Rajgad Dnynpeeths

Anantrao Thopte College, Bhor

DEPARTMENT OF CHEMISTRY

B. Sc. Chemistry

Goals :

The Department has formulated three broad educational goals for the undergraduate degree programs:

Chemistry knowledge: To provide students with the basic foundation in Chemistry and allied subjects, the interplay of theory and experiment, and to motivate scientific enthusiasm and curiosity and the joy of learning.

Problem solving skills: To provide students with the tools needed to analyse problems with the skills required to succeed in graduate school, the chemical industry or professional school.

Employment and technical skills: To provide the students with technical skills necessary for successful careers in chemistry and related or alternative careers for which a chemistry foundation can be very useful. These include to a breadth of experimental techniques using modern instrumentation and communication skills (oral and written).

Programme Outcomes :

Knowledge outcome:

After completing B.Sc. Chemistry Programme students will be able to:

PO1: Transfer and apply the acquired fundamental knowledge of chemistry, including basic concepts and principles of 1) organic chemistry, Inorganic chemistry, Physical and Analytical Chemistry; (2) analytic techniques and experimental methods for chemistry to study different branches of chemistry;

PO2: Demonstrate the ability to explain the importance of the Periodic Table of the Elements and represent key aspects of it and its role in organizing chemical information.

Skills Outcomes Professional Skills

After completing B.Sc. Physics Programme students will be able to:

PO3: apply and demonstrate knowledge of essential facts, concepts, laws, principles and theories related to chemistry;

PO4: demonstrate the learned laboratory skills, enabling them to perform qualitative and quantitative analysis of given samples and able to make conclusions on it;

PO5: set procedure and synthesize simple compounds of commercial importance;

PO6: engage in oral and written scientific communication, and will prove that they can think critically and work independently.

PO6: Communicate effectively using graphical techniques, reports and presentations within a scientific environment.

PO7: to recognize problems in chemical science and make strategies to solve it

PO8: Respond effectively to unfamiliar problems in scientific contexts.
PO9: Plan, execute of design experiment, make documentation of it, interpretdata at entry level of chemical industry and report the results;
PO10: Integrate and apply these skills to study different branches of chemistry.

Generic Competencies

PO11: The student will acquire knowledge effectively by self-study and work independently, present information in a clear, concise and logical manner and apply appropriate analytical and approximation methods
PO12: The student will learn professionalism, including the ability to work in groups and in society, and apply basic ethical principles.

Program Specific Outcomes

After completing B. Sc. Chemistry, students will be able to
PSO1: Understand the nature and basic concepts of Physical, Organic andInorganic chemistry;
PSO2: Analyze Organic and inorganic compounds qualitatively andquantitatively;
PSO3: Understand the applications of physical, organic, inorganic and analyticalchemistry in pharmaceutical, agriculture and chemical industries;
PSO4: Able to perform experimental procedures as per laboratory manual in thearea of physical, Inorganic and organic chemistry;
PSO5: interpretation and synthesis of chemical information and data obtainedfrom chemical and instrumental analysis.

F. Y. B. Sc. Chemistry Course Outcomes

SEMESTER-I

CH- 101: Physical Chemistry

At the end of course student will be able to -

CO1: Chemical Energetics: Students will be able to apply thermodynamic principles to physical and chemical process, Calculations of enthalpy, Bond energy, Bond dissociation energy , resonance energy, Variation of enthalpy with temperature –Kirchoff's equation, Third law of thermodynamic and its applications

CO2: Chemical Equilibrium: Knowledge of Chemical equilibrium will make students to understand , Relation between Free energy and equilibrium and factors affecting on equilibrium constant , Exergonic and endergonic reaction, Gas equilibrium, equilibrium constant and molecular interpretation of equilibrium constant ,Van't Hoff equation and its application

CO3: Ionic equilibria: Concept to ionization process occurred in acids, bases and pH scale, Related concepts such as Common ion effect hydrolysis constant, ionic product, solubility Product, Degree of hydrolysis and pH for different salts, buffer solution.

CH- 102: Organic Chemistry

By the end of this course students will able to

CO1: The students are expected to understand the fundamentals, principles, and recent developments in the subject area.

CO2: It is expected to inspire and boost interest of the students towards chemistry as the main subject

CO3: To familiarize with current and recent developments in Chemistry

CO4: To create foundation for research and development in Chemistry

CH- 103: Chemistry Practical Course I

At the end of course student will able **to**

CO1: Importance of chemical safety and Lab safety while performing experiments in lab.

CO2: Determination of thermo chemical parameters and related concepts;

CO3: Techniques of pH measurements;

CO4: Preparation of buffer solutions

CO5: Elemental analysis of organic compounds (non-instrumental)

CO6: Chromatographic Techniques for separation of constituents of mixtures handle laboratory glassware's, hazardous chemicals safely in laboratory.

SEMESTER-II

CH-201: Inorganic Chemistry

At the end of course student will be able to –

CO1: Atomic Structure: Various theories and principles applied to revel atomic structure, Origin of quantum mechanics and its need to understand structure of hydrogen atom, Schrodinger equation for hydrogen atom, Radial and angular part of hydrogenic wave functions, Significance of quantum numbers, Shapes of orbital's.

CO2: Periodicity of Elements : Explain rules for filling electrons in various orbitals- Aufbau's principle, Pauli exclusion principle, Hund's rule of maximum multiplicity, Discuss electronic configuration of an atom and anomalous electronic configurations, Describe stability of half-filled and completely filled orbital's, Discuss concept of exchange energy and relative energies of atomic orbital's, Design Skeleton of long form of periodic table, Describe Block, group, modern periodic law and periodicity, Classification of elements as main group, transition and inner

transition elements , Write name, symbol, electronic configuration, trends and properties, Explain periodicity in the following properties in details: Effective nuclear charge, shielding or screening effect; some numerical problems, Atomic and ionic size. , Crystal and covalent radii, Ionization energies, Electro negativity- definition, trend, Pauling electronegativity scale., Oxidation state of elements

CO3: Chemical Bonding: Attainment of stable electronic configurations , Define various types of chemical bonds- Ionic, covalent, coordinate and metallic bond , Explain characteristics of ionic bond, types of ions, energy consideration in ionic bonding, lattice and solvation energy and their importance in the context of stability and solubility of ionic compounds ,Summarize Born-Lande equation and Born-Haber cycle, Define Fajan's rule, bond moment, dipole moment and percent ionic character, Describe VB approach, Hybridization with example of linear, trigonal, square planer, tetrahedral, TBP, and octahedral, Discuss assumption and need of VSEPR theory ,Interpret concept of different types of valence shell electron pairs and their contribution in bonding, Application of non-bonded lone pairs in shape of molecule , Basic understanding of geometry and effect of lone pairs with examples such as ClF_3, Cl_2O, BrF_5.

CH- 202: Analytical Chemistry

At the end of course student will be able to –

CO1: Introduction to Analytical Chemistry: Analytical Chemistry –branch of chemistry, Perspectives of analytical Chemistry, analytical problems

CO2: Calculations used in Analytical Chemistry: Calculations of mole, molar concentrations and various units of concentrations which will be helpful for preparation of solution , Relation between molecular formula and empirical formula, Stoichiometric calculation , Define term mole, millimole, molar concentration, molar equilibrium concentration and Percent Concentration. , SI units, distinction between mass and weight, Units such as parts per million, parts per billion, parts per thousand, solution-dilatant volume ratio, function density and specific gravity of solutions.

CO3: Qualitative Analysis of Organic Compounds: Basics of type determination, characteristic tests and classifications, reactions of different functional groups. Separation of binary mixtures and analysis, Elemental analysis -Detection of nitrogen, sulfur, halogen and phosphorous by Lassiagen's test., Purification techniques for organic compounds.

CO4: Chromatographic Techniques – Paper and Thin layer Chromatography: Basics of chromatography and types of chromatography, Theoretical background for Paper and Thin Layer Chromatography.

CO5: pH metry: pH meter and electrodes for pH measurement, Measurement of pH , Working of pH meter, Applications of pH meter.

CH- 203: Chemistry Practical –II

CO1: The practical course is in relevance to the theory courses to improve the Understanding of the concepts.

CO2: It would help in development of practical skills of the students.

CO3: Use of microscale techniques wherever required.

S. Y. B. Sc. Chemistry Course Outcomes

SEMESTER-III

CH-301: Physical and Analytical Chemistry

CO1: Chemical Kinetics:

After studying the Chemical Kinetics student will able to-

1. Define / Explain concept of kinetics, terms used, rate laws, molecularity, order, 2. Explain factors affecting rate of reaction, 3. Explain / discuss / derive integrated rate laws, characteristics, expression for half-life and examples of zero order, first order, and second order reactions, 4. Determination of order of reaction by integrated rate equation method, graphical method, half-life method and differential method, 5. Explain / discuss the term energy of activation with the help of energy diagram., 6. Explanation for temperature coefficient and effect of temperature on rate constant k, 7. Derivation of Arrhenius equation and evaluation of energy of activation graphically, 8. Derivations of collision theory and transition state theory of bimolecular reaction and comparison, 9. Solve / discuss the problem based theory and equations.

CO2: Surface Chemistry:

•Define / explain adsorption, classification of given processes into physical and chemical Adsorption, •Discuss factors influencing adsorption, its characteristics, differentiates types as physisorption and Chemisorption, •Classification of Adsorption Isotherms, to derive isotherms, •Explanation of adsorption results in the light of Langmuir adsorption isotherm, Freundlich's adsorption Isotherm and BET theory, •Apply adsorption process to real life problem. •Solve / discuss problems using theory.

CO3: Errors in Quantitative Analysis:

•Define, explain and compare meaning of accuracy and precision, •Apply the methods of expressing the errors in analysis from results, •Explain / discuss different terms related to errors in quantitative analysis, •Apply statistical methods to express his / her analytical results in laboratory, •Solve problems applying equations.

CO4: Volumetric Analysis:

After studying the Volumetric Analysis student will able to-

1. Explain / define different terms in volumetric analysis such as units of concentration, indicator, equivalence point, end point, standard solutions, primary and secondary standards, complexing agent, precipitating agent, oxidizing agent, reducing agent, redox indicators, acid base indicators, metallochome indicators, etc., 2. Perform calculations involved in volumetric analysis, 3. Explain why indicator show colour change and pH range of colour change. 4. To prepare standard solution and **b.** perform standardization of solutions, 5. To construct acid – base titration curves and performs choice of indicator for particular titration. 6. Explain / discuss acid-base titrations, complexometric titration / precipitation titration /redox titration, 7. Apply volumetric methods of analysis to real problem in analytical chemistry / industry.

CH 302: Inorganic and Organic Chemistry

CO1: Molecular Orbital Theory of Covalent Bonding:

After studying the Molecular Orbital Theory student will able to-

1. Define terms related to molecular orbital theory (AO, MO, sigma bond, pi bond, bond order, magnetic property of molecules, etc), 2. Explain and apply LCAO principle for the formation of MO's from AO's., 3. Explain formation of different types of MO's from AO's.

4. Distinguish between atomic and molecular orbitals, bonding, anti-bonding and non-bonding molecular orbitals, 5. Draw and explain MO energy level diagrams for homo and hetero diatomic molecules. Explain bond order and magnetic property of molecule, 6. Explain formation and stability of molecule on the basis of bond order, 7. Apply MOT to explain bonding in diatomic molecules other than explained in syllabus.

CO2: Introduction to Coordination Compounds:

After studying the Introduction to Coordination Compounds student will able to-

1. Define different terms related to the coordination chemistry (double salt, coordination compounds, coordinate bond, ligand, central metal ion, complex ion, coordination number, magnetic moment, crystal field stabilization energy, types of ligands, chelate effect, etc.), 2. Explain Werner's theory of coordination compounds. Differentiate between primary and secondary valency. Correlate coordination number and structure of complex ion, 3. Apply IUPAC nomenclature to coordination compound.

CO3: Aromatic Hydrocarbons:

After studying the aromatic hydrocarbons student will able to-

1. Identify and draw the structures aromatic hydrocarbons from their names or from structure name can be assigned, 2. Explain / discuss synthesis of aromatic hydrocarbons, 3. Give the mechanism of reactions involved. 4. Explain / Discuss important reactions of aromatic hydrocarbon, 5. To correlate reagent and reactions.

CO4: Alkyl and Aryl Halides:

After studying the Alkyl and Aryl Halides student will able to-

1. Identify and draw the structures alkyl / aryl halides from their names or from structure name can be assigned, 2. Explain / discuss synthesis of alkyl / aryl halides, 3. Write / discuss the mechanism of Nucleophilic Substitution (SN1 , SN2 and SNi) reactions, 4. Explain /Discuss important reactions of alkyl / aryl halides, 5. To correlate reagent and reactions, 6. Give synthesis of expected alkyl / aryl halides.

CO5: Alcohols, Phenols and Ethers (Up to 5 Carbons):

After studying the Alcohols and Phenols student will able to-

1. Identify and draw the structures alcohols / phenols from their names or from structure name can be assigned, 2. Able to differentiate between alcohols and phenols, 3. Explain / discuss synthesis of alcohols / phenols, 4. Write / discuss the mechanism of various reactions involved. 5. Explain /Discuss important reactions of alcohols / phenols, 6. To correlate reagent and reactions of alcohols / phenols, 7. Give synthesis of expected alcohols / phenols.

CH-303: Practical Chemistry-III

CO1: Chemical Kinetics:

1. Students understand the Acid catalyzed hydrolysis of an ester and calculate the rate constant (k), 2. Students aware about kinetics of reaction, 3. students can calculate energy of activation and order or reaction.

CO2: Inorganic quantitative / qualitative analysis

1. Students perform the quantitative analysis using titration, 2. Students knows the Green Approach concept, 3. Students understand the Separation and Identification of metal ions by Paper Chromatography.

CO3: Organic Qualitative Analysis

1. **Separation of Two Components** from given binary mixture of organic compounds containing mono-functional group (Ex. - carboxylic acid, phenols, amines, amide,

nitro, etc.) and systematic identification of each component qualitatively.

CO4: Organic Preparations

1. Preparation of benzoic acid from ethyl benzoate (Identification and confirmatory Test of –COOH group, M.P and purity by TLC), 2. Acetylation of primary amine (Green approach) 3. Base catalyzed Aldol condensation (Green approach), 4. Preparation of Quinone from hydroquinone (Confirm the conversion by absence of phenolic –OH group in product, M.P and purity by TLC).

CO5: pH Metry

To determine equivalence point of neutralization of acetic acid by pH-metric titration with NaOH and to find best indicator for the titration.

CO6: Volumetric Analysis

1. Estimation of Aspirin from a given tablet and find errors in quantitative analysis, **2.** Determination of acetic acid in commercial vinegar by titrating with standard NaOH. Express your results as average ± standard deviation, **3.** Determination of Hardness of water from given sample by complexometric titration (Using E.D.T.A.) method and total dissolve solids by conductometry. Express your results as average ± standard deviation.

Learning Outcome- Practical Chemistry-III

1. Verify theoretical principles experimentally.
2. Interpret the experimental data on the basis of theoretical principles.
3. Correlate theory to experiments. Understand/verify theoretical principles by experiment observations; explain practical output / data with the help of theory.
4. Understand systematic methods of identification of substance by chemical methods.
5. Write balanced equation for the chemical reactions performed in the laboratory.
6. Perform organic and inorganic synthesis and is able to follow the progress of the chemical reaction by suitable method (colour change, ppt. formation, TLC).
7. Set up the apparatus / prepare the solutions - properly for the designed experiments.
8. Perform the quantitative chemical analysis of substances explain principles behind it.
9. Systematic working skill in laboratory will be imparted in student.

SEMESTER-IV

CH-401: Physical and analytical chemistry

CO1: Phase equilibrium:

•Define the terms in phase equilibria such as- system, phase in system, components in system, degree of freedom, one / two component system, phase rule, etc., •Explain meaning and Types of equilibrium such as true or static, metastable and unstable equilibrium, •Discuss meaning of phase, component and degree of freedom, •Derive of phase rule, •Explain of one component system with respect to: Description of the curve, Phase rule relationship and typical features for i) Water system ii) Carbon dioxide system iii) Sulphur system.

CO2: Ideal and real solutions:

•Define various terms, laws, differentiate ideal and no-ideal solutions, •Discuss / explain thermodynamic aspects of Ideal solutions-Gibbs free energy change, Volume change, Enthalpy change and entropy change of mixing of Ideal solution, •Differentiate between ideal and non-ideal solutions and can apply Raoult's law, •Interpretation of i) vapor pressure–composition diagram ii) temperature- composition diagram, •Explain distillation of liquid solutions from temperature – composition diagram, •Explain / discuss azeotropes, Lever rule,

Henrys law and its application., •Discuss / explain solubility of partially miscible liquids-systems with upper **c**ritical. Solution temperature, lower critical solution temperature and having both UCST and LCST, •Explain / discuss concept of distribution of solute amongst pair of immiscible solvents, •Derive distribution law and its thermodynamic proof, •Apply solvent extraction to separate the components of from mixture interest, •Solve problem by applying theory.

CO3: Conductometry:

•Explain / define different terms in conductometry such as electrolytic conductance, resistance, conductance, Ohm's law, cell constant, specific and equivalent conductance, molar conductance, Kohlrausch's law, etc. •Discuss / explain Kohlrausch's law and its Applications, Conductivity Cell, Conductivity Meter, Whetstone Bridge. •Explain / discuss conductometric titrations. •Apply conductometric methods of analysis to real problem in analytical laboratory. •Solve problems based on theory / equations. •Correlate different terms with each other and derive equations for their correlations.

CO4: Colorimetry:

•Explain / define different terms in Colorimetry such as radiant power, transmittance, absorbance, molar, Lamberts Law, Beer's Law, molar absorptivity •Discuss / explain / derive Beer's law of absorptivity. •Explain construction and working of colorimeter.•Apply colorimetric methods of analysis to real problem in analytical laboratory. •Solve problems based on theory / equations. •Correlate different terms with each other and derive equations for their correlations.

CO5: Column Chromatography:

•Explain / define different terms in column chromatography such as stationary phase, mobile phase, elution, adsorption, ion exchange resin, adsorbate, etc.•Explain properties of adsorbents, ion exchange resins, etc. •Discuss / explain separation of ionic substances using resins. •Discuss / explain separation of substances using silica gel / alumina.•Apply column chromatographic process for real analysis in analytical laboratory.

CH-402: Inorganic and Organic Chemistry

CO1: Isomerism in coordination complexes:

After studying the aromatic hydrocarbons student will able to-

1. Isomerism in coordination complexes, 2. Explain different types of isomerism in complexes.

CO2: Valance Bond Theory of Coordination Compounds:

After studying the aromatic hydrocarbons student will able to-

1. Apply principles of VBT to explain bonding in coordination compound of different geometries. 2. Correlate no of unpaired electrons and orbitals used for bonding. 3. Identify / explain / discuss inner and outer orbital complexes. 4. Explain / discuss limitation of VBT.

CO3: Crystal Field Theory

After studying the aromatic hydrocarbons student will able to-

1. Explain principle of CFT. 2. Apply crystal field theory to different type of complexes (Td, Oh, Sq. Pl complexes) 3. Explain: i) strong field and weak field ligand approach in Oh complexes ii) Magnetic properties of coordination compounds on the basis of weak and strong ligand field ligand concept. iii) Origin of colour of coordination complex. 4. Calculate field stabilization energy and magnetic moment for various complexes. 5. To identify Td and Sq. Pl

complexes on the basis of magnetic properties / unpaired electrons. 6. Explain spectrochemical series, tetragonal distortion / Jahn-Teller effect in Cu(II) Oh complexes only.

CO4: Aldehydes and Ketones (aliphatic and aromatic)

After studying the aldehydes and ketones student will able to

1. Identify and draw the structures aldehydes and ketones from their names or from structure name can be assigned. 2. Explain / discuss synthesis of aldehydes and ketones. 3. Write / discuss the mechanism reactions aldehydes and ketones. 4. Explain /Discuss important reactions of aldehydes and ketones. 5. To correlate reagent and reactions of aldehydes and ketones 6. Give synthesis of expected aldehydes and ketones. 7. Perform inter conversion of functional groups.

CO5: Carboxylic acids and their derivatives:

After studying the carboxylic acids and their derivatives student will able to-

1. Identify and draw the structures carboxylic acids and their derivatives from their names or from structure name can be assigned. 2. Explain / discuss synthesis of carboxylic acids and their derivatives. 3. Write / discuss the mechanism reactions carboxylic acids and their derivatives 4. Explain /Discuss important reactions of carboxylic acids and their derivatives. 5. Correlate reagent and reactions of carboxylic acids and their derivatives 6. Give synthesis of expected carboxylic acids and their derivatives. 7. Perform inter conversion of functional groups.

CO6: Amines and Diazonium Salts:

After studying the amines and diazonium Salts student will able to-

1. Identify and draw the structures amines from their names or from structure name can be assigned. 2. Explain / discuss synthesis of carboxylic amines. 3. Write / discuss the mechanism reactions carboxylic amines. 4. Explain /Discuss important reactions of carboxylic amines. 5. To correlate reagent and reactions of carboxylic amines. 6. Give synthesis diazonium salt from amines and reactions of diazonium salt. 7. Perform inter conversion of functional groups.

CO7: Stereochemistry of Cyclohexane:

After studying the aromatic hydrocarbons student will able to-

1. Draw the structures of different conformations of cyclohexane. 2. Define terms such as axial hydrogen, equatorial hydrogen, confirmation, substituted cyclohexane, etc. 3. Convert one conformation of cyclohexane to another conformation and should able to identify governing structural changes. 4. Explain / discuss stability with respect to potential energy of different conformations of cyclohexane. 5. Draw structures of different conformations of methyl / t-butyl monosubstituted cyclohexane (axial, equatorial) and 1, 2 dimethyl cyclohexane. 6. Identify cis- and trans-isomers of 1, 2 dimethyl substituted cyclohexane and able to compare their stability.

CH-403: Practical Chemistry-IV

CO1: Conductometry

a) To determine the cell constant of the given cell using 0.01 M KCl solution and
determine dissociation constant of a given monobasic weak acid. b) To investigate the conductometric titration of the following i) Strong acid against strong base ii) Strong base against weak acid.

CO2: Chromatography

1. Separation of binary mixture of cations by Column Chromatography by ion exchange

resins / cellulose. Separation should be confirmed by qualitative test.

CO3: Ideal and Real solutions

1. To study the variation of mutual solubility temperature with % concentration for the phenol - water system **2.** To study the effect of added electrolyte on the critical solution temperature of phenol water system and to determine the concentration of the given solution of electrolyte. **3.** To obtain the temperature-composition phase diagram for a two component liquid system with maximum (or minimum) boiling point and to determine the maximum (or minimum) boiling point and composition.

CO4: Adsorption

To verify the Freundlich and Langmuir adsorption isotherm for adsorption of acetic acid on activated charcoal.

CO5: Synthesis of Coordination compounds

1. Synthesis of sodium cobaltinitrite (a laboratory chemical) from Co (II) salt and $NaNO_2$ salts. Students comment on color and magnetic properties of the complex. 2. Synthesis of potassium Tris(oxalate)aluminum (III) using scrap Al metal powder. Students comment on color and magnetic properties of the complex. 3. Synthesis of Tris(acetylacetone)iron (III) by green chemistry method by reaction between $Fe(OH)_3$ and acac. Students comment on colour and magnetic properties of the complex.4. Synthesis of Tris(ethylenediamine)nickel (II) from Ni(II) salt, ethylediamine and sodium thiosulfate. Students comment on colour and magnetic properties of the complex.

CO6: Inorganic colorimetric investigations

1. Prepare standard solutions of $KMnO_4$ / $CuSO_4$, record their absorbance and Verify Beer's Law and determine unknown concentration. 2. Prepare solution of Fe(III) and SCN of in different molar proportion, record their absorbance and calculate equilibrium constant of $[Fe(SCN)]^{2+}$ complex.3. Prepare solution of Fe(III)/Cu(II) and salicylic acid in different molar proportion and determine metal ligand ratio in Fe(III) or Cu(II)–Salicylic acid complex.

Co7: Organic Estimations (any two)

1. Determination of molecular weight: Determination of molecular weight of organic acid by titration against standardized NaOH - a) monobasic acid or b) dibasic acid

2. Estimation of amides: Determine the amount of acetamide in given solution by volumetric method. (Standardization of acid must be performed)

3. Estimation of Ethyl benzoate: To determine the amount of ethyl benzoate in given solution volumetrically. (Standardization of acid must be performed).

Section - C: Industrial Visit

Visit any Chemical / Pharmaceutical / Polymer / Research Institutes / Sugar Factories / waste water treatment plant, etc. and submit report. **Learning Outcomes**

1. Verify theoretical principles experimentally. 2. Interpret the experimental data on the basis of theoretical principles. 3. Correlate the theory to the experiments. Understand / verify theoretical principles by experiment or explain practical output with the help of theory. 4. Understand systematic methods of identification of substance by chemical methods. 5. Write balanced equation for all the chemical reactions performed in the laboratory. 6. Perform organic and inorganic synthesis and able to follow the progress of the chemical reaction.

T. Y. B. Sc. Chemistry Course Outcomes

SEMESTER-V

CH-501: Physical Chemistry- I

CO1: Quantum Chemistry

After successfully completion, students will be able to:

1. Know historical of development of quantum mechanics in chemistry. 2. Understand and explain the differences between classical and quantum mechanics. 3. Understand the idea of wave function 4. Understanding of De Broglie hypothesis and the uncertainty principle 5. Understanding the operators: Position, momentum and energy 6. Solving Schrodinger equation for 1D, 2D and 3D model 7. Physical interpretation of the ψ and ψ2 and sketching the wave function 8. Applications to conjugated systems, zero-point energy and quantum tunnelling, Numerical Problems

CO2: Investigation of Molecular structure

After studying this chapter, the student will be able to:

1. Understand the term additive and constitutive properties. 2. Understand the term specific volume, molar volume and molar refraction. 3. Understand the meaning of electrical polarization of molecule, induced and orientation polarization. 4. Dipole moment and its experimental determination by temperature variation method. 5. Electromagnetic spectrum, Nature of wave and its characteristics such as wavelength, wave number, frequency and velocity, Energy level diagram, 6. Classification of molecules on the basis of moment of Inertia, 7. Rotational spectra of rigid diatomic molecules, selection rules, nature of spectral lines. 8. Simple Harmonic oscillator model, Born-Oppenheimer approximation. Vibrational spectra of diatomic molecules selection rules, nature of spectral lines. 9. Explain the difference between Rayleigh, Stokes and anti-Stokes lines in a Raman spectrum. 10. Justify the difference in intensity between Stokes and anti-Stokes lines. 11. Draw the Stokes and anti-Stokes lines in a Raman spectrum 12. Raman spectra: Concept of polarizability, 13. Pure rotational Raman spectra of diatomic molecules, Energy Expression, Selection rule, Rotational energy level diagram, Rotational Raman spectrum and Problems

CO3: Photochemistry

After studying this chapter, the student will be able to know and understand:

1. Difference between thermal and photochemical processes. 2. photochemical laws: Grothus - Draper law, Stark-Einstein law, 3. Quantum yield and reasons for high and low quantum yield, 4. factors affecting the quantum yield, 5. Experimental method for the determination of quantum yield 6. Photochemical reactions: photosynthesis, photolysis, photocatalysis, photosensitization 7. Various photochemical phenomena like fluorescence and phosphorescence, Chemiluminescence, 8. Problems

CH-502: Analytical Chemistry- I

Course outcome: After completion of the course student should be able to

1. Define basic terms in gravimetry, spectrophotometry, qualitative analysis and parameters in instrumental analysis. Such as: Gravimetry, precipitation, solubility product, ionic product, common ion effect, precipitating agent, washing of ppt., drying and ignition of ppt., linearity range, detection limit, precision, accuracy, Sensitivity, Selectivity, Robustness and Ruggedness, electromagnetic radiations, spectrophotometry, Beers law, absorbance, transmittance, molar absorptivity, monochromator, wavelength of maximum absorbance, metal ligand ration, qualitative analysis, group reagent, dry tests, wet test, confirmatory

test,precipitation, thermogravimetry, thermogram, percent wt. loss, differential thermal analysis, etc. 2. Identify important parameters in analytical processes or estimations. Example: minimum analyte concentration in particular method, reagent concentration in particular analysis (gravimetry, spectrophotometry, thermogravimetry), reagent for particular analysis, reaction condition to convert analyte into measurable form, drying and ignition temperature for ppt in gravimetry, heating rate thermogravimetry, wavelength in spectrophotometry, group reagent, removal borate and phosphate in qualitative analysis, etc. 3. Explain different principles involved in the gravimetry, spectrophotometry, parameters in instrumental analysis, qualitative analysis. 4. Perform quantitative calculations depending upon equations student has studied in the theory. Furthermore, student should able to solve problems on the basis of theory. 5. Discuss / Describe procedure for different types analyses included in the syllabus. 6. Select particular method of analysis if analyte sample is given to him. 7. Differentiate / distinguish / Compare among the different analytical terms, process and analytical methods. 8. Demonstrate theoretical principles with help of practical. 9. Design analytical procedure for given sample. 10. Apply whatever theoretical principles he has studied in theory during practical session in laboratory.

CH-503: Physical Chemistry Practical - I

CO1: Refractometry:

1) To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition their mixture C. 2) To determine the molecular refractivity of the given liquids A, B, C and D. 3) To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy contribution to the molar refraction by -CH2 group. 4) Determine the refractive index of a series of salt solutions and determine the concentration of a salt of unknown solution

CO2: Spectrophotometry and Colorimetry:

1) To titrate Cu^{2+} ions with EDTA photometrically. 2) To determine the indicator constant of methyl red indicator 3) To estimate of Fe^{3+} ions by thiocyanate method. 4) Cobalt by using R-nitroso salt method. 5) To determine the order of reaction for the oxidation of alcohol by potassium dichromate and potassium permanganate in acidic medium calorimetrically. 6) Simultaneous determination of Cu^{2+} and Ni^{2+} ions by colorimetry/spectrophotometry method

CO3: Conductometry:

1) Titration of a mixture of weak acid and strong acid with strong alkali. 2) To determine the velocity constant of hydrolysis of ethyl acetate by NaOH solution by conduct metric method.
3) To determine the normality of citric acid in given fruit by titrating it against standard NaOH solution by conductometric method. 4) To determine $\lambda\infty$ of strong electrolyte (NaCl or KCl) and to verify Onsager equation. 5) To estimate the amount of lead present in given solution of lead nitrate by conductometric titration with sodium sulphate. 6) To determine the relative strength of monochloro acetic acid and acetic acid conductometrically

CO4: Viscosity: (any one)

1. To determine the molecular weight of a high polymer by using solutions of different concentrations. 2. Determine the radius of glycerol molecule from viscosity measurement.

CO5: Photoflurometry

1. Analysis of Riboflavin from vitamin supplementary capsules / syrup / tablet sample by Photoflurometry

CO6: Table work

1. Analysis of the given vibration-rotation spectrum of HCl(g)

CH-504: Inorganic Chemistry - I

CO1: Molecular Orbital Theory of Coordination Compounds, A student should know:

i. Explain electroneutrality principle and different types of pi bonding. ii. Able to explain Nephelauxetic effect towards covalent bonding. iii. Explain MOT of Octahedral complexes with sigma bonding. iv. Able to explain Charge Transfer Spectra. v. Able to compare the different approaches to bonding in Coordination compounds.

CO2: Inorganic Reaction Mechanism

i. To understand about inert and labile complexes and stability of complexes in aqueous solutions ii. Classification of reactions of coordination compounds iii. The basic mechanisms of ligand substitution reactions. iv. Substitution reactions of square planer complexes. v. Tran's effect and applications of Trans effect. vi. Stereochemistry of mechanism vii. Gain the knowledge of inorganic reaction mechanisms available in the literature to solve chemical problems.

CO3: Chemistry of Transition

1. To know position of d-block elements in periodic table. 2. To know the general electronic configuration & electronic configuration of elements. 3. To know trends in periodic properties of these elements w.r.t. size of atom and ions, reactivity, catalytic activity, oxidation state, complex formation ability, color, magnetic properties, non-stoichiometry, density, melting point, boiling point.

CO4: Chemistry of f-block elements, A student should know:

1. The meaning of term f-block elements, Inner transition elements, lanthanides, actinides. 2. Electronic configuration of lanthanides and actinides. 3. Oxidation states of lanthanides and actinides and common oxidation states. 4. Separation lanthanides by modern methods. 5. Lanthanide contraction and effects of lanthanide contraction on post-lanthanides. 6. Use of lanthanide elements in different industries. 7. Transuranic elements. 8. Preparation methods of transuranic elements. 9. Nuclear fuels and their applications. 10. Why transuranic elements are called as the synthetic elements? 11. IUPAC nomenclature for super heavy elements with atomic no. 100 onwards.

CO5: Metals, Semiconductors and Superconductors, A student should be able –

1. The meaning of metal & semiconductor. 2. The difference between metal, semiconductor and insulator. 3. Metallic bond on the basis of band theory. 4. The energy band and energy curve. 5. Draw n (E) & N (E) curves. 6. Explain the electrical conductivity of metals with respect to valence electrons. 7. Explain the effect of temperature and impurity on conductivity of metals and semiconductors. 8. Intrinsic and extrinsic semiconductor. 9. The term valance band and conduction band. 10. n and p type of semiconductors. 11. Non-stoichiometry and semi conductivity. 12. Insulators on the basis of band theory. 13. The difference between Na, Mg, and Al in terms of valence electrons and conductivity. 14. Meaning of super conductors and their structure. 15. Discovery and applications of superconductors.

CH-505: Industrial Chemistry - I

CO1: Modern Approach to Chemical Industry

The students are expected to learn; i. Importance of chemical industry, ii. Meaning of the terms involved, iii. Comparison between batch and continuous process, iv. Knowledge of various industrial aspects

CO2: Manufacture of Basic Chemicals

The students are expected to learn i. Concept of basic chemicals, ii. Their uses and manufacturing process. iii. They should also know the physico-chemical principals involved in manufacturing process

CO3: Sugar and Fermentation Industry

Sugar Industry: The students are expected to learn

i. Importance of sugar industry, ii. Manufacture of direct iii. Consumption (plantation white) sugar with flow diagram. iii. Cane juice extraction by various methods, iv. Clarification by processes like carbonation, vi. Sulphitation, vii. Phosphatation, etc. v. Concentration of juice by using multiple effect evaporator system, vi. Crystallization of sucrose by using vacuum pan. Fermentation Industry- The students are expected to learn i. Importance, ii. Basic requirement of fermentation process, iii. Manufacturing of ethyl alcohol by using molasses and fruit juice.

CO4: Soap and detergents

The students are expected to learn

i. Different types of soap products, ii. Chemistry of soap. iii. Raw materials required for soap manufacture iv. Meaning of the term's Surfactants, Types of surfactants v. Raw materials for detergents vi. Detergent builders, additives vi.Washing action of soap and detergents

CO5: Dyes and Pigments

Dyes - Students should know about

i. Dyes: introduction, ii. Dye intermediates, iii. Structural features of a dye; iv.Classification of dyes, v. Synthesis, Structures, properties and applications of dyes

Pigments: Students should know about

i. Introduction, ii. Classification and general properties of pigment, iii. Production processes of zinc oxide and iron oxide

CO6: Industrial visit:

Visit to any one of the Chemical / Pharmaceutical / Polymer / Research Institutes / Sugar Factories / waste water treatment plant, etc. is essential and a systematic report is to be submitted by the student to the Department of Chemistry.

CH-506: Inorganic Chemistry Practical - I

CO1: Gravimetric estimations

1. Gravimetric estimation of Fe as Fe_2O_3 2. Gravimetric estimation of Ba as $BaSO_4$ using homogeneous precipitation method. 3. Gravimetric estimation of Nickel as Ni – DMG. 4. Analysis of sodium bicarbonate from mixture by thermal decomposition method. 5. Determination of water of crystallization by thermal decomposition. 6. Analysis of Food/Pharmaceutical sample for ash and sulphated ash example-Aspirin

CO2: Inorganic preparations

Preparation of inorganic complexes and spot tests for metal ions and ligands:

1. Preparation of hexamminenickel(II) chloride, $[Ni(NH_3)_6]Cl_2$. 2. Preparation of Potassium trioxalatoferrate(III), $K_3[Fe(C_2O_4)_3]$. 3. Preparation of Manganese (III) acetylacetonate, $[Mn(acac)_3]$. 4. Preparation of tris(glycinato)nickelate(II), $[Ni(gly)_3]$- 5. Preparation of Potassium dioxalatocuprate(II),$[Cu(C_2O_4)_2]^{2-}$.

CO3: Inorganic Qualitative Analysis

1. Inorganic Qualitative analysis [1 simple water soluble mixture, 2 mixtures containing borates and 2 mixtures containing phosphates] 2. Limit test for iron, chloride and sulphate

from pharmaceutical raw materials.; OR 2. Qualitative and confirmatory tests of inorganic toxicants of any four ions (Borate, copper, hypochlorite or nitrate or nitrite, Sb or Bi, Iodate, H_2O_2).

CH-507: Organic Chemistry - I

CO1: Polynuclear and Heteronuclear Aromatic Compounds: After studying the polynuclear and heteronuclear aromatic compounds, students will able to

1. Define and classify polynuclear and hetreonuclear aromatic hydrocarbons. 2. Write the structure, synthesis of polynuclear and hetreonuclear aromatic hydrocarbons. 3. Understand the reactions and mechanisms 4. Explain the reactivity of polynuclear and hetreonuclear aromatic hydrocarbons. 5. Describe the synthesis of chemical reactions of polynuclear and hetreonuclear aromatic Hydrocarbons.

CO2: Active Methylene Compounds: Students should be able to understand

1. Meaning of active methylene group 2. Reactivity of methylene group, 3. Synthetic applications ethyl acetoacetate and malonic ester 4. To predict product with panning or supply the reagent/s for these reactions

CO3: Molecular Rearrangements Students will study

1. What is rearrangement reaction? 2. Different types of intermediate in rearrangement reactions? 3. To write the mechanism of some named rearrangement reactions and their applications 4. Electrocyclic rearrangement with their mechanisms

CO4: Elimination Reactions: Students should be familiar with

1. 1,1 and 1,2 elimination 2. E1, E2 and E1cB mechanism with evidences of these reactions 4
3. Understand stereochemistry by using models and learn reactivity of geometrical isomers 4. Orientation and reactivity in E1 and E2 elimination 5. Hoffmann and Saytzeff's Orientation
6. Effect of factors on the rate elimination reactions

CH-508: Chemistry of Biomolecules

CO1: Introduction to molecular logic of life. The student will be understanding of Cell types, Difference between a bacterial cell, Plant cell and animal cell. Biological composition and organization of cell membrane, structure and function of various cell organelles of plant and animal cell. Concepts of biomolecules, Bonds that link monomeric units to form macromolecules

CO2: Carbohydrates: The student will understand the types of carbohydrates and their biochemical significance in living organisms, structure of carbohydrates and reactions of carbohydrates with Glucose as example. Properties of carbohydrates.

CO3: Lipids: The student needs to know the types of lipids with examples, structure of lipids, properties of lipids

CO4: Amino acids and proteins: The student will understand the structure and types of amino acids. Reactions of amino acids. Properties of amino acids. Peptide bond formation. Types of proteins. Structural features in proteins. Effect of pH on structure of amino acid, Determination of N and C terminus of peptide chain.

CO5: Enzymes: The student knows the classes of enzymes with subclasses and examples. Enzyme specificity, Equations of enzyme kinetics Km and its significance, features of various types of enzyme inhibitions, industrial applications of enzymes.

CO6: Hormones: Basic concepts of Endocrinology. Types of Endocrine glands and their hormones. Biochemical nature of hormones. Mechanism of action of lipophilic and hydrophilic hormones.

CH-509: Organic Chemistry Practical-I, Learning Outcomes:

CO1: Separation of Binary Mixtures and Qualitative Analysis:

1. Perform the quantitative chemical analysis of binary mixture, explain principles behind it. 2. Separate, purify and analyze binary water insoluble mixture. 3. Separate, purify and analyze binary water-soluble mixture. 4. Understand the techniques involving drying and recrystallization by various method. 5. Familiarize the test involving identification of special elements. 6. Learn the confirmatory test for various functional groups.

CO2: Preparations The students will be able to

1. Systematic working skill in laboratory will be imparted in student. 2. Learn the basic principles of green and sustainable chemistry. 3. Synthesis of various organic compounds through greener approach. 4. Do and understand stoichiometric calculations and relate them to green process metrics. 5. Learn alternative solvent media and energy sources for chemical processes. 6. Learn the preparations of derivative various functional groups aspects of electrical experiments. 7. Understand the techniques involving drying and recrystallization by various method 8. Expertise the various techniques of preparation and analysis of organic substances 9. Understand principle of Thin Layer Chromatographic techniques. 10. understand the purification technique used in organic chemistry.

Skills Enhancing Course-I, Choose one out of the two options, A and B.

CH-510 (A): Introduction to Medicinal Chemistry

CO1: Upon completion of the course the student shall be able to understand,

CO1: The basics of medicinal chemistry, biophysical properties, overview of basic concepts of traditional systems of medicine.

CO2: Over view of the overall process of drug discovery, and the role played by medicinal chemistry in this process.

CO13: Biological activity parameters and importance of stereochemistry of drugs and receptors.

CO4: Knowledge of mechanism of action of drugs belonging to the classes of infectious and non-infectious diseases. 5. Enhancement of practical skills in synthesis, purification and analysis.

CH-510 (B): Polymer Chemistry

The students are expected to learn the following aspects of Polymer Chemistry:

CO1: History of polymers., Difference between simple compounds and polymer, Names of polymers, Various ways of nomenclature.

CO2: Difference between natural, synthetic, organic and inorganic polymers, Terms-Monomer, Polymer, Polymerization, Degree of polymerization, Functionality, Number average, Weight average molecular weight, Mechanisms of polymerization.

CO3: Polymerization techniques, Uses & properties of polymers Role of polymer industry in the economy Advantages of polymers.

Skills Enhancing Course-II

CH-511 (A): Environmental Chemistry

CO1: Concepts and Scope of Environmental Chemistry

Students should know:

i. Importance and conservation of environment. ii. Importance of biogeochemical cycles

2 CO2: Hydrosphere and Water Pollution

Students should know:

i. Water resources ii. Hydrological Cycle iii. Organic and inorganic pollutants iv. Water quality parameters

CO3: Analytical Techniques in water Analysis

Water quality parameters and standards, domestic water quality parameters, surface water, sampling, preservation, Monitoring techniques and methodology (pH, conductance, DO, ammonia, nitrate and nitrite, Cl, F, CN, Sulfide, sulphate, phosphate, total hardness, boron, metals and metalloids- As, Cd,Cr, Cu, Fe, Pb, Mn, Hg (Exclude polarographic and AAS methods), COD, BOD, TOC, phenols, pesticides, surfactants, tannis and lignins, E. Coli, Case studies of water pollution.

CO4: Water pollution and treatment methods

Water pollutants, Eutrophication, Waste water treatment (domestic waste water, aerobic treatment, anaerobic treatment, upflow aerobic sludge bed, industrial waste water treatment, drinking water supplies, Trace elements in water, chemical speciation (Cu, Pb, Hg, As, Se, Cr)

CH-511 (B): Cheminformatics

CO1: Introduction to Cheminformatics

1. Students should understand the significance of cheminformatics in the modern practices of chemical science 2. Students should learn the necessity of cheminformatics in chemical science

2 CO2: Representation of Molecules and Chemical Reactions:

1. Students should learn the basic concepts about these representation methods. 2. Students should understand the significance of different representation methods for their specific applications. 3. Students should able to identify these representation methods with understanding. 4. Students should able to read these representation methods for basic examples.

CO3: Searching Chemical Structures:

1. Students should learn the basic concepts of referencing 2. Students should understand the significance of structural data in the process of referencing 3. Students should able to correlate the necessity of input methods and the expected outcomes for the set of chemicals 4. Students should able to understand data interpretation using these methods for basic or representative molecules.

CO4: Applications of Cheminformatics:

Learning Outcomes:

1. Students should learn the basic idea about how to apply cheminformatics tool for variety of applications. 2. Students should understand the significance of database for the specific purpose of application. 3. Students should able to correlate the content of data with the possible applications for the set of chemicals. 4. Students should get aware with the principle and the basic operational methods of well-practiced software used in the data interpretation in cheminformatics. **5.** Students should learn the basic concepts of Machine Learning and Artificial intelligence

Semester-VI

CH-601: Physical Chemistry-II

CO1: Electrochemical Cells

After studying this chapter, the student will be able to know and understand:

1. Electrochemical cells: Explanation of Daniell cell, Conventions to represent electrochemical cells 2. Thermodynamic conditions of reversible cell, Explanations of reversible and irreversible electrochemical cell with suitable example, 3. EMF of electrochemical cell and its measurement. 4. The Weston standard cell 5. The primary reference electrode: The standard hydrogen electrode (SHE) with reference to diagram, Construction, representation, working and limitation, 6. Secondary reference electrodes: (a) The calomel electrode, (b) The glass electrode (c) The silver-silver chloride electrode. Understanding of these electrodes with reference to diagram, representation, Construction, working 7. Nernst Equation for theoretical determination of EMF 8. Types of Reversible electrodes: Metal-metal ion electrodes, Amalgam electrodes, Gas electrodes, Metal-metal insoluble salt electrodes, Oxidation-reduction electrodes with respect to examples, diagram, representation, construction, working (electrode reactions) and electrode potential. 9. Sign convention for electrode potentials and Electrochemical series 10. Standard electrode potentials, 11. Types of concentration cells: Concentration cells without and with transference Concentration cells with liquid junction potential 12. Liquid junction potential and salt bridge 13. Applications of emf measurements: 1. Determination of pH of a solution by using hydrogen electrode, quinhydrone electrode and glass electrodes 2. Potentiometric titrations: i) Acid-base titrations, (ii) Redox titrations and (iii) Precipitation 14. Primary Batteries: Dry Cells, alkaline batteries with respect to construction, diagram and working 15. Secondary Batteries: Nickel-cadmium, Lithium-ion batteries, the lead acid battery with respect to construction, diagram and working 16. Applications for Secondary Batteries 17. Fuel Cells: Types of fuel cells, advantages, disadvantages of these fuels cells, comparison of battery Vs fuel cell 18. Problems

CO2: Crystal structure

After studying this topic students are expected to know and understand:

1. Distinguish between crystalline and amorphous solids / anisotropic and isotropic solids. 2. Explain the term crystallography and laws of crystallography. 3. Weiss and Millers Indices, determination of Miller Indices 4. Bravais lattices, space groups, seven crystal systems and fourteen Bravais lattices; 5. Cubic lattice and types of cubic lattice 6. Distance between the planes for 100, 110 and 111 for cubic lattice 7. Methods of Crystal structure analysis: The Laue method and Braggs method: Derivation of Bragg's equation, 8. Determination of crystal structure of NaCl by Bragg's method, 9. X ray analysis of NaCl crystal system and Calculation of d and λ for a crystal system, 10. Problems

CO3: Nuclear Chemistry

After studying this topic students are expected to know

1. Radioactivity 2. Types and properties of radiations: alpha, beta and gamma 3. Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter, Film Badges 4. Types of radioactive decay: α- Decay, β-Decay and γ-Decay 5. The Group Displacement Law, Radioactive Disintegration Series 6. Kinetics of Radioactive Decay, Half-life, average life and units of radioactivity 7. Energy released in nuclear reaction: Einstein's equation, Mass Defect, Nuclear Binding Energy, 8. Application of

radioisotopes as a tracer: Chemical investigation- Esterification, Friedel - Craft reaction and structure determination w.r.t PCl_5, Age determination use of tritium and C_{14} dating. 9. Solve the problems based on this topic

CH-602: Physical Chemistry-III

CO1: Colligative properties of dilute solutions

After studying this topic students are expected to know

1. Meaning of the terms-Solution, electrolytes, nonelectrolytes and colligative properties, 2. Lowering of vapour pressure of solvent in solution, 3. Elevation of B.P. of solvent in solution, Landsberger's method, 4. freezing point depression, Beckmann's method Osmosis and Osmotic pressure, Berkeley and Hartley method, 5. Application of colligative properties to determine molecular weight of nonelectrolyte, abnormal molecular weight, 6. Relation between Vant Hoff's factor and degree of dissociation of electrolyte by colligative property,
7. Problems.

CO2: Kinetics of Reactions in the Solid State:

1. Factors affecting on solid state reactions, 2. Rate laws for reactions in solid state 3. Applying rate laws for solid state reactions 4. Results of kinetics studies

CO3: Electronic structure and macroscopic properties

1. Cohesive Energy of ionic crystals based on coulomb's law and Born Haber Cycle 2. Correspondence between energy levels in the atom and energy bands in solid 3. Band structure in solids – Na , Ca and diamond 4. Conductors and insulators – Its correlation with Extent of energy in energy bands 5. phenomena of photoconductivity 6. Semiconductors – Role of impurity in transformation of insulator into semiconductor 7. Temperature dependant conductivity semiconductors 8. Cohesive Energy in metals 9. Numericals based on cohesive energy

CO4: Polymers

After studying this topic students are expected to know

1) History of polymers. 2) Classification of polymers 3) Chemical bonding & Molecular forces in Polymer 4) Molecular weight of polymers 5) Practical significance of polymer molecular weights 6) Molecular weight determination

CH-603: Physical Chemistry Practical-II

CO1: Potentiometry

1) To determine the PKa value of given monobasic weak acid by potentiometric titration. 2) To determine the formal redox potential of Fe^{2+}/ Fe^{3+} system potentiometrically. 3) To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate. 4) To determine the solubility product and solubility of AgCl potentiometrically using chemical cell. 5) Estimate the amount of Cl-, Br- and I- in given unknown halide mixture by titrating it against standard AgNO3 solution (mixture of any two ions). 6) To prepare standard 0.2 M Na2HPO4 and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pH value of these and unknown solution. 7) To determine the composition of Zinc ferrocyanide complex potentiometrically 8) To determine the standard electrode potentials of Cu and Ag electrodes and to determine the EMF of a concentration cell.

CO2: pH metry

1) To determine the degree of hydrolysis of aniline hydrochloride. 2) To determine the dissociation constant of oxalic acid by pH-metric titration with strong base. 3) Determination

of Pka of given weak acid by pH metry titration with strong base 4) To determine the acid and base dissociation constant of an amino acid and hence the isoelectric point of an acid. 5) pH metric titration of strong acid against strong base by pH measurement and hence determine the concentration and strength of strong acid.

CO3: Radioactivity

1) To determine plateau voltage of the given G M counter. 2) To determine the resolving time of GM counter. 3) To determine Emax of beta particle

CO4: Colligative properties

1. To determine the molecular weight of solute by depression in freezing point method 2. To study the association of Benzoic acid in benzene by Beckmann Method 3. Determine the molecular weight of given electrolyte and non-electrolyte by Landsberger's method and to study the abnormal molecular weight of electrolyte

CO5: Turbidometry:

1. Determination of SO_4^{2-} and Clby turbidimetric method (turbidimetric titration or calibration curve method) 2. To determine the molecular weight of a given polymer by turbidometry

CO6: Table work

1. Analysis of crystal structure from X-ray diffraction spectra of any two compounds (Calculation d, lattice constant, crystal volume and density, and assigning planes to peaks using JCPDS data)

CH-604: Inorganic Chemistry -II

CO1: Organometallic Chemistry

i.To understand M-C bond and to define organometallic compounds ii. To define organometallic chemistry iii. To understand the multiple bonding due to CO ligand. iv. To know methods of synthesis of binary metal carbonyls. v. To understand the structure and bonding using valence electron count (18 ele. rule) vi. To understand the catalytic properties of binary metal carbonyls. vii. To understand the uses of organometallic compounds in the homogenous catalysis. viii. Chemistry of ferrocene

CO2: Homogeneous and Heterogeneous catalysis

i. Understand the phenomenon of catalysis, its basic principles and terminologies. ii. Define and differentiate homogeneous and heterogeneous catalysis. iii. Give examples and brief account of homogeneous catalysts. iv. Understand the essential properties of homogeneous catalysts-Give the catalytic reactions for Wilkinson's Catalysis, hydroformylation reaction, Monsanto acetic acid synthesis, Heck reaction v. Understand the principle of heterogeneous catalyst and development in it. vi. Give examples of heterogeneous catalysts. vii. Understand the classification and essential properties of heterogeneous catalysts. viii. Give the brief account of Hydrogenation of olefins, Zeolites in catalysis, biodiesel synthesis, Automotive Exhaust catalysts ix. Understand the catalytic reactions used in industries around.

CO3: Bioinorganic Chemistry, A student should:

i. Identify the biological role of inorganic ions & compounds. ii. Know the abundance of elements in living system and earth crust. iii. Give the classification of metals as enzymatic and non-enzymatic. iv. Understand the role of metals in non-enzymatic processes. v. Know the metalloproteins of iron. vi. Explain the functions of hemoglobin and myoglobin in O_2 transport and storage. vii. Understand the toxicity of CN- and CO binding to Hb. viii. Draw the structure of Vit.B_{12} and give its metabolism.

CO4: Inorganic Polymers, A student should be able to:
i. know thy types of Inorganic polymers ii. comparison with organic polymers iii. synthesis, structural aspects of Inorganic polymers iv. understand the polymers of Si, B, Si and P v. Inorganic polymers and their use.
CO5: Inorganic solids/ionic liquids of technological importance, A student should know:
i. Understand Preparation of inorganic solids by various methods, ii. Inorganic liquid crystals iii. Ionic liquids, their preparations, and their significance w.r.t green chemistry. iv. Technological importance of ionic liquids,

CH-605: Inorganic Chemistry -III

CO1: Acid–Base and Donor–Acceptor Chemistry, A student should:
1. Student will learn the concept of acid base and their theories. 2. They will also come to know different properties of acids and bases. 3. Strength of various types acids. 4. How acid and base strengths get affected in non-aqueous solvents. **Reference:** Inorganic chemistry, Gary L Messler and Donald A Tar, Third Ed, Pearson publisher, pages: 67-178, 183 – 208.
CO2: Ionic Solids, **A student should:**
1. Know the nature of solids. 2. Know the crystal structures of solids. 3. Draw the simple cubic, BCC and FCC structures. 4. Identify the C.N. of an ion in ionic solid. 5. Identify the type of void. 6. Know the effect of radius ratio in determining the crystal structure. 7. Be able to define Pauling's univalent radius and crystal radius. 8. Be able to solve simple problems based on Pauling's univalent radii and crystal radii. 9. Know how to draw Born-Haber cycle. 10. Be able to solve simple problems based on Born- Haber cycle. 11. Know the defects in Ionic solids. 12. Be able to differentiate between the defects.
CO3: Chemistry of Zeolites, **A student should:**
1. Different Zeolite Framework Types and their classification 2. Zeolite synthesis and their structure 3. Application of zeolites
CO4: Introduction to Nanochemistry, **A student should:**
1. Various methods of nanoparticle synthesis 2. Stabilization of Nanoparticles in solution 3. Properties and Application of Nanoparticles 4. Know about carbon nanotube and its application
CO5: Chemical Toxicology, A student should be able -
i) To know toxic chemical in the environment. ii) To know the impact of toxic chemicals on enzyme. iii) To know the biochemical effect of Arsenic, Cd, Pb, Hg. iv) To explain biological methylation.

CH-606: Inorganic Chemistry Practical-II

CO1: Volumetric Estimations
1. Analysis of Phosphate (PO_4^{3-}) from Fertilizer. 2. Analysis of Iodine from Iodized salt. 3. Strength of medicinal H_2O_2. 4. Analysis of Calcium from milk powder. 5. Analysis of Cu from Cu-Fungicide.
CO2: Flame Photometry
1. Estimation of Na by flame photometry by calibration curve method. 2. Estimation of Na by flame photometry by regression method. 3. Estimation of K by flame photometry by calibration curve method. 4. Estimation of K by flame photometry by regression method.
CO3: Column Chromatography
1. Purification of water using cation/anion exchange resin and analysis by qualitative analysis /Conductometry.

CO4: Nanomaterial synthesis
1. Synthesis of Silver nanoparticles. 2. Synthesis of ZnO nanoparticles.
CO5: Verification of periodic trends using solubility of alkaline earth metal hydroxides $Ca(OH)_2$, $Mg(OH)_2$, $Cr(OH)_2$, $Ba(OH)_2$.
CO6: Synthesis of amine complexes of Ni(II) and its ligand exchange reaction (bidentate ligands like acac, DMG, Glycine) by substitution method. **OR**
Determination of the Metal to ligand ratio (M : L) in complexes.
CO7: Solvent free microwave assisted one pot synthesis of pthalocynin copper (II) complex.
OR Fenton reaction: Degradation of H_2O_2 using Fe catalyst.
CO8: Table work: Band gap calculation for the nanomaterial TiO_2/ SnO_2/ ZnO from its electronic spectra (UV-Visible).

CH-607: Organic Chemistry-II

Learning Outcomes
CO1: Organic Spectroscopic Methods in Structure Determination. (Chapter 1-5) Students will learn the interaction of radiations with matter. They will understand different regions of electromagnetic radiations. They will know different wave parameters.
1. Students will learn the principle of mass spectroscopy, its instrumentation and nature of mass spectrum. 2. Students will understand the principle of UV spectroscopy and the nature of UV spectrum. They will learn types of electronic excitations. 3. Students will be able to calculate maximum wavelength for any conjugated system. And from the value of λ-max they will be able to find out the extent of conjugation in the compound. 4. Students will understand the principle of IR spectroscopy, types of vibrations and the nature of IR spectrum. 5. From the IR spectrum, they will be able to find out IR frequencies of different functional groups. And thus, they will be able to find functional groups present in the compound. 6. Students will understand the principle of NMR spectroscopy and will understand various terms used in NMR spectroscopy. They will learn measurement of chemical shift and coupling constants. 7. Students will be able to interpret the NMR data and they will be able to use it for determination of structure of organic compounds. 8. Students will be able to determine the structure of simple organic compounds on the basis of spectral data such as λ max values, IR frequencies, chemical shift (δ values).
CO2: Students should be able to learn
1. The use of models to draw different types of disubstituted cyclohexanes in chair form 2. The geometrical isomerism in disubstituted cyclohexanes 3. The stability, energy calculations and optical activity of these conformers 4. The use models and to draw different types of conformational isomers of decalin in chair form 5. To know the stability of geometrical isomers of decalin

CH-608: Organic Chemistry-III

CO1: Retrosynthetic Analysis and Applications
Introduction, Different terms used – Disconnection, Synthons, Synthetic equivalence, FGI, TM. One group disconnection, Retrosynthesis and Synthesis of target molecules:
Acetophenone, Crotonaldehyde, Cyclohexene, Benzylbenzoate, and Benzyl diethyl malonate.
CO2: Organic Reaction Mechanism and Synthetic Applications
1. Chemistry of reactive intermediates (carbocations, carbanions, free radicals, carbenes, nitrenes, benzynes etc…); 2. Wolff rearrangement (Step up), 3. Hofmann rearrangement (Step down), 4. Simmons-Smith reaction, 5. Michael reaction, 6. Wittig reaction and McMurry

reaction, 7. Diels-Alder reaction, 8. Functional group interconversions and structural problems using chemical reactions.

CO3: Reagents in Organic Synthesis

Students study about Reagents- Preparation and Applications of following reagents.

Reducing Reagents: Lithium aluminium hydride $LiAlH_4$, $NaBH_4$, DIBAL-H, $Li(tBuO)_3AlH$ & Raney Nickel. and **Oxidizing Reagents:** 1. DMSO either with DCC or Ac_2O, Dess Martin reagent, Osmium tetroxide, Selenium dioxide-(SeO_2), DDQ.

CO4: Natural Products

Terpenoids: Introduction, Isolation, Classification. Citral- structure determination using chemical and spectral methods, Synthesis of Citral by Barbier and Bouveault Synthesis.

Alkaloids: Introduction, extraction, Purification, Some examples of alkaloids and their natural resources. Ephedrine- structure determination using chemical methods.Synthesis of Ephedrine by Nagai.

CH-609: Organic Chemistry Practical-II

Learning Outcomes:

CO1: Interpretations of IR and PMR Spectra The students will be able to

1. Explain "fingerprint region" of an infrared spectrum can used in the identification of an unknown compound. 2. Identify the functional group or groups present in a compound. 3. Identify the broad regions of the infrared spectrum in which occur absorptions caused by N−H, C−H, and O−H, C≡C and C≡N, C=O, C=N, and C=C. 4. Understand use NMR spectra to determine the structures of compounds. 5. Interpret integration of NMR spectra 6. Calculate coupling constants from 1 H NMR spectra. 7. Interpret elemental analysis technique

CO2: Organic Estimations The students will be able to

1. Practical knowledge of handling chemicals. 2. Achieve the practical skills required to estimations of glucose and glycine. 3. Achieve the practical skills required to Saponification value of oil. 4. Determine the molecular weight of given tribasic acids.

CO3: Organic Extractions The students will be able to

1. Apply the principles of extraction 2. Understand the equipment for extraction. 3. Gain practical hands-on experience of modern Extraction. 4. Develop basic design of extractor 5. Describe the extraction separation process.

CO4: Column chromatography, The students will be able to

1. Defines the basic parameters in chromatography 2. Explain the processes of a chromatography analysis 3. Describes the types and materials of column. 4. Explains the types of mobile phase and elution. 5. Realize the selection of appropriate mobile phase, column and detector

Skill Enhancing Course-III **Choose one out of the two options, A and B.**

CH-610 (A): Chemistry of Soil and Agrochemicals

After studying this course, student is expected to

CO1: Understood various components of soil and soil properties and their impact on plant growth, Understood the classification of the soil, Explores the problems and potentials of soil and decide the most appropriate treatment for land use.

CO2: Understood the Reclamation and management of soil physical and chemical constraints. Useful in making decisions on nutrient dose, choice of fertilizers and method of application etc. practiced in crop production.

CO3: Got experience on advanced analytical and instrumentation methods in the estimation of soil, Understood various Nutrient management concepts and Nutrient use efficiencies of major and micronutrients and enhancement techniques.
CO4: Proper understanding of chemistry of pesticides will be inculcated among the students, Imparts knowledge on different pesticides, their nature and, mode of action and their fate in soil so as to monitor their effect on the environment.

CH-610 (B) Introduction to Forensic Chemistry

After studying this paper the students will know –
CO1: The forensic identification of illicit liquors., The classification and characteristics of the narcotics, drugs and psychotropic substances.
CO2: The menace of designer drugs, the methods of identifying of narcotics, drugs and psychotropic substance.

Skill Enhancing Course-IV **Choose one out of the two options, A and B.**

CH-611(A): Analytical Chemistry-II

After completion of the course student should able to
CO1: Define basic terms in solvent extraction, basics of chromatography, HPLC, GC, and AAS and AES. Some important terms are: solvent extraction, aqueous and organic phase, distribution ratio and coefficient, solute remain unextracted, percent extraction, ion association complex, theoretical plate, HETP, retention time, selectivity, resolution, stationary phase, normal and reverse phase, ion exchange, column efficiency, carrier gas, split and spitless injection, packed column, tubular column, atomic absorption and emission spectroscopy, electronic excitation in atoms, nebulization, atomization, reduction of metal ions in flame, absorbance by atoms in flame, flame atomizers, furnace atomizers, interference in AES and FES, HCL, hydride generator, etc.
CO2: Identify important parameters in analytical processes or estimations. Example: minimum analyte concentration in particular method, reagent concentration for particular analysis, reagent for particular analysis, reaction condition to convert analyte into measurable form, wavelength selection in HPLC with spectrophotometric and fluorometric detector, solvent or carrier gas in HPLC and GC, choice method for the sample preparation in atomic spectroscopic methods, choice of filter and HCL in atomic spectroscopic methods, etc.
CO3: Explain different principles involved in the analyses using solvent extraction, basics of instrumental chromatography, HPLC, GC, and atomic spectroscopic techniques, Perform quantitative calculations depending upon equations students has studied in the theory. Furthermore, student should able to solve problems on the basis of theory, Discuss / Describe procedure for different types analyses included in the syllabus.
CO4: Select particular method of analysis if analyte sample is given to him. 7. Differentiate / distinguish / compare among the different analytical terms, process and analytical methods, Demonstrate / explain theoretical principles with help of practical, Design analytical procedure for given sample, Apply whatever theoretical principles he has studied in theory during practical in laboratory.

CH-611 (B): Chemistry of Cosmetics and Perfumes

CO1: Chemical composition, preparation and uses of some cosmetics
A general study including chemical composition, preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel,

creams (cold, vanishing and shaving creams), Eye make-up (Mascara, Eyeshadow, Eyeliner, Eyebrow pencil), Antiperspirants,

CO2: Chemistry of Perfumes and fragrances

History of perfume, classification sources of fragrance, Development and role of natural products in cosmetics, Extraction of Essential oils and their importance and uses in cosmetic industries with reference to Chemistry of - Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

CO3: Rules and regulations for cosmetic industry

Understanding of regulations of Central Drugs Standard Control Organization, India Cosmetic Regulation, Steps for process of cosmetic registration in India

CO5: Projects: (students can choose any one of the following projects and submit a project report at the end of semester for evaluation**)**

1. Preparation of talcum powder. 2. Preparation of shampoo. 3. Preparation of enamels. 4. Preparation of hair remover. 5. Preparation of face cream. 6. Preparation of nail polish and nail polish remover. 7. Preparation of Emulsified and solid fragrances. 8. Isolation of Simple Floral fragrances and Alcoholic fragrances solution.

M. Sc. Organic Chemistry

Goals :

The Department has formulated three broad educational goals for the undergraduate degree programs:

Chemistry knowledge: To provide students with the advanced knowledge in Organic Chemistry and allied subjects, the interplay of theory and experiment, and to motivate scientific enthusiasm and curiosity and the joyof learning.

Problem solving skills: To provide students with the tools needed to analyse problems with the skills required to succeed in graduate school, thechemical industry or professional school.

Employment and technical skills: To provide the students with technical skills necessary for successful careers in chemistry and related or alternative careers for which a advanced chemistry foundation can be very useful. These include to a breadth of experimental techniques using moderninstrumentation and communication skills (oral and written).

Programme Outcomes :

Knowledge outcome:

After completing M.Sc. Organic Chemistry Programme students will be able to: PO1: develop the knowledge and understanding of essential facts, concepts,
principles and theories of the analytical chemistry

PO2: do literature survey and apply it to enhance their conceptual knowledge that will be apply for solving problems in day to day life or chemical industry or at place of work

Skills Outcomes - Professional Skills

After completing M.Sc. Organic Chemistry students will be able to:

PO3: improve the ability to define the problem and find out its solution

PO4: use research based knowledge and research methods including design of experiment, analysis, interpretation of data and make conclusions

PO5: select and apply appropriate method of chemical analysis and understand the limitations of methods

PO6: apply scientific knowledge to perform laboratory experiments and its documentation, able to write effective report, make and give its effective presentation

PO7: explain the impact of chemical pollutants on environment and ecosystem PO8: effectively use Good Laboratory Practices (GLPs)and understand
laboratory safety precautions

PO9: plan, execute of design experiment, make documentation of it, interpret data at entry level of chemical industry and report the results;

PO10: integrate and apply these skills to study different branches of chemistry.

Generic Competencies

PO11: The student will acquire knowledge effectively by self-study and work independently, present information in a clear, concise and logical mannerand apply appropriate analytical and approximation methods

PO12: The student will learn professionalism, including the ability to work in groups and in society, and apply basic ethical principles.

Programme Specific Outcomes :

After completing M.Sc. Organic Chemistry, students will be able to

PSO1: demonstrate knowledge and understanding of molecular spectroscopy for molecular structure determination;

PSO2: apply theoretical and practical understanding of advanced analytical instruments for analysis of inorganic materials, biological substances, micronutrients, pollutants;

PSO3: formulate hypotheses, proposals and predictions and design and undertakeexperiments and projects in a safe and responsible;

PSO4: take research work at the higher degree level in the field of nanotechnology, analytical chemistry and material science.

Course Outcomes :

M.Sc. Part-I Semester-I

CHP-110, Physical Chemistry-I

At the end of course student should able to

CO1: describe discovery of atom with different models and also physicalproperties of matter and its study and rate of reaction.

CO2: relate classical mechanics and quantum mechanics. And differentiationbetween order of reactions.

CO3: illustrate the difference between molecular thermodynamics and classical thermodynamics.

CO4: solve the derivations regarding quantum mechanics, thermodynamics, chemical kinetics and molecular thermodynamics.

CO5: interpret and discuss about the numerical based on theory.

CO6: recall the concepts of quantum mechanics, thermodynamics, chemicalkinetics and molecular thermodynamics.

CO7: derive the statistical and kinetics equations.

CO8: present the quantum mechanical based problems.

CHI-130, Inorganic Chemistry-I,

At the end of course student should able to -

CO1: recall symmetry, group multiplication table, periodic table, periodic trends

CO2: list symmetry elements, types of planes, allotropes and their uses.

CO3: describe symmetry operations, hydrides, solutions in liq. Ammonia, organometallic compounds, intercalation compounds

CO4: discuss character table, SALC, molecular sieves, crown ethers, oxoanionsof nitrogen,

CO5: explain point group, boron hydrides, oxy-acids and oxoanions of halogen,structure and bonding.

CO6: classify molecules into point groups and planes, hydrides, carboranes. CO7: derive the character table and SALC equation for different point groups. CO8: draw structures of different compounds of s & p block elements.

CHO – 150 Organic Chemistry-I,

By the end of this course students will able to

CO1: define the terms related to Organic Reactions such as Aliphatic Nucleophilic, Aromatic electrophilic and Nucleophilic SubstitutionReactions

CO2: list Different factors responsible for reactivity of organic compounds in Addition

reactions to Unsaturated compounds
CO3: recall the information about acidity Basicity and Aromaticity CO4: explain the Elimination reactions
CO5: solve the chemical Reactions for Aliphatic Nucleophilic, Aromatic electrophilic and Nucleophilic Substitution Reaction
CO6: classify the organic reactions like substitution, Addition and elimination Reactions.
CO7: categorize different nucleophiles Electrophiles and Bases. CO8: judge what type of reagent need for the organic Conversion

CHG – 190, General Chemistry-I

SECTION-I: Theory Course

CO1: Introduction to Solid State of Matter

At the end of course student will understand
1. Bonding in solids – band theory 2. Electronic conductivity 3. Semiconductors, photoconductivity 4. Non-stoichiometry, defects and types of defects in solids 5. Ionic conductivity and their applications 6. Superconductivity and theory of superconductivity 7. Method of synthesis of solids

CO2: Chemical Mathematics

At the end of course student will understand

1. Functions

Differential and integral calculus, limits, derivatives, physical significance, basic rules of differentiation, maxima and minima, application is chemistry, exact and inexact differentiation, Taylor and McLaurin Theorem, curve sketching, partial differentiation, rules of integration, separation of variable, substitution, partial function method to solve to indefinite integrals in chemistry.

2. Differential Equations

Separation of variables, homogeneous, exact, linear equations of second order, series solution method.

3. Vectors Matrices, and Determinants

Vectors, dot, Cross and triple products, introduction to matrix algebra, addition and multiplication of matrices, inverse, adjoins and transport of matrices, unit and diagonal matrices.

CO3: Introduction to Chemical Biology-I

The goal of this course is to introduce students to fundamental concepts in Chemical Biology and methods of chemistry used to solve problems in molecular and cell biology.
After completion of this course, successful students will:
1) Students will be able to explore new areas of research in both chemistry and allied fields of science and technology. 2) Students will be able to function as a member of an interdisciplinary problem-solving team. 3) To impart the student's thorough idea in the chemistry of carbohydrates, amino acids, proteins and nucleic acids etc. 4) Be able to describe the chemical basis for replication, transcription, translation and how each of these central processes can be expanded to include new chemical matter. 5) Develop skills to critically read the literature and effectively communicate research in a peer setting.

SECTION-II: Practical Course

At the end of course student will understand

CO1: Inorganic Material Analysis, Synthesis and Applications

1. Determination of Silica and Manganese from pyrolusite ore. 2. Determination of Aluminum and Silica from Bauxite ore. 3. Determination of silica and iron from hematite ore. 4. Determination of copper and iron from Chalcopyrite ore. 5. Determination of tin and lead from solder alloy. 6. Determination of iron and chromium from stainless steel alloy. 7. Determination of copper and nickel from cupranickel alloy. 8. Synthesis of ZnO from zinc oxalate - precursor method and determine band gap by absorption spectroscopy 9. Synthesis of TiO_2 $TiCl_4$ or Ti-Isopropoxide by Sol-gel method and determine band gap by absorption spectroscopy 10. Synthesis of Colloidal silver nanoparticles and determine band gap by absorption spectroscopy 11. Synthesis of Fe_2O_3 nanoparticles sol gel/coprecipitation/hydrothermal (any one method) 12. ZnO, TiO_2, Fe_2O_3 nanoparticles powder XRD, SEM, TEM (at least one spectral analysis should be done) 12. Removal and kinetics of photocatalytic dyes, degradation (methylene blue) by ZnO TiO_2 photocatalysis 13. Study of adsorption of phosphate ion on alfa-Fe2O3 (Ref-2)

CO2: Chemical Biology-I Practical

1. Statistical treatment of experimental data (calculation of mean and standard deviation for given data and least square method for calibration curve method) –

1. Preparation of biological buffers. 2. Qualitative analysis of carbohydrates 3. Qualitative analysis of Lipids 4. Qualitative analysis of amino acids 5. Paper chromatographic / TLC separation of mixture of amino acids and their detection 6. Paper chromatographic separation of mixture carbohydrates and their detection 7. Quantitative estimation of Glucose by dinitro salicylic acid by using calorimetric method 8. Quantitative estimation of proteins by Loawry's method 9. Kjeldahl method of Protein Determination 10. Saponification number of fats 11. Iodine value of oil 12. Isolation Quantitative estimation of DNA by Diphenyl amine method 13. Determination of Inorganic Phosphate in Biological Samples

CHP-107: Basic Practical Chemistry – I

At the end of course student will understand

Sec-I: CO1: Physical Chemistry Practical

1. Statistical treatment of experimental data (calculation of mean and standard deviation for given data and least square method for calibration curve method) (compulsory) 2. Kinetic decomposition of diacetone alcohol by dilatometry. 3. Determination of an order of a reaction.4. Brönsted primary salt effect. 5. Kinetics of oxidation of ethanol by $K_2Cr_2O_7$ 6. Determination of surface excess of amyl alcohol or TX-100 surfactant by Capillary rismethod.7. Determination of molecular weight by steam distillation. 8. Glycerol radius by viscosity. 9. Partial Molar Volume (Polynometry) Determination of the densities of a series of solutions and to calculate the molar volumes of the components. 10. Simultaneous determination of Ni and Co by spectrophotometry 11. Simulations determination of $KMnO_4$ and $K_2Cr_2O_7$ by spectrophotometry 12. To study the adsorption of certain dyes such as methyl violet, picric acid or malachite green on charcoal13. To determine the indicator constant of bromocresolpuple by half height method 14. Estimation of Cu(II) by titration with Na_2 EDTAby colorimetry 15. a. Determination of energy of n to Π^* transition in acetone and study of effect of solvent on energy of this transition by recording absorbance spectra in n-hexane

and water. b. To study the effect of the extended conjugation on the λ_{max} of p-nitro phenol by recording spectrum in acidic and alkaline medium (Ref-8). 10. Estimation of Mn in tea leaves by NAA. 11. Half-life of a radioactive nuclide and counting errors. 12. Determination of E-max of β radiation and absorption coefficients in Al.

Sec-II: CO2: Organic Chemistry

Introduction to Laboratory Safety: Meaning of safety signs on container of chemicals, safety handling of chemicals, MSDS sheets: Detailed explanation at least for 4 different types of substances (e.g. nitric acid, benzene, potassium dichromate, bromine, etc.), Handling of glassware's and care to be taken, handling of organic flammable as well as toxic solvents in laboratory, use of safety goggles, shoes and gloves, fire extinguisher and its use, action to be taken in accidental cases e.g. cleaning of acid spill over, use eye wash station and bath station in emergency, etc. (compulsory)

Part-I: Purification Techniques a) Purification of **two** organic solids by recrystallization using solvents other than water b) Purification of **two** organic liquids by upward/downward/traditional distillation technique c) Column Chromatography technique should be performed for any one of the following preparation d) Sublimation by Cold Thumb Method e) Thin Layer Chromatography technique **two mixtures**

Part-II: Introduction to Green Chemistry Concept of green chemistry, twelve principals of green chemistry, applications of green chemistry for sustainable development, Atom economy, monitoring of reaction using TLC. 1. Preparation of Schiff's bases in aqueous medium. 2. Preparation of dihydropyrimidinone under solventfree conditions 3. Preparation of acetanilide from aniline and acetic acid using Zn dust.

M.Sc. Part-I Semester-II

CHP-210, Physical Chemistry-II,

SECTION – I, Molecular Spectroscopy

CO1: Microwave Spectroscopy: Types of molecules on the basis of moment of inertia and rotational spectra of di- and poly
atomic molecules.

CO2: Infra-red Spectroscopy: The vibrating diatomic molecule, harmonic and Anharmonic oscillator, The diatomic vibrating rotator, breakdown of the Born-Oppenheimer approximation, The vibrations of polyatomic molecule, Fourier transform spectroscopy and its advantages, The carbon dioxide laser, Applications.

CO3: Raman Spectroscopy: Quantum and classical theory of Raman effect, pure rotational Raman spectra, vibrational Raman spectra, polarization of light and Raman effect, structure determination from Raman and Infra-red spectroscopy, applications.

CO4: Electronic Spectroscopy of molecules: Electronic spectra of diatomic molecules - The Born- Oppenheimer approximation, Vibrational coarse structure, Frank- Condon principle, dissociation energy and dissociation product, Rotational fine structure of electronic-vibration transition, The fortrat diagram, Pre-dissociation, molecular photoelectron spectroscopy.

CO5: Mossbauer Spectroscopy: Principle, Instrumentation and Applications of Mossbauer Spectroscopy.

SECTION – II, Nuclear and Radiation Chemistry

CO1: Radioactivity: Types of radioactive decay, general characteristics of radioactive decay, decay kinetics, general expression for the activity of a daughter nuclide, Geiger-Nuttalis law, α-decay: A problem in classical physics, Internal conversion and the Auger effect.

CO2: Elements of Radiation: Chemistry: Interaction of radiation with matter, interaction of γ radiation with matter, units for measuring radiation absorption, Radiation dosimetry,Radiolysis of water, free radicals in water radiolysis, Radiolysis of some aqueous solutions.

CO3: Nuclear Fission: The discovery of nuclear fission, the process of nuclear fission, fission fragments and their mass distribution, charge distribution, Ionic charge of fission fragments, fission energy, M. Sc. fission cross-section and threshold, fission neutrons, theory of nuclear fission, Neutron evaporation and spallation.

CO4: Applications of Radioactivity: Typical reaction involved in the preparation of radioisotopes, The Szillard- Chalmers reaction, Radiochemical principles in the use of tracers, Isotopes in elucidating reaction mechanism and structure determination, physic-chemical research - The solubility of a sparingly soluble substances, surface area of a powder or precipitate rates of diffusion, Analytical applications- Isotope dilution analysis, Neutron activation analysis, Radiometric titrations, Medical Applications-Thyroiditis, Assessing the volume of blood in a patient, Industrial applications thickness measurements and control, friction and wear out, gamma Radiography

CHI-230, Inorganic Chemistry-II,

SECTION-I Coordination Chemistry

At the end of course student should able to -

CO1: 1. Student should able to find out the no of microstates and meaningful term symbols, construction of microstate table for various configuration

CO2. Hund's rules for arranging the terms according to energy.

CO 3. Student should understand interelectronic repulsion.

CO 4. Student should know the concept of weak and strong ligand field.

CO 5. Student able to find out splitting of the free ion terms in weak ligand field and strong ligand field.

CO 6. To draw correlations diagram for various configurations in Td an Oh ligand field.

CO 7. Student should know basic instrumentation and selection rules and relaxation in rules.

CO 8. Student should know basic d-d transition, d-p mixing, charge transfer spectra.

CO 9. Interpretation of electronic spectra for spin allowed oh and td complexes using Orgel diagram.

CO 10. Understand the concept of spectro chemical series and Nephelauxetic series.

CO 11. Should able to solve numerical based on crystal field parameters.

CO 12. Understand the various terms involved in magnetochemistry.

CO 13. Various phenomenons of magnetism and their temperature dependence.

CO 14. Various experimental methods to find out magnetic moment.

CO 15. Understand the various Quenching of orbital angular momentum.

Section-II: Bioinorganic Chemistry

1) Importance of bioinorganic chemistry.
2) Role of metals in Metalloprotein and metalloenzymes.
3) Similarities in coordination theory for metal complexes and metal ions complexed with biological ligands.
4) Importance and transport of metal ions.
5) Passive transport metal ions by ionophores and gramicidin.
6) Mechanism for active transport of Na^+ and K^+
7) Nerve impulse generation in rod cell of retina.
8) Importance and function of Ca, Fe and Mg in metalloprotein
9) Catalytic role of Mn in photosynthesis

CHO – 250, Organic Chemistry-II,

By the end of this course students will able to
CO 1. MOT and will be able to extend this in predicting reaction mechanism and stereochemistry of electrocyclic reactions.
CO 2. The concepts in free radical reactions, mechanism and the stereo chemical outcomes.
CO 3. The basic principle of spectroscopic methods and their applications in structure elucidation of organic compounds using given spectroscopic data or spectra.

CHG – 290, General Chemistry-II,

SECTION-I: Theory Course

By the end of this course students will able to

Elective Option-A: Material Characterization Technique

At the end of course student will understand / able to explain
CO 1. Different characterization technique of solids.
CO 2. Principle of XRD, instrumentation of powder XRD, Brags law, applications of XRD for crystal structure determination, numerical problems.
CO 3. Principle of SEM, instrumentation of SEM and interpretation of surface morphology of solid from SEM.
CO 4. Principle of TEM, instrumentation of TEM and interpretation of TEM images.
CO 5. Basics of X-rays, Principle of XRF, types of XRF, instrumentation, qualitative and quantitative analysis, numerical.

Elective Option - B: Organometallic and Inorganic Reaction Mechanism

At the end of course students will able to explain
CO 1. Valence electron count, back bonding in organometallics, spectral characterization of organometallic compounds.
CO 2. Catalytic reaction involving organometallic compounds and mechanism of these reactions
CO 3. Types of reaction involving organometallic compounds
CO 4. Types of reactions in coordination compounds, inert and labile complexes, substitution reactions in coordination complexes and their mechanism, stereochemistry of reaction, kinetics of reactions.

Elective Option - C: Introduction to Chemical Biology-II

The goal of this course is to introduce students to fundamental concepts in Chemical Biology and methods of chemistry used to solve problems in molecular and cell biology.

After completion of this course, successful students will:

CO 1) Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

CO 2) Students will be able to function as a member of an interdisciplinary problem solving team.

CO 3) To impart the student's thorough idea in the chemistry of carbohydrates, amino acids, proteins and nucleic acids etc.

CO 4) Be able to describe the chemical basis for replication, transcription, translation and how

each of these central processes can be expanded to include new chemical matter.

CO **5)** Develop skills to critically read the literature and effectively communicate research in a peer setting.

CO **6)** Describe the importance of chemical biology research and interdisciplinary work.

SECTION-II: Practical Course

Elective Option-A:

CO1: Electrochemical Methods of Analysis

1. Hydrolysis of NH_4Cl or CH_3COONa or aniline hydrochloride. 2. Determination of λ_0 or $\lambda\alpha$ and dissociation constant of acetic acid. 3. Hydrolysis of ethyl acetate by NaOH. 4. Determination of ΔG, ΔH, and ΔS of silver benzoate by conductometry. 5. Determination of critical micellar concentration (CMC) and ΔG of micellization of sodium Lauryl Sulphate / Detergent 6. Determination of half wave potential E 1/2 and unknown concentration of Cu or Pb or Zn ion. 7. Amperometric titration of $Pb(NO_3)_2$ with $K_2Cr_2O_7$. 8. Stability Constant of a complex ion. 9. Solubility of a sparingly soluble salt. 10. To determine the ionic product of H_2O 11. Estimation of halide in mixture. 12. Determination of the acid and base dissociation constant of an amino acid and hence the isoelectric point of the acid. 13. Determination of dissociation constants of tribasic acid (phospheric acid) 14. Construct pH curve for titration of strong base – strong acid, strong base - weak acid and predict the best indicator in these titrations (methyl orange, methyl orange, brocresol green, phenolphthalein, etc.) 15. Analysis of powder XRD of $SrTiO_3$ and Ag metal or any two compounds (Calculation d, lattice constant, crystal volume and density, and assigning planes to peaks using JCPDS data16. Cyclic voltamogram of $K_3Fe(CN)_6$ in KCl/H_2O / Ferrocene in TEAP//MeCN. 17. Detailed interpretation of Raman spectra of diatomic molecules

Elective Option-B:

CO2: Chemical Biology-II Practical

1. Dialysis and Reverse dialysis of protein salt solution 2. Separation of protein by Gel filtration method 3. Separation of protein by affinity chromatography method 4. Separation of protein by Ion exchange chromatography 5. Native and SDS PAGE of proteins 6. Separation of amino acids by paper chromatography 7. Separation of nucleic acid by Agarose gel electrophoresis 8. Effect of pH on enzyme activity 9. Effect of Temperature on enzyme activity 10. Effect of substrate concentration on enzyme activity 11. Detection of λ Max of proteins 12. Detection of λ Max of Nucleic acid

CHP-227: Basic Practical Chemistry – II

At the end of course students will able to explain
CO 1. Students are trained to different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.
CO 2. Students are made aware of safety techniques and handling of chemicals. M. Sc. [I]
CO 3. Students are made aware of carrying out different types of reactions and their workup methods.
CO 4. This practical course is designed to make student aware of green chemistry and role of green chemistry in pollution reduction.
radiochemicals.

M.Sc. Part-II Semester-III

CHO-350: Organic Reaction Mechanism and Biogenesis

Section I: Organic Reaction Mechanism

CO1: Methods for determining Reaction Mechanisms
(Students know about Kinetic and no kinetic methods),

CO2: Free Radicals: Generation, stability, reactivity, Free radical substitution, addition to multiple bonds, radicals in synthesis, Inter- and intra-molecular bond formation via mercury hydride, tin hydride, thiol donors, cleavage of C-X , C-Sn, C-S, O-O bonds, Oxidative coupling, C-C bond formation in aromatics, SNAr reactions, Free Radicals in Organic Synthesis.

CO3: Linear Free Energy Relationships, 4. Hammet plots, Hammet equation, substituent constants, reaction constants, use of Hammet plots, calculation of k and K, Deviations from straight line plots, Taft equation, solvent effects.

Section II: Biogenesis: The building Blocks and Construction Mechanisms,

CO1: Terpenoids: Mono-, Sesqui-, Di-, tri-terpenoids and cholesterol,

CO2: Alkaloids: Derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan.

CO3: The Shikimate pathway: Cinnamic acids, lignans and lignin, coumarins, flavonoids and stilbens, isoflavanoids and terpenoid quinines

CO4: A case study: Alkaloids isolated from the Roots of ***Piper nigrum***

CHO-351: Structure Determination of Organic Compounds by Spectroscopic Methods

Section-I: NMR Spectroscopy

CO1: NMR in Stereochemistry Determination: Homotopic, enatiotopic and distereotopic protons, Chemical and Magnetic equivalence; First and second order splitting, Complex multiplicity patterns and coupling constants in asymmetric compounds; Simplification of complex spectra, NOE, Diastereomerism, Atrop or axial chirality, % Enantiomeric excess, chiral NMR solvents etc in structure elucidation.

CO2: ^{13}C NMR spectroscopy - APT, DEPT and INEPT

CO3: ^{15}N, ^{19}F and ^{31}P NMR spectroscopy: Fundamentals and applications in structure elucidation of organic compounds, catalysts and biomolecules.

CO4: 2D NMR spectroscopy in structure elucidation: (a)Homonuclear: COSY, TOCSY, 2D

INADEQUATE, 2D- ADEQUATE, NOESY, ROESY (b) Heteronuclear: HSQC, HMQC, HMBC

Section-II: Mass Spectrometry

CO1: Mass Spectrometry: Principle, ionization methods like EI, CI, ES, MALDI and FAB Fragmentation of typical organic compounds, stability of fragments, Rearrangements, factors affecting fragmentation, ion analysis, ion abundance, High-Resolution mass spectrometry in determination of molecular formula.

CO2: Applications of Mass Spectrometry: Determination of the elemental composition, Isotopic Abundance in structure establishment; Analysis of Biomolecules: Proteins and Peptides, Oligonucleotides and Oligosaccharides

CO3: Problems solving: Structure elucidation using UV, IR, 1D (1H and13C) NMR and 2D NMR (1H-1H, 13C- 1H COSY /HETCOR only), APT, DEPT and MS data as well as spectra.

CHO-352: Stereochemistry and Asymmetric Synthesis of Organic Compounds

At the end of course student should able to -

Section I- Stereochemistry

CO1: Conformations of polysubstituted cyclohexane, six membered rings with SP_2 carbon, heterocycles with N and O, anomeric effect, stereochemical principles involved in reactions of six membered rings and other than six membered rings, concept of I- Strain.

CO2: A) Stereochemistry of fused and bridged ring systems: Nomenclature, synthesis; stereochemical aspects of Perhydrophenanthrene, Perhydroanthracene, hydrindane, Steroids; Bridged system (bi, tri and polycyclo system) including heteroatoms, Bredt's Rule.

CO3: B) Conformations of following compounds with justification of each: cis and trans - 1,3- and l,4-di-t-butyl-cyclohexanes; Cis-4-di-t-butylcis-2,5-dihydroxycyclohexane; Twistane; bicyclo- [2.2.2]octane; Trans-anti-transPerhydro-anthracene and the lactone; cyclohexane-l,4-dione; 1,2,2,6,6-penta-methyl-4- hydroxy-4-phenylpiperidine; ψ-tropine; 2-hydroxy-2-phenyl quinolizidine; 4-t-butyl-4- methyl-l,3-dioxane; cis- and trans-2,5-di-t-butyl-l,3-dithianes;cis-2,5-di-t-butyl-l,3,2- dioxaphosphorinan-2-one 3. Determination of configuration, Cram's rule, Cram's cycle model, Cram's dipolar model, Felkin-Anh Model; Resolution and analysis of stereomers - formation of racemization and methods of resolution. Stereochemistry of a polymer chain – Types and examples of Tacticity 4. Decalols, Decalones, Octahydronaphthalenes, decahydroquinolines

Section II- Asymmetric Synthesis: students know about

CO1: Introduction of Asymmetric Synthesis, Chirol pool and Chiral auxillaries.

CO2: Asymmetric Organocatalysis

CO3: Asymmetric Aldol Reaction, Enantioselective, diastereoselective and double diastereoselective Aldol reactions.

CO4: Transition Metal-Catalyzed Homogeneous Asymmetric Hydrogenation

CO5: Transition Metal-Catalyzed Homogeneous Asymmetric Hydroxylation and Epoxidation

CO6: Asymmetric Phase-Transfer and Ion Pair Catalysis

CHO-353(A): Protection - De-protection, Chiron approach and Carbohydrate

At the end of course student should able to -

Section I: Protection - De-protection, Chiron approach

CO1: Protection and de-protection of functional group in organic synthesis: Hydroxyl group- alkyl ether, benzyl ether,acyl, PMB, Trityl, TMS, TBDMS, THP, MOM, MEM, MIP ether; **Diol** - Acetone,Cyclohexanone; **Amines**- Benzyl, Acyl, CBZ, BOC, FMOC,

CO2: Carboxyl group-Ester, DCCI, DIPCDI; **Ketone and aldehydes**- Glycol, Thioglycol, Ketal,

Acetal; Othroesters as protecting groups, Protection de-protection approach - In Solid phase synthesis of polypeptide; polynucleotide, cyclitols, and amino-sugars**.**

CO3: Chiron approach: a) Introduction, b) The concept of chiral templates and chirons wherein the carbon skeleton is the chiral precursor, c) Utilization of the basic concepts in synthesis of (S) Propanediol, (R) and (S) – Epichlorohydrin, L (+)-Alanine, (-) Multistratin, (-) Pentenomycin and (-) Shikimic acid.

Section - II: Carbohydrate Chemistry

CO1: Basics of Carbohydrates: Introduction of sugars, structures of monosaccharides, triose, tetrose, pentose, hexose, D/L forms of aldoses and ketoses in Fisher projections, cyclic hemiacetal forms of monosaccharides, representation of monosaccharide structure (Fisher, Zig-zag, Mills, Haworth projection and Chair conformation), The structure of Glucose, the anomeric configuration, mutarotation (D-Glucose), Conformations of monosaccharides, the anomeric effect. Modified monosaccharides, Alditols, Cyclitols, Nomenclature of monosaccharides, Cyclic forms of the α and β-D-aldoses.

CO2: Synthesis of Glycosides: glycosyldonar acceptor concept, general methods for glycosyl bond formation: Glycosyl halides, Trichloroacetimides, Glycals and Glycal derivatives, Thioglycosides, Phosphites, n-Pentyl glycosides, SulfoxidesDiazarines, Alkylation of reducing sugars

CO3: - Mannosides, Synthesis of 2-Deoxy Sugars, Orthogonal strategy in Oligosaccharide synthesis, Effect of protecting groups on glycosylation stereoselectivity and coupling efficiency, Intramolecular glycosylation, Total synthesis of natural products: Oligosaccharides and Glycoconjugates.

CHO-353(B): Designing Organic Syntheses and Heterocyclic Chemistry

At the end of course student should able to -

Section I: Designing Organic Syntheses

CO1: Concepts of Retrosynthesis: Retrosynthetic analysis, disconnection approach, Synthons, multiple step synthesis, functional group intercoversion, Illogical two group intercoversion, C-C disconnection, Donor and acceptor Synthons, two group disconnection, 1,5 related functional group disconnection, Umpolung, convergent synthesis, special methods for small rings, Heteroatom and Heterocyclic compounds, problems,

CO2: Application of Retrosynthetic Approach: Retrosynthesis and synthesis of following Molecules: Strychnine, Reserpine, Thienamycin, Asteltoxin, Indolizomycin, Erythronolide B**.**

Section II: Advanced Heterocyclic Chemistry

CO1: 1. Systematic nomenclature (Hantzsch-Widman System) for monocyclic, fused and bridged heterocycles. Tautomerism in aromatic heterocycles. Strain-bond angle, torsional strains and their consequences in small ring heterocycles. **2.** General chemical behaviour of heterocyclic compounds and their applications in: Biological systems (Anthocyanins, Flavones, Neurotransmitters), Natural Products (Alkaloids: Nicotin, Quinine), Drugs andMedicines (Omeprazole, Amlodipine, Cilostazol)

CO2: Synthesis, reactions and structural effects of heterocyclic rings

a) Common Methods in Ring Synthesis of Aromatic Heterocyclic Systems**:** Typical ring synthesis involving C – Heteroatom, C – C bond formations, Electrocyclic processes in heterocyclic Synthesis: 1,3 -dipolar cycloadditions producing five - membered heterocycles, Nitrenes in heterocyclic synthesis, Palladium catalysis in the synthesis of Benzo - Fused heterocycles, Fischer synthesis, Epoxidation, Use of Sulphur Ylides, Azides for small rings b) Three and four membered heterocylces: Aziridines, Oxiranes, Thirienes, Azetidines, Oxitanes and Thietanes c) Five-membered and benzo-fused five memberedheterocycles:Oxazole, Isoxazole,Thiazole, Pyrazole, Imidazole, Benzothiazole and Benzimidazole d) Six membered and benzo-fused six membered heterocycles:Pyrazine, Pyridazine, Pyrimidine, Quinazoline, Quinoxaline, Aziridines, Quinoline

CHO-354: Practical-I Solvent Free Organic Synthesis

CO1: Solvent Free Carbon–Carbon Bond Formation

1. Pinacol coupling reaction 2. Reformatsky reaction/Luche reaction 3. Knoevenagel condensation 4. Dieckmann condensation 5. Corrole Synthesis 6. Knoevenagel condensation,3-carboxycoumarin 7. 3-(ethoxycarbonyl)-4-hydroxy-5-(1-hydroxyalkyl)-2isoxazoline-2-oxide 8. Biginelli reaction 9. Claisen reaction10. Pechmann reaction 11. calix[4]resorcinarene

CO1: Solvent-Free C–N Bond Formation

1. terephthalic acid dihydrazide 2. azomethine synthesis 3. diazepinone synthesis 4. dibenzyl sulfone Synthesis

CO2: Solvent-Free C–S Bond Formation : 1. 1,3-dithiolane synthesis

CO3: Solvent-Free C–X Bond Formation: 1. Cinnamic acid/ stilbene halogenations 2. Phenol bromination using , *N*-bromosuccinimide

CO4: Solvent-Free N–N Bond Formation : 1. Triazenes Synthesis 2. Beckmann rearrangement

CO1: Other Solvent-Free Reactions

1. D-mannitol protection using phenylboronic acid 2. Baeyer-Villiger reaction
3. 2-Hydroxybenzaldehyde oxidation using urea-hydrogen peroxideComplex
4. Alumina-supported permanganate oxidation 5. Sulfide oxidation using MnO_2 6. Oxidative coupling of thiol using MnO_2 .7. Iodine catalysed S-S bond formation of Cystine

CO5: Solvent free supramolecular assembly formation

1. Caffeine and oxalic acid . 2. *rac-Bis*-beta-naphthol and benzoquinone
3. Isovaleraldehyde and pyrogallol

M.Sc. Part-II Semester-IV

CHO-450: Chemistry of Natural Products

Section I:

CO1: Understanding and planning of total synthesis while maintaining the stereochemistry. A case study: Longifolene – (All Nine syntheses from Advanced Organic Chemistry Carey, Sundberg; Part B).

CO2: Total Synthesis of i. Hirsutellone B ii. Ribisins A and Biii. Subincanadine E :

Section II :

CHO-451: Organometallic Reagents in Organic Synthesis

Students knows about:

CO1: 1**.** Transition metal complexes in organic synthesis; Pd, Ni, Ru, Fe, Ir and Cu only (C-C, C-N, C-O bond formation reactions with catalytic cycle, ligand and % mole concepts) 2. C=C formation reactions: Wittig, Horner-Wordworth-Emmons, Shapiro, Bamford tevens, McMurry, Julia-Lythgoe and Peterson olefination reactions. 3. multi-component reactions: Ugi, Passerini, Biginelli and Mannich reaction 4. Ring formation reactions: Pausan-Khand, Bergman and Nazerov cyclization 5. Click chemistry: criterion for click reaction, Sharpless azides cycloadditions. Click reactions in synthesis of bioconjugates (sugars and proteins) 6**.** Metathesis: Schrock and Grubbs catalyst, Olefin cross coupling (OCM), ring closing (RCM) and ring opening (ROM) metathesis, application in polymerization and synthesis of small organic molecules**.** 7. Use of Boron and Silicon reagents in organic synthesis. 8. Other important reactions: Baylis Hilman, Eschenmoser-Tanabe fragmentation, Mitsunobu reaction

CBOP-4, CHO-452(A): Concepts and Applications of Medicinal Chemistry

Section-I:

CO1: Introduction to Peptides and proteins, Proteins as biological catalyst Nucleic acids, Metabolism, Chemistry of cofactors/coenzymes, Chemistry of TPP, PLP, Folic Acid and other vitamins, Principle of drug design, Chemistry of diseases and Drug development, Proton pump inhibitors and Problem solving.

CO2: Peptides, sequencing and applications in therapeutics, Solution phase and solid phase peptide synthesis and Modern techniques for biomolecules and disease diagnosis.

CO3: Introduction to medicinal Chemistry. History, drug targets, Drug discovery, design and development, Case Study: Design of Oxamniquine

CO4: Pharmacokinetics and Pharmacodynamics of drug: Drug absorption, distribution, metabolism, elimination and toxicity, drug metabolism, biotransformation, Drug receptor interactions, Hansch Equation and significance of terms involved in it.

Section II:

CO1: Structure and activity Relationship: QSAR, Applications of SAR and QSAR in drug design, physio-chemical parameters lipophilicity, partition coefficient, electronic ionization constant, Case Study: Statins

CO2: Introduction, Developments, SAR, Mode of action, limitations and adverse effect of Anti-infective Agents, Beta lactam antibacterial agents (Penicillins, Cephalosporins), Tetracyclins, Macrolides, Chloramphenicol, Polyenes, Amphotrecin-B, Azoles, Amantadine,Acyclovir, Quinine, Quinolines, Quinolones, Refamycine, Sulphonamides

CHO-452(B): Applied Organic Chemistry

Section-I:

CO1: Covalent Organic Frameworks: Structures, Synthesis, and Applications.
CO2: Organic Electroluminescent Materials,

Section –II :

CO1: Supramolecular Organic Compounds
CO2: Single Molecule Switches
CO3: Molecular Machines

CHO-453: Practical-III: Select ANY TWO Section I, II and III

Section-I: Ternary Mixture Separation

The mixture separation should be carried out on micro-scale using ether or water.
The students should be able to:
CO1: Understand and employ concept of type determination and separation
CO2: Meticulously record physical constants
CO3: Perform micro scale chemical elemental analysis
CO4: Perform qualitative estimation of functional groups
CO5: Recrystallize /distill the separated compounds
CO6: Extend these skills to organic synthesis

Section-II: Carbohydrates Synthesis and Isolation Natural Products

Unit I: Students know about Carbohydrate Synthesis
CO1: 1) Synthesis and structural determination of α- and β-D-glucose penta- acetate. 2) Selective deacylation of α- and β-D-glucose penta-acetate. 3) Benzoylation of D-glucose.to D-glucose penta-benzoate. 4) Selective debenzoylation of D-glucose penta-benzoate 5) Synthesis 1,2:5,6-di-O-isopropylene-D-glucofuranose.
CO2: Synthesis of 1,2: 5,6 – di-O-isopropylene-3-O-benzyl –D-glucofuranose. Carbohydrate (sugar molecules) are highly soluble in water, to derivatives the sugar molecules require special practical skill in order to get product in hand.
i) To understand the meaning of dry condition in reaction.
ii) How to prepare dry solvents.
iii) Workup of reaction in minimum quantity of water.
iv) To acquire skill in handling of carbohydrates reaction.

Unit II: Isolation of pigments from the natural products
CO1: 1. Orange Marigold 2. Rose 3. Sunflower 4. Hibiscus 5. Any colored flowers/fruits available in the local area

Unit III: Isolation of essential oils from the natural products
CO1: 1. Ginger 2. Lemongrass 3. Garlic 4. Ajwain/ajowan/Trachyspermum ammi 5. Vekhand (achourus calamus) root 6. natural products available in the local area

Unit IV: Isolation of medicinally important component from the natural products
CO1: 1. Nimbin from Neem leave 2. Amyrin from Apati/Apta bark 3. Eujenol from Tulsi leaves 4. D-Galacturonic Acid from Jeshtamadh 5. Piper from Betel leaf **6.** Any medicinally important plants available in the local area.

Section-III:

Project/ Industrial Training/Summer Training/ Internships

Students should carry out a small research project. This should make them familiar with

CO1: Literature survey, research methodologies ii. Data Analysis

CO2: Column and TLC chromatographic techniques

CO3: Characterization of the products by analytical and spectral methods.

CHO-454: Practical-II: Convergent and Divergent Organic Syntheses

Students should acquire **pre-experiment** (Reading MSDS, purification of reactants and reagents, mechanism, stoichiometry etc) and **post-experiment skills** (work-up, isolation and purification of products, physical constants characterization using any spectroscopic methods etc.)

SET-I

CO1: Convergent Synthesis 1 (Three Stage Synthesis)

1. Stage I: Anisole to 4-nitro anisole to 4-amino anisole (2 steps) 2. Stage II: Toluene to 4-nitro toluene to 3-acyl nitro toluene (2 steps) 3. Stage III: Synthesis of N-(1-(2-methyl-5-nitrophenyl) ethyl) aniline from 4-amino anisole, 3-acyl nitro toluene and SBH (One pot synthesis: MCR)

CO2: Divergent Synthesis 1 (5 Single Stage Synthesis from Acetyl acetone):

1. Acetyl acetone to Pyrimidine 2. Acetyl acetone to 2,4-dimethyl-1H-benzo[b][1,4]diazepine 3. Acetyl acetone to Pyrazole 4. Acetyl acetone with 1mmol benzaldehyde to 3-benzylidenepentane-2,4-dione 5. Acetyl acetone with 3 mmol benzaldehyde into 3-benzylidene-6-phenylhex-5-ene-2,4- dione

SET-II

CO1: Convergent Synthesis 2(Three Stage Synthesis)

1. Stage I: 4-Nitro toluene to 4-amino toluene (Reduction by using Sn/HCl) 2. Stage II: Phenol into 2-hydroxy benzaldehyde (Reimer-Tiemann reaction) 3. Stage III: Synthesis of amidoalkyl-2-naphthols from β-Naphthol,4-amino toluene and of 2-hydroxy benzaldehyde (One pot synthesis: MCR)

CO2: Divergent Synthesis (5 Single Stage Synthesis from β-Naphthol)

1. β-Naphthol to Synthetic dye (By diazonium coupling) 2. β-Naphthol to 6-Bromo-2-naphthol (Bromination reaction) 3. β-Naphthol to β-Naphthyl methyl ether (Methylation reaction) 4. β-Naphthol to temperature dependent sulfonation (Sulfonation reaction) 5. β-Naphthol to (±) Binol then Resolution of Binol (Resolution technique)

SET-III

CO1: Convergent Synthesis-3 (Three Stage Synthesis)

1. Stage I: Salicylic acid to 5-Chloro-2-hydroxybenzoic acid 2. Stage II: o- Anisidine to 2-methoxy-4-nitroaniline 3. Stage III: Synthesis of 5-chloro-2-hydroxy-N-(2-methoxy-4-nitrophenyl) benzamide from 5-Chloro-2-hydroxybenzoic acid, -methoxy-4-nitroaniline (One pot synthesis: MCR)

CO2: Divergent Synthesis-3 (5 Single Stage Synthesis from Salysaldehyde)

1. Salicylaldehyde to Salicylaldehyde phenylhydrazone 2. Salicylaldehyde with melanonitrile to 2-iminochromene by intramolecular cyclization. 3. Salicylaldehyde to 2-hydroxy-3,5-dinitrobenzaldehyde4. Salicylaldehyde to o-Formylphenoxy acetic acid 5. Salicylaldehyde to catechol

SET-IV

CO1: Convergent Synthesis- 4 (Three Stage Synthesis)

1. Stage I: Benzene to actophenone (F.C acylation) 2. Stage II: 4-Nitrochlorobenzene into 4-amino chlorobenzene (Reduction by using hydrazine) 3. Stage III: Quinoline synthesis by using acetophenone, 4-amino chloro benzene and styrene (One pot synthesis: [3 + 2 + 1] cycloaddition reaction)

CO2: Divergent Synthesis-4 (5 Single Stage Synthesis from Acetophenone)

1. Acetophenone to Ethyl benzene by Wolf Kishner reduction 2. Acetophenone to m-Nitro acetophenone by nitration 3. Acetophenone to Chalcone using aromatic aldehyde 4. Acetophenone into Schiff base using aromatic amine **5.** Acetophenone to Benzoic acid and Iodoform 4. Hermann, Terence C. Mor