Maharashtra Education Society

Abasaheb Garware College, Pune

(Autonomous)

(Affiliated to *Savitribai Phule Pune University*)

Three Years B.Sc. Degree Program in Chemistry

(Faculty of Science and Technology)

Syllabi under Autonomy

F.Y. B. Sc. (Chemistry)

Choice Based Credit System [CBCS] Syllabus

To be implemented from Academic Year 2022-2023

Title of the subject: B.Sc. (Chemistry)

Preamble:

Taking into consideration the rapid changes in science and technology and new approaches in different areas of Chemistry and related subjects board of studies in Chemistry with concern of teachers of Chemistry and industry has prepared the syllabus of F. Y. B. Sc. Chemistry. To develop the syllabus the U.G.C. Model curriculum is followed.

Programme objectives:

1. To understand fundamental concept of physical, organic and Inorganic chemistry.
2. To impart basic understanding of stoichiometric calculations.
3. To impart practical skills and learn basics behind experiments.
4. To prepare background for advanced and applied studies in chemistry.

Eligibility:

Passed 12th Science or equivalent course with Chemistry as one of the subjects.

Structure of the course F. Y. B. Sc. Chemistry

Year	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
1	I	Compulsory	USCH-111	Physical Chemistry	Theory	02	36 L
		Compulsory	USCH-112	Organic Chemistry	Theory	02	36 L
		Compulsory	USCHP-113	Chemistry Practical–I	Practical	1.5	12 P
	II	Compulsory	USCH-121	Inorganic Chemistry	Theory	02	36 L
		Compulsory	USCH-122	Analytical Chemistry	Theory	02	36 L
		Compulsory	USCHP-123	Chemistry Practical –II	Practical	1.5	12 P

Year	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
2	III	**Compulsory**	USCH-231	Physical and Analytical Chemistry	Theory	02	36 L
		Compulsory	USCH-232	Organic and Inorganic Chemistry	Theory	02	36 L
		Compulsory	USCHP-233	Chemistry Practical–I	Practical	02	12 P
		Compulsory	USEVS-231	Environmental Science	Theory	02	36L
		Compulsory	USLG-231	Language A. English OR B. Hindi OR C. Marathi	Theory	02	36L
	IV	**Compulsory**	USCH-241	Physical and Analytical Chemistry	Theory	02	36 L

		Compulsory	USCH-242	Organic and Inorganic Chemistry	Theory	02	36 L
		Compulsory	USCHP-243	Chemistry Practical –II	Practical	02	12 P
		Compulsory	USEVS-241	Environmental Science	Theory	02	36L
		Compulsory	USLG-241	A. English B. Hindi C. Marathi	Theory	02	36L

Year	**Semester**	**Course Type**	**Course Code**	**Course Title**	**Remark**	**Credit**	**No. of Lectures /Practical to be conducted**
3	**V**	**Compulsory**	USCH-351	Physical Chemistry-I	Theory	02	36 L
		Compulsory	USCH-352	Analytical Chemistry-I	Theory	02	36 L
		Compulsory	USCHP-353	Physical Chemistry Practical-I	Practical	02	12 P
		Compulsory	USCH-354	Inorganic Chemistry	Theory	02	36 L
		Compulsory	USCH-355	Industrial Chemistry	Theory	02	36 L
		Compulsory	USCHP-356	Inorganic Chemistry Practical-I	Practical	02	12P
		Compulsory	USCH-357	Organic Chemistry-I	Theory	02	36 L
		Compulsory	USCH-358	Chemistry of Biomolecules	Theory	02	36 L
		Compulsory	USCHP-359	Organic Chemistry Practical-I	Practical	02	12 P
		Compulsory	USDEG-1	Democracy, Election and Governance	Theory	01	10 L
		Elective	USCH-3510	A. Introduction of Medicinal Chemistry OR B. Polymer Chemistry	Theory (select any one)	02	36 L
		Elective	USCH-3511	A. Environmental Chemistry OR	Theory (select any one)	02	36 L

				B. Cheminformatics			
	VI	**Compulsory**	USCH-361	Physical Chemistry-II	Theory	02	36 L
		Compulsory	USCH-362	Physical Chemistry-III	Theory	02	36 L
		Compulsory	USCHP-363	Physical Chemistry Practical-II	Practical	02	12 P
		Compulsory	USCH-364	Inorganic Chemistry-II	Theory	02	36 L
		Compulsory	USCH-365	Inorganic Chemistry-III	Theory	02	36 L
		Compulsory	USCHP-366	Inorganic Chemistry Practical-II	Practical	02	12 P
		Compulsory	USCH-367	Organic Chemistry-II	Theory	02	36 L
		Compulsory	USCH-368	Organic Chemistry-III	Theory	02	36 L
		Compulsory	USCHP-369	Organic Chemistry Practical-II	Practical	02	12 P
		Compulsory	USDEG-2	Democracy, Election and Governance	Theory	01	10 L
		Elective	USCH-3610	A. Chemistry of soil and Agrochemicals OR B. Introduction to Forensic Chemistry	Theory (select any one)	02	36 L
		Elective	USCH-3611	A. Analytical Chemistry-II OR B. Chemistry of Cosmetics and Perfumes	Theory (select any one)	02	36 L

SEMESTER - I

Course code and Title: USCH-111: Physical Chemistry (2 Credits, 36 L)

Learning Outcome

1. Students will be able to apply thermodynamic principles to physical and chemical process
2. Calculations of enthalpies
3. Variation of enthalpy with temperature –Kirchhoff's equation
4. Third law of thermodynamic and its applications
5. Knowledge of Chemical equilibrium will make students to understand relation between Free energy and equilibrium and factors affecting on equilibrium constant.
6. Exergonic and endergonic reaction
7. Gas equilibrium, equilibrium constant and molecular interpretation of equilibrium constant
9. Van't Haff equation and its application
10. Ionic equilibria chapter will lead students to understand Concept to ionization process occurred in acids, bases and pH scale.
11. Related concepts such as Common ion effect hydrolysis constant, ionic product, solubility product.
12. Degree of hydrolysis and pH for different salts, buffer solutions.

1. Chemical Energetics (11 L)

Review of thermodynamics, Heat, work, internal energy, enthalpy and first law of thermodynamics, Importance of state functions: internal energy and enthalpy, Entropy and second law of thermodynamics. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances, problems

Recapitulation of basic terms of thermodynamics

2. Chemical Equilibrium: (11L)

Introduction: Free Energy and equilibrium – Concept, Definition and significance, the reaction Gibbs Energy, Exergonic and endergonic reaction. Thermodynamic derivation of the law of Chemical Equilibrium, Van't Hoff reaction isotherm, Problems. The perfect gas equilibrium, the general case of equilibrium, relation between equilibrium constants, Molecular interpretation of equilibrium constant. The response of equilibria to conditions-response to pressure, response to temperature, Temperature- dependence of the equilibrium constant: Van't Haff equation, Value of K at different temperature, Problems

3. Ionic Equilibria (14L)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts– applications of solubility product principle.

Recapitulation of basics of acids and bases

References:

1. Samuel Glasstone, *Thermodynamics for Chemists*, Affiliated East West Private Limited.
2. B. S. Bahl, G. D. Tuli, Arun Bahl, *Essentials of Physical Chemistry*
3. Peter Atkins and Julio de Paula, *Elements of Physical Chemistry*, Sixth edition (2013), Oxford press
4. Ball D. W., *Physical Chemistry*, Thomson Press, India (2007)
5. Castellan, G.W. *Physical Chemistry*, 4th Ed. Narosa (2004).
6. *Atkins' Physical Chemistry –Thermodynamics and Kinetics*, 11th Edition, Oxford Press
7. Thomas Engel, Philip Reid; *Physical Chemistry*, Pearson Education (2006)
8. J. N. Gurtu, A. Gurtu; *Advanced Physical Chemistry*, Pragati Edition
9. Mortimer R. G., *Physical Chemistry*, 3rd Edition, Elsevier, Noida (UP)
10. Samuel H. Maron and Carl F. Prutton, *Principal of physical Chemistry*, 4th Edition, Collier Macmillan Ltd.

Course code and Title: USCH-112: Organic Chemistry (2 Credits, 36 L)

Learning Outcome

1. The students are expected to understand the fundamentals, principles, and recent developments in the subject area.
2. It is expected to inspire and boost interest of the students towards chemistry as the main subject.
3. To familiarize the applications of Chemistry in day to day life.
4. To create foundation for research and development in Chemistry.

1. Fundamentals of Organic Chemistry (09L)

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases Comparative study with emphasis on factors affecting pK values, Types of organic reactions (addition, elimination, substitution, rearrangement with one example).

Self- Learning: Importance of arrows in organic reactions.

2. Aliphatic Hydrocarbons (09L)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkenes: (Up to 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: (Up to 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalide Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

Self-learning: Alkanes: Preparation and Reactions.

3. Stereochemistry (14L)

Introduction, classification, Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Conformations with respect to butane and cyclohexane. Configuration: Geometrical - cis – trans, and E / Z Nomenclature (for upto two C=C systems). Optical isomerism Enantiomerism, Diastereomerism and Meso compounds). Concept of

chirality (upto two carbon atoms). Threo and erythro; D and L; nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) Stereochemistry of Glucose

Self- Learning: Conformations of ethane and propane

4. Introduction to aromaticity (04L)

Hückel's rule, aromatic, anti-aromatic and non-aromatic concept benzenoids and non benzenoids, heterocyclic compounds

Self-learning: Structure of benzene.

Reference Books

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
4. Eliel, E. L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
5. Finar, I. L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
7. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.

Course code and Title: USCHP-113: Chemistry Practical

(1.5 Credit, Any 12)

Learning Outcome:

1. Importance of chemical safety and Lab safety while performing experiments in laboratory
2. Determination of thermochemical parameters and related concepts
3. Techniques of pH measurements
4. Preparation of buffer solutions
5. Elemental analysis of organic compounds (non instrumental)
6. Chromatographic Techniques for separation of constituents of mixtures

Section A: Chemical and Lab Safety (Compulsory) and Inorganic Chemistry

1. MSDS sheets, points in MSDS Find out MSDS sheets of at least hazardous chemicals (K2Cr2O7, Benzene, cadmium nitrate, sodium metal, etc.)
2. Safety symbol on labels of pack of chemicals and its meaning
3. Precautions in handling of hazardous substances like Conc. acids, ammonia, organic solvents, etc.
4. Toxicity of the compounds used in chemistry laboratory and classification of toxicity.
5. To find the concentration of $KMnO_4$ by titrating it against Oxalic acid.
6. Determination of Dissolved Oxygen in different samples of water.

Section B: Physical Chemistry

a. Thermochemistry (Any three)

1. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
2. Determination of enthalpy of hydration of copper sulphate.
3. Study of the solubility of benzoic acid in water and determination of ΔH.
4. Determination of heat capacity of calorimeter for different volumes.
5. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
6. Determination of enthalpy of ionization of acetic acid.

b. Ionic equilibrium (Any two)

1. Preparation of buffer solutions and measurement of the pH of buffer solutions and comparison of observed values with theoretical values.
   (i) Sodium acetate-acetic acid and determine its buffer capacity
   (ii) Ammonium chloride-ammonium hydroxide and determine its buffer capacity

OR

2. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter
3. Experiment on Potentiometer

Section C: Organic Chemistry (Any five)

1. Organic Qualitative Analysis (3 solid, 1 liquid) – Type, detection of elements (N, S, Cl, Br, I), Saturation/Unsaturation, Physical constant, Functional group test in organic compounds (containing up to two extra elements)
2. a) Nitration of acetanilide.
   b) Recrystallization of the product obtained
   c) Determination of physical constant before and after recrystallization.

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
6. Prof. Robert H. Hill Jr., David C. Finster Laboratory Safety for Chemistry Students, 2nd Edition
Wiley ISBN: 978-1-119-02766-9 May 2016
7. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated
Version, ISBN 978-0-309-13864-2 | DOI 10.17226/12654, THE NATIONAL ACADEMIES PRESS Washington, D.C.

SEMESTER- II

Course code and Title: USCH-121: Inorganic Chemistry (2 Credits, 36 L)

Learning Outcome

1. Atomic Structure

1. Various theories and principles applied to revel atomic structure
2. Origin of quantum mechanics and its need to understand structure of hydrogen atom
3. Schrodinger equation for hydrogen atom
4. Radial and angular part of hydrogenic wave functions
5. Significance of quantum numbers
6. Shapes of orbitals

2. Periodicity of Elements

1. Explain rules for filling electrons in various orbitals- Aufbau's principle, Pauli exclusion principle, Hund's rule of maximum multiplicity
2. Discuss electronic configuration of an atom and anomalous electronic configurations.
3. Describe stability of half-filled and completely filled orbitals.
4. Discuss concept of exchange energy and relative energies of atomic orbitals
5. Design Skeleton of long form of periodic table.
6. Describe Block, group, modern periodic law and periodicity.
7. Classification of elements as main group, transition and inner transition elements
8. Write name, symbol, electronic configuration, trends and properties.
9. Explain periodicity in the following properties in details:
    a. Effective nuclear charge, shielding or screening effect; some numerical problems.
    b. Atomic and ionic size.
    c. Crystal and covalent radii
    d. Ionization energies
    e. Electronegativity- definition, trend, Pauling electronegativity scale.
    f. Oxidation state of elements

3. Chemical Bonding

1. Attainment of stable electronic configurations.
2. Define various types of chemical bonds- Ionic, covalent, coordinate and metallic bond
3. 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
4. Summarize Born-Lande equation and Born-Haber cycle,
5. Define Fajan's rule, bond moment, dipole moment and percent ionic character.
6. Describe VB approach, Hybridization with example of linear, trigonal, square planer, tetrahedral, TBP, and octahedral.

7. Discuss assumption and need of VSEPR theory.
8. Interpret concept of different types of valence shell electron pairs and their contribution in bonding.
9. Application of non-bonded lone pairs in shape of molecule
10. Basic understanding of geometry and effect of lone pairs with examples such as ClF_3, Cl_2O, BrF_5, XeO_3 and $XeOF_4$.

4. Nanoscience and Nanotechnology:

1. History of Nanoscience and nanotechnology
2. Classification of Natural and artificial nanoparticle , Ancient Nanotechnology
3. Defination: Nanomaterials, Nanoparticals, Nanocomposite, Nanochemistry, Nanotechnology, 0D, 1D, 2D and 3D nanomaterisls .
4. History of nanotechnology- Feynman, Drexler and Taniguchi.

1. Atomic Structure (12 L)

Origin of Quantum Mechanics: Why study quantum mechanics?, Quantum mechanics arose out of interplay of experiments and Theory Energy quantization- i) Black body radiation ii) The photoelectric effect iii) Wave particle duality - a) The particle character of electromagnetic radiation b) the wave character of particle, iv) diffraction by double slit v) atomic spectra, Review of-Bohr's theory and its limitations, Heisenberg Uncertainty principle.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it, Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Significance of quantum numbers, orbital angular momentum and quantum numbers *ml* and *ms*. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number(*s*) and magnetic spin quantum number (*ms*).

2. Periodicity of Elements (09L)

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations. Long form of periodic table-s, p, d, and f block elements. Detailed discussion of following properties of elements with reference to s and p block

a. Effective nuclear charge , shielding or screening effect
b. Atomic and ionic radii
c. Crystal radii
d. Covalent radii
e. Ionization energies
f. Electronegativity , Pauling's / electronegativity scale
g. Oxidation states of elements

3. Crystal Structure and Chemical Bonding (09L)

Attainment of stable electronic configurations, Types of Chemical bonds: Ionic, covalent, coordinate and metallic bonds.

Ionic Bond: General characteristics of ionic bonding, Types of ions, Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability.

Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bond: Valence Bond Approach, Hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal, bipyramidal and octahedral arrangements. VSEPR theory, Assumptions, need of theory, application of theory to explain geometries of molecules such as i) ClF_3 ii) Cl_2O iii) BrF_5 iv) XeO_3 v) $XeOF_4$

4. Nanoscience and Nanotechnology (06L)

Scale, Nanoscience and nanotechnology, Natural and artificial nanoparticles, Ancient Nanotechnology, Stalwarts of nanotechnology- Feynman, Drexler and Taniguchi, Size dependant properties of nanoparticles. General applications of nanotechnology.

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. &Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
6. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013
7. Nanomaterials: By Dr.Sulbha Kulkarni.
8. The chemistry of Nanomaterials: by C.N.R.Rao , A. Muller, A. K. Cheetham Wiely – VCH verlag GmbH& Co. Volumes 1 & 2

Course code and Title: USCH-122: Analytical Chemistry (2 Credits, 36 L)

Learning Outcomes

1. Introduction to Analytical Chemistry
   i. Analytical Chemistry –branch of chemistry ii. Qualitative and Quantitative Analysis
   iii. Stages in Chemical analysis iv. Factors affecting chemical analysis
2. Calculations used in Analytical Chemistry
   i. Calculations of mole, molar concentrations and various units of concentrations which will be helpful for preparation of solution
   ii. Relation between molecular formula and empirical formula
   iii. Stoichiometric calculation iv. Define term mole, millimole, molar concentration, molar equilibrium concentration and Percent Concentration.
   v. SI units, distinction between mass and weight
   vi. Units such as parts per million, parts per billion, parts per thousand, solution-dilatant volume ratio, function density and specific gravity of solutions.
3. Qualitative Analysis of Organic Compounds
   Basics of type determination, characteristic tests and classifications, reactions of different functional groups.
   i. Separation of binary mixtures and analysis
   ii. Elemental analysis -Detection of nitrogen, sulfur, halogen and phosphorous by Lassiagen's test.
   iii. Purification techniques for organic compounds.
4. Chromatographic Techniques – Paper and Thin layer Chromatography
   i. Basics of chromatography and types of chromatography
   ii. Theoretical background for Paper and Thin Layer Chromatography
5. Introduction to Instrumental Analysis: pH metry and Potentiometry
   i. pH meter and electrodes for pH measurement, ii.Measurement of pH
   iii. Working of pH meter iv. Applications of pH meter
   v. Reference electrodes used in potetiometry vi. Indicator electrodes used in potentiometry vii. Applications of Potentiometry

1. Introduction to Analytical Chemistry (04L)

What is analytical Chemistry? Chemical Analysis, Qualitative and Quantitative analysis, Applications of Chemical Analysis, Stages in a chemical Analysis, Sampling and Physical state of sample, Types of chemical methods of analysis, Common Techniques for Quantitative Analysis, Special Techniques for quantitative analysis, Factors affecting Choice of method in analysis.

2. Calculations used in Analytical Chemistry (09L)

Some important units of measurements- SI units, distinction between mass and weight, mole, millimole and Calculations of mole and millimole;

Solution and their concentrations- Molar concentrations, Molar analytical Concentrations, Molar equilibrium concentration, percent Concentration, part per million, part per billion, part per thousand, Solution –diluent volume ratios, functions , density and specific gravity of solutions, problems;

Chemical Stoichiometry – Empirical and Molecular Formulas, Stoichiometric Calculations, Numerical Problems.

Self-learning: stoichiometric calculations of preparations of solutions

3. Qualitative Analysis of Organic Compounds (05L)

Types of organic compounds, characteristic tests and classifications, reactions of different functional groups, analysis of binary mixtures.

Analysis – Detection of nitrogen, sulfur, halogen and phosphorous by Lassiagen's test.

Purification of organic compounds- Introduction, recrystallization, distillation, sublimation.

4 Introduction to Chromatographic techniques (06L)

IUPAC definition of chromatography, History of Chromatography- paper chromatography, Thin Layer Chromatography, **Thin Layer Chromatography:** Theory and principles, outline of the method, surface adsorption and spot shape, Comparison of TLC with other forms of chromatography, adsorbents, preparation of plates, application of samples, development.

Paper Chromatography- Origin, overview of technique, sample preparation, types of paper, solvents, equilibrium, development, sample application and detection, Identification, Quantitative methods, applications of paper chromatography

Self-Learning: Advance techniques of chromatography

5. Introduction to Instrumental Analysis: pH metry and potentiometry (08L)

Introduction, pH meter, Glass pH electrode, combination of pH electrode-Complete Cell, Standard Buffer –reference for pH measurement, Accuracy of pH measurement, Using pH meter –How does it work? Applications of pH meter.

Introduction, potentiometry, General principles, Reference Electrodes: Calomel Electrode and Ag-AgCl reference electrode; Indicator Electrodes: Metallic Indicator electrode and

Membrane Indicator electrode; Applications of Potentiometry; Potentiometric titration of Chloride with Silver Nitrate.

6. Errors in Chemical Analyses: (04L)

Classification of errors; Accuracy; Relative Error, Absolute error, Precision; Mean, Mean Deviation; Standard deviation, Relative standard Deviation Numerical based on each term; Significant figures and their computation; Minimization of errors.

Self-learning: Numerical calculations of errors

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
9. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
10. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
11. A Braithwait and F. J. Smith, Chromatographic method, 5th edition, Kluwer Academic publishers
12. G D Christian -Analytical Chemistry
13. Qualitative Organic Analysis 4th Edn by A I Vogel (ELBS)
14. Vogel's Quantitative Analysis
15. Douglas A Skoog, Donald M West, F James Holler ,Stainly R Crounch , Fundamentals of Analytical Chemistry, 9th edition
16. David Harvey, Modern Analytical Chemistry, McGraw Hill Higher education
17. Gurudeep R Chatwal, Sham K Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
18. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
19. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
20. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).

21. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
22. Atkins' Physical Chemistry, 10th edition (2014), Oxford University Press
23. Thomas Engel, Philip Reid; Physical Chemistry , Pearson Education (2006)
24. J. N. Gurtu, A. Gurtu, Advanced Physical Chemistry, Pragati Edition
25. McQuarrie, D. A., & Simon, J. D., Physical Chemistry: A molecular approach. Sausalito, CA: University Science Books (1997)
26. Atkins, P., & de Paula, J., Physical Chemistry for the Life Sciences. New York: W. H. Freeman and Company (2006)
27. McMahon, D. (2005). Quantum Mechanics Demystified. NewYork: McGraw-Hill Professional
28. Ladd, M. Introduction to Physical Chemistry (3rd ed). Cambridge, UK: Cambridge University Press (1998)

Course code and Title: USCHP-123: Chemistry Practical
(1.5 Credits, any 12)

Learning Outcome:

1. Inorganic Estimations using volumetric analysis
2. Synthesis of Inorganic compounds
3. Analysis of commercial products
4. Purification of organic compounds
5. Preparations and mechanism of reactions involved

Section A: Chemical and Lab Safety, Physical Chemistry and Inorganic Chemistry

I]

1. To draw polar plots of s and p orbitals
2. Preparation of Molar and Normal solutions of different concentrations – a) Oxalic acid b) NaOH c) $ZnSO_4.7H_2O$ d) $K_2Cr_2O_7$ and e) Potassium hydrogen phthalate
3. Principles in green chemistry

II] Synthesis of commercially important inorganic compounds (any two)

1) Synthesis of potash alum from aluminium metal (scrap Aluminium metal)
2) Synthesis of Mohr's Salt $[(FeSO_4)\ (NH_4)_2SO_4]\bullet\ 6H_2O$
3) Preparation of Dark red inorganic pigment: Cu_2O
4) Synthesis of $FeSO_4\bullet 7H_2O$

Note:

i. In synthesized compound student must confirm the particular cation and anion by performing qualitative tests.
ii. Costing of product for 100 g pack can be calculated on the basis of cost of raw materials used and percent yield of the product.
iii. Synthesized compounds should be collected from all students and stored properly. They should be used in other experiments such as Mohr's salt for determination of water of crystallization. Potash alum and FeSO4 can be given in IQA experiments or for estimations at SY and TY level.

III] Volumetric Analysis (Any Two)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

2. Determination of basicity of boric acid or oxalic acid or citric acid hence determination of their equivalent weight.

3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

IV] Analysis of Commercial products containing inorganic substances (any two)

1) Estimation of acid-neutralizing capacity of antacids like Gelusil tablet/ Gellusil syrup

2) Estimation of selectively Cu (II) from brass alloy by iodometrically (Use KIO_3 as primary standard for standardization of $Na_2S_2O_3$ and not $K_2Cr_2O_7$).

3) Estimation of Aspirin and Error determination

Section B: Organic Chemistry

I] Organic preparations:

Preparation of derivative -2, 4 DNP of aldehyde/ketone. b) Analysis by TLC

II] Bromination of Cinnamic acid using sodium bromide and Sodium bromate. (Green Chemistry Approach) OR

III] Bromination of acetanilide using KBr and Cerric ammonium nitrate in aqueous medium. (Green Chemistry Approach)

IV] a) Purification by Sublimation method

b) Demonstration of Distillation process

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

Practical Examination Scheme:

1. The practical examination will be conducted at the end of each semester for **35 marks**.
2. The examination structure will be given before the commencement of examination.
3. Use of only handbook will be allowed at the time of examination.

Theory Paper Examination Scheme:

Theory examination pattern for each semester will be of **35 marks External examination + 15 marks Internal Examination = Total 50 marks.** For theory courses, end semester question papers will be set by the College and centralized assessment for theory papers done as per the rules laid down by the College.

Questions will be designed to test the conceptual knowledge and understanding of the basic and advanced concepts of the subject. Each paper will be of **50 marks.** In question paper setting weightage for each chapter will be proportional to number of theory lectures assigned to that chapter.

Internal examination will be of 15 marks. It may include home assignments/ google forms/ short answer questions / open book test. A student must accomplished any two of said examination laid by the college or subject teacher before external examination.

Course Outcome:

USCH- 111: Physical Chemistry

After completing the course work learner will be acquired with knowledge of chemical energetics, Chemical equilibrium and ionic equilibria.

USCH- 112: Organic Chemistry

Students will learn Fundamentals of organic chemistry, stereochemistry (Conformations, Configurations and nomenclatures) and functional group approach for aliphatic hydrocarbons.

USCH- 121: Inorganic Chemistry

Students will learn quantum mechanical approach to atomic structure, Periodicity of elements, various theories for chemical bonding.

USCH-122: Analytical Chemistry

Students will know about basics of analytical chemistry, some techniques of analysis and able to do calculations essential for analysis.

Lab Course USCHP- 113 and USCHP-123

1. The practical course is in relevance to the theory courses to improve the Understanding of the concepts.
2. It would help in development of practical skills of the students.
3. Use of micro scale techniques wherever required