B.Sc. (Hons) Chemistry

THREE-YEARS FULL-TIME PROGRAMME

(Six-Semester Course)

LINGAYA'S UNIVERSITY

choose to know

CHOICE BASED CREDIT SYSTEM

B.Sc. (Hons) Chemistry First Semester				
SN	**Course Code**	**Course Name**	**L-T-P**	**Cr.**
1	BCH-110	Inorganic Chemistry – I	3-1-0	4
1	BCH-114	Organic Chemistry – I	3-1-0	4
2	BCH-120	Physical Chemistry – I	3-1-0	4
3	BMA-111	Calculus	5-1-0	6
4	BEN-101	Communication Skill (English)	2-0-0	2
5	BCH-160	Inorganic Chemistry – I Lab	0-0-4	2
6	BCH-170	Physical Chemistry – I Lab	0-0-4	2
5	BCH-164	Organic Chemistry – I Lab	0-0-4	2
		Total	32	26

B.Sc. (Hons) Chemistry Second Semester				
SN	**Course Code**	**Course Name**	**L-T-P**	**Cr.**
2	BCH-115	Physical Chemistry – II	3-1-0	4
1	BCH-121	Inorganic Chemistry –II	3-1-0	4
2	BCH-122	Organic Chemistry –II	3-1-0	4
3	BPH-122	Electricity and Magnetism	3-1-0	4
4	CEA-101A	Environmental Science and Ecology	2-0-0	2
6	BCH-165	Physical Chemistry – II Lab	0-0-4	2
7	BPH-172	Electricity and Magnetism Lab	0-0-4	2
6	BCH-171	Inorganic Chemistry –II Lab	0-0-4	2
7	BCH-172	Organic Chemistry –II Lab	0-0-4	2
8	HD-101	Hobby Club	0-0-2	2
		Total	36	28

B.Sc. (Hons) Chemistry Third Semester				
SN	**Course Code**	**Course Name**	**L-T-P**	**Cr.**
3	BCH-219	Physical Chemistry-III	3-1-0	4
1	BCH-221	Inorganic Chemistry –III	3-1-0	4
2	BCH-222	Organic Chemistry –III	3-1-0	4
4	BMA-230	Differential Equation-I	5-1-0	4
5	BCS-201	Computer for Chemists/Skill Based Subject –I	3-0-0	3
6	BA-272-A	Entrepreneurship	3-0-0	3
7	BCH-271	Inorganic Chemistry –III Lab	0-0-4	2
8	BCH-272	Organic Chemistry –III Lab	0-0-4	2
8	BCH-269	Physical Chemistry-III Lab	0-0-4	2
Total			**36**	**28**

B.Sc (Hons) Chemistry Fourth Semester				
SN	**Course Code**	**Course Name**	**L-T-P**	**Cr.**
1	BCH-225	Organic Chemistry –IV	3-1-0	4
3	BCH-223	Physical Chemistry-IV	3-1-0	4
4	BCH-226	Analytical Chemistry / Discipline Specific Elective-I	3-1-0	4
5	BA-264A	Managerial Skill/ Skill Enhancement Subject –II	3-0-0	3
4	BPH-224/ BMA-241	Element of Modern Physics/ Elementary Mathematics-II	3-1-0/5-1-0	4
9	BPH-274	General Elective Lab – IV / Element of Modern Physics Lab	0-0-4	2
6	BCH-275	Organic Chemistry –IV Lab	0-0-4	2
8	BCH-273	Physical Chemistry-IV Lab	0-0-4	2
4	BCH-276	Analytical Chemistry lab/ Discipline Specific Elective-I- lab	0-0-4	4
Total			**35/37**	**29**

B.Sc. (Hons) Chemistry Fifth Semester				
SN	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
1	BCH-324	Inorganic Chemistry –IV	3-1-0	4
2	BCH-325	Organic Chemistry-V	3-1-0	4
3	BCH-321	Physical Chemistry-V	3-1-0	4
4	BCH-322	Spectroscopy & and Some Important Compounds/Discipline Specific Elective-II	3-1-0	4
5	BCH-371	Physical Chemistry-V Lab	0-0-4	2
6	PD-392	PDP/Interpersonal Skills	2-0-0	2
7	BCH-374	Inorganic Chemistry –IV Lab	0-0-4	2
8	BCH-375	Organic Chemistry -V Lab	0-0-4	2
9	BCH-378	Workshop on Chemistry	0-0-4	4
Total			**34**	**28**

B.Sc. (Hons) Chemistry Sixth Semester				
SN	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
7	BCH-326	Discipline Specific Elective /Polymer Chemistry	3-1-0	4
4	BCH-327	Discipline Specific Elective-IV/ Fuel Chemistry	3-1-0	4
8	BCH-377	Project/ Dissertation/ Industrial	0-0-6	10
Total			**14**	**18**

Sem 1	Sem 2	Sem 3	Sem 4	Sem 5	Sem 6	Total
26	**28**	**28**	**29**	**28**	**16**	**155**

Semester I

SUBJECT NAME: INORGANIC CHEMISTRY-I
SUBJECT CODE: BCH-110

OBJECTIVES:

1. Here in this course we are trying to enlightening the student about the role of periodic table in the field of inorganic chemistry.
2. Students can categories the elements in the groups on the basis similar chemical and physical behavior.

UNIT-1: S & P BLOCK ELEMENT

Comparative study of the elements includes diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function.
Emphasis on comparative study of periodic properties of p-block elements (including diagonal relationship and excluding methods of preparation).

UNIT-2: CHEMISTRY OF NOBLE GASES

Chemical properties of noble gases with emphasis on their low chemical reactivity, chemistry of xenon, structure and bonding of fluorides, oxides and oxyflourides of xenon.

UNIT-3: BORON FAMILY

Oxide of boron (B_2O_3), Oxyacid of boron (H_3BO_3)-preparation, properties and uses.
Preparation, properties and structure of diborane and borazine. Trihalides of boron-preparation, properties and relative strengths of trihalides of boron as Lewis acid.

UNIT-4: CARBON FAMILY

Catenation, carbides, fullerenes, fluorocarbons, silicates (structural aspects), silicones- general methods of preparations, properties and uses.

UNIT-5: NITROGEN & OXYGEN FAMILY

Oxides: structures of oxides of N, P. Oxyacids: structure and relative acid strengths of oxyacids of nitrogen and phosphorus. Structure of white, yellow and red phosphorus.Oxyacids of sulphur-structures and acidic strength of H_2O_2- structure, properties and uses.

LEARNING OUTCOMES:

1. After study of these five units student must aware with the S, P, block elements and role of Periodic table and their groups in the field of inorganic chemistry.
2. Student must also know the reasons and relationship between the elements situated into similar groups and similar periods.
3. Students also learn characteristic feature of different families of the elements like,

oxygen, nitrogen and boran families etc.

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

SUBJECT NAME: INORGANIC CHEMISTRY LAB -I
SUBJECT CODE: BCH-160

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

SUBJECT NAME: PHYSICAL CHEMISTRY- I
SUBJECT CODE: BCH-120

OBJECTIVES:

1. Here with the help of this syllabus we are trying to educate the student Kinetic of all in chemical Reaction.
2. we are also trying to teach rate of the reaction, what are the factor involves in the every chemical reactions and how to control the chemistry between two states of compounds.
3. Student must also be aware with the transform of material from one state to another.
4. Why any chemical compound behaves totally different on changing their states only

UNIT-1: CHEMICAL KINETICS

Rate of reaction, Rate equation, Factors influencing the rate of reaction- concentration, temperature, pressure, catalyst. Order of reaction, integrated rate expression for zero order, first order, second order reaction. Half life period of a reaction, methods for determination of order of reaction.

Effect of temperature on the rate of reaction, Arrhenius equation, Theories of reaction rate- simple collision theory for unimolecular and bimolecular collision.

UNIT-2: PHASE EQUILIBRIUM

Statement and meaning of the terms: phase component and degree of freedom thermodynamic derivation of Gibbs phase rule, phase rule, phase equilibria of one component system- example water and sulphur systems. Phase equilibrium of two components system solid liquid equilibria: simple eutectic example Pb -Ag system, desilverization of lead, congruent system (Zn-Mg system), incongruent system (Na-K system).

UNIT-3 ELECTROCHEMISTRY-I

Electrolytic conduction, factors affecting electrolytic conduction, specific conductance, molar conductance, equivalent conductance and relation among them, Arrhenius theory of ionization, Ostwald's dilution law, Debye-Huckel equation, Transport number, definition and determination of Hittorf's methods.

UNIT-4 SOLID STATE

Classification of solids, laws of crystallography- (i) Law of constancy of interfacial angles (ii) Laws of rationality of indices (iii) Law of symmetry

Definition of unit cell and space lattice, Bravais lattices, crystal system. X-ray diffraction by crystals, derivation of Bragg equation.

UNIT-5 LIQUID STATE

Structure of liquids, properties of liquids- surface tension, viscosity, vapor pressure, Refractive Index and Types of Crystals.

LEARNING OUTCOMES:

1. Outcome of this syllabus can't be explained in single word.
2. Student must learn after go through with these units, How any chemical compound transformation into one state to another with drastic change in their features and

behavior without changing their chemical formula.

3. Student also got aware Classification of solids, laws of crystallography, Classification of solids, laws of crystallography, deviation of real gases from ideal behavior, derivation of vander Waal's equation of state.

Reference Books:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press

Ball, D. W. Physical Chemistry Thomson Press, India (2007).

Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).

Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

SUBJECT NAME: PHYSICAL CHEMISTRY LAB-I
SUBJECT CODE: BCH-170

1. **Surface tension measurements.**
    a. Determine the surface tension by (i) drop number (ii) drop weight method.
    b. Study the variation of surface tension of detergent solutions with concentration.
2. **Viscosity measurement using Ostwald's viscometer**.
    a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
    b. Study the variation of viscosity of sucrose solution with the concentration of solute.
3. **Indexing of a given powder diffraction pattern of a cubic crystalline system.**
4. **pH metry**
    a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
    b. Preparation of buffer solutions of different pH
        i. Sodium acetate-acetic acid
        ii. Ammonium chloride-ammonium hydroxide
    c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
    d. Determination of dissociation constant of a weak acid.

Reference Books

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed*.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

SUBJECT NAME: ORGANIC CHEMISTRY – I
SUBJECT CODE: BCH-114

OBJECTIVES:

1. In the branch of Organic Chemistry Student must learn the classification of Organic compound, nomenclature, chemical and physical properties of chemical bonding.
2. Basic fact and factors involve in bond formation and dissociation.
3. Here student must also learn types of organic reactions and mechanism of cyclic and non-cyclic compound and their stereochemistry.

UNIT-1 BASICS OF ORGANIC CHEMISTRY-I

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.
Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

UNIT-2 BASICS OF ORGANIC CHEMISTRY-II

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.
Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

UNIT-3 STEREOCHEMISTRY:

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.
Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

UNIT-4 CHEMISTRY OF ALIPHATIC HYDROCARBONS

(i) A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

(ii) Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.
Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.
Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

UNIT-5 CYCLOALKANES AND CONFORMATIONAL ANALYSIS

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

LEARNING OUTCOMES:

1. At the end of this module student must fully aware about organic compounds their classification how to apply nomenclature rule on the different cyclic and non-cyclic hydrocarbons.
2. Factor direct indirect involves in interaction of one molecule to another.
3. Student also got aware with the stable state of organic compound either boat or cyclic form and so on.

Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

SUBJECT NAME: ORGANIC CHEMISTRY LAB- II
SUJBJECT CODE: BCH-164

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
   c. Alcohol-Water

3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)

5. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds, Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)

6. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

b. Separation of a mixture of two sugars by ascending paper chromatography

c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)

- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)

SUBJECT NAME: CALCULUS (GENERAL ELECTIVE)

SUBJECT CODE: BMA-111

OBJECTIVES :

1. Understand the major problems of differential and integral calculus.
2. Appreciate how calculus allows us to solve important practical problems in an optimal way.

UNIT-1: LIMIT & CONTINUITY *:* The real line and its geometrical representation; *e-δ* treatment of limit and continuity; Properties of limit and classification of discontinuities; Properties of continuous functions.

UNIT-2: DIFFERENTIABILITY: Successive differentiation; Leibnitz Theorem; Statement of Rolle's Theorem; Mean Value Theorem; Taylor and Maclaurin's Theorems; Indeterminate forms.

UNIT 3: APPLICATIONS OF DIFFERENTIATION *:* Asymptotes; Concavity, convexity and points of inflection; Curvature; Extrema; elementry curves, tangent and normal in parametric form; Polar Coordinates.

UNIT-4: PARTIAL DIFFERENTIATION: Limits and continuity of functions of two variables; Partial derivatives; Taylor's theorem and Maclaurin's Theorem for function of two variable; Maxima and minima for function of two variable.

UNIT-5: DOUBLE AND TRIPLE INTEGRALS; Change of order in double integrals. Application of Integration : length of a curve; Arc length as a parameter; Evoute & Envelope; Volumes and surface areas of solids of revolution.

LEARNING OUTCOMES:

Upon completion of the course, the student will be able to:

1. Interpret a function from an algebraic, numerical, graphical and verbal perspective and extract information relevant to the phenomenon modeled by the function.
2. Calculate the limit of a function at a point numerically and algebraically using appropriate techniques including L'Hospital's rule.

Reference Books:

1. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
2. Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
3. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar Inc. New York 1975.
4. Shanti Narayan, Elements of Real Analysis, S. Chand & Company, New Delhi.
5Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
6. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
7. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
8. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd.,Singapore, 2002.

SUBJECT : COMMUNICATION SKILL
SUBJECT CODE: BEN-101

OBJECTIVES:

1. Will be able to integrate their ideas with those of others using summary, paraphrase, quotation, analysis, and synthesis of relevant sources.
2. Assist students in the development of intellectual flexibility, creativity, and cultural literacy so that they may engage in life-long learning.
3. Will be able to Document their work using appropriate conventions.

UNIT 1: COMMUNICATION AND ITS ELEMENTS: An introduction to the need of communication competency; Role of vocabulary in effective communication**;** Word formation; A set of selected 50 synonyms, antonyms, homonyms & homophones; suffixes & prefixes

UNIT 2: LISTENING AND READING SKILLS: Listening comprehension & reading comprehension; Listening to recorded speeches, TV News and other audio materials to test listening comprehension with given exercises

UNIT 3: WRITING SKILLS: Ad Creation; Slogan making; Picture composition; Expanding hints, proverbs; Movie review.

UNIT 4: LETTER WRITING: Types of letter writing; Structure & Lay out; Leave application; Letter of enquiry & response with respect to educational & official matters; Informal letter expressing or discussing social or educational issues.

UNIT5: SPOKEN SKILLS: Introduction to oral communication; Importance of Pronunciation; Importance of phonetics; Usage of Phonetics; Types of Conversation; Strategies for effective conversation for social and official interaction; Developing conversation on topics of current importance. Soft Skills Non-verbal Importance of Body Language and its usage to communicate better.

LEARNING OUTCOMES:

1. Students should be able to apply critical and theoretical approaches to the reading and analysis of literary and cultural texts in multiple genres.
2. Students should be able to write analytically in a variety of formats, including essays, research papers, reflective writing, and critical reviews of secondary sources.
3. Students should be proficient in oral communication and writing

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Semester II

SUBJECT NAME: PHYSICAL CHEMISTRY II
SUBJECT CODE: BCH-115

OBJECTIVES:

1. Here in this syllabus we start learning with aspects of thermochemistry and thermodynamics.
2. It become easy to understand the aspect of thermodynamic behavior of chemical reaction and their direct indirect influence on chemical activity after the study.
3. We also learn the theory of Chemical equilibrium and their different aspect of forward and backward reactions.
4. Student may also able to understand the colligative properties of any chemical systems.

Unit-I THERMOCHEMISTRY-I:

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Unit-2 THERMOCHEMISTRY-II

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit-3 SYSTEMS OF VARIABLE COMPOSITION:

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Unit-4 CHEMICAL EQUILIBRIUM:

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in

ideal gases, Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Unit-5 SOLUTIONS AND COLLIGATIVE PROPERTIES:

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

LEARNING OUTCOMES:

1. On finishing these modules of chemistry we are able to differentiate colligative properties of solution like elevation of boiling point, depression of freezing point with relatively lowering the vapor pressure.
2. Its also easy to understand thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Reference Books

- Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press (2011).
- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
- Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C.R. *2000 solved problems in chemistry,* Schaum Series (2006)

SUBJECT NAME: PHYSICAL CHEMISTRY LAB- II
SUBJECT CODE: BCH-165

Thermochemistry

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubilityΔ of benzoic acid in water and determination of H.

SUBJECT NAME: INORGANIC CHEMISTRY-II
SUBJECT CODE: BCH-121

OBJECTIVES

Here in this course work we design for student to understand following objects;

1. Student would learn theory of acid and base in practical chemistry.
2. Student also easily understands the reason of corrosion and principle of metallurgy.
3. Oxidation reduction would help the student to determine the reaction activity of any chemical compound.

UNIT-1 ACID AND BASE:

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle

UNIT-2: GENERAL PRINCIPLES OF METALLURGY

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

UNIT- 3 CORROSION AND ITS CONTROL

Types of Corrosion: Wet corrosion, dry corrosion, galvanic corrosion, water-line corrosion, differential aeration corrosion & stress corrosion, Factors effecting corrosion, Protection from corrosion: Barrier, sacrificial, cathodic and anodic protection.

UNIT-4 OXIDATION AND REDUCTION

Use of redox potential data - analysis of redox cycle, redox stability in water - Frost, Latinmer and Pourbaix diagrams, Principles involved in the extraction of elements.

UNIT-5 INORGANIC POLYMER

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates

LEARNING OUTCOMES:

1. After completing the curriculum students are aware with the importance of inorganic polymer, oxidation and reduction properties of compounds.
2. Student also differentiates the metallurgy and corrosion theory of metal and metloids.

SUBJECT NAME: ORGANIC CHEMISTRY-II

SUBJECT CODE: BCH-122

OBJECTIVES

1. The present curriculum enhance the knowledge of organic chemistry of students; they should aware with alkenes, dienes their properties and chemical activity.
2. Alkynes also plays an important role in organic chemistry to understand the students, it have their own importance.
3. Nomenclature of halide improves the knowledge of student in term of nomenclature and all.

UNIT-1: ALKENES & DIENES

Nomenclature of alkenes, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides. Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes.Chemical reactions of alkenes – mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration- oxidation, reduction, ozonolysis, hydration, hydroxylation and oxidation with KMnO4, polymerization of alkenes, substitution at allylic and vinylic positions of alkenes. Industrial application of ethylene and propene. Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of butadiene, Chemical reactions – 1, 2 and 1, 4 additions (elecrophilic & free radical mechanisms), Diels –Alder reaction.

UNIT-2: ALKYNES

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of elecrophilic and nucleophilic addition reactions, hydroboration – oxidation of alkynes, metal –ammonia reductions, oxidation and polymerization.

UNIT-3: ALKYL & ARYL HALIDES

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms and stereochemistry of nucleophilic substitution reactions of alkyl halides, SN_2 and SN_1 reactions with energy profile diagrams.

Methods of formation and reactions of aryl halides, the addition elimination and the elimination – addition mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides.

UNIT-4: ARENES AND AROMATICITY

Nomenclature of benzene derivatives: Aromatic nucleus and side chain, Structure of benzene: Molecular formula and Kekule structure Aromaticity: Huckel rule, aromatic ions, anti-aromatic, non - aromatic compounds.Aromatic electrophilic substitution – general pattern of the mechanism, mechanism of nitration, halogenations, sulphonation, and friedel – crafts reaction. Energy profile diagrams. Activating deactivating substituent, orientation and ortho/para ratio. Side chain reactions of benzene derivatives, Birch reduction. Methods of formation and chemical reactions of alkyl benzenes, alkyl benzenes and byphenyl.

UNIT-5: POLY NUCLEAR HYDROCARBONS

Haworth synthesis of naphthalein and phenanthene, Pschorr synthesis of phenanthrene, synthesis of anthracene involving Friedal craft acylation of benzene with phthalic anhydride and Diels-Alder reaction between 1,3-butadiene and 1,4- naphthaquinone, reaction of naphthalene, anthracene and phenanthrene, relative reactivities at different positions and mechanism of electrophilic substitution reactions in naphthalene, anthracene and phenanthracene.

LEARNING OUTCOMES:

1. After finishing this curriculum students are able to to differentiate between alkyl aryl and aldehyde.
2. Student learn synthesis of napthalein, and other poly nuclear hydrocarbons.
3. Here with this curriculum electrophilic and substitution reaction are define the properties of chemical compounds.

Reference Books:

Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

SUBJECT NAME: ORGANIC CHEMISTRY LAB-II

SUBJECT CODE: BCH-172

1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting or boiling point:
   (i) Phenyl benzoate from phenol and benzoyl chloride
   (ii) M-dinitrobenzene from nitrobenzene(use 1:2 conc. HNO_3 - H_2SO_4 mixture if fuming HNO_3 is not available).
   (iii) Picric acid
   (iv) Aspirin from salicylic acid
2. To study the differential extraction of compounds.
3. Crystallization and decolourization of impure naphthalene from ethanol.
4. Mixed M.P determination of urea & Cinnamic acid mixture of various composition(1:4,1:1 & 4:1)

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).

SUBJECT NAME: ELECTRICITY AND MAGNETISM (GENERAL ELECTIVE)
SUBJECT CODE: BPH-122

OBJECTIVES

1. This module discusses the basic phenomena of electricity and magnetism as they relate to effects animation.
2. Explain electrostatic induction and polarization.
3. Appraise the physical accuracy of electrical effects such as ohmic heating and electrocution

UNIT-1 ELECTRIC FIELD AND ELECTRIC POTENTIAL

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

UNIT-2 DIELECTRIC PROPERTIES OF MATTER:

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.

UNIT-3 MAGNETIC FIELD:

Magnetic force between current elements and definition of Magnetic Field**B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

UNIT-4 ELECTROMAGNETIC INDUCTION & BALLISTIC GALVANOMETER:

Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping.

UNIT-5 ELECTRICAL CIRCUITS & NETWORK THEOREMS:

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem,, Maximum Power Transfer theorem.

LEARNING OUTCOMES:

Having successfully completed this module, you will be able to demonstrate knowledge and understand of

1. The use of Coulomb's law and Gauss' law for the electrostatic force
2. The relationship between electrostatic field and electrostatic potential
3. The use of the Lorentz force law for the magnetic force
4. The use of Ampere's law to calculate magnetic fields
5. The use of Faraday's law in induction problems
6. The basic laws that underlie the properties of electric circuit elements

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

SUBJECT NAME: ELECTRICITY AND MAGNETISM LAB
SUBJECT CODE: BPH-172

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

NOTE: Each student is required to perform at least seven experiments.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,

reprinted 1985, Heinemann Educational Publishers
A Laboratory Manual of Physics for undergraduate

SUBJECT NAME: ENVIRONMETAL SCIENCE AND ECOLOGY
SUBJECT CODE: CEA-101-A

OBJECTIVES:

1. Environmental Studies is a multidisciplinary area, the issues of which everyone should know.
2. The aim of the course is to make everyone aware of environmental issues like continuing problems of pollution, loss of forest, solid waste disposal, and degradation of environment.
3. Issues like economic productivity and national security, global warming, the depletion of ozone layer and loss of biodiversity are other serious concerns before the mankind.

UNIT_1.THE MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES:

Basic definitions related to environment; Scope, vis-à-vis environmental science and environmental engineering; a uses of environmental degradation, atmospheric composition and associated spheres, habitat and climate; objective, goals and principals involved in environmental education, environmental awareness, Environmental ethics, environmental organization and their involvement.

UNIT-2 NATURAL RESOURCES:

Renewable and non-renewable resources; forest resources, over-exploitation, and deforestation / afforestation; water resources, impact of over-utilization of surface and ground water, floods, drought, conflicts over water, dams; mineral resources: dereliction of mines, environmental effects of extracting and using mineral resources; Food resources, modern agriculture and its impact, problem associated with fertilizer and pesticide, water logging, salinity ; energy resources, renewable, non-renewable energy sources, solar energy, wind energy, hydro energy, biomass energy, geothermal energy, nuclear energy and its associated hazards; land as a resource, land degradation, man induced landslides, soil erosion and desertification.

UNIT-3 ECOSYSTEMS:

Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids; characteristic features, structure and function of the following ecosystem -forest ecosystem, grassland ecosystem desert ecosystem and aquatic ecosystems.

UNIT-4 BIODIVERSITY AND ITS CONSERVATION:

Bio-geographical classification of India; biodiversity at global, national and local levels, India as a mega-diversity nation, hot-spots of biodiversity; value of biodiversity-consumptive use, productive use, social, ethical aesthetic and option values; threats to biodiversity; conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

UNIT-5 ENVIRONMENTAL POLLUTION AND SOCIAL ISSUES:

Causes, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution; solid waste management, e-waste management; disaster

management –floods, earthquake, cyclone and landslides. Water conservation, rain water harvesting, watershed management; climate change, global warming, acid rain, ozone layer depletion; Environmental Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act.

LEARNING OUTCOMES:

On the completion of the course, students should be able to:

1. understand fundamental terms related to environment and aware of environmental problems;
2. analyze the complexities of environmental problems and should know remedies available to them and implement them at their own level;
3. Move forward in their professional life with a environment conscious mind and preserve our environment as much as they can.

Reference Book:

1. Agarwal, K.C., "Environmental Biology", 2nd Edition, Nidhi Publ. Ltd., Bikaner, 2001.
2. Bharucha Erach, "The Biodiversity of India", 2nd Edition, Mapin Publishing Pvt. Ltd., 2006.
3. Kaushik, Anubha, and Kaushik, C.P., "Perspectives in Environmental Studies", 4th Edition,
4. New Age International Publishers, 2004
5. Brunner R. C., "Hazardous Waste Incineration", 1st Edition McGraw Hill Inc., 1989.
6. Clark R.S., "Marine Pollution", 1st Edition Clanderson Press Oxford,1989
7. .Cunningham, W.P., Cooper, T.H. Gorhani, E. & Hepworth, M.T., Environmental Encyclopedia", 2nd Edition, Jaico Publ. House, 2001.
8. De, A. K., "Environmental Chemistry", 2nd Edition, Wiley Eastern, 1989
9. Jadhav, H. and Bhosale, V.M ., "Environmental Protection and Laws", 1st Edition, Himalaya Pub. House, Delhi, 1995.
10. Mckinney, M.L. and Schocl. R.M., "Environmental Science Systems & Solutions", 2nd Edition, Web enhanced edition, 1996.

Semester III

SUBJECT NAME: PHYSICAL CHEMISTRY- III
SUBJECT CODE: BCH-219

OBJECTIVES:

1. It comprises to study the one and two component system with different process of sublimation, vaporization and melting.
2. Topics also contain adsorption and desorption phenomenon on the solid surface. With this syllabus distribution of solute in to the solvent and extraction of the solute particles from solvent also included.
3. Further to these topics buffer and strength of acid and base by different formulas of pH and pOH are also given.

UNIT-1: THERMODYNAMICS

Definition of thermodynamics terms: system, surrounding, types of systems, intensive and extensive properties. State and path functions, Thermodynamic processes. Concept of heat and work. Zeroth Law of thermodynamics, first law of thermodynamics: statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – joule – Thomson coefficient for ideal gas and real gas: and inversion temperature. Calculation of work done, heat, internal energy, enthalpy for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

UNIT-2: SURFACE CHEMISTRY

Adsorption by solids, Application of adsorption, Adsorption of gases by solids, Factors influencing the adsorption, Langmuir theory of adsorption, Adsorption from solution, Gibbs adsorption isotherm.

UNIT-3: DISTRIBUTION LAW

Nernst distribution law, conditions for the validity of Nernst distribution law, Derivation of molecular complexity from distribution law. Application of distribution law i.e. calculation of solubility of solute in solvent, determination of equilibrium constant from distribution law, distribution indicator, process of extraction and determination of degree of hydrolysis and study of complex ion formation, limitation of distribution law.

UNIT-4: ELECTROCHEMISTRY – II

Kohlarausch's Law, calculation of molar ionic conductance and effect of viscosity, temperature & pressure on it. Application of Kohlarausch's law in calculation of conductance of weak electrolytes at infinite dilution.

Application of conductivity measurements: determination of degree of dissociation, determination of K_a of acids, determination of solubility product of sparingly soluble salts, conductance titrations. Definition of pH and pKa, Buffer action, Buffer mechanism of buffer action.

UNIT-5 GASEOUS STATE

Maxwell's distribution of velocities and energies(derivation excluded), average velocity and most probable velocity, collision diameter, collision number, collision frequency, deviation of real gases from ideal behavior, derivation of vander Waal's equation of state.

LEARNING OUTCOMES:

1. It comprises to study the one and two components phase system on the basis of gibbs phase rule.
2. Unit I will also give the information about the eutectic points, congruent and incongruent systems.
3. Unit II gives the surface knowledge of solids when adsorption and desorption of adsorbate takes place. Distribution law of solute in to solvent tells the class about the solubility and extraction of solute form different solvent. From electrochemistry class will be able to understand about electrolyte and their behavior in different solvents. pH and buffer will inform about the acidity basicity of the solution.

Reference Books:

Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.*, Oxford University Press (2010).

- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.

SUBJECT -PHYSICAL CHEMISTRY PRACTICALS -III
SUBJECT CODE- BCH-269

1. To determine the melting point and eutectic point of given mixture
2. To determine the partition coefficient of benzoic acid between water and benzene at room temperature.
3. Buffer Solution:
   Preparation of buffer solution.

   NH_4Cl - NH_4OH and determination of pH of buffer solution
   CH_3COOH and CH_3 COONa and determination of pH of buffer solution.
4. Surface Tension measurement (Use of organic solvent excluded)
   (a) Determination of surface tension by drop number method & drop weight method
   (b) Variation of surface tension of detergent solution with concentration.
5. Phase equilibria: Construction of phase diagram of
   (a) Simple eutectic system
   (b) Congruent melting point using cooling curve.

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

SUBJECT NAME: INORGANIC CHEMISTRY-III
SUBJECT CODE: BCH-221

OBJECTIVES:

1. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.
2. They comprises of chemistry of d-block elements with lanthanide elements and its contraction. Introduction of halogen family and inter-halogen compounds are also given in to the syllabus.

UNIT-1: CHEMISTRY OF ELEMENTS OF IST TRANSITION SERIES:

Definition of transition elements, position in the periodic table, General characteristics & properties of Ist transition elements, Structures & properties of some compounds of transition elements– TiO_2, $VOCl_2$, $FeCl_3$, $CuCl_2$ and $Ni(CO)_4$

UNIT-2: CHEMISTRY OF ELEMENTS OF IIND & IIIRD TRANSITION SERIES:

General characteristics and properties of the IInd and IIIrd transition elements Comparison of properties of 3d elements with 4d & 5d elements with reference only to ionic radii, oxidation state, magnetic and Spectral properties and stereochemistry.

UNIT-3: LANTHANIDES:

Comparative study of lanthanide elements with respect to electronic configuration atomic and ionic radii, oxidation state and complex formation, lanthanide contraction. Separation of lanthanides. Application of lanthanide complexes.

UNIT-4: COORDINATION COMPOUNDS

Werner's coordination theory, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

UNIT-5: HALOGEN FAMILY

Basic properties of halogen, interhalogens types properties, hydro and oxyacids of chlorine – structure and comparison of acid strength.

LEARNING OUTCOMES:

1. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.
2. From this syllabus class will be able to understand about the chemistry of d-block elements with lanthanides and their properties.
3. With this syllabus class will be to know Introduction of halogen family and inter-halogen compounds.

Reference Books:

- Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
- Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing

Company 1994.
- Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999.
- Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann, 1997.

SUBJECT NAME: INORGANIC CHEMISTRY LAB-III
SUBJECT CODE: BCH-271

1. Semi micro qualitative analysis of mixture containing not more than four radicals (including interfering and excluding insoluble):
   Pb^{2+}, Hg^{2+}, Hg^{2+}, Ag^{+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+},Ca^{2+},Mg^{2+},NH^{4+}, CO_3^{2-}, S^{2-},SO_3^{2-}, $S_2O_3^{2-}$, NO_2^{-}, CH_3COO^{-}, Cl^{-},Br^{-}, I^{-}, NO^{3-}, SO_4^{2-},$C_2O_4^{2-}$, PO_4^{3-}.
2. Inorganic preparations:
   (a) Cuprous chloride
   (b) Manganese (II) phosphate

Reference Book:
1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.

SUBJECT NAME: ORGANIC CHEMISTRY-III
SUBJECT CODE: BCH-222

OBJECTIVES:
1. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.
2. Syllabus contains the topics related to oxygen containing alcohol, ester and carboxylic groups and their reactions in alkyl and aryl form. Epoxides also included in the syllabus.
3. Derivatives of carboxylic group with also given within the syllabus.

UNIT-1: ALCOHOLS
Monohydric alcohols—nomenclature, methods of formation by reduction of aldehydes, ketones, Carboxylic acids and esters. Hydrogen bonding. Acidic nature, Reactions of alcohols. Dihydric alcohols- nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement.

UNIT-2:EPOXIDES
Synthesis of epoxides, acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

UNIT-3: PHENOLS
Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols — electrophilic aromatic substitution, Mechanisms of Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction, Kolbe's reaction and Schotten and Baumann reactions.

UNIT-4: CARBOXYLIC ACIDS

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength, Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides, reduction of carboxylic acids. Mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids. Hydroxy acids: malic, tartaric and citric acids. Methods of formation and chemical reactions of unsaturated monocarboxylic acids. Industrial manufacture of acetic acid and benzoic acid (flow sheet diagram). Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents.

UNIT-5: CARBOXYLIC ACID DERIVATIVES

Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides, relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution, Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterification and hydrolysis (acidic and basic).

LEARNING OUTCOMES:

1. Syllabus will give the information about the oxygen containing alcohol, ester and carboxylic groups and their reactions in alkyl and aryl form.
2. Students will be able to understand about epoxides and its reactions. Carboxylic groups and derivatives will be an additional informtaion for the students.

Reference Books:

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, John Welly & Sons (1976).
- Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.
- Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P)

SUBJECT NAME: ORGANIC CHEMISTRY LAB-III
SUBJECT CODE: BCH-272

1. Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple Compound: Naphthalene, anthracene, acenaphthene, benzyl chloride, p-dichlorobenzene, m-dinitrobenzene, p-nitrotoluene, resorcinol, hydroquinone, α-naphthol, β-naphthol, benzophenone, ethyl-methyl ketone, benzaldehyde, vanillin.
2. To find out equivalent weight of acid (neutralization and silver salt method).

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry,*

5th Ed., Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press (2000).

SUBJECT NAME: DIFFERENTIAL EQUATIONS-I (GENERAL ELECTIVE)
SUBJECT CODE: BMA-230

OBJECTIVES:

1. Maintain a core of Mathematical and technical knowledge that is adaptable to changing technologies and provides a solid foundation for future learning.
2. Students will demonstrate their ability to solve problems in mathematics using appropriate technology, translating problems from one form to another, using various problem-solving strategies.

UNIT 1: Geometrical meaning of a differential equation. Exact differential equations, integrating factors. First order higher degree equations solvable for x,y,p Lagrange's equations, Clairaut's equations. Equation reducible to Clairaut's form.

UNIT-2: Linear differential equations with constant coefficients. Homogeneous linear ordinary differential equations. Equations reducible to homogeneous equation.

UNIT -3: Method of variations of parameters. Method of undetermined coefficients. Reduction of order of a differential equation. Linear differential equations of second order: Reduction to normal form.

UNIT-4: Transformation of the equation by changing the dependent variable/ the independent variable. Solution by operators of non-homogeneous linear differential equations.

UNIT-5: Ordinary simultaneous differential equations. Solution of simultaneous differential equations involving operators x (d/dx) or t (d/dt) etc. Simultaneous equation of the form dx/P = dy/Q = dz/R. Total differential equations. Condition for Pdx + Qdy +Rdz = 0 to be exact. General method of solving Pdx + Qdy + Rdz = 0 by taking one variable constant.

COURSE OUTCOMES:

1. Students can perform abstract mathematical reasoning.

2. Students can identify and explain cases in which major results of one branch of mathematics rely nontrivially on results from another branch (e.g., the application of linear algebra to solving systems of differential equations).

Reference Books:

1. B.Rai & D.P. Chaudhary : Ordinary Differential Equations; Narosa, Publishing House Pvt. Ltd.

2. D.A. Murray : Introductory Course in Differential Equations. Orient Longaman (India)

SUBJECT NAME:ENTREPRENEURSHIP DEVELOPMENT
SUBJECT CODE: BA-272-A

OBJECTIVES

1. It provides exposure to the students to the entrepreneurial cultural and industrial growth so as to prepare them to set up and manage their own small units.
2. Creates a pre-understanding and a foundation for which the students can be tested in theoretical insight, understanding and critical thinking.
3. The students solve a specific innovation challenge and apply their knowledge into actual action that creates value for others.

UNIT I INTRODUCTION: The Entrepreneur: Definition, Emergence of Entrepreneurial Class; Theories of Entrepreneurship.

UNIT 2 PROMOTION OF A VENTURE:

Opportunity Analysis; External Environmental Analysis Economic, Social and Technological; Competitive factors; Legal requirements of establishment of a new unit and Raising of Funds; Venture Capital Sources and Documentation Required.

UNIT 3 ENTREPRENEURIAL BEHAVIOUR:

Innovation and Entrepreneur; Entrepreneurial Behaviour and Psycho-theories, Social responsibility.Entrepreneurial Development Programmes (EDP): EDP, Their Role, Relevance and Achievements; Role of Government in Organizing EDP's Critical Evaluation.

UNIT 4 ROLE OF ENTREPRENEUR:

Role of an Entrepreneur in Economic Growth as an Innovator, Generation of Employment Opportunities, Complimenting and Supplementing Economic Growth, Bringing about Social Stability and Balanced Regional Development of Industries: Role in Export Promotion and Import Substitution, Forex Earnings.

LEARNING OUTCOMES:

1. You understand different methods to assess the attractiveness of business opportunities
2. You understand what characterizes an attractive business opportunity and common pitfalls during the entrepreneurial process.

Text Books:

1. Hisrich, Robert and Peters, Michael, (2002), Entrepreneurship, 5thEdition, McGrawHill Education.

2. Charantimani, (2006), Entrepreneurship Development and Small Business Enterprise, 1stedition, Pearson Education.

Reference Books:
1. Chandra, Ravi, (2003), Entrepreneurial Success: A Psychological Study, Sterling Publication Pvt. Ltd., New Delhi.
2. Balaraju, Theduri, (2004), Entrepreneurship Development: An Analytical Study, Akansha Publishing House, New Delhi.
3. David, Otes, (2004), A Guide to Entrepreneurship, Jaico Books Publishing House, Delhi.
4. Kaulgud, Aruna, (2003), Entrepreneurship Management, Vikas Publishing House, Delhi.

SUBJECT NAME- ELEMENTARY MATHEMATICS-I
COURSE CODE- BMA-231

OBJECTIVES:

1. Maintain a core of mathematical and technical knowledge that is adaptable to changing technologies and provides a solid foundation for future learning.
2. Students will demonstrate their ability to solve problems in mathematics using appropriate technology, translating problems from one form to another, using various problem-solving strategies.

UNIT-1: SEQUENCE AND SERIES:

Arithmetic Progression (A.P.), Arithmetic Mean (A.M.), Geometric Progression (G.P.), general term of a G.P., sum of n terms of a G.P. Arithmetic and geometric series, infinite G.P. and its sum, geometric mean (G.M.). Relation between A.M. and G.M. Sumto n terms of the special series : $\sum n$, $\sum n^2$ and $\sum n^3$.

UNIT-2: MATRICES

Concept, notation, order, equality, types of matrices, zero matrix, transpose of a matrix, symmetric and skew symmetric matrices. Addition, multiplication and scalar multiplication of matrices, simple properties of addition, multiplication and scalar multiplication. Non-commutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2). (Here all matrices will have real entries).

UNIT-3: DETERMINANTS

Determinant of a square matrix (up to 3×3 matrices), properties of determinants, minors, cofactors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

UNIT-4: DIFFERENTIATION

Differentiability, derivative of composite functions, chain rule, , derivative of implicit function. Concepts of exponential, logarithmic functions. Derivatives of $\log e^x$ and e^x. Logarithmic differentiation. Derivative of functions expressed in parametric forms. Second order derivatives.
Rate of change, maxima and minima.Simple problems

UNIT-5: INTEGRALS

Integration as inverse process of differentiation. Integration of a variety of functions by substitution, by partial fractions and by parts. Definite integrals as a limit of a sum. Fundamental Theorem of

Calculus (without proof). Basic properties of definite integrals and evaluation of definite integrals. Applications in finding the area under simple curves

COURSE OUTCOMES:

1. Students' can perform abstract mathematical reasoning.

2. Students' can identify and explain cases in which major results of one branch of mathematics rely nontrivially on results from another branch (e.g., the application of linear algebra to solving systems of differential equations).

TEXT BOOKS/REFERENCE BOOKS:

1. R.D SHARMA FOR CLASS 11th AND 12TH MATHEMATICS
2. R.S . AGRAWAL FOR CLASS 12TH MATHEMATICS
3. PRADEEP'S REFERENCE BOOK FOR CLASS 11TH

SUBJECT NAME: COMPUTER FOR CHEMISTS

SUBJECT CODE: BCS-201

OBJECTIVES:

1. Understand the principles of creating an effective web page including an in-depth consideration of information architecture.

2. Understand how to plan and conduct user research related to web usability.

3. Learn the language of the web: HTML

UNIT – 1: INTRODUCTION TO INTERNET

World Wide Web and concepts of website, web pages etc. Client – Server Architecture, The idea of hypertext and hyper media: how the web works: HTTP, HTML and URLs; how the browser works: MIME types, plug-ins and helper applications, standards, Introduction to HTML, XML, XHTML and the W3C.

UNIT –2 : HYPERTEXT MARKUP LANGUAGE

HTMLS: The anatomy of an HTML document; marking up for structure and style: basic page markup, ordered and unordered list, Structuring content with HTML using natural divisions, Marquee text with or without background with attributes, Working with Links Internal Links: Anchor Link, Email Link; embedding images, table creation: Table attributes Colspan, Rowspan, Table Border, Align, Valign, Table background image, Nesting tables, Frames and Nesting, iframes, forms, Semantic elements of HTMLS, Media tags in HTMLS.

UNIT – 3 : CASCADING STYLE SHEET

Introduction to Cascading Style Sheet: Selector, Declaration and declaration block. Types of CSS – Inline and Internal style specifications within HTML; external linked style specification using CSS, page and site design considerations. Types of Selector:Universal, Class and ID Selector, Building & Applying Class Selectors, ID Selector using Div Tags and span tag.

UNIT – 4 : CLIENT SIDE PROGRAMMING:

Introduction to JavaScript syntax: output, Comments, variables, functions, operators, conditions, switch, loop. Java1Script object model: Window, Location and History object model; HTML DOM: Introduction to DOM: methods, event handling, navigation, Forms validation.

UNIT – 5 : TESTING WEB APPLICATION

Introduction, Fundamentals, Terminology, Quality characteristics, test objectives, test levels, Test Methods and Techniques, Link Testing, Browser Testing, Usability Testing Load, stress and continuous testing; Testing Security; Test automation; Benefits and drawbacks of automation testing.

LEARNING OUTCOMES:

1. Develop and implement solutions to problems encountered in all phases of the design process.
2. Apply effective business practices and project management skills appropriate to his/her position in the web design field.

Semester IV

SUBJECT NAME: PHYSICAL CHEMISTRY-IV
SUBJECT CODE: BCH-223

OBJECTIVES:

1. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.
2. To use solution thermodynamic concepts to compute phase & reaction equilibrium data.

UNIT-1 THERMODYNAMICS

Second law of thermodynamics. Need of the law, Concept of entropy, entropy as a state function of V and T, entropy as a function of P and T. Entropy change in physical processes. Entropy as criteria of Spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases, work function, Gibb's free energy function. Gibbs function (G) and Helmholtz function (A) as thermodynamic function. Criteria of spontaneity of reversible processes in terms of enthalpy change, entropy change, work function and free energy function. Variation of G and A with P, V and T. Gibb Helmholtz equation and its application, Third law of thermodynamics and its applications. Partial molar quantities. Chemical potential. Gibb's Duhem equation. Gibb's adsorption equation and its application.

UNIT-2 COLLOIDAL STATES

Colloids, classification of colloids, solids in liquids (sols) properties: Kinetic, optical and Electrical, stability of colloids, protective colloids, Hardy-schulze Rule, gold number, Emulsion types of emulsion and their preparation, Emulsifier. Gels (liquid in solids): Classification and properties, General application of colloids.

UNIT-3 CRITICAL PHENOMENON

Critical temperature**, critical** pressure, critical volume and their determination. PV isotherms of real gases, continuity of states, the isotherms of Vander Waal's equation, relationship between critical constants and Vander Waal's constants. Critical compressibility factor, the law of corresponding states. Liquefaction of gases.

UNIT-4 NUCLEAR CHEMISTRY:

Radioactivity, Properties of radiation, detection & measurement of radioactivity, types of radioactive decay, Group displacement law, rate of radioactive decay, half life, calculation of half life, radioactive dating, nuclear reactions: nuclear fission and nuclear fusion reaction. Nuclear binding energy.

UNIT-5 CHEMICAL BONDING:

Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB

treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

LEARNING OUTCOMES:

Students will gain an understanding of:

1. The relationship between microscopic properties of molecules with macroscopic thermodynamic observables
2. The differences between classical and quantum mechanics
3. The fundamentals of nuclear decay.
4. Students will estimate equilibrium conversion in reversible reactions at given pressure and temperature following rigorous thermodynamic method

Reference Books:

- Atkins, P.W & Paula, J.D. *Physical Chemistry*, 9th Ed., Oxford University Press (2011).
- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
- Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
- Barrow, G. M., *Physical Chemistry 5th Ed.,* Tata McGraw Hill: New Delhi (2006).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
- Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
- Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry 4th Ed.,* John Wiley & Sons, Inc. (2005).

SUBJECT NAME: PHYSICAL CHEMISTRY LAB- IV
SUBJECT CODE: BCH-273

1. To determine the enthalpy of neutralization of strong acid/ strong base.
2. To determine the enthalpy of ionization of ethanoic acid.
3. To determine the solubility of benzoic acid in water at room temperature.
4. Determination of enthalpy of hydration of $CuSO_4$.
5. Determination of basicity of polyprotic acid by thermochemical methods in terms of change of temperature observed in the graph.
6. Determination of heat capacity of calorimeter and integral enthalpy (Endothermic & Exothermic).
7. To determine parachor value of $–CH_2$ group.
8. To determine the viscosity index of given oil by Redwood viscometer-I

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand

& Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

SUBJECT NAME: ORGANIC CHEMISTRY-IV
SUBJECT CODE: BCH-225

OBJECTIVES:

1. Understand the language and diagrammatic notation of organic chemistry and be able to communicate and apply this knowledge
2. Predict the properties of organic compounds.
3. Demonstrate some knowledge of the sources of and uses for organic compounds in the practical world.
4. Design reactions paths by which a great variety of moderately complex organic compounds could be prepared from simple, readily available compounds.
5. Be able to account for how reactions occur at the molecular level.

UNIT-1: ORGANOMETALLIC COMPOUNDS

Reagents-formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions. Organo lead compounds: formation and chemical reactions. Organo cadmium compounds: formation and chemical reactions. Organo copper compounds: formation and chemical reactions

UNIT-2: ORGANOSULPHUR COMPOUNDS

Nomenclature, structural features, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine. Synthetic detergents alkyl and aryl sulphonates.

UNIT-3: ORGANO PHOSPHORUS COMPOUNDS

Nomenclature, Trivalent phosphorus compounds - trialkyl and triaryl phosphine (method of formation and reactions), Pentavalent phosphorus compounds, organic phosphoranes, phosphorus ylides, wittig reaction. Biological role of phosphorus.

UNIT-4: HETEROCYCLIC COMPOUNDS

Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six-membered heterocycles. Prepration and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

UNIT-5: ORGANIC SYNTHESIS *VIA* ENOLATES

Acidity of hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.

LEARNING OUTCOMES:

1. To know the complete detailed structure of the molecule

2. Able to explain the relationship between starting materials, reagents and products arising from variety of reactions
3. To understand the way in which bonds are made and broken to bring about product formation in these reactions (that is, the reaction mechanism)
4. The effect of structural variations on reactivity (rate or position of equilibrium) in these reactions.

SUBJECT NAME: ORGANIC CHEM LAB-IV
SUBJECT CODE: BCH-275

1. Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple mono and bifunctional organic compounds. oxalic acid, succinic acid, benzoic acid, salicylic acid, aspirin, phthalic acid, cinnamic acid, benzamide, urea, acetanilide, benzamide, aniline hydrochloride, p-toluidine, phenyl salicylate(salol), glucose, fructose, sucrose, o-,m-, p-nitroanilines, thiourea.
2. Estimation of phenol (bromide- bromate method) and aniline (bromide-bromate and acetylation method).

Reference Books:

- Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
- Arthur, I. V. *Quantitative Organic Analysis*, Pearson.

SUBJECT NAME: ANALYTICAL CHEMISTRY
SUBJECT CODE: BCH-226

OBJECTIVES:

1. Understanding basic concepts of instrumentation, data acquisition and data processing.
2. Analysis of water and soil and utilize this information to calculate the pH of the water and soil.
3. Thorough understanding of the chemical and physical properties of substances.
4. Know how to conduct analytical measurements using equipment such as chromatographs and mass spectrometers.

UNIT-I INTRODUCTION:

Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

UNIT-II ANALYSIS OF SOIL & WATER:

Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium

and Magnesium ions as Calcium carbonate by complexometric titration. Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.

UNIT-III ANALYSIS OF FOOD PRODUCTS:

Nutritional value of foods, idea about food processing and food preservations and adulteration. a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter.

UNIT-IV CHROMATOGRAPHY:

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion (Fe3+ and Al3+). b. To compare paint samples by TLC method. Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

UNIT-V ANALYSIS OF COSMETICS:

Major and minor constituents and their function a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

LEARNING OUTCOMES:

1. Must be able to perform qualitative analysis to detect the presence of a chemical in a substance.
2. Perform accurate and precise analysis in the field of analytical chemistry.
3. Perform quantitative and qualitative analysis of known standards as well as unknown samples

SUBJECT NAME: MANAGERIAL SKILLS
COURSE CODE: BA- 264A

OBJECTIVES:

1. The objective of this course is to develop a basic understanding about the management concepts as well as of human in various managerial processes in organization.
2. Will be able to learn strong working knowledge of ethics and professional responsibility.

UNIT-1SKILL DEVELOPMENT

Writing Business Letter, Official letters, 7C's & 4'S in Communication , Report writing , Skills, Presentation Skills , Communication : Concept, Types , process, barriers, making Communication effective.

MANAGERIAL CREATIVITY- Business Process Re-engineering - Concept , Process, Redesign, BPR, experiences in Indian Industry , Total Quality Management(TQM) - Concept , Systems model of Quality, Deming's approach, TQM as a business Strategy .

UNIT-2 TECHNOLOGY LED DEVELOPMENT

Knowledge Management (KM)- What , why, how, of Knowledge Management , KM process , approach, strategies, tools. E-commerce- Ideology, methodology, classification by application /nature of transactions , Driving Forces of EC, Impact of EC, Scope

UNIT-3 LEADERSHIP FOR MANAGERS

Concept, Traits, Styles, Types of leadership, Leadership for managers-varied case studies for identifying and imbibing leadership attributes.

Selling & Negotiation Skills-Types of Negotiation , Negotiation Strategies ,Selling skills – Selling to customers , Selling skills – Body language, Conceptual selling, Strategic selling

UNIT-4 CONFLICT MANAGEMENT

Conflict Management - Types of conflicts and Conflict Management, Coping strategies and Conflict Management, Conflict Management Styles

UNIT-5 POSITIVE THINKING

Attitudes, Beliefs, Positive thinking – Martin Seligman's theory of Learned Helplessness , Learned Optimism, Case Studies and Presentations.

LEARNING OUTCOMES:

1. Manage the selection and initiation of individual projects and of portfolios of projects in the enterprise.

2. Demonstrate effective project execution and control techniques that result in successful projects

References

1.Stoner, Freeman , Gilbert Jr. : Management (Pearson education)
2.Kootz,O'Donnell , Weighrich : Essentials of Management
3.Michael , J. Stahl : Management -Total Quality in a global environment (Blackwell Business)
4.Newman , Warren and Summer : The Process of Management , Concept, Behaviour & Practice.

SUBJECT NAME: ELEMENTARY MATHEMATICS-II (GENERAL ELECTIVE)

SUBJECT CODE: BMA-241

OBJECTIVES:

1. The ability to identify reflects upon, evaluate, integrate, and apply different types of information and knowledge to form independent judgments.
2. The ability to assess and interpret complex situations, choose among several potentially appropriate mathematical methods of solution, persist in the face of difficulty, and present full and cogent solutions that include appropriate justification for their reasoning.

UNIT-1: PRINCIPLE OF MATHEMATICAL INDUCTION & BINOMIAL THEOREM

Process of the proof by induction, motivating the application of the method by looking at natural numbers as the least inductive subset of real numbers. The principle of mathematical induction and simple applications.

History, statement and proof of the binomial theorem for positive integral indices. Pascal's triangle, General and middle term in binomial expansion, simple applications

UNIT-2: MATHEMATICAL REASONING

Mathematically acceptable statements. Connecting words/ phrases - consolidating the understanding of "if and only if (necessary and sufficient) condition", "implies", "and/or", "implied by", "and", "or", "there exists" and their use through variety of examples related to real life and Mathematics. Validating the statements involving the connecting words difference between contradiction, converse and contrapositive.

UNIT-3: STATISTICS & PROBABILITY

Measures of dispersion; Range, mean deviation, variance and standard deviation of ungrouped/grouped data. Random experiments; outcomes, sample spaces (set representation). Events; occurrence of events, 'not', 'and' and 'or' events, exhaustive events, mutually exclusive events. Conditional probability, multiplication theorem on probability. independent events, total probability, Baye's theorem, Random variable and its probability distribution, mean and variance of random variable.

UNIT-4: VECTORS:

Vectors and scalars, magnitude and direction of a vector.Direction cosines and direction ratios of a vector. Types of vectors (equal, unit, zero, parallel and collinear vectors), position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio. Definition, properties and application of scalar (dot) product of vectors, vector (cross) product of vectors.

UNIT-5: LINEAR PROGRAMMING:

Introduction, related terminology such as constraints, objective function, optimization, different types of linear programming (L.P.) problems, mathematical formulation of L.P. problems, graphical method of solution for problems in two variables, feasible and infeasible regions (bounded and unbounded), feasible and infeasible solutions, optimal feasible solutions (up to three non-trivial constraints).

LEARNING OUTCOMES:

1.Apply mathematical concepts and principles to perform computations

2.Create, use and analyze graphical representations of mathematical relationships

TEXT BOOKS/REFERENCE BOOKS:

1. 12th NCERT Text Book
2. R.D SHARMA FOR CLASS 11th AND 12TH MATHEMATICS
3. R.S . AGRAWAL FOR CLASS 12TH MATHEMATICS
4. PRADEEP'S REFERENCE BOOK FOR CLASS 11TH

SUB: ELEMENT OF MODERN PHYSICS
SUBJECT CODE: BPH-224

OBJECTIVE:

1. Students will apply understanding and skill related to the principles and concepts of modern physics essential for graduate school and/or professional employment in the field.

UNIT 1

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.

UNIT 2

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude.

UNIT 3

Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

UNIT 4

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

UNIT 5

Mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

COURSE OUTCOMES:

1. Demonstrated ability to solve relativity of space and time problemsDemonstrated ability to solve relativistic mass, energy, and momentum problems.
2. Demonstrated ability to solve problems involving the quantization of mass, charge, light, and energy including Avogadro's number, black-body radiation, photoelectric effect, and Compton scattering.
3. Described various models of the atom and explained why each was proposed and rejected except for the quantum model.
4. Demonstrated ability to apply wave-particle duality and uncertainty principle to solve physics problems.
5. Demonstrated ability to solve quantum mechanical eigenvalue equations for various operators and obtain expectation values of the corresponding observables.
6. Demonstrated ability to solve 1-D quantum problems including the quantum particle in a box, a well, the simple harmonic oscillator, and the transmission and reflection of waves

TEXT BOOKS/REFERENCE BOOKS:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.

ELEMENTS OF MODERN PHYSICS LAB

Subject Code: BPH-274

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.

Semester V

SUBJECT NAME: PHYSICAL CHEMISTRY-V
SUBJECT CODE: BCH-321

OBJECTIVES

1. Development of a scientific curiosity about physical chemistry.
2. Understanding concept of quantization of energy and its application.
3. To relate the principles learned in physical chemistry to area of photochemistry.
4. Understanding how light interacts with matter and how it can be used to quantitatively understand chemical samples.

UNIT-I QUANTUM CHEMISTRY-I

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions.

UNIT-2 QUANTUM CHEMISTRY –II:

Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

UNIT-3 PHOTOCHEMISTRY

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical 34 reactions in biochemical processes, photostationary states, chemiluminescence

UNIT-4 MOLECULAR SPECTROSCOPY:

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

UNIT-5 ELECTRONIC SPECTROSCOPY:

Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

LEARNING OUTCOMES:

1. Relate the concepts of quantum chemistry and its application
2. Interrelate the study of light to the nature of the atom
3. Correlate the atomic structure of an element to its physical and chemical properties.
4. Understand the concept of photochemistry and its application in day to day life.
5. Begin to relate the principles learned in chemistry to your chosen area of study.

Reference Books:

- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
- House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
- Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

SUBJECT NAME: PHYSICAL CHEMISTRY LAB –V

SUBJECT CODE: BCH-371

1. To determine the refractive index of given liquid and calculation of specific and molar refractivity.
2. Determination of concentration of binary mixture by measurement of refractive index.
3. Setting of a Galvanic Cell and determination of cell voltage.
4. To verify Lambert-beer Law for $KMnO_4$ solution &determine the conc. of given unknown solution
5. To verify Lambert-beer Law for $CuSO_4$ solution &determine the conc. Of given unknown solution of $CuSO_4$.
1. To prepare the following colloidal sol: Arsenious sulphide, Ferric hydroxide sol, Aluminum hydroxide sol.

Reference Books

- Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

SUBJECT NAME: SPECTROSCOPY AND IMPORTANT ORGANIC COMPOUNDS (DEPARTMENT ELECTIVE)
SUBJECT CODE: BCH-322

OBJECTIVES

1. Deduce the structural formula of an unknown organic compound from spectroscopic or chemical data.
2. Able to understand the concept of natural product.
3. To understand the concept and difference between natural and synthetic rubber.

UNIT-1:NMR SPECTROSCOPY: Principle of nuclear magnetic resonance,the PMR spectrum,number of signals, peak areas, equivalent and nonequivalent protons positions of signals and chemical shift, shielding and deshielding of protons, proton counting,splitting of signals and coupling constants, magnetic equivalence of protons. Discussion of PMR spectra of the molecules: ethyl bromide, n-propyl bromide, isopropyl bromide, 1, 1-dibromoethane, 1, 1, 2-tribromoethane, ethanol, acetaldehyde, ethyl acetate, toluene, benzaldehyde, acetophenone, *p*-anisidine and *p*-nitrotoluene. Simple problems on PMR spectroscopy for structure determination of organic compounds.

UNIT-2: MASS SPECTROSCOPY: Introduction, instrumentation, mass spectrum, determination of molecular formula, parent peak and base peak, recognition of molecular ion peak, fragmentation pattern of alkanes, alkenes and benzene.

UNIT-3:CARBOHYDRATES: CLASSIFICATION AND NOMENCLATURE-Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of glucose and fructose. Open chain and cyclic structure of D (+)-glucose & D (-) fructose. Mechanism of mutarotation.

UNIT-4:CARBOHYDRATES : STRUCTURES OF RIBOSE AND DEOXYRIBOSE.:An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) involving structure determination.

UNIT-4 FABRICS: Fabrics – natural and synthetic (acrylic, polyamido, polyester), Rubbers – Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers- natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.

LEARNING OUTCOMES:

1. Understanding the various ways organic chemical structures are depicted.
2. Drawing organic chemical structures from names.
3. Knowledge of the basic mechanisms of reactions involved in synthesis of carbohydrate and fabrics.
4. Apply the concept of spectroscopy.

Reference Books:

Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry.
IV Edition. W.H. Freeman and Co.

SUBJECT NAME: INORGANIC CHEMISTRY-IV

SUBJECT CODE: BCH-324

OBJECTIVES:

1. To know the ions effect on reaction process.
2. To learn the removal process of interfering anions after group-II
3. To study kinetics and reaction mechanisms of different complexes
4. To learn role of ions in human body through bio-inorganic chemistry
5. To study the organometallic compounds and different process of alkane synthesis

UNIT-1: THEORETICAL PRINCIPLES IN QUALITATIVE ANALYSIS:

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II

UNIT-2: REACTION KINETICS AND MECHANISM

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

UNIT-3: BIOINORGANIC CHEMISTRY

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

UNIT-4: ORGANOMETALLIC CHEMISTRY

Definition, Nature of Metal Carbon bond, classification of organometallic compounds by bond types viz. i) covalent ii) Ionic iii) Electron deficient, cluster compounds bond compounds including sandwitch derivatives. Structure and bonding in Meta carbonyls, cyclopentadienyl derivative, metal-

ethylenic, metal-acetylenic complexes, Applications of organometallic compounds as homogeneous catalysts in hydrogenation, hydroformylation, polymerization, oligomerization and metathesis reactions of alkenes
and alkynes (Ziegler - Natta polymerization of ethylene and propylene).

UNIT-5 ORGANOMETALLIC COMPOUNDS

VBT.π-acceptorbehaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.
Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkylaluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium. Wacker Process, Synthetic gasoline (Fischer Tropsch reaction) Synthesis gas by metal carbonyl complexes.

LEARNING OUTCOMES:

1. Understand the ions effect on reaction process
2. Understand the removal process of interfering anions after group-II
3. Learn kinetics and reaction mechanisms of different complexes
4. Learn role of ions in human body through bio-inorganic chemistry
5. Study the organometallic compounds and different process of alkane synthesis.

SUBJECT NAME: INORGANIC CHEM LAB-IV
SUBJECT CODE: BCH-374

1. Determination of acetic acid in commercial vinegar using NaOH
2. Determination of alkali content - antacid tablet using HCl
3. Estimation of calcium content in chalk as calcium oxalate by permanganometry.
4. Gravimetric Analysis
   (i) Aluminium as oxinate
   (ii) Mg as $MgNH_4PO_4.6H_2O$
   (iii) Ba as $BaSO_4$
4. Synthesis of
   (a) Sodium hexa nitritocobaltate (III) (b) Sodium ammonium hydrogen phosphate

SUBJECT NAME: ORGANIC CHEMISTRY-V
SUBJECT CODE: BCH-325

OBJECTIVES:

1. Understand the language and diagrammatic notation of organic chemistry and be able to communicate and apply this knowledge.

2. Predict the properties of organic compounds.

3. Demonstrate some knowledge of the sources of and uses for organic compounds in the practical world.

4. Design reactions paths by which a great variety of moderately complex organic compounds could be prepared from simple, readily available compounds.

5. Be able to account for how reactions occur at the molecular level.

UNIT-1:FATS, OIL AND DETERGENTS:

Occurrence, chemical composition and importance, hydrogenated oils, Rancidity, acid value, saponification and iodine numbers, difference between toilet and washing soaps, comparison of soap and detergents, classification and principle of cleansing action of detergents.

UNIT-2:POLYMERS:

Polymers, Classification on the basis of source, repeating units, sequences, method of polymerization, intermolecular interactions, atoms present. Mechanism of polymersisation.Synthesis of polymers: Nylon-6,6.; Perlon, Dacron, PAN, PVC. Natural rubber, synthetic rubber, vulcanization; Plastics; resins

UNIT-3:ALKALOIDS

Natural occurrence, General structural features, Isolation and their physiological action
Hoffmann's exhaustive methylation, Emde's modification, Structure, Medicinal importance elucidation and synthesis of Nicotine, cocaine, atropine.

UNIT-4: DRUGS

Introduction, structure and use of methylene blue, Prontosil, use of pronyosil in synthesis of other sulpha drugs. Synthesis, structure and uses of sulphadiazine, mode of action of p-aminobenzenesulphonamide on bacteria.

UNIT-5: SYNTHETIC DYES

Color and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, and Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.

LEARNING OUTCOMES:

1. To know the complete detailed structure of the organic Compounds.
2. Able to explain the relationship between starting materials, reagents and products arising from variety of reactions
3. To understand the way in which bonds are made and broken to bring about product formation in these reactions (that is, the reaction mechanism)
4. The effect of structural variations on reactivity (rate or position of equilibrium) in these reactions.

Reference Books:

- Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub.

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

- Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.

- Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.

- Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

- Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.

- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University Press.

SUBJECT NAME: ORGANIC CHEMISTRY LAB-V
SUBJECT CODE: BCH-375

Determination of :
(a) Acid value: Resin, Plasticizers
(b) Iodine number : Linseed oil, Castrol oil
(c) Saponification value: coconut oil, polyester.
Synthesis of the following organic compounds:
(a) p-Nitroacetanilide from acetanilide and its hydrolysis to p-nitroaniline.
(b) Phthalimide from phthalic anhydride and its rearrangement to anthranilic acid.
(c) Benzanilide from benzophenone.
Synthesis of urea-formaldehyde and phenol-formaldehyde resin.
Paper Chromatography
Determination of Rf values and identification of organic compounds
(a) Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid.
Leucine and glutamic acid . Spray reagent-ninhydrin.
(b) Separation of mixture of D,L-alanine, glycine and L-leucine using n-butanol : acetic acid water (4:1:5). Spray reagent-ninhydrin.

Reference Books:

- Vogel, A.I. *Quantitative Organic Analysis*, Part 3, Pearson (2012).
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)

- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).

Semester VI

POLYMER CHEMISTRY : DEPARTMENTAL ELECTIVE

SUBJECT CODE: BCH-326

OBJECTIVES:

1. Learn about the monomers, polymers and types of polymers
2. Learn about the kinetics of polymerization, crystallinity and factors affecting the melting point of polymers
3. Learn about the glass transition temperature and methods of determining the molecular weight of polymers

UNIT 1: INTRODUCTION AND HISTORY OF POLYMERIC MATERIALS

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Functionality and its importance: Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

UNIT 2: KINETICS OF POLYMERIZATION

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques. Crystallization and crystallinity: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

UNIT 3: NATURE AND STRUCTURE OF POLYMERS

Structure Property relationships. Determination of molecular weight of polymers (*Mn*, *Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

UNIT 4: POLYMER SOLUTION

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

UNIT 5: PROPERTIES OF POLYMERS

Physical, thermal, Flow & Mechanical Properties. Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride), poly(vinyl acetate), acrylic polymers, fluoro polymers, polyamides. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline].

LEARNING OUTCOMES:

1. Understand and perform the various polymerization techniques
2. Understand the various properties of polymers.
3. Describe the relationship between the lower and upper critical solution temperature. How it changes?
4. Describe how thermodynamics properties such as entropy, enthalpy and free energy changes on mixing of polymer solution.
5. Study the different polymers (Natural and synthetic) present in this world.

List of Text Books:

- *Seymour's Polymer Chemistry,* Marcel Dekker, Inc.
- G. Odian: Principles of Polymerization, John Wiley.
- F.W. Billmeyer: Text Book of Polymer Science, John Wiley.

List of Reference Books

- P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
- R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

FUEL CHEMISTRY (DEPARTMENTAL ELECTIVE)
SUBJECT CODE: BCH-327

OBJECTIVES:

- learn more about the energy-fuels-environment connection;
- prepare for making an intelligent contribution to the difficult energy policy choices in the twenty-first century
- To know in detail about different kind of fuel and its efficiencies.

UNIT-1: LUBRICANTS & LUBRICANTS

Introduction, Mechanism of lubrication: fluid film, boundary lubrication and extreme pressure lubricants, Classification of lubricants: Solid, semi-solid, liquid and emulsion, synthetic lubricants and additives for lubricants.

UNIT-2 PROPERTIES OF LUBRICANTS

Properties of lubricants: Flash & Fire point, Saponification number, Iodine value, Acid value , Viscosity and Viscosity index, Aniline point, Cloud point and pour point, Corrosive Tendency, Specific gravity, Volatility, oiliness, Emulsification, decomposition stability and carbon residue of lubricants

UNIT-3: COAL AS ENERGY RESOURCES

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value, Characteristics of good fuel, Comparison between solid, liquid and gaseous fuel, BOMB calorimeter, Coal, Classification of coal, Uses of coal in various industries, Selection of coal, analysis of coal, carbonization of coal. Pulverized coal and Metallurgical coal.

UNIT- 4 PETROLEUM

Petroleum, Cracking, Fractionation Distillation, Cracking: Thermal & Catalytic Cracking, Refining of gasoline, Synthetic petrol and methods of polymerization for synthetic petrol, Reforming: Thermal and Catalytic reforming, Knocking, Improvement in anti knocking properties.

UNIT-5: FUELS

Diesel Engine fuel, Kerosene & LPG as fuel, Non petroleum fuels, Natural gas, Coal gas, Oil gas Water gas/ Blue gas, Non- conventional source of energy, Biomass, Biogas, Combustion, Analysis of fuel gas.

LEARNING OUTCOMES:

Students should know following aspects after completion of course:

1. Energy use and the chemical processing aspects of energy production;
2. the chemical processes of fuel refining, conversion and utilization, including processes that can control air pollution;
3. the selection of equipment for efficient utilization of fuels and upgrading of fuels to maximize energy conversion and minimize the environmental impact of fuel utilization;
4. Applications of materials for purification of air and water;
5. Use of lubricants in different machines in industries.

Reference Books:

- Fuels and fuel-additives. S.P. Srivastava & Jeno Hancsok. Willey.
- The chemistry of Hydrocarbon fuels. *Harold H. Schobert. Science Direct.*
- The chemistry and technology of petroleum. J.G. Speight.
- The chemistry and technology of coal. James Speight.

M.Sc. CHEMISTRY

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M.Sc. Chemistry Specialization in Organic Chemistry

(Two Year Programme)

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M.Sc.1st Semester

Paper Code	Paper Name	L-T-P	Credits
MCH-111	Organic Chemistry-I	4-1-0	5
MCH-112	Physical Chemistry-I	4-1-0	5
MCH-120	Inorganic Chemistry-I	4-1-0	5
MCH-161	Organic Chemistry –I Lab	0-0-4	2
MCH-162	Physical Chemistry-I Lab	0-0-4	2
MCH-170	Inorganic Chemistry Lab-I	4-1-0	5
	Total		24

M.Sc. 2nd Semester

Paper Code	Paper Name	L-T-P	Credits
MCH-114	Inorganic Chemistry-II	4-1-0	5
MCH-115	Organic Chemistry-II	4-1-0	5
MCH-116	Physical Chemistry-II	4-1-0	5
MCH-117	Analytical Chemistry	4-1-0	5
MCH-164	Inorganic Chemistry Lab-II	0-0-4	2
MCH-165	Organic Chemistry Lab-II	0-0-4	2
MCH-166	Physical Chemistry Lab-II	0-0-4	2
MCH-167	Analytical Chemistry Lab-I	0-0-4	2
MCH-168	Summer Project	0-0-4	6
	Total		30

M.Sc. 3rd Semester (Inorganic Chemistry Specialization)

Paper Code	Paper Name	L-T-P	Credits
MCH-212	Heterocyclic Compounds	3-1-0	4
MCH-213	Physical Chemistry III	4-1-0	4
MCH-219	Nuclear & Radioactive Chemistry	4-1-0	5
MCH-220	Bio Inorganic & Environmental Chemistry	3-1-0	5
MCH-260	Inorganic Chemistry-III Lab	0-0-4	2
MCH-261	Organic Chemistry-III Lab	0-0-4	2
MCH-263	Physical Chemistry-III Lab	0-0-4	2
	Total		24

M.Sc. 4th Semester (Inorganic Chemistry Specialization)

Paper Code	Paper Name	L-T-P	Credits
MCH-221	Organo Transition metal Chemistry	4-1-0	5
MCH-222	Electro Analytical Chemistry	4-1-0	5
MCH-223	Medical aspects of Inorganic Chemistry	4-1-0	5
MCH-224	Industrial Chemistry	4-1-0	5
MCH-271	Inorganic Chemistry-IV Lab	0-0-4	2
MCH-272	Inorganic Chemistry-V Lab	0-0-4	2
MCH-267	Dissertation/ Major Project	0-0-6	3
	Total		27

SYLLABUS FOR M.SC. (CHEMISTRY)

SEMESTER I

INORGANIC CHEMISTRY-I:

Learning Objective:

The learners should be able to analyse the mechanism of selected catalytic organic reactions from the structure-bonding aspects and reactivity of simple organometallic compounds. Organometallic reaction mechanisms are thoroughly discussed with emphasis on ligand substitution, oxidative addition, reductive elimination, insertion and elimination reactions, nucleophilic and electrophilic addition and abstraction at ligands, and the involvement of carbenes in metathesis and polymerization. The accumulated know-how at this point serves as the foundation for discussions about how organometallic complexes are utilized in homogeneous catalysis and in the activation of small molecules. The application of organometallics in catalysis is highlighted with selected important industrial processes.

Unit-I Organometallic Chemistry:

Basic concept of organometallic chemistry, Metal carbonyl, Phosphine's, alkenes, alkynes & allyl complexes. Hydride, carbenes , carbynes, metallocene, metal arenes compresses. Fluxonality in Organometallic compound.

Unit-II Organometallic Chemistry:

Homogeneous & Heterogeneous catalysis: Oxidative all & reductive elimination , Insertion reaction, Agostic Interaction, Hydroformylation, Zeigler Natta catalyst, Wilkinson catalyst, Syntheses gas. Monasto process & waker process , catalytic .

Unit- III Inorganic Reaction mechanism:

Mechanism of substitution reaction of tetrahedral, trigonal bipyramidal, square planar & octahedral complexes. Potential energy diagram. Factors affecting reactivity of square planer complex. Trans effect & its application to synthesis of complexes.

Unit-IV Molecular rearrangement Process:

Electron transfer reaction: outer & inner sphere complexes formation & rearrangement, Nature of bridging ligands, fission of successor complex, two electron transfers, syntheses of coordination compounds using electron transfer reaction.

Unit-V Bioinorganic Chemistry:

Basic Introduction (Porphyrin Ring, metallo porphyrin ring) , oxygen transport & oxygen storage system (Hemoglobin, myoglobin, hamocyanin, Hemerythrin), Metalloeneyme- CAE , CP, LADH , Xanthine Oxidase, Tyrosine, Cytochrome –C, Cyt-P-450, Vitamin B-12), Coenzyme-12.Electron transfer protean, Fe-Sulphur protein, cytochrome.Metal storage & metal transfer system ferritin , transferrin.

Reference Books:

1. Principle of Bioinorganic chemistry – Lippard and Berg, Univ. Science Books, 1994.

2. Bio-coordination chemistry – Fenton, Oxford chemistry primer, 1995.

3. Bioinorganic chemistry: Inorganic perspective in the chemistry of Life, Kaim and Schwederski, 1994.

4. Inorganic chemistry – Shriver, Atkins, and Langford, 1994.

5. Bioinorganic Chemistry – Bertini, Gray, Lippard and Valentine Viva books Pvt. Ltd. 1998.

Learning Outcomes:

At the end of the course, the learners should be able to: Identify the structure and bonding aspects of simple organometallic compounds Apply different electron counting rules to predict the shape/geometry of low and high nuclearity metal carbonyl clusters Identify the different types of organometallic reactions and apply the above concepts to explain different catalytic reactions.Having competence in the course you should: have a good overview of the fundamental principles of organotransition-metal chemistry and know how chemical properties are affected by metals and ligands, be able to use knowledge about structure and bonding issues to understand the stability and reactivity of simple organometallic complexes, have insight into the use of modern methods to characterize organometallic compounds.

PRACTICAL INORGANIC CHEMISTRY-I:

1. Preparation of Hexaamminecobalt(lII) chloride

2. Synthesis of CHLOROPENTAAMMINECOBALT(III) CHLORIDE

3. Preparation of ChloropentaamminecobaIt (III) chloride

4. To determine the molar conductance of [Co(NH3)5]Cl3, and [Co(NH3)5Cl]Cl2 by measuring conductivity of these compounds.

5. To determine the number of chloride ions in the [Co(NH3)5]Cl3 and [Co(NH3)5Cl]Cl2.

6. Synthesis of trans-dichlorobis (ethylenediamine) cobalt (III) Chloride

7. Synthesis of cis-Dichlorobis(ethylenediamine)cobalt (III) Chloride

ORGANIC CHEMISTRY-I:

Learning Objectives:

1. Differentiate chiral and achiral molecules.

2. Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.

3. Identify the stereocenters in a molecule and assign the configuration as R or S.

4. Know the relationship between enantiomers and their specific rotations.

5. Differentiate chiral and achiral molecules.

Unit-1: Stereochemistry-I:

Molecular Symmetry and Chirality: Symmetry operations and elements, point groups and symmetry number
Stereoisomerism: classification, racemisation, molecules with one, two or more chiral centres, DL, RS and EZ nomenclature. Planar and axial chirality. Stereochemistry of allenes, spiranes, alkylidine cycloalkanes, adamantanes, catenanes, biphenyls(atropisomerism), bridged biphenyls and cyclophanes.

Unit-1 Stereochemistry-II:

Topicity and prostereoisomerism: topicity of ligands and faces and their nomenclature, stereogenicity, pseudoasymmetry, stereogenic and prochiral centres.
Simple chemical correlation of configurations with examples, quasiracemates
Cyclostereoisomerism: configuration, conformation, stability of cyloheanes(mono, di and tri-substituted), cyclohexenes, cyclohexanones, halocyclohexanones.
Asymmetry induction: Cram's, prelog's and Horeau's rules; Dynamic stereochemistry (acyclic and cyclic) Curtin-Hammett Principle, circular dichromism and cotton effect.

Unit-3 Study of reactive intermediates-I:

Linear free energy relationships and their applications (Hammett equation and modifications)
Carbocations: Classical and non-classical, NGP (Neighbouring group participation), ion-pairs, molecular rearrangements in acyclic, monocyclic and bicyclic systems, stability and reactivity of bridged-head carbocations.

Unit-4 Carbanions:

Generation, structure and stability, ambident ions and their general reactions; HSAB principle and its application
Radicals: Generation, structure and stability and reactions, radical cations and anions.

Unit-5 Carbenes:

Formation and structure, reactions invoving carbenes and carbenoids.
Nitrenes: Formation, structure, reactions of nitrenes
Nucleophilic aromatic substitution: Benzynes. SNAr and SRN1 mechanisms; Ipso effect.

Reference Books:

1. F. A. Carey and R. A. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th edition, Springer, New York, 2007.

2. W. Carruthers and I. Coldham, Modern methods of Organic Synthesis, First South Asian Edition 2005, Cambridge University Press.

3. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2007.

4. I. Fleming, Frontier Orbitals and Organic Chemical Reactions, Wiley, London, 1976.

5. S. Sankararaman, Pericyclic Reactions- A text Book, Wiley VCH, 2005.

Learning Outcomes:

To learn the involvement of reactive intermediates and understand their structure and reactivity through various organic reactions. To learn and understand the orbital interactions (Woodward Hoffmann rules) in concerted reactions. Learn to apply concerted and stepwise reactions in organic synthesis.
On Completion of this module, the learner will be able to:Calculate optical purity and enantiomeric excess, Discuss the relative stability of conformational isomers of cyclohexanes and related compounds, Draw all the stereoisomers of organic compounds, and recognise diastereomers, enantiomers, meso compounds and centres of symmetry, Recognise and discuss the stereoisomers of chiral compounds that do not contain a stereogenic carbon centre and assign the configuration of the stereoisomers.

PRACTICAL ORGANIC CHEMISTRY-I:

I) Qualitative analysis of mono and bifunctional compounds.
II) Small Scale organic synthesis using one of the following reactions:
i) Acylation reaction
ii) Bromination and bromine addition
iii) Diazotization reactions

iv) Coupling reactions.

PHYSICAL CHEMISTRY-I:

Learning Objectives:

Recognize the most significant and elementary solutions of Schrodinger equation in molecular quantum mechanics through a study of time independent perturbation theory, valence bond and molecular orbital theories.

and uncertainty principles.Differential equations, partial differential equations, series solutions and special functions, linear vector spaces, transformations of coordinate matrix, representation of operators, eigenvalue problem, orthonormal sets Fourier and Laplace transforms.

Unit-II Some exactly soluble problems:

Particle in a box and ring. Concept of degeneracy and Jahn-Teller distortion. Simple harmonic oscillator problem and its solution using series solutions or factorization method. Calculation of various average values using ladder operators and recursion relations of Hermite polynomials.
Angular momentum operators. Eigenvalues and eigenfunctions. Ladder operators. Rigid rotator and hydrogen atom: Complete solution. Radial distributions. Virial theorem.

Unit-III HMO method and its applications:

π-Electron approximation, Huckel molecular orbital theory of conjugated systems, calculation of properties- delocalization energy, electron density, bond order, alternant and nonalternant hydrocarbons, pairing theorem.

Unit-IV Approximate methods-I:

First order time-independent perturbation theory for non degenerate states. Variation theorem and variational methods. Use of these methods illustrated with some examples (particle in a box with a finite barrier, anharmonic oscillator, approximate functions for particle in a box and hydrogen atom).

Unit-V Approximate methods-II:

Ground and excited state of helium atom.Pauli's exclusion principle. Many-electron atoms. Concept of spin and determinantal wave functions.

Reference Books:

1. P. W. Atkins and R. S. Friedman, Molecular Quantum Mechanics, Oxford University Press, Oxford, 2004. (Must for Quantum Chemistry basics)

2. Quantum Chemistry by RK Prasad

3. Quantum Chemistry by Era Levine (For Advance Quantum Chemistry)

4. Introduction to Quantum Chemistry by Clifford Dykstra

5. Elementary Quantum Chemistry by Frank Pilar, Mineola, N.Y. Dover, 2001

6. Quantum chemistry and spectroscopy by Thomas Engel, Pearson/Benjamin Cummings, c 2006

7. Quantum chemistry : fundamentals to applications by Tamás Veszprémi , Kluwer Academic/Plenum, 1999.

8. J. P. Lowe and K. Petersen, Quantum Chemistry, Elsevier Academic Press, MA, USA, 2006

Learning Outcomes:

- You master the elementary principles of quantum mechanics.
- You understand the electronic structure of atoms and their periodicity.
- You understand the electronic structure of molecules and chemical bonding.
- You have a basic understanding of chemical structure determination.

PRACTICAL PHYSICAL CHEMISTRY-I:

Chemical kinetics:

1. Determine the specific rate constant for the acid catalysed hydrolysis of methyl acetate by the initial rate method. Study the reaction at two different temperatures and calculate the thermodynamic parameters.
2. Study the saponification of ethyl acetate with sodium hydroxide volumetrically.

Conductometry:

1. Determine the cell constant of the given conductivity cell at room temperature and study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (acetic acid).
2. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration of ions.

3. Determine the equivalent conductance, degree of dissociation and dissociation constant (Ka) of acetic acid.
4. Study the conductometric titration of acetic acid vs. sodium hydroxide

Potentiometry:

1. Prepare and test Calomel electrode.
2. Titrate hydrochloric acid and sodium hydroxide potentiometrically.
3. Determine the dissociation constant of acetic acid potentiometrically.
4. Titrate oxalic acid and sodium hydroxide potentiometrically.

SEMESTER II

INORGANIC CHEMISTRY-II:

Learning Objectives:

Apply the concept of linear combination of atomic orbitals to hybridization and directed bonding in polyatomic molecules. Solve the real-world problem using advanced numerical programs through Gaussian orbitals. Show that molecular symmetry operations form a group and can be characterized by fundamental representations of groups known as irreducible

Course A: Group Theory and its Applications:

Symmetry elements and symmetry operations, Groups, subgroups, classes and its characteristics, products, classes and application of symmetry operations
Equivalent atoms, equivalent symmetry elements, relation between symmetry elements and operations
Point group classification along with the Optical activity and Dipole moment based applications.
Reducible and irreducible representations, position vector, base vector for representation, character table, Wave functions for irreducible representations (p- and d- block only), Correlation diagram, Russell-Saunders coupling, vibronic coupling, non-cetrosymmetric complexes.
Infrared and Raman spectroscopy, SALCs, Hybridization and its applications, LCAO.

Course B: d- and f- block elements:

Russel Saunders state, Term and symbols, CFT and splitting in T_d, D_{4h}, C_{4v} systems, Determination of D_q and Racah parameters, Orgel and Tanabe sugano diagrams, electronic absorption spectra (complex ions), Magnetic properties (Transition metal complexes) Structure and bonding in complexes containing π-acceptor ligands. Spectrochemical and nephelauxetic series.

Reference Books:

1. D. M. P. Mingos and D. J. Wales; Introduction to Cluster Chemistry, Prentice Hall, 1990.

2. N. N. Greenwood and E. A. Earnshaw; Chemistry of elements, Second Edition, Butterworth- Heinemann, 1997.

3. T. P. Fehlner, J. F. Halet and J-Y. Saillard; Molecular Clusters: A Bridge to solid-state Chemistry, Cambridge University press, 2007.

4. B. D. Gupta and A. J. Elias; Basic Organometallic Chemistry: Concepts, Synthesis, and Applications, Universities Press (India), 2010.

5. D. M. P. Mingos, Essential Trends in Inorganic Chemistry, Oxford, University Press, 1998.

6. C. E. Housecroft, Metal-Metal Bonded Carbonyl Dimers and Clusters, Oxford Chemistry Primers (44), Oxford, University Press, 1996.

Learning Outcomes:

At the end of the course, the learners should be able to: Apply time independent perturbation theory to complex problems of molecular energy levels in the presence of external electric and magnetic fields, Determine the symmetry operations of any small and medium-sized molecule and apply point group theory to the study of electrical, optical and magnetic properties and selection rules for absorption.

PRACTICAL INORGANIC CHEMISTRY-II:

1. Qualitative analysis of mixtures of inorganic salts including rare earth salts.
2. Quantitative analysis of mixtures of metal ions by complexometric titrations using masking and de masking agents.

ORGANIC CHEMISTRY-II:

Learning Objectives:

The course aims to improve a student's understanding of fundamental organic reactions and to add further transformations and principles to their knowledge base. They will encounter anion, radical, pericyclic and organometallic mediated processes, gaining new insights into the factors governing the mechanistic, stereo-chemical and region-chemical course of such reactions. Throughout the course the usefulness of the chemistry discussed with be highlighted through applications.

Course A: Organic Synthetic methodology:

Reduction Chemistry: Stereochemistry and selectivity of catalytic hydrogenation along with the mechanism, Applications of Lithium aluminium hydride, Sodium borohydride, sodium cyanohydride, alkoxy substituted LAH, DIBAL, diborane, diisoamylborane, thexyborane, 9-BBN as reducing agents, Homogeneous hydrogenation mechanism using Ru and Rh metal complexes along with its applications.
Oxidation Chemistry: Sharpless epoxidation, Applications of DDQ, SeO_2, $Tl(NO_3)_3$.
Coupling Reactions with Pd(0) and Pd(II): Stille, Suzuki and Sonogashira coupling, Heck reaction and Negishi coupling.
Reductions: stereochemistry, stereoselection and mechanism of catalytic hydrogenation and metal-liquid ammonia reactions.

Course B: Spectroscopy:

PMR: Effect of external magnetic field on the spinning nucleus, precessional motion and frequency. Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effects. Integrals of protons, spin-spin coupling, magnitude of coupling constant. Chemical and magnetic equivalence, proton exchange, factors affecting the coupling-first and non-first order spectra. Simplification of complex spectra and NOE experiments.Applications of PMR in structural elucidation of simple and complex compounds.

CMR: Resolution and multiplicity of ^{13}C NMR. ^{1}H-decoupling, noise decoupling, broad band decoupling, deuterium, fluorine and phosphorus coupling. NOE signal enhancement, off-resonance, proton decoupling, structure applications of CMR, DEPT and INEPT experiments. Introduction to 2D-NMR, COSY, HMQC and HETCOR spectra.

ESR: Hyperfine splitting, g-values, ESR spectra of molecules.

MASS: Unit mass and molecular ions, Singly, doubly/multiple charged ions, metastable peak, base peak, isotopic mass peaks, Recognition of M^+ ion peak, Ionization methods (CI, EI and FAB), general fragmentation rules, fragmentation of various classes of organic molecules, McLafferty rearrangement, ESI, APCI and MALDI etc.

Reference Books:

1. P. W. Atkins, Molecular Quantum Mechanics, 2nd edition, Oxford University Press, 1983.

2. P. F. Bernath, Spectra of Atoms and Molecules, 2nd Edition, Oxford University Press, 2005.

3. E. B. Wilson, Jr., J. C. Decius and P. C. Cross, Molecular Vibrations: The Theory of Infrared and Raman Spectra, Dover Publications, 1980.

4. W. Demtroder, Molecular Physics, Wiley-VCH, 2005.

5. J. A. Weil and J. R. Bolton, (Eds), Electron Paramagnetic Resonance: Elementary Theory and Practical Applications, Second Edition, Wiley Interscience, John Wiley & Sons, Inc., 2007.

6. A. E. Derome, Modern NMR Techniques for Chemistry Research, Pregamon, 1987.

7. C. P. Slichter, Principles of Magnetic Resonance, Third Edition, Springer-Verlag, 1990.

8. T. C. Farrar and E. D. Becker, Pulse and Fourier Transform NMR, Academic Press, New York, 1971.

Learning Outcomes:

Having successfully completed this module you will be able to: Describe different approaches to the formation of carbanions, discuss their structures, stabilities/reactivities and applications in synthesis, Appreciate the likely course of a radical addition reaction when myriad options are, in principle, available (e.g. in casdade radical reactions), Delineate the mechanistic and stereochemical course of some sophisticated cascade radical reactions and appreciate their value in target oriented synthesis.

PRACTICAL ORGANIC CHEMISTRY-II:

I) Qualitative analysis of mono and bifunctional compounds.
II) Small Scale organic synthesis using one of the following reactions:
  i) Oxidation and reduction
  ii) Condensations
  iii) Diazotization reactions
  iv) Acylation reaction

PHYSICAL CHEMISTRY-II:

Learning Objectives:

The learners should be able to apply principles and laws of equilibrium thermodynamics to multicomponent systems. In addition, they should be able to use spectroscopic data to calculate thermodynamic properties of ideal gases, real gases, solids and metals using the principles and techniques of statistical thermodynamics.

The learners should be able to apply elementary laws of chemical kinetics and analyze reaction mechanisms and changes in transport properties of chemical reactions and collision processes.

Course A:

Statistical mechanics, thermodynamics, kinetics and macromolecules statistical mechanics and thermodynamics.

Fundamentals:

Concept of distribution. Thermodynamic probability and most probable distribution. Canonical and other ensembles. Statistical mechanics for systems of independent particles and its importance in Chemistry. Types of statistics: Maxwell-Boltzmann. Thermodynamic probability (W) for the three types of statistics. Derivation of distribution laws (most probable distribution) for the three types of statistics. Lagrange's undetermined multipliers. Stirling's approximation, molecular partition function and its importance. Assembly partition function.

Application to ideal gases:

The molecular partition function and its factorization. Evaluation of translational, rotational and vibrational partition function of monatomic, diatomic and polyatomic gases. The electronic and nuclear partition functions. Calculation of thermodynamic properties of ideal gases in terms of partition function. Statistical definition of entropy. Third law of Thermodynamics, Residual entropy.

Macromolecules:

Concepts of number average and mass molecular weights. Methods of determining molecular weights (osmometry, viscometry, sedimentation equilibrium methods). Distribution of chain lengths. Average end-to-end distance.

Course B: Kinetics:

Theories of reaction rates: Collision theory. Potential energy surfaces (basic idea). Transition state theory (both thermodynamic and statistical mechanics formulations). Theory of unimolecular reactions, Lindemann mechanism, Hinshelwood treatment, RRKM model (qualitative treatment).

Solution kinetics:

Factors affecting reaction rates in solution. Effect of solvent and ionic strength (primary salt effect) on the rate constant. Secondary salt effects.

Electrochemistry:

Solutions: Activity coefficients and ion-ion interactions. Physical significance of activity coefficients, mean activity coefficient of an electrolyte and its determination. Derivation of

Debye-Huckel theory of activity coefficients (both point ion size and finite ion size models). Excess functions.

Reference Books:

1. P. Atkins and J. Paula, Physical Chemistry, 10th Edition, Oxford University Press, Oxford 2014.
2. D. A. McQuarrie and J. D. Simon, Molecular Thermodynamics, University Science Books, California 2004
3. R. S. Berry, S. A. Rice and J. Ross, Physical Chemistry, 2nd Edition, Oxford University Press, Oxford, 2007
4. D. A. McQuarrie, Statistical Mechanics, University Science Books, California 2005
5. B. Widom, Statistical Mechanics - A Concise Introduction for Chemists, Cambridge, University Press, 2002

Learning Outcomes:

At the end of the course, the learners should be able to: Calculate change in thermodynamic properties, equilibrium constants, partial molar quantities, chemical potential. Identify factors affecting equilibrium constant, Apply phase rule and, draw phase diagrams for one, and two component systems, identify the dependency of temperature and pressure on phase transitions, and identify first/second order phase transitions, Solve problems based on Debye-Huckel limiting law. Calculate excess thermodynamic properties, Calculate the absolute value of thermodynamic quantities (U, H, S, A, G) and equilibrium constant (K) from spectroscopic data, Predict heat capacity (Cv, Cp) of an ideal gas of linear and non-linear molecules from the number of degrees of freedom, rotational and vibrational wave numbers.

PRACTICAL PHYSICAL CHEMISTRY-II:

Chemical kinetics:

1. Compare the strength of hydrochloric acid and sulphuric acid studying the rate of hydrolysis of methyl acetate.
2. Study the kinetics of iodination of acetone in the presence of acid by the initial rate method.

Conductometry:

1. Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in commercial sample of soda ash.
2. Study the conductometric titration of acetic acid vs. ammonium hydroxide
3. Study the conductometric titration of sodium acetate vs. HCl

Potentiometry:

1. Prepare and test Calomel electrode.
2. Titrate a mixture of strong and weak acids (Hydrochloric and acetic acids)
3. Titrate a mixture of weak acid (acetic acid) and dibasic acid (oxalic acid)
4. Titrate a mixture of strong acid (hydrochloric acid) and dibasic acid (oxalic acid) versus sodium hydroxide.

ANALYTICAL CHEMISTRY-I

Course Objectives:

The learners should be able to apply the conceptual understanding of the principles and implementation modes of several analytical instruments to chemical systems.

To know that mixtures are composed of constituents which are not combined. To apply methods of distillation, sublimation, chromatography, filtration (including buchner filtration), evaporation, decantation, using magnetism, sieving and skimming to separate mixtures.To understand the terms filtrate, residue, filtration, sediment, decant, distil, distillate, chromatogram and solvent front.

Course A: Introduction to analytical chemistry:

Scope & objectives, Analytical chemistry and chemical analysis, Classification of analytical methods, Method selection, Sample processing, Steps in a quantitative analysis, Quantitative range (bispartite classification), Data organization, Analytical validations, Limit of detection and limit of quantitation, The tools of analytical chemistry and good lab practices.

Errors in Chemical Analysis and Statistical Evaluation of Data:

Systematic and random errors, Accuracy and precision, Ways of expressing accuracy and precision, Normal error curve and its equation, Propagation of error, Useful statistical test: test of significance, the F test, the student ‘t’ test, the chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least-square method for linear plots), statistics of sampling and detection limit evaluation.

Course B: Separation Methods:

(a) Multiple liquid-liquid extraction:

Countercurrent extraction, Craig's tube and Craig's apparatus, distribution of single solute, Gaussian treatment in describing distribution pattern of solute fraction in r^{th} tube after n-transfers.

(b) Fractional Distillation:

Temperature composition diagram of a binary system, concept of theoretical plates, HETP, Bubble-cap distillation column and derivation of Fenske equation.

(c) Chromatography:

General description of Chromatography, Principle of chromatography, Classifications of chromatography, Techniques of planar and column chromatography, Gas chromatography, High-performance liquid chromatography.

Gas Chromatography:

Introduction, principle of gas chromatography, instruments for gas-liquid chromatography, detectors:- thermal conductivity detector, flame ionization detector, electron capture detector and others, gas chromatographic columns and stationary phases, factors affecting the efficiency of the column, Van-Deemter equation, resolution, retention time and other basic parameters. Interpretation of gas chromatograms. Qualitative analysis, Kovats retention index (I), Quantitative analysis, measurement of peak area, response factor; Temperature programming in gas chromatography, Applications of gas chromatography.

High Performance Liquid Chromatography (HPLC):

Basic difference between HPLC and conventional liquid chromatography with respect to sample applications, packing materials and equipments, detectors. Advantages and applications.

Reference Books:

1. *Wilson, Ian D.; Adlard, Edward R.; Cooke, Michael; et al., eds. (2000). Encyclopedia of separation science. San Diego: Academic Press. ISBN 978-0-12-226770-3*

2. D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 6th Edition, Brooks/Cole Cengage Learning, Belmont, CA, 2007

3. H. H. Willard, L. L. Merrln, Jr., J. A. Dean, and F. A. Senle, Jr., Instrumental Methods of Analysis: Wadsworth, 7th Edition, Belmont., 1989

4. F. Rousseac and A. Roessac, Chemical Analysis: Modern Instrumentation Methods and Analysis, 4th Edition, John Wiley & Sons, Ltd., 2000

5. J. Wang, Analytical Electrochemistry, 3rd Edition, Wiley – VCH, 2006

6. P.T. Kissinger and W. R. Heineman, Laboratory Techniques in Electroanalytical Chemistry, 2nd Edition, Marcel Dekker Inc., 1996

7. B. Voigtlaender, Scanning Probe Microscopy: Atomic Force Microscopy and Scanning

Learning Outcomes:
At the end of the course, the learners should be able to: Solve problems based on various analytical concepts, Design experiments with improved sample preparation, new measurement procedures and tools, Quantify analytes with proper data handling and analysis.

Describe qualitatively and model quantitatively the operation and design of economically viable processes and equipment for diffusional separation of binary mixtures or one-component transfer. Distinguish between staged and continuous separation equipment and apply the appropriate analysis and design techniques.

PRACTICAL ANALYTICAL CHEMISTRY-I

1. Determination of accuracy, precision, mean deviation, standard deviation, coefficient of variation, normal error curve and least square fitting of certain set of experimental data in an analysis.
2. Composition of two sets of results in terms of significance (Precision and accuracy) by (I) student's t-test, (ii) F-test.
3. Determination of Fe (III) by chloride extraction in ether.
4. Determination of Fe (III) as the 8-hydroxy quinolate (oxinate) by extraction in chloroform.
5. Separation of Cd^{+2} and Zn^{+2} quantitatively through an anion exchanger.
6. Separation of nickel, manganese, cobalt and zinc and determination of R_f values by thin layer or paper strip techniques.
7. Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration).

M.SC. CHEMISTRY THIRD SEMESTER

Course Objectives:

A major objective of the present course of lectures is the rationalization of the reactivity of heteroaromatic compounds. Will have some knowledge of methods to prepare some heterocyclic compounds with Five and Six members, fused rings and heterocyclic compounds two or more heteroatom's. Improving the students' knowledge of the methods of preparation followed by the Reaction Mechanism. Application for the Synthesis and Design of some biologically active compounds derived from heterocyclic compounds.

HETEROCYCLIC COMPOUNDS

Unit-I Introduction to heterocycles:

Nomenclature, spectral characteristics, reactivity and aromaticity

Unit-II Synthesis and reactions of three and four membered heterocycles:

Aziridine, azirine, azetidine, oxiranes, thiarines, oxetanes and thietanes.

Unit-III Five-membered rings with two heteroatoms:

pyrazole, imidazole, oxazole, thiazole, isothiazole, benzofused analogs.

Unit-IV Chemistry of bicyclic compounds containing one or more heteroatoms.

Bezofused six membered rings with one, two and three heteroatoms: benzopyrans, quinolones, isoquinolines, quinoxazalines, acridines, phenoxazines, phenothiazines, benzotriazines, pteridines.

Unit-V Seven and large membered heterocycles:

azepines, oxepines, thiepines.

Chemistry of porphyrins and spiro heterocycles.

Recommended Texts:

1. "Heterocyclic Chemistry" by J A Joule and K Mills
2. "Name Reactions in Heterocyclic Chemistry" by Jie Jack Li
3. "Advances in Heterocyclic Chemistry" by Alan R Katritzky
4. "Synthesis of some heterocyclic compounds by advanced techniques" by Sandip Sadaphal and Murlidhar Shingare
5. "Heterocyclic Chemistry" by Raj K Bansal
6. "Heterocyclic Chemistry" by GILCHRIST
7. "HETEROCYCLIC CHEMISTRY" by Ahluwalia V K
8. "Heterocyclic Chemistry" by John A Joule and Keith Mills
9. "3000 Solved Problems in Organic Chemistry (Schaum's Solved Problems Series)" by Herbert Meislich and Estelle K Meislich
10. "Heterocyclic Chemistry" by SAINSURY M

Organic Chemistry –III Practical:

1. Qualitative Analysis:

    a) Less common metal ions- Tl, Se, Te, Mo, W, Ti, Zr, U&V

    b) Insolubles- Oxides(WO_3, Silica, Alumina); Sulphates(Lead Sulphate, Barium Sulphate Strontium Sulphate and Calcium Sulphate); Halides(Calcium fluoride and silver halides)

    (2 less common metal ions and 1 insoluble to be given)

2. Quantitative Analysis:

    a) Separation and determination of two metal ions such as Ag- Cu, Cu- Ni, Cu- Zn, Ni- Zn, Cu-Fe etc. involving volumetric and gravimetric methods.

Learning Outcomes:

Be familiar with the structures of important classes of heterocyclic aromatic organic compounds. Be able to classify simple heterocyclic aromatic compounds as electron deficient or electron rich and explain their reactivity based on these properties. Know how selected organometallic reactions can be applied in heterocyclic chemistry. Be able to explain on a mechanistic level, reactions and synthesis of important electron deficient nitrogen containing heterocycles; pyridines, diazines and their benzo-condenced analogs.

PHYSICAL CHEMISTRY-III

Learning objectives:

The student is able to determine the (most important) quantum states of a given material (atoms, small molecules) and can assign these states to energy Terms. The student is able to determine which quantum state(s) belong(s) to the ground state. The student can rationalize which transitions between quantum states as a result of an absorption, emission or scattering event have a more than zero probability of taking place. The student can determine which atomic orbitals, molecular orbitals, vibrational normal modes and energy terms belong to a particular irreducible representation and rationalize from there which transitions in vibrational and electronic spectroscopy are symmetry forbidden. The student is able to determine which vibrational motion belongs to a particular transition in the infrared region. The student is able to qualitatively predict which signals are to be observed in the rotational, vibrational or electronic spectrum of various materials ranging from single atoms (atomic spectroscopy) to large molecules (IR, Raman, UV-vis spectroscopy).

Unit I-Rotational spectroscopy:

Introduction to molecular spectroscopy, Rotational spectroscopy of diatomic molecules based on rigid rotator approximation, Determination of bond lengths and/ or atomic masses from microwave data, effect of isotopic substitution, non-rigid rotator, classification of polyatomic molecules, energy levels and spectra of symmetric top molecules and asymmetric top molecules, First order Stark effect.

Unit II-Vibrational spectroscopy:

Normal coordinate analysis of mononuclear and heteronuclear diatomic molecules, Extension to polyatomic linear molecules, Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation, Force constants and amplitudes, Anharmonic oscillator, Overtones and combination bands, Dissociation energies from vibrational data, Vibration-rotation spectra, P, Q and R branches, Breakdown of the Born-Oppenheimer approximation, Nuclear spin effect.

Unit III-Raman Spectroscopy:

Stokes and anti-stokes lines, Polarizability ellipsoids, Rotational and Vibrational Raman spectroscopy. Selection rules, Polarization of Raman lines.

Unit IV-Atomic Spectra:

(i) Characterization of atomic states, Microstate and spin factoring methods, Hund's rules, Derivation of spin and orbital selection rules (based on recursion relations of Legendre polynomials), spectra of complex atoms. Zeeman and Stark effect, Atomic photoelectron spectroscopy.

(ii) Electronic spectroscopy: Diatomic molecules, Selection rules. Breakdown of selection rules, Franck-Condon factors, Dissociation energies, Photoelectron spectroscopy of diatomic (N_2) and simple polyatomic molecules (H_2O, formaldehyde), Adiabatic and vertical ionization energies, Koopmans' theorem.

Unit V-NMR spectroscopy:

Larmor precession. Mechanism of spin-spin and spin-lattice relaxation and quantitative treatment of relaxation, Quantum mechanical treatment of the AB system, Selection rules and relative intensities of lines.

Recommended Texts books:

1. Hollas. J.M Modern Spectroscopy 4^{th} Ed. Wiley & Sons(2004)
2. Barrow. G. M. introduction to Molecular Spectroscopy Mc Graw-Hill (1962)

3. Brand. J.C.D. & Speakman. J.C. Molecular Structure the Physical Approach 2nd Ed. Edward Arnold London (1975)
4. Chang. R. Basic Principles of Spectroscopy McGraw- Hall. New York, N.Y. (1970)
5. Moore, W.J. Physical Chemistry 4th Ed. Prentice-Hall (1972)
6. Warren, B.E. X-Ray Diffraction Dover Publications (1990)
7. Bacon, G.E. Fifty Years of Neutron Diffraction Hilger (1987)

Learning Outcomes:

After the end of this course, the student;

Will be able to interpret IR spectroscopy, Explain basic principles of IR spectroscopy, Arrange components of IR spectroscopy device, Explain working principles and taking spectrum of IR spectroscopy device, Will be able to interpret NMR spectroscopy, Explain basic principles of NMR spectroscopy, Explain sample preparation procedure in NMR spectroscopy, Explain working principles, taking spectrum and outline of NMR spectroscopy device, 4. Will be able to interpret elemental analysis technique, Explain working basic and using of elemental analysis device, Report results of C,H,O,S analysis in sample, Will be able to interpret fluorescence spectroscopy, Explain basic principles of fluorescence spectroscopy, Explain working principles, taking spectrum and outline of fluorescence spectroscopy device, Will be able to interpret atomic absorption spectroscopy, Explain basic principles of atomic absorption spectroscopy, Explain the types of atomic absorption spectrometer, Explain working principles, taking spectrum and outline of atomic absorption spectroscopy device.

1. Titrate a moderately strong acid (salicylic/mandelic acid) by the

   (a) Salt-line method

   (b) Double alkali method

2. Titrate a mixture of copper sulphate, acetic acid and sulphuric acid with sodium hydroxide.

3. Titrate a tribasic acid (phosphoric acid) against NaOH and $Ba(OH)_2$ conductometrically.

4. Titrate

   (i) Magnesium sulphate against BaCl2 and its reverse titration

   (ii) HCl Vs NH_4OH

   (iii) Sodium oxalate Vs HCl

5. Estimate the concentration of each component of a mixture of $AgNO_3$ and HNO_3 by conductometric titration against NaOH.

6. Determine the degree of hydrolysis of aniline hydrochloride.

7. Determine the critical micelle concentration of a surfactant (sodium lauryl sulphate) by the conductivity method.
8. Study the effect of dielectric constant on the nature of the conductometric titration between maleic acid and sodium methoxide using different mixtures of benzene and methanol as solvents.
9. Determine the velocity constant for the saponification of ethyl acetate conductometrically.

Inorganic Chemistry Specialization Papers

Course Objectives:

Improve their knowledge of the basic information of Radiation and Nuclear chemistry; requirements, methods of preparation, uses of Radioelements. Be aware of the contributions of chemistry to society. Improve their knowledge of types of radioactive decay, natural decay series, nuclear models, nuclear properties, Mass energy, relationships, nuclear reactions, rates of radioactive decay, interaction of radiation with matter. Improve their knowledge of instrumentation and Introduction to health – physical applications in nuclear and radiochemistry.

Nuclear & Radio Chemistry:

Section-A:

Nuclear Binding Energy:

Justifications and applications; nuclear stability rules and decay of unstable nuclei. Nuclear Structure: Nuclear force, Liquid drop model, shell model and collective mode.

Section-B:

Interaction of Radiation with matter:

Physical and chemical effects of radiation on matter (photoelectric effect, Compton effect and pair production).

Radiochemical Techniques:

NAA: Principle, Application and Limitation

IDA: Principle, Application and Limitation, Radiometric titrations.

Section-C:

Detection of Nuclear Radiation:

Various methods of detecting nuclear radiations, Gas-filled counters – Ionization chamber; Proportional counter and G.M. counters.Scintillation detectors; Solid state detectors.

Section-D:

Nuclear Reactions:

Energetics of nuclear reactions; various types of nuclear reactions including photonuclear, thermonuclear and spallation reactions; mechanism of nuclear reaction by compound nucleus model.

Nuclear fission:

Fission probability; energy release; theories of fission.

Nuclear Fussion:

Brief idea about breeder reactors,; accelerators and cyclotron.

Learning Outcomes:

After studying this module, you shall be able to know about-

¬ The significance of Radio Chemical Techniques

¬ The basic principle and methodology of Radio Chemical Techniques

¬ The applications of Radio Chemical Techniques

Learning Objectives:

Students will demonstrate the ability to plan and execute experiments that demonstrate the use and understanding of modern instruments, accurate quantitative measurements, appropriate recording skills, safe lab practices, and appropriate use of Bioinorganic Chemistry.
Students will demonstrate their ability to communicate effectively about environmental chemistry, demonstrating the ability to create an awareness about environment.
Students will develop a sense of community responsibility by becoming aware of scientific issues in the larger social context.

Section-A:

Metal Ions in Biological Systems:

General survey of essential and trace metals, Disturbing factors in metabolic process and causes of diseases, different classes of drugs.

Alkali and alkaline earth metals in biological systems:

Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, blood clotting and hormones.

Interaction of metal ions with Nucleotides:

metal ions in nucleotide systems, effect of metal ions on nuclei acids.

Section-B:

Oxygen carriers: Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier model systems

Nitrogen fixation:

Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N_2 complexes, photosynthesis and chlorophyll.

Metal transport and storage:

Transferrin, Ferritin, Siderophores

Section-C:

Environmental Chemistry:

Atmosphere: Chemical composition of atmosphere, atmospheric structure, Earth's radiation balance; oxides of N,C,S and their effects, Green house effect, acid rain, photochemical smog , air quality standards, depletion of ozone, particulate matter in atmosphere , mechanism of aerosol formation in air, Noise pollution and their health hazards.

Reference Books:

1. "Advances in Inorganic Biochemistry: Metal Ions in Genetic Information Transfer v. 3" by Luigi G Marzilli and Gunther L Eichhorn.
2. "Mechanisms of Metallocenter Assembly (Advances in inorganic biochemistry)" by Luigi G Marzilli and Gunther L Eichhorn.
3. "Molecular Design in Inorganic Biochemistry (Structure and Bonding)" by Daniel Rabinovich.
4. "Fundamental Concepts of Environmental Chemistry" by G S Sodhi, Narosa Book Distributors Pvt Limited.
5. "Environmental Chemistry" by Anil Kumar De, NEW AGE; 7 Edition.

Learning Outcomes:

Students completing in Bio inorganic and Environmental Chemistry shall have the ability to:

- Acquire broad knowledge of the field of Environmental Chemistry including basic principles, target organ toxicity and the toxicity of a select group of chemical compounds. Synthesize and apply concepts from multiple sub-disciplines in environmental chemistry.
- Use technical and analytical skills to quantify the level and effects of Bioinorganic Chemistry.
- Understand relationships between chemical exposure and effects on physiological systems and design strategies for study of harmful effects of different pollutants.

Inorganic Chemistry –V Practical:

Preparation of selected Inorganic compounds/complexes and their characterization using techniques/methods such as elemental analysis, conductance measurement, molecular weight determination, magnetic susceptibility measurements, infrared, UV, visible, Mossbauer and ESR spectra etc. Handling of air and moisture sensitive compounds.

i) Chromous Acetate

ii) $Hg[Co(SCN)_4]$

iii) $Ni(dmg)_2$

iv) $[Cu(NH_3)_4]SO_4.H_2O$

v) $[Ni(NH_3)_6]Cl_2$

vi) $K_3[Fe(C_2O_4)_3]$

vii) $VO(acac)_2$

viii) $Mn(acac)_3$

ix) Prussian blue

x) $[Co(NH_3)_5Cl]Cl_2$; $[Co(NH_3)_5NO_2]Cl_2$; $[Co(NH_3)_5ONO]Cl_2$

xi) $K_3[Al(C_2O_4)_3]$

xii) $[Ni(en)_3]S_2O_3$ etc.

Semester-IV

ORGANO-TRANSITION METAL CHEMISTRY:

Learning Objectives:

The objective of this course is on the synthesis, structure and bonding, properties and reactivity of main group organometallics (including Grignard reagents, organolithium reagents, organophosphorus compounds, etc), organotransition metal chemistry and organometallic catalysis. The laboratory component of the course will aim to develop skills in the handling of air-sensitive compounds and the purification of compounds using chromatographic techniques.

Section-A:

Organo metallic Compounds: Introduction and Classification of organometallic compounds by bond types viz.covalent, ionic, electron deficient and cluster compounds.

Alkyls and Aryls of Transition Metals:

Types, routes of synthesis, stability and d decomposition pathways, organo copper in organic synthesis.

Section-B:

Transition Metal –Complexes:

Transition metal –complexes with unsaturated molecules- alkenes, alkynes, allyl, & dienyl(metallocene) complexes, preparation, properties and nature of bonding and structural features, important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis.

Section-C:

Compounds of Transition Metal-Carbon Multiple Bonds:

Transition metal-carbenecomplexes: Fischer type and Schrock type carbene complexes, their synthesis, reactionsand structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features.

Section-D:

Fluxional Organometallic Compounds:

Fluxionality & dynamic equilibria in compounds such as acyclic alkenes, -bonded and –bonded cyclic alkenes, rotation of ligands on metals, ligand scrambling on metals.

Applications of Transition metal Organometallics as Catalysts:

Zeigler-Natta polymerization ; homogeneous catalytic hydrogenation; alkene hydrogenation-Wilkinson Catalyst; Oxidation of olefins-Wacker's process; hydroformylation of olefins – the oxo process.

Reference Books:

1. Principles and Applications of Organotransition Metal Chemistry by James, P. Collman , University Science Book, First Edition.
2. Transition Metals in the Synthesis of Complex Organic Molecules 2nd Edition by Louis , S. Hegedus, Hegedus, Bjorn C. G. Soderberg, University Science Book, Third Edition.
3. Organo-transition metal chemistry: from bonding to catalysis by John Hartwig , University Science Books; 2010 edition.

Learning Outcomes:

On completion of this course, students will have the knowledge and skills to:

1. Explain and rationalize the synthesis, structure, bonding, properties and reactivity of both main group and transition metals.

2. Explain and rationalize industrially important catalytic processes through the application of organometallic principles.

3. Work to a professional level of skills in a chemical synthesis laboratory demonstrating effective laboratory safety and etiquette especially in the areas of handling of air sensitive reagents, chromatographic techniques and spectroscopic characterization.

ELECTRO ANALYTICAL CHEMISTRY

SECTION –A:

Electrons at and across interfaces, Electro-chemical and chemical reactions**,** Basic principles, residual current, migration current, diffusion current and limiting current, saturated calomel electrode(SCE) and dropping mercury electrode(DME). Ilkovic equation, Koutecky equation for diffusion current, Polarographic waves (anodic and cathodic), Half wave potentials. Oxygen interference, maxima function of supporting electrolytes.

SECTION-B:

Determination of stability constant complex by D.C.Polarography, Catalytic hydrogen wave. Principles of Amperometric titrations, types of titration curves, apparatus and techniques.Hanging mercury drop electrode, rotating droping mercury electrode, platinum electrodes(RPE), Gold electrode, carbon paste electrode, glassy carbon electrode and graphite electrode.

Section-C:

Super imposed a.c. Polarography, voltametry in quiet and stirred solution with electrode other than mercury, square-wave polarography, normal and differential pulse polarography, chronopotentiometry, chronoamperometry and coulometry.

Section-D:

Theory of anodic stripping voltametry, concentration process, rest period, stripping process, Cathodic stripping voltametry, Anodic deposition, Cathodic redissolution, Experimental and applications of above system to Inorganic systems. Theory of ion selective electrodes, Experimental and applications of ISE to Inorganic systems.

Reference Books:

1. "Electrochemical Methods: Fundamentals and Applications" by A J Bard

2. "Fundamentals of Electroanalytical Chemistry" by P S Monk

3. "Electrochemical Reactions: The Electrochemical Methods of Analysis" by Gaston Charlot

4. "Modern Modified Electrochemical Methods for Pharmaceutical Analysis" by Dar Riyaz Ahmad and Brahman Pradeep Kumar

5. "Electrochemical Methods of Process Analysis" by D E Smith

6. "Electrochemically Engineered Nanoporous Materials (Springer Series in Materials Science)" by Dusan Losic and Abel Santos

7. "Electroanalytical Methods: Guide to Experiments and Applications" by Fritz Scholz

MEDICINAL ASPECTS OF INORGANIC CHEMISTRY

Section-A:

Metals in Medicine:

Biochemical bases of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies, carcinogens and carcinostatic agents, zinc in tumour growth and inhibition, anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, copper and Gold complexes, anti cancer activity of Selenium, antibacterial and antiviral properties of metal complexes, polyamino carboxylic acids and polyethylene amines as chelating drugs.

Section-B:

Miscellaneous applications of Inorganic compounds as medicines:

Drugs in hypo and hyper activity of thyroids, Inorganic drugs in dental carries, clinical disorders of alkali and alkaline earth metals and their remedies, lithium drugs in psychiatry.

Heavy metals in Biological systems:

Toxicity of heavy metals – and their detoxification, role of Selenium in Biological systems with reference to its essentiality and toxicity, mechanism of metal ion induced toxicity, interaction between orally administered drugs & metal ions in guts.

Section-C:

Ligand Therapy:

Ligand induced toxicity, interference with haemoglobin in oxygen transport system, intefererence with metallo-enzymes, beneficial effects of ligand chelation; carcinogenic ligands, carcinostatic ligands, alkylating agents as anticancer drugs, Thiosemicarbazones as anticancer drugs, macrocyclic antibiotic ligands and prodable mechanism of the drug, antiviral activity of chelating agents, aspirin chelation,drugs where chelation and therapeutic activity are unrelated.

Section-D:

Hydrosphere:

Chemical composition of water bodies-lakes, streams & rivers; water quality parameters- dissolved oxygen, BOD, water quality standards; Purification and treatment of water.Radio pharmacology, nuclear medicines, radioiodine-131, technetium-99m, gallium and indium scan.

Reference Books:

1. Helmut Sigel (1973): Metal ions in biological system, Vol.9, Marcel Dekker INC, New York and Basel.

2. Helmut Sigel (1973): Metal ions in biological system (Concepts on metal ion toxicity), Vol.7 Marcel Dekker INC, New York and Basel.

3. Kaim, Wand Schewederski,B (1994):Bioinorganic Che mistry : Inorganic E l e m e n t s in the Chemistry of Life, John Wiley & Sons, NewYork, USA.

4. Guy Berthon (1995): Handbook of Metal-Ligand interactions in Biological fluid, Bioinorganic medicine, Vol.2, Marcel Dekker INC, New York and Basel.

5. Rosette M. Roat- Malone (2007): Bioinorganic Chemistry: A Short Course, Wiley.

6. Ivano Bertini (1994): Bioinorganic Chemistry, Mill Valley, CA: University Science Books.

Inorganic Chemistry IV-Practical:

1. Estimation of metal ions by atomic absorption spectrophotometry and Flame Photometry.
2. Spectrophotometric determination of Fe, Ni,Mn,Cr,V,Ti and fluoride, Nitrate and phosphate etc.
3. Determination of pK value of an indicator Spectrophotometrically.
4. Study of Complexation (Stoichiometry and stability constant) between Fe-thiocynate, Fe-Phenanthroline and Cu- ethylenediamine by Job's method/ slope ratio method.
5. Polarographic determination of metal ions such as Zn, Cd,
6. Mg, Tl etc.(including mixtures). Amperometric titrations.

Industrial Chemistry:

Course Objective:

The aim of this course is that the students will learn the essential principles used in industrial pollution abatement and understand important issues in industrial pollution abatement and pertinent environmental legislations

UNIT I Raw Materials for Chemical Industry:

Raw materials – Characteristics of raw materials and their resources – methods of raw material concentrations–integral utilization of raw materials. Energy for chemical industry–Fuels–classification of fuels–coal–fuel gases and liquid fuels–petroleum–cracking–Octane number–cetane number–composition and uses of coal gas, water gas, producer gas, oil gas and gobar gas.

UNIT II Explosive and Pesticides:

Explosives:

Classification, characteristics, preparation of nitrocellulose-T.N.T, Picric acid, Dynamite-cordite and Gunpowder, Dynamite, HMX, PETN, Cyclonite, plastic explosives, gelatin, RDX, cordite and seismic explosives, propellants-manufacture of liquid and solid propellants-hydrazine, incendiaries and smoke screens. Industrial applications.

Pesticides:

Introduction, classification, synthesis of few common pesticides of chlorinated (DDT, BHC, Chlordane, Aldrin), organophosphorus and carbamate (parathion, malathion, carbaryl) compounds family, Plant pesticides, Pesticide formulations.

UNIT III Cement, Ceramics, Polymeric Materials, Glass, Paints and Fertilizers

Cement:

Manufacture – Wet Process and Dry process. Types, Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India.

Ceramics:

Important clays and feldspar, glazing and verification.

Polymeric Materials:

Industrial polymers (Thermoplastics polymers and thermosetting Polymers) and composite materials–their constitutions, chemical and physical properties, Industrial applications.

Glass:

Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass.

UNIT IV Industrial Chemical Analysis:

Sampling procedures, sampling of bulk materials, techniques of sampling–solids, Liquids and gases. Collection and processing of data. Chromatography: Principles, working and applications of paper chromatography, TLC, GLC, HPLC.

Particle size determination, rheological properties of liquids, plastics and their analysis. Modern Instrumental Methods of analysis–UV-visible spectroscopy-IR spectroscopy and non-dispersive IR- Raman spectroscopy-NMR Spectroscopy-Electron spin resonance spectroscopy-Atomic absorption spectroscopy-Flame photometry-Neutron diffraction-X-ray fluorescence-Ion chromatography

UNIT V Industrial Hygiene and Chemical Safety:

Classification of hazaradous chemicals, storage, transportation, handling, risk assessments, challenges/solutions (d) Eco-friendly effluents disposal: Water pollutants, health hazards, sampling and analysis of water, water treatment, different industrial and domestic effluents and their treatment and disposal, advanced waste water treatment, effluent quality standards and laws, chemical industries, tannery, dairy, textile effluents, common treatment.

Text Books:

1. Mukhlyonov (ed.) (1979): Chemical Technology, Vol.1, 3rd Edition, Mir publication, Moscow.
2. De.,A.K. (1989): Environmental Chemistry,WileyEasternLtd.,11th edn., Meerut.
3. Sharma, B.K (1997): Industrial Chemistry, Goel publishing house.

References:

1. Norris Shreve, R. and J.A. Brink (1977): Jr. Chemical Process Industries. 4thedn.McGrawHill, Tokyo.
2. Chakrabarty, B.N (1981): Industrial Chemistry, Oxford & IBH Publishing Co., New Delhi.

Learning Outcomes:

•Understand the different types of wastes generated in an industry, their effects on living and non-living things.
•Understand environmental regulatory legislations and standards and climate changes.
•Understand about the quantification and analysis of wastewater and treatment.
•Understand the different unit operations and unit processes involved in conversion of highly polluted water to potable standards.
•Understand the atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices.
•Understand about analysis and quantification of hazardous and nonhazardous solid waste.

Inorganic Chemistry V-Practical:

1. Quantitative estimation of aniline,phenol,ethyl methyleketone and glucose (by both Betrane's
and Lane and Bynon methods).
2. Semi-micro Qualitative Analysis Analysis of mixtures containing two familar and two less familiar cations from among the following:
Ti, W, Se, Te, Mo, Ce,Th,Ti,Zr,V,B 0 e,U and Li.