computer assisted design, assessment of drug activity, receptors and drug action, mechanism of drug action, drug metabolism pathways, Drug potentiation, drug antagonism and drug resistance

Unit 3 Medicinal agents from natural products
History of the use of natural products as therapeutic agents, medicinal plants, active principle, Isolation methods of alkaloids, terpenes, antioxidants, natural oils from plants

Unit 4 Medicinal agents
Medicinal agents belonging to alkaloids, steroids, polypeptides, modified nucleic acid bases, sulphonamide and sulpha drugs, antibacterials - sulpha drugs, substituted sulphonamides, anticonvulsants, anticoagulants, antiamoebic agents, antihelmintic agents, anti-malarial agents, diuretics and cardio vascular agents, drugs for AIDS, medicinal agents affecting CNS, analgesics, antipyretics, antiseptics and disinfectants, Histamine and anti-histaminic agents, antibiotics - cell wall biosynthesis, inhibitors of ß - lactam rings, antibiotics inhibiting protein synthesis, isolation, structure elucidation, synthesis, structure-activity relationship and mode of action of penicillin, streptomycin, tetracycline and chloroamphanicol, synthesis of penicillin G & V, ampicillin, amoxicillin and cephalosporin

Unit 5 Infectious and Non infectious diseases
Infectious diseases:
A) Malaria: Life cycle stages of malaria parasite and molecular pathways for therapeutic intervention. a) Artemisinin class of compounds, mode of action, advantages and drawbacks; chemical modifications to improve therapeutic profile and new leads (to demonstrate the importance of natural products in drug development). b) Proteases as drug targets in the rational design of new anti-malarials (to expose students to protease function, mechanism, homology modeling and rational drug design)

B) AIDS: Protease and reverse transcriptase as drug targets.

C) Leishmaniasis: Polyene macrolides (Membrane disrupting agents); Toxicity issues, Drug delivery, Therapeutic index

Non-infectious diseases:
A) Cancer chemotherapy: a) Introduction to cancers, recognition of cancer cells, types of neoplasms, metastasis, mechanism of tumor formation Anti-mitotic agents: mitotic cycle, tubulin polymerization, treatment of cancer, determination of drug response, cytotoxic anticancer drugs, antitumor antibiotics, endocrine agents, miscellaneous anticancer agents Mode of action of taxol, epothilones, Colchicine and Vinblastine. b) Anti-metabolite strategy in drug development. 5-fluorouracil. c)

Drugs targeting DNA: Bleomycin, Anthracyclines and Enediyne anti-tumor agents (Calicheamicins and Dynemicin A).

B) Nervous System and neurotransmitters. Acetylcholine analogs as Agonists and antagonists with examples.

TEXTBOOKS:

1. *John M beak and John H Block, 'T Wilson, O. Gisvold and R. F. Deorge - Text book of Organic, Medicinal and Pharmaceutical Chemistry', 7th edition, J.B. Lippincott Williams and Wilkons Company, 1977.*
2. *A.Burger, 'Medicinal Chemistry', 3rd edition, Wiley Interscience, 1970.*
3. *V.K.Ahluwalia and Madhu Chopra, 'Medicinal Chemistry', Ane Books pvt Ltd, 2008.*

REFERENCES

1. *V.Kothekar, 'Essentials of Drug Designing', 14th edition, Dhruv publications, 2005.*
2. *V.K.Ahluwalia, Lalita S.Kumar and Sanjiv Kumar, 'Chemistry of Natural Products', Ane Books India.*
3. *L.P.Graham 'An introduction to Medicinal Chemistry', 3rd edition, Oxford University Press, 2005.*

15CHY638 SUPRAMOLECULAR CHEMISTRY 3 0 0 3

Unit 1 Introduction to Supramolecular Chemistry
From molecular to supramolecular chemistry: Factors leading to strong binding, hydrogen bonding and stacking interactions, Bottom-up approach, Top-Down Approach, Energy and Signals Semiochemistry, photo switching devices, electro switching devices, mechanical switching processes,

Unit 2 Processing of Energy and Signals by Molecular and Supramolecular system Fundamental principles of photo induced electron and energy transfer, Molecular electronics, Molecular photonics, Molecular Chemionics, Molecular electro photonics, Molecular Photochemionics.

Unit 3 Molecular Recognition
Molecular receptors: crown ethers, siderophores, cyclophanes, cyclodextrin and their application in specific recognition processes. Metal guided self assembly reactions, molecular knot with double helical complexes, Self-assembly of polynuclear metal complexes.

Unit 4 Electrochemistry of Supramolecular Systems
Electroluminescent systems as sensors and devices, Redox controlled molecular switches, Biohybrid electrochemical devices, Dendrimers as multielectron storage devices, Redox-active Metal-Polypyridine dendrimers as light harvesting antennae.

Unit 5 Molecular Scale Mechanical Devices
Introduction to mechanical devices, Spontaneous mechanical like motions, Allosteric movements, Tweezers and Harpoons, A natural proton pump, Twisters, Tweezers,

Threading-Dethreading movements, Ring switching processes in Rotaxanes and Catenanes, Molecular valves, Molecular Muscles.

TEXTBOOKS:

1. *Vincezo Balzani, 'Supermolecular Chemistry', Kluwer Academic, 1992*
2. *Vincenzo Balzani, Alberto Credi and Margherita Venturi, 'Molecular Devices and Machines: A Journey Into the Nanoworld', Wiley, 2006.*
3. *Paola Ceroni, Alberto Credi and Margherita Venturi, 'Electrochemistry of Functional Supramolecular Systems', Wiley, 2010.*

REFERENCES:

1. *Jonathan W. Steed Atwood, Jerry L.Chich, 'Supramolecular Chemistry', 2nd edition, Wiley, 2009.*
2. *Fritz Vögtle and F.Alfter 'Supramolecular Chemistry: An Introduction', John Wiley & Sons, 1999.*
3. *Jean-Marie Lehn, 'Supramolecular Chemistry', RCS pubs., 2005*
4. *Jonathan Steed, David Turner and Carl Wallace, 'Core concepts in Supramolecular Chemistry and nanochemistry', John Wiley & Sons, 2007*
5. *Katsuhiko Ariga and Toyoki Kunitake, 'Supramolecular chemistry – Fundamentals and applications advanced textbook', Springer-Verlag, 2000*

15CHY639 NANOMATERIALS FOR BIOMEDICAL APPLICATIONS 3 0 0 3

Unit 1
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; Spectroscopic techniques to characterize nanostructures - Raman, XPS, Auger, EDAX;

Unit 2
Synthetic approaches: Colloidal, Self-Assembly (Self-assembled monolayers - SAMs) and electrostatic self-assembly, electrochemical methods (cathodic and anodic processes), sol-gel, Langmuir-Blodgett (LB) technique, chemical vapour deposition, plasma arcing and ball milling, lithography;

Unit 3
Electrical, optical, mechanical, chemical and magnetic properties of nanomaterials; Carbon Clusters: Synthesis, properties and biomedical applications of Fullerenes, Carbon nanotubes and Graphenes.

Unit 4
Quantum Dots, wells and wires (metallic and semiconducting) - Preparation, properties and biomedical applications; Dendrimeric structures and their applications;

Unit 5 Biofunctionalisation of nanomaterials - Surface Plasmon resonance – Fluorescence Resonance energy transfer (FRET).

TEXTBOOKS/ REFERENCES:

1. *Nabok A, Organic and Inorganic Nanostructures, Artech House, Inc., 2005.*
2. *Ju H, Zhang X and Wang J, NanoBiosensing, Principles, Development and Application, Springer, 2011.*
3. *Mozafari M R (Ed.), Nanomaterials and Nanosystems for Biomedical Applications, Springer 2007.*
4. *Wang Z L (Ed.), Characterisation of Nanophase Materials, Wiley VCH, 2000.*

15CHY640 INDUSTRIAL METAL FINISHING PROCESSES 3 0 0 3

Unit 1

Background Theory: Review of reversible and irreversible processes - electrodes, indicator and reference - Nernst and Butler-Vohmer equation - phenomenon of polarization - factors influencing - Tafel experiment and Tafel plot - Significance.

Unit 2

Electrodeposition: Industrial plating of copper-nickel (dull and bright) - chromium on mild steel – operating conditions and sequence – pre-treatment processes - plant layout – electroplating of zinc on MS and post plating chromating, yellow and blue passivation processes – decorative plating of silver and gold on non-ferrous metals – brief discussion on nano plating of metals and micro structure of the deposition.

Properties of deposits: Tests for adhesion, hardness, thickness, uniformity and corrosion resistance of the electro deposits.

Electroless deposition: Nickel, copper, gold on metal components – bath composition and operating conditions - immersion plating - plating on plastics – pre-treatment processes – long duration plating – electroforming, operating conditions and sequence.

Unit 3

Anodising: Industrial anodizing of aluminium and its alloys – baths used, operating conditions and sequence – plant layout – effect of temperature and current density on the thickness of anodic film – determination of thickness – industrial applications.

Nano anodizing of titaniuim, aluminium and tantalum – application to sensor field.

Plasma electrolytic oxidation: power supply requirements – baths used – process sequence for aluminium, magnesium and titanium – properties of the coating and industrial applications.

Unit 4

Electropolishing: Mechanism of electropolishing – electropolishing of ferrous and non-ferrous metals – industrial baths used – operating conditions and sequence - industrial applications.

Unit 5

Electrochemical etching: Etching of ferrous and non-ferrous metals – special properties of matt and satin finish – DC and AC processes – operating conditions and sequence.

Special Topics: Electrochemical and chemical metal colouring of ferrous and non-ferrous metals.

Black nickel coating – Hard chromium deposition – Hard anodizing of aluminium – Electrochemical machining of hard steels – Electro-winning process – Barrel plating – Electrodeposition of paint.

TEXTBOOK:

Derek Pletcher and Frank C. Walsh, 'Industrial Electrochemistry', Blackie Academic and Professional, (1993).

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).*
1. *Curtis, 'Electroforming', London, (2004).*
2. *Rumyantsev E and Davydov A, 'Electrochemical machining of metals', Mir, Moscow, (1989).*
3. *Peter G Sheasby 'Basics of aluminium anodising', Banbury, Oxon (2001)*
4. *Robert Brugger 'Nickel Plating' Robert Draper Ltd, Teddington, (1970)*
5. *J.K.Dennis, T.E.Such, 'Nickel and Chromium Plating, Third Edition' Woodhead Publishing Series in Metals and Surface Engineering, 3rd Edition, (1993)*

15CHY681 ADVANCED PHYSICAL CHEMISTRY LAB. 0 0 5 2

1. To construct the phase diagram for three component system.
2. Determination of equivalent conductance at infinite dilution of weak electrolytes.
3. Determination of order of reaction for ion exchange reaction.
4. Extraction efficiency of solute from a solution by immiscible solvent method.
5. Determination of calorific value using Bomb calorimeter.
6. Kinematic viscosity of lubricants using Bomb calorimeter.
7. Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometerically.
8. Determination of flash point, fire point of a lubricant.
9. Determination of cloud point and pour point of a lubricant.

TEXTBOOKS:

1. *Alexander Findly, 'Practical physical chemistry', 9th edition, Wiley, 1972.*
2. *R.C.Das and B.Behera, 'Experimental Physical Chemistry', Tata McGraw-Hill, 1983.*

REFERENCE BOOKS:

1. *J.B.Yadav, 'Advanced Practical Physical Chemistry', Krishna Prakashan Media, 29th edition, 2010.*
2. *Francis William Gray, 'A Manual of Practical Physical Chemistry' Macmillan and Co., Limited, 1914.*

15CHY682 INSTRUMENTAL AND ANALYTICAL METHODS LAB. 0 0 5 2

1. Determination of strengths of halides in a mixture potentiometrically.
2. To find the redox potential of the given sample using cyclic voltametry.
3. Determination of half wave potential of Cd & Zn by polarography.
4. Determination of pKa of an indicator in aqueous and micellar medium using UV-Vis spectroscopy.
5. Determination of stoichiometry and stability constant of inorganic (ferric-salicylic acid) and organic (amine iodine) complexes using UV–Vis spectroscopy.
6. Determination of copper and cadmium in a mixture by electrogravimetry.
7. Determination of rate constant for enzyme kinetics-inversion of sucrose.
8. Determination of molecular weight of a polymer by Viscometry.
9. Determination of a molecular weight of a solute using Beckmann thermometer.
10. Refractrometric determination of composition of solutions.

TEXTBOOKS:

1. *Alexander Findly, 'Practical physical chemistry', 9th edition, Wiley, 1972.*
2. *R.C. Das and B.Behera, 'Experimental Physical Chemistry', Tata McGraw-Hill, 1983.*

REFERENCE BOOKS:

1. *J.B.Yadav, 'Advanced Practical Physical Chemisty', Krishna Prakashan Media, 29th edition, 2010.*
2. *Francis William Gray, 'A Manual of Practical Physical Chemistry' Macmillan and Co., Limited, 1914.*

15CHY696 DISSERTATION 10 cr

The students shall carry out a major project starting from ninth semester and submit thesis/ dissertation at the end of the tenth semester. This carries 10 credits. Necessarily the project work should involve a research component and reflect the original thinking of the student. Main focus will be on identifying chemistry oriented in-house problems and offering solutions to these problems. Similar problems will be chosen from in and around chemical processing industries and work will be carried out internally or in the respective industry. The project work will be done individually under the supervision of a chemistry faculty. Starting from ninth semester monthly reviews shall be conducted by a panel of chemistry faculty. At the end of the tenth semester the student shall submit a detailed report of the work done and also give a power point presentation before a panel of chemistry faculty and external experts in the respective field as a viva-voce examination. The 10 credits shall be awarded based on the dissertation, presentation and viva-voce.

15CSA100 PROBLEM SOLVING AND COMPUTER PROGRAMMING 3 0 0 3

Unit 1

Introduction to problem solving: algorithm development and flowchart. Introduction to Computer terminologies and computer languages. Number systems: binary, octal and hexadecimal. Bitwise operators and enumeration.

Unit 2

C Fundamentals: structure of C program: directives, functions, statements, printing strings, comments; compilation and execution, Programming errors and debugging. Variables and assignment, reading input; data types, constants, identifiers, keywords, operators - arithmetic, logical, relational, assignment; expressions - precedence and associativity, type cast-implicit and explicit

Unit 3

Selection statements: if, if else, nested if, if else ladder, switch. Case. Iterative structures: entry controlled and exit controlled loop, exiting from a loop: break, continue, goto; nested loops.

Unit 4

Functions: library functions user defined functions: defining and calling functions, function declaration, passing arguments to a function, returning values from function. Storage classes - auto, extern, static, register variables, scope of a variable. Recursion.

Unit 5

Arrays: one dimensional numeric arrays, initialization, accessing and usage, two dimensional numeric arrays, initialization, accessing and usage. Introduction to multidimensional arrays. Strings: literal, variables: initialization, reading, writing and accessing. String handling functions. Array of strings. Passing arrays and strings to functions.

TEXTBOOK:

Jeri Hanly and Elliot Koffman, "Problem solving and program design in C", Fifth Edition, Addison Wesley (Pearson), 2007.

REFERENCE:

Reema Thareja, "Computer Fundamentals and programming in C", Oxford University Press, 2012.

15CSA116 ADVANCED COMPUTER PROGRAMMING 3 0 0 3

Unit 1

Structures: structures variables - declaration, bit fields, initialization and operation on structures, typedef, nested arrays and structures: arrays in structures, nested structures, arrays of structures.

Unit 2

Pointers – Declarations, Passing arguments by call by reference, Functions returning pointer, Pointer Arithmetic. Pointer to pointer, Pointers and Arrays – pointer to array, array of pointers, Dynamic memory allocation – malloc(), calloc(), deallocation: free(), dangling pointers.

Unit 3

Pointers and structures, structures and functions: passing structure as argument and returning structure from functions, self-referential structure, unions.

Unit 4

Files - file pointers, standard streams and redirection, text files, binary files, file operations: open, mode, close; Input and output - character I/O, line I/O, formatted I/O. Random file access, Command line arguments.

Unit 5

Preprocessor – Macros. User defined libraries and headers, introduction to the graphics library.

TEXTBOOK:

Jeri Hanly and Elliot Koffman, "Problem solving and program design in C", Fifth Edition, Addison Wesley (Pearson), 2007.

REFERENCE:

Reema Thareja, "Computer Fundamentals and programming in C", Oxford University Press, 2012.

15CSA180 PROBLEM SOLVING AND COMPUTER PROGRAMMING LAB. 0 0 2 1

Basic Linux commands, programs using input/output statements, operators, control structures and loops. Programs using functions and recursions. Programs using numeric one-dimensional array, two-dimensional array. Programs using strings, string handling functions and string arrays. Programs using passing arrays and strings to functions.

15CSA187 ADVANCED COMPUTER PROGRAMMING LAB. 0 0 2 1

Programs to demonstrate functions call by reference and returning values by reference. Programs using pointer arithmetic operations and handling pointers. Programs to demonstrate dynamic memory allocation and de-allocation. Programs to show structure and union operations. Programs using files, command line arguments and macros. Programs using user defined libraries and graphics library.

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 Vedanta and Bhagavad Gita.

Unit 3

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

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)

15ENG101 COMMUNICATIVE ENGLISH 2 0 2 3

Objectives: *To help the student to obtain ability to communicate in English; to impart an aesthetic sense and enhance creativity.*

Unit 1

Parts of Speech, Tenses, Prepositions, Determiners - Agreement (Subject – Verb, Pronoun - Antecedent), Phrasal Verbs, Modifiers, Linkers/ Discourse Markers, Question Tags.

Unit 2

Paragraph writing – Cohesion - Development: definition, comparison, classification, contrast, cause and effect - Essay writing: Descriptive and Narrative.

Unit 3

Letter Writing - Personal (congratulation, invitation, felicitation, gratitude, condolence etc.) Official (Principal/ Head of the department/ College authorities, Bank Manager, Editors of newspapers and magazines).

Unit 4

Reading Comprehension – Skimming and scanning - inference and deduction – Reading different kinds of material – Graphical Representation – Speaking: Narration of incidents / stories/ anecdotes - Current News Awareness.

Unit 5

Prose: R. K. Narayan's Fifteen Years - A.P.J. Abdul Kalam's Wings of Fire (Parts I - 3)

Short Stories: Katherine Mansfield's A Cup of Tea – Kishori Charan Das's Death of an Indian.

Poems: Maya Angelou's I Know Why the Caged Bird Sings - Sri Aurobindo's The Tiger and the Deer.

REFERENCES:

1. *A P J Abdul Kalam, Wings of Fire, Universities Press (India) Ltd., Hyderabad, 2004.*
2. *Khushwant Singh & Neelam Kumar, Our Favourite Indian Short Stories, Seventh Imp., Jaico Publishers, 2007.*
3. *Jatin Mohanty (Ed.), Ten Short Stories, Universities Press (India) Ltd., Hyderabad, 1983.*
4. *Martinet, Thomson, A Practical English Grammar, IV Ed. OUP, 1986.*
5. *Murphy, Raymond, Murphy's English Grammar, CUP, 2004*
6. *R. K. Narayan, A Writer's Nightmare: Selected Essays 1958-1988, Penguin Books India Pvt. Ltd., New Delhi, 1988.*
7. *Seely, John, Writing and Speaking, OUP, 1998*
8. *Sri Aurobindo, Collected Poems, Sri Aurobindo Ashram, Pondicherry.*
9. *Syamala, V. Speak English in Four Easy Steps, Improve English Foundation Trivandrum: 2006*

15ENG121 PROFESSIONAL COMMUNICATION 1 0 2 2

Objectives: *To convey and document information in a formal environment; to acquire the skill of self projection in professional circles; to inculcate critical thinking and to improve aesthetic sense.*

Unit 1

Vocabulary Building: Prefixes and Suffixes; One word substitutes, Modal auxiliaries, Error Analysis: Position of Adverbs, Redundancy, Dangling modifiers – Reported Speech.

Unit 2

Instruction, Suggestion & Recommendation - Graphical Interpretation: Extracting data from charts and graphs - Essay writing: Analytical and Argumentative.

Unit 3

Circulars, Memos – Business Letters – e-mails.

Unit 4

Reports: Trip report, incident report, event report - Sounds of English – Stress, Intonation - Situational Dialogue - Group discussion.

Unit 5

Listening and Reading Practice - Book Review.

REFERENCES:

1. *Felixa Eskey Tech Talk, University of Michigan. 2005*
2. *Michael Swan. Practical English Usage, Oxford University Press. 2005*
3. *Anderson, Paul. Technical Communication: A Reader Centered Approach, V Edition, Hercourt, 2003.*
4. *Raymond V. Lesikar and Marie E. Flatley. Basic Business Communication, Tata McGraw Hill Pub. Co. New Delhi 2005. Tenth Edition.*

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.*

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, Roopanthar ki Drishti se - Bhasha – Paribhasha aur Bhed - Sangya - Paribhasha Aur Bhed - Sangya ke Roopanthar - 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 Ist 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, Juloos.

TEXTBOOKS:

1. *Prem Chand Ki Srvashrestha 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 drisya & shravya using the best specimens provided as anthology.*

Unit 1

Kavya Tarang; Dhumil ke Anthim Kavitha [Poet - Dhumil], 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.

TEXTBOOKS:
Kavay Tarang: Dr. Niranjan, Jawahar Pusthakalay, Mathura.
Gadya Manjusha: Editor: Govind, Jawahar Pusthakalay, Mathura

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 Iyangar – Adalitha Kannada – Chetana Publication, Mysuru*
2. *A.N.Murthy Rao – Aleyuva Mana – Kuvempu Kannada Adyayana Samste*
3. *Nemi Chandra – Badhuku Badalisabahudu – Navakarnataka Publication*
4. *Sanna Kathegalu - Prasaranga, 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 Iyangar – 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.Balakrishnan, Thunjan padhanangal, D. C. Books, 2007.*
2. *G.Balakrishnan Nair, Jnanappanayum 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 Sahityacharitram, 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), Kalidasan (Translated 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. 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. *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, Sariyum 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.*

15MAT105 INTRODUCTION TO CALCULUS AND MATRIX THEORY 3 1 0 4

Unit 1

Calculus on a Single variable (Based on Textbook 1)
Graphs Functions and their graphs. Shifting and scaling of graphs. Limit and Continuity - Limit of Functions, One sided limits and limits at infinity.

Unit 2

Continuous Functions, Discontinuities. Applications of Derivative - Extreme values of functions, Concavity and Curve Sketching.

Unit 3

Integration - Definite Integrals, Properties of definite integrals. Integration techniques. Fundamental theorem of Calculus.
Numerical Methods - Trapezoidal and Simpson's rules. (Sections: 1.3, 1.5, 2.3, 2.4, 2.5, 2.6, 4.1, 4.4, 5.3, 5.4, 8.7)

Unit 4

Matrix Eigen Value problems (Based on Text book 2)
Linear Independence and rank of a matrix, Eigen values and Eigen vectors- Definitions and properties.

Unit 5

Some applications of eigenvalue problems, Symmetric, Skew Symmetric and Orthogonal matrices, Eigenbases, Diagonalization, Quadratic forms. (Sections: 8.1-8.4)

Numerical Methods - Power Method for Eigen Values and Eigen Vectors. (Sections: 20.8)

TEXTBOOKS:

1. Calculus, G. B. Thomas, Pearson, 2009, Eleventh Edition.
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India, Tenth Edition, 2015.

REFERENCE BOOKS;

1. George Turrell, Mathematics for Chemistry and Physics, Academic Press, 2002.
2. Herbert S. Wilf, Applied Mathematics for Physical Chemistry, 2nd Edition, Prentice Hall, 1998.

15MAT114 ORDINARY DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS 3 1 0 4

Unit 1

Ordinary Differential Equations: First Order Differential Equations - Basic concepts, Exact ODEs and Integrating factor, Orthogonal trajectories. (Sections 1.1, 1.4, 1.6)

Unit 2

Second Order Differential Equations - Review of linear homogeneous ODE of second order with constant coefficients. Euler-Cauchy Equations. Solution of second order linear non-homogeneous ODE by method of Undetermined Coefficients and by method of Variation of Parameters. (Sections 2.1, 2.2, 2.5, 2.7, 2.10)

Unit 3

System of ODEs - Homogeneous and Non-homogeneous systems with Constant Coefficients. (Sections 4.1, 4.2, 4.6)
Numerical Methods - Euler's methods, Runge-Kutta method. (Sec: 21.1)

Unit 4

Vector Calculus: Vector and Scalar Functions, fields, derivatives, Curves, Tangent and normal vectors, Arc Length, gradient, divergence and curl (Sections: 9.4, 9.5, 9.7, 9.8, 9.9).

Unit 5

Line Integral, Line Integrals Independent of Path, Double integrals, Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem. (Sections: 10.1 - 10.7 and 10.9).

TEXTBOOK:

Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India, Tenth Edition, 2015.

REFERENCE BOOKS:

1. George Turrell, Mathematics for Chemistry and Physics, Academic Press, 2002.
2. Robert G. Mortimer, Mathematics for Physical Chemistry, 3rd Edition, Elsevier, 2005.

15MAT227 INTRODUCTION TO PROBABILITY AND STATISTICS 3 1 0 4

Unit 1

Probability Concepts: Review of probability concepts - conditional probability - Bayes theorem.

Random Variable and Distributions: Introduction to random variable – discrete and continuous random variables and its distribution functions - mathematical expectations – moment generating function and characteristic function.

Unit 2

Binomial, Poisson, Geometric, Uniform, Exponential. Normal distribution functions (moment generating function, mean, variance and simple problems) – Chebyshev's theorem.

Correlation and Regression: Scatter diagram, simple correlation and simple regression for data.

Unit 3

Theory of Estimation: Population and sample – sampling distributions – determination of sample size – t, F and Chi-square distributions – theory of estimation – types of estimation - point estimation and properties of point estimator - interval estimation methods based on normal, t, F and chi-square distributions.

Unit 4

Testing of Hypothesis: Central limit theorem, large sample tests for mean, variance and proportions - small sample tests for mean and variances – tests based on Chi-square distribution (tests for independence of attributes and goodness-of-fit).

Unit 5

Analysis of Variance (ANOVA): Introduction - analysis of variance – one-way analysis of variance – two way analysis of variance - Latin square design – Two factor factorial design.

TEXTBOOKS:

1. *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.*
2. *J. Ravichandran, "Probability and Statistics for Engineers", Revised Edition 2012, Wiley India.*

REFERENCE BOOKS:

1. *Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education Asia, 2007.*
1. *Sheldon M Ross, Introduction to Probability and Statistical Inference, 3rd Edition, Academic Press.*

15MAT236 INTEGRAL TRANSFORMS 3 1 0 4

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.

Unit 2

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

Unit 3

Fourier Series and Fourier Transform: Fourier series, Half range Expansions, Parseval's Identity, Fourier Integrals, Fourier integral theorem. Sine and Cosine Integrals.

Unit 4

Fourier Transforms, Sine and Cosine Transforms, Properties, Convolution theorem. (Text book-1, Sections: 11.1-11.3, 11.7-11.9)

Unit 5

Applications of 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, 12.2, 12.3, 12.4)

TEXTBOOK:

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

REFERENCE BOOKS:

1. *George Turrell, Mathematics for Chemistry and Physics, Academic Press, 2002.*
2. *Donald Allan McQuarrie, Mathematics for Physical Chemistry, University Science books, 2008.*

15OEL231 – 2xx OPEN ELECTIVES 3 0 0 3

Open electives syllabi – see at the end of the booklet.

15PHY103 MECHANICS 3 1 0 4

Unit 1 Motion

Motion in 1D; vectors, motion in 2D & 3D, projectile and uniform circular motion; relative motion and relative velocity.

Unit 2 Forces and dynamics

Force, mass, Newton's laws, inertial mass, examples of forces, free body diagram analysis for simple applications; friction and contact forces, drag force and terminal speed, uniform circular motion.

Unit 3 Work, Energy, Collisions

Work, kinetic energy, work-kinetic energy theorem, work done by gravitational and spring forces, power; Work and potential energy, conservative forces, conservation of mechanical energy, potential energy curve; Center of mass, Newton's law for system of particles, linear momentum and its conservation, Impulse forces, collisions - elastic and inelastic collisions in 1D and 2D; systems with variable mass - rockets.

Unit 4 Rotational Motion

Rotational variables, linear and angular variables, rotational kinetic energy, rotational inertia; torque, Newton's law for rotation, work, rolling – combined translation and rotation, angular momentum, Newton's law in angular form, system of particles, conservation of angular momentum.

Unit 5 Oscillatory motion

Small oscillations in physical systems; determination of frequency; simple harmonic motion; damped oscillations, resonance.

TEXTBOOK:

Halliday, Resnick, and Walker, Fundamentals of Physics, 8th Extended Ed., Wiley Indian Reprint, 2008, Chap. 1-12, 15

REFERENCES:

1. *Young and Freedman, University Physics, 11th Ed, Dorling Kindersley India, 2006*
2. *Halliday, Resnick, and Krane, Physics, Vol. 1, 5th Ed., Wiley Indian Reprint, 2007*
3. *Feynamn, Leighton and Sands, "The Feynman Lectures on Physics", Narosa, 1E, 2008*

15PHY113 ELECTRICITY AND MAGNETISM 3 1 0 4

Unit 1 Electric forces and fields

Electric forces, charges, conservation of charge, superposition of electric forces; electric fields, calculation of electric fields of static discrete and continuous charge distributions; Gauss' law and determination of electric fields of simple symmetric charge distributions.

Unit 2 Electric potential and Capacitors

Electrical potential energy and electric potential of discrete and continuous distributions of charges; calculating electric field from potential; potential energy of system of point charges; capacitors and dielectrics.

Unit 3 Magnetostatics

Force due to magnetic fields, Hall effect, circular and helical orbits, magnetic force on a current carrying wire, torque on a current loop, magnetic dipole moment; calculation of magnetic field from current sources using Biot-Savart's law and Ampere's law; solenoids and toroids.

Unit 4 Changing magnetic fields

Faraday's law, Electromagnetic Induction, Self & mutual inductance; Magnetism in matter and Maxwell's equations.

Unit 5 DC and AC Circuits

Electric current, resistance, resistivity, microscopic view; DC circuits involving resistance and capacitance; AC Circuits, RLC circuits, transformers.

TEXTBOOK:

Halliday, Resnick, and Walker, Fundamentals of Physics, 8th Ed., Wiley Indian Reprint, 2008, Chapters 22-33.

REFERENCES:

1. *Halliday, Resnick, and Krane, Physics, Vol. 1, 5th Ed., Wiley Indian Reprint, 2007*
2. *Young and Freedman, University Physics, 11th Ed, Dorling Kindersley India, 2006*
3. *Edward Purcell, Electricity and Magnetism, 2e, Tata-McGraw Hill, 2011.*
4. *Feynamn, Leighton and Sands, "The Feynman Lectures on Physics", Narosa, 1E, 2008*

15PHY184 PHYSICS LAB. I 0 0 2 1

List of experiments:

1. Surface Tension – Capillary Rise Method.
2. Coefficient of Viscosity - Stoke's Method.
3. The Torsion Pendulum.
   a. Moment of Inertia of the Disc.
   b. The Rigidity Modules of the Material of Wire.
4. Young's Modulus – Uniform Bending.
5. Spectrometer – Dispersive Power.
6. Liquid Lens – Refractive index of liquid.
7. Laser - Wave length of Laser beam.
8. Laser - Slit Width of the given slit.
9. Magnetometer – Measurement of magnetic flux.

15PHY186 PHYSICS LAB. II 0 0 2 1

List of experiments:

1. Lee's disc – Thermal Conductivity of a bad conductor.
2. Solar cell characteristics.
3. Potentio meter – Comparison of emfs.
4. Conversion of galvanometer to Voltmeter.
5. Field along the axis of a coil.
6. Measurement of Laser beam divergence.
7. Spectrometer - i – d – curve.
8. Newton's rings.
9. Meter bridge - Resistance measurement.
10. Ref. index of a Transport bar.
11. Elective field distribution.

15PHY203 BASIC ELECTRONICS 3 1 0 4

Unit 1

Voltage and current - resistors, voltage dividers, voltage and current sources, Thevenin's theorem, sinusoidal signals, signal amplitudes and decibels, other signals, logic levels, signal sources.

Unit 2

Conduction in metals, semiconductors and insulators, intrinsic semiconductors, n and p materials, conduction by drift and diffusion, The p-n junction, Fermi level ofpn junction, diode equation, Hall effect, diode characteristics, capacitance of a p-n junction, rectification, rectifier configurations for power supplies, circuit applications of a diode-as a switch, clipping, clamping, different types of diodes - Zener diodes, LEDs, diode lasers, photodiodes, etc.

Unit 3

Transistors - npn and pnp, transistor characteristics - CB, CE and CC configurations, relation between a, b and g, transistor switch, transistor biasing. Feedback circuits. Transistor action, emitter follower, Transistor applications as amplifier. RC coupled amplifier.

Unit 4

Transistor as an oscillator, FET, JFET, MOSFET, etc.
Operational amplifiers; differential amplifier, inverting and non-inverting amplifiers ers. Op-amp applications-integrator, differentiator, adder etc. ICs – examples.

Unit 5

Digital electronics: Digital versus analog, logic gates, truth table, discrete circuits for gates, logic identities, minimization and Karnaugh maps.

TEXTBOOK:

Bernar Grob and Mitchel.E.Schultz, Basic Electronics (9th Edition), Tata Mc.Graw Hill, New Delhi (2003)

REFERENCES:

1. *John D.Ryder, Electronic Fundamentals and Applications, Prentice Hall of India Pvt.Ltd. New Delhi (1983).*
2. *Albert Paul Malvino, Digital Computer Electronics Tata McGraw Hill Pub. Co. Ltd New Delhi (1983*
3. *Horowitz and Hill, The art of Electronics (Cambridge University press)*

15PHY214 WAVES AND OPTICS 3 1 0 4

Unit 1

Review of Geometrical Optics: Fermat's principle, laws of reflection and refraction from Fermat's principle. Refraction at a spherical surface, Linear and lateral magnifications, Refraction through a thick lens. Focal lengths of thick and thin lenses. Combination of two lenses. Cardinal points.

Unit 2

Wavemotion: Simple Harmonic Oscillation (SHO), differential equation for SHO and its general solution, super position of two or more SHOs, Damped and forced oscillators, resonance. Wave equation, travelling and standing waves in one dimension, energy density and energy transmission in waves, Group velocity and phase velocity.

Unit 3

Interference: Wave nature of light, Spatial and temporal coherence, coherent sources, interference of light by division of wave front: Fresnel's biprism, interference of light by division of amplitude: interference in thin films, fringes of equal inclination, air-wedge, Newton's rings and Michelson's interferometer. Multiple beam Interference - Fabry-Perot interferometer, multilayer thinfilms: AR and HR coatings.

Unit 4

Diffraction: Fresnel and fraunhoffer diffraction, diffraction grating, Rayleigh criterion and resolving power.

Polarisation: linear, circular and Elliptic polarization, double refraction and optical rotation. Propagation of light through matter, dispersion and absorption, Nonlinear optics, second harmonic generation, integrated optics (qualitative only).

Unit 5

Fiber optics: Introduction to optical fiber, the numerical aperture, coherent bundle, pulse dispersion in step index fiber, graded index fiber, single mode fiber, multimode fiber, fiber optic sensors - examples - fiber optic communication (qualitative), Advantages of fiber optic communication system.

REFERENCES:

1. *E.Hecht & A.R.Ganesan, Optics, Pearson, 2008*
2. *Jenkins and White, Fundamentals of Optics, TMH India, 4E, 2011*
3. *A K Ghatak, Introduction to Modern Optics, Tata-McGraw Hill, 4E, 2008*
4. *G R Fowles, Introduction to Modern Optics, Dover, 2E, 1989*

15PHY314 BASIC SPECTROSCOPIC TECHNIQUES 3 1 0 4

Unit 1 - Electromagnetic spectrum

Introduction – Definition of spectrum - Electromagnetic radiation - regions of spectrum, quantization of different forms of energies in molecules (translational, rotational, vibrational and electronic) - Born Oppenheimer approximation.

Unit 2 - Electronic Spectroscopy

Principle - Absorption laws. Calculations involving Beer Lambert's law - instrumentation - photo colorimeter and spectrophotometer - block diagrams with description of components - theory - types of electronic transitions - chromophore and auxochromes - Absorption bands and intensity - factors governing absorption maximum and intensity. Calculation of ?max using Woodward fischer rule for simple molecules.

Unit 3 - Vibrational Spectroscopy

Principle – vibrational frequency – fundamental vibrations - modes of vibration of diatomic, triatomic linear (CO2) and nonlinear triatomic molecules (H2O) - stretching and bending vibrations - selection rules. Hooks law. Instrumentation - sampling techniques. Applications of IR Spectroscopy – interpretation of the spectra of alcohols, aldehydes, ketones and esters – aliphatic and aromatic.

Unit 4 - NMR Spectroscopy

Principle of nuclear magnetic resonance – basic instrumentation - number of signals

- chemical shift - shielding and deshielding. Spin-spin coupling and coupling constants. TMS as NMR standard. Introduction to H1 and C13 NMR spectrum. Interpretation of Proton NMR spectra of simple organic compounds such as Acetone, Anisole, Benzaldehyde, Ethyl acetate, Ethylamine, Ethyl Bromide, Toluene and Isopropyl phenyl ketone.

Unit 5 - Mass spectrometry

Basic principles - instrumentation - molecular ion peak, base peak, metastable peak, isotopic peak their uses. Fragmentation pattern – Nitrogen rule - determination of molecular formulae – Types of mass analysis. Interpretation of mass spectra of simple organic compounds such as Acetone, Anisole, Benzaldehyde, Ethyl acetate, Ethylamine, Ethyl Bromide, Toluene and Isopropyl phenyl ketone. Mc-Lefferty Rearrangement.

TEXTBOOKS:

1. *P.S.Kalsi, 'Spectroscopy of Organic Compounds', 6th edition, New age international publishers, 2005.*
2. *W. Kemp, 'Organic Spectroscopy, Macmillan, 1987*

REFERENCE BOOKS:

1. *R. M. Silverstein, F. Webster and D. Kiemle, 'Spectroscopic Identification of Organic Compounds', 7th edition, J. Wiley and Sons, 2005*
2. *C. N. Banwell, 'Fundamentals of Molecular Spectroscopy', 4th edition, Mcgraw-Hill College, 1994.*
3. *Dyer John.R, 'Applications of Absorption Spectroscopy of Organic Compounds', PHI learning publishers, 1965*

15SAN101 SANSKRIT I 2 0 0 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 READINGS:

1. *Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore-560 085*
2. *Sanskrit Reader I, II and III, R. S. Vadhyar 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.*

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 (Panchatantra) Subhashitas, 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 READINGS:

1. *Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore-560 085*
2. *Sanskrit Reader I, II and III, R. S. Vadhyar 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.*

15SSK201 LIFE 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 and Articles: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving; Number System; LCM &HCF; Divisibility Test; Surds and Indices; Logarithms; Ratio, Proportions and Variations; Partnership; 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; Linear Arrangements; Circular and Complex Arrangement; Conditionalities and Grouping; Sequencing and Scheduling; Selections; Networks; Codes; Cubes; Venn Diagram in Logical Reasoning.

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.*

REFERENCES:

1. *Quantitative Aptitude, by R S Aggarwal, S Chand Publ.*
2. *Verbal and Non-verbal Reasoning, R S Aggarwal, S Chand Publ.*
3. *Data Interpretation, R S Aggarwal, S Chand Publ.*
4. *Nova GRE, KAPAL GRE, Barrons GRE books;*
5. *Quantitative Aptitude, The Institute of Chartered Accountants of India.*
6. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
7. *The BBC and British Council online resources*
8. *Owl Purdue University online teaching resources*
9. *www.thegrammarbook.com online teaching resources*
10. *www.englishpage.com online teaching resources and other useful websites.*

15SSK211 LIFE 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 – 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.

Special 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.*

REFERENCES:

1. *Quantitative Aptitude, by R S Aggarwal, S Chand Publ.*
2. *Verbal and Non-verbal Reasoning, R S Aggarwal, S Chand Publ.*
3. *Quantitative Aptitude by Abjith Guha, Tata McGraw hill Publ..*
4. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
5. *The BBC and British Council online resources*
6. *Owl Purdue University online teaching resources*
7. *www.thegrammarbook.com online teaching resources*
8. *www.englishpage.com online teaching resources and other useful websites.*

15SSK301 LIFE 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.

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 Amazon Publication.*

REFERENCES:

1. *Speed Mathematics, Secrets of Lightning Mental Calculations, by Bill Handley, Master Mind books;*
2. *The Trachtenberg Speed System of Basic Mathematics, Rupa & Co., Publishers;*
3. *Vedic Mathematics, by Jagadguru Swami Sri Bharati Krsna Tirthayi Maharaja, Motilal Banarsidass Publ.;*
4. *How to Ace the Brainteaser Interview, by John Kador, Mc Graw Hill Publishers.*
5. *Quick Arithmetics, by Ashish Agarwal, S Chand Publ.;*
6. *Quicker Maths, by M tyra & K Kundan, BSC Publishing Co. Pvt. Ltd., Delhi;*
7. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
8. *The BBC and British Council online resources*
9. *Owl Purdue University online teaching resources*
10. *www.thegrammarbook.com online teaching resources*
11. *www.englishpage.com online teaching resources and other useful websites.*

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) – puṟanāṉūṟu (74, 112, 184, 192 pāṭalkaḷ) – tirukkuṟaḷ (iṟaimāṭci, amaiccu).

Unit 2

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

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

Medieval Literature: bāratiyar kaṇṇaṉ pāṭṭu (eṉ viḷaiyāṭṭu piḷḷai) – bāratitacaṉ kuṭumpaviḷakku (tāyiṉ tālāṭṭu).

Unit 3

Novel: Jeyakāntaṉ "kuru pīṭam"

Essay: Aṇṇā "ē tāḻnta tamiḻakamē"

Unit 4

Tiruñāṉa campantar – tirunāvukkaracar – cuntarar – māṇikka vācakar – āṇṭāḷ – tirumūlar – kulacēkara āḻvār – cīttalaic cāttaṉār toṭarpāṉa ceytikaḷ, mēṟkōḷkaḷ maṟṟum ciṟappup peyarkaḷ.

Unit 5

Tamil Grammar: Col vakaikaḷ - vēṟṟumai urupukaḷ - valliṉam mikumiṭam mikāyiṭam - canti(puṇarcci) - ilakkaṇakkuṟippu.

Practical skills: Listening, speaking, writing and reading.

TEXTBOOKS:

Aṇṇā "ē tāḻnta tamiḻakamē" nakkīraṉ papḷikēṣaṉs.

Caktitācaṉ cupramaṇiyaṉ "nalla kuṟuntokai mūlamum uraiyum" mullai patippakam, 2008.

http:/Www.Tamilvu.Org/libirary/libindex.Htm.

jeyakāntaṉ "kuru pīṭam" mīṉāṭci puttaka nilaiyam, 1971.

Nā. Pārttacārati "puṟanāṉūṟṟuc ciṟukataikaḷ" tamiḻp puttakālayam, 1978, 2001

Poṉ maṇimāṟaṉ "aṭōṉ tamiḻ ilakkaṇam "aṭōṉ papḷiṣiṅ kurūp, vañciyūr, tiruvaṉantapuram, 2007.

puliyūrk kēcikaṉ "kuṟuntokai mūlamum uraiyum" cārāta patippakam, 2010.

Puliyūrk kēcikaṉ "puṟanāṉūṟu" srīceṇpakā patippakam, 2010

15TAM111 TAMIL II 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: Naṭṭupuṟap paṭalkaḷ, kataikkaḷ, paḻamoḻikaḷ - ciṟukataikaḷ tōṟṟamum vaḷarcciyum, cirṟilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.

Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu maṟṟum aimperum – aiñciṟuṅ kāppiyaṅkaḷ toṭarpāṉa ceytikaḷ.

Unit 2

tiṇai ilakkiyamum nītiyilakkiyamum - patiṉeṇkīḻkkaṇakku nūlkaḷ toṭarpāṉa piṟa ceytikaḷ - tirukkuṟaḷ (aṉpu, paṇpu, kalvi, oḻukkam, naṭpu, vāymai, kēḷvi, ceynaṉṟi, periyāraittuṇakkōṭal, viḻippuṇarvu pēṉṟa atikārattil uḷḷa ceytikaḷ.

Aṟanūlkaḷ: Ulakanīti (1-5) – ēlāti (1,3,6) - Cittarkaḷ: Kaṭuveḷi cittar pāṭalkaḷ (āṉantak kaḷippu – 1,4,6,7,8), maṟṟum akappēy cittar pāṭalkaḷ (1-5).

Unit 3

tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūṟṟu ayaṟkūṟṟu.

Unit 4

tamiḻaka aṟiñarkaḷiṉ tamiḻ toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṉ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṉ, na.Piccaimūrtti, akilaṉ, kalki, jī.Yū.Pōp, vīramāmuṉivar, aṇṇā, paritimāṟ kalaiñar, maṟaimalaiyaṭikaḷ.

Unit 5

tamiḻ moḻi āyvil kaṇiṇi payaṉpāṭu - Karuttu parimāṟṟam - viḷampara moḻiyamaippu - pēccu - nāṭakam paṭaippu - ciṟukatai, katai, putiṉam paṭaippu.

TEXTBOOKS:

http:/Www.tamilvu.trg/libirary/libindex.htm.

http:/Www.tunathamizh.tom/2013/07/blog0post_24.html

Mu. Varatarācaṉ "tamiḻ ilakkiya varalāṟu" cāhitya akaṭemi papḷikēṣaṉs, 2012

nā. Vāṉamāmalai "paḻaṅkataikaḷum, paḻamoḻikaḷum" niyū ceñcuri puttaka veḷiyīṭṭakam, 1980, 2008

nā. Vāṉamāmalai, "tamiḻar nāṭṭuppāṭalkaḷ" niyū ceñcuri puttaka veḷiyīṭṭakam 1964, 2006

poṉ maṇimāṟaṉ "aṭōṉ tamiḻ ilakkaṇam "aṭōṉ papḷiṣiṅ kurūp, vañciyūr, tiruvaṉantapuram, 2007.