

Savitribai Phule Pune University [SPPU]

**B.Sc. (Chemistry)**

(Three Years Integrated Degree Program)

**Choice Based Credit System [CBCS]**

**From Academic Year**

**2019-2020**

**First Year (F.Y. B. Sc.)**

**Board of Studies (Chemistry)**

Savitribai Phule Pune University [SPPU]

Pune-41107

**Structure of F. Y. B. Sc. Chemistry**

Semester	Course	Discipline Specific Core Course (DSCC)*
I	Theory	CH-101 : Physical Chemistry ( 2 credit , 36 L)
	Theory	CH-102 : Organic Chemistry (2 credit, 36 L)
	Practical	CH-103 : Chemistry Practical –I (1.5 Credit, 46.8 L)
II	Theory	CH-201 :Inorganic Chemistry ( 2 credit , 36 L)
	Theory	CH-202 : Analytical Chemistry (2 credit, 36 L)
	Practical	CH-203 : Chemistry Practical –II (1.5 Credit, 46.8 L)

**\*N.B.:**

- i. Each lecture (L) will be of 50 minutes.**
- ii. Each practical of 3h 15 min and 12 practicals per semester**
- iii. 12 weeks for teaching 03 weeks for Contentious assessments**
- iv. For details refer UG rules and regulations (CBCS for Science program under science & Technology) given in Appendix**

# Savitribai Phule Pune University, Pune

## F.Y.B.Sc. Chemistry Syllabus

(CBCS Semester Pattern)

From Academic Year 2019-2020

### Equivalence with Previous Syllabus

<b>New Course (2019 Semester Pattern) ( 50 min /L)</b>	<b>Old Course (2013 Annual Pattern) ( 48 min /L)</b>
CH-101 : Physical Chemistry ( 2 credit , 36 L) 50 Marks	Paper I : Physical and Inorganic Chemistry ( 72 L) 100 Marks
CH-201 :Inorganic Chemistry ( 2 credit , 36 L) 50 Mark	
CH-102 : Organic Chemistry (2 credit, 36 L) 50 Marks	Paper II : Organic and Inorganic Chemistry ( 72 L) 100 Marks
CH-202 : Analytical Chemistry (2 credit, 36 L) 50 Marks	
CH-103 : Chemistry Practical-I (1.5 Credit, 46.8 L) 50 Marks	Paper III : Chemistry Practical 100 Marks
CH-203 : Chemistry Practical-II (1.5 Credit, 46.8L) 50 Marks	

**Preamble:**

The syllabus of Chemistry for First year has been redesigned for Choice based Credit System (CBCS) to be implemented from 2019-2020.

In CBCS pattern semester system has been adopted for FY, SY and TY which includes Discipline Specific Core Course (DSCC) at F Y level, Ability Enhancement Compulsory Course (AECC), Discipline Specific Elective Course (DSEC) and Skill Enhancement Course (SEC). DSCC courses has been introduced at FY level and AECC courses at SY level along with DSEC. At TY level DSEC and SEC courses has been introduced.

Syllabus for Specific Core Courses of Chemistry (2 Theory and 1 Practical) subject for F. Y. B. Sc. is to be implemented from the year 2019-20. Syllabus for S. Y. and T. Y. B. Sc. will be implemented from the year 2020-21 and 2021-22 respectively as per structure approved.

**Learning Objectives:**

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

# SEMESTER-I

## CH- 101: Physical Chemistry (2 Credits, 36 Lectures of 50 min.)

### 1. Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances, problems [11]

### 2. Chemical Equilibrium:

Introduction: Free Energy and equilibrium - Concept, Definition and significance  
The reaction Gibbs Energy, Exergonic and endergonic reaction. The perfect gas equilibrium, the general case of equilibrium, the relation between equilibrium constants, Molecular interpretation of equilibrium constant. The response of equilibria to conditions- response to pressure, response to temperature, Van't Hoff equation, Value of K at different temperature, Problems [11]

### 3. Ionic Equilibria

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. [14]

## Learning Outcome

### 1. Chemical Energetics

1. Students will be able to apply thermodynamic principles to physical and chemical process
2. Calculations of enthalpy, Bond energy, Bond dissociation energy, resonance energy
3. Variation of enthalpy with temperature –Kirchoff's equation
4. Third law of thermodynamic and its applications

### 2. Chemical Equilibrium

Knowledge of Chemical equilibrium will make students to understand

1. Relation between Free energy and equilibrium and factors affecting on equilibrium constant.
2. Exergonic and endergonic reaction
3. Gas equilibrium, equilibrium constant and molecular interpretation of equilibrium constant
4. Van't Hoff equation and its application

### 3. Ionic equilibria

Ionic equilibria chapter will lead students to understand

1. Concept to ionization process occurred in acids, bases and pH scale
2. Related concepts such as Common ion effect hydrolysis constant, ionic product, solubility product
3. Degree of hydrolysis and pH for different salts, buffer solutions

## CH- 102: Organic Chemistry (2 Credits, 36 Lectures of 50 min.)

### Fundamentals of Organic Chemistry

Physical Effects, 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. Aromaticity: Benzenoids and Hückel's rule. [09]

### Stereochemistry

Introduction, classification, Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Conformations with respect to ethane, 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) [14]

### Aliphatic Hydrocarbons

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

**Alkanes:** (Up to 5 Carbons) *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

**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.  $\text{KMnO}_4$ ) 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  $\text{CaC}_2$  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  $\text{KMnO}_4$ , ozonolysis and oxidation with hot alk.  $\text{KMnO}_4$ . [13]

## 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 with current and recent developments in Chemistry.
4. To create foundation for research and development in Chemistry.

## Reference Books

1. Graham Solomon, T.W., Fryhle, C.B. & Snyder, 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.
  8. Samuel Glasstone, *Thermodynamics for Chemists*, Affiliated East West Private Limited.
  9. B S Bahl, G D Tuli, Arun Bahl, *Essentials of Physical Chemistry*
  10. Peter Atkins and Julio de Paula, *Elements of Physical Chemistry*, Sixth edition ( 2013), Oxford press
  11. Ball D. W., *Physical Chemistry*, Thomson Press , India (2007)
  12. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
  13. Atkins' *Physical Chemistry –Thermodynamics and Kinetics*, 11<sup>th</sup> Edition, Oxford Press
  14. Thomas Engel, Philip Reid; *Physical Chemistry*, Pearson Education (2006)
  15. J. N. Gurtu, A. Gurtu; *Advanced Physical Chemistry*, Pragati Edition
  16. Mortimer R. G., *Physical Chemistry*, 3rd Edition, Elsevier, Noida (UP)
  17. Samuel H. Maron and Carl F. Prutton, *Principles of physical Chemistry*, 4<sup>th</sup> Edition, Collier Macmillan Ltd.
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## CH- 103: Chemistry Practical Course I

(1.5 Credits, 46.8 Lectures of 50 min.)

### Section A: Chemical and Lab Safety (Compulsory)

1. Toxicity of the compounds used in chemistry laboratory.
2. Safety symbol on labels of pack of chemicals and its meaning
3. What is MSDS sheets? Find out MSDS sheets of at least hazardous chemicals ( $K_2Cr_2O_7$ , Benzene, cadmium nitrate, sodium metal, etc.)
4. Precautions in handling of hazardous substances like Conc. acids, ammonia, organic solvents, etc.

### Section B: Physical Chemistry

#### a. Thermochemistry (Any three)

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

#### b. Ionic equilibria (Two experiments)

1. 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.

OR

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

### Section C: Organic Chemistry (Five experiments)

1. To determine type and detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements) (Three)
2. Separation of constituents of mixtures by Chromatography: Measure the  $R_f$  value in each case (Two)
  - (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acids) / pigments from plant extract/ 2 organic compounds by paper chromatography
  - (b) Identify and separate the sugars present in the given mixture by paper chromatography.

**Note: Combination of two compounds/plant extract to be given**



**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.

**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
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## SEMESTER-II

### CH-201: Inorganic Chemistry (2 Credits, 36 Lectures of 50 min.)

#### 1. Atomic Structure

**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  $\psi$  and  $\psi^2$ , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for  $1s$ ,  $2s$ ,  $2p$ ,  $3s$ ,  $3p$  and  $3d$  orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to  $1s$  and  $2s$  atomic orbitals. 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 ( $ms$ ). [14]

#### 2. Periodic table and Periodicity of Elements

**Periodic table:** periodic table after 150 years, review on the eve of international year of periodic table[IYPT].

**Periodicity of elements:** 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

- Effective nuclear charge, shielding or screening effect
- Atomic and ionic radii
- Crystal radii
- Covalent radii
- Ionization energies
- Electronegativity, Pauling's / electronegativity scale
- Oxidation states of elements

[10]

#### 3. Chemical Bonding

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)  $\text{ClF}_3$  ii)  $\text{Cl}_2\text{O}$  iii)  $\text{BrF}_5$  iv)  $\text{XeO}_3$  v)  $\text{XeOF}_4$  [12]

## Learning Outcome

### 1. Atomic Structure

1. Various theories and principles applied to reveal 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-Landé 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  $\text{ClF}_3$ ,  $\text{Cl}_2\text{O}$ ,  $\text{BrF}_5$ ,  $\text{XeO}_3$  and  $\text{XeOF}_4$ .

## CH- 202: Analytical Chemistry (2 Credits, 36 Lectures of 50 min.)

### 1. Introduction to Analytical Chemistry

What is analytical Chemistry, the analytical perspectives, Common analytical problems. [03]

### 2. Calculations used in Analytical Chemistry

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

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

**Chemical Stoichiometry** – Empirical and Molecular Formulas, Stoichiometric Calculations, Problems. [10]

### 3. Qualitative Analysis of Organic Compounds

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 Lassaigne's test.

Purification of organic compounds- Introduction, recrystallization, distillation, sublimation [05]

### 4. Chromatographic Techniques –Paper and Thin Layer Chromatography

Introduction- Introduction to chromatography, IUPAC definition of chromatography.

History of Chromatography- paper chromatography, Thin Layer Chromatography, Ion exchange Chromatography, Gas permeation Chromatography, affinity chromatography, Gas chromatography, Supercritical fluid chromatography, High Performance Liquid Chromatography, Capillary electrophoresis, Classification of chromatographic methods – according to separation methods, according to development procedures.

**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 [14]

**5. pH meter**

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. [04]

**Learning Outcomes****1. Introduction to Analytical Chemistry**

- i. Analytical Chemistry –branch of chemistry
- ii. Perspectives of analytical Chemistry
- iii. analytical problems

**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-dilutant 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 Lassaigne'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. pH metry**

- i. pH meter and electrodes for pH measurement
- ii. Measurement of pH
- iii. Working of pH meter
- iv. Applications of pH meter

**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. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
  6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
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  10. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
  11. A Braithwait and F. J. Smith, *Chromatographic method*, 5<sup>th</sup> edition, Kluwer Academic publishers
  12. G D Christian -Analytical Chemistry
  13. Qualitative Organic Analysis 4<sup>th</sup> Edn by A I Vogel (ELBS)
  14. Vogel's Quantitative Analysis
  15. Douglas A Skoog, Donald M West, F James Holler ,Stainly R Crouch , *Fundamentals of Analytical Chemistry*, 9<sup>th</sup> 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*, 10<sup>th</sup> 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*. New York: McGraw-Hill Professional
  28. Ladd, M. *Introduction to Physical Chemistry* (3rd ed). Cambridge, UK: Cambridge University Press (1998)
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## CH- 203: Chemistry Practical –II (1.5 Credits, 46.8 Lectures of 50 min.)

### Section A: Inorganic Chemistry

Wherever required standardization of volumetric reagent must be performed.

#### I] 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  $[(\text{FeSO}_4)(\text{NH}_4)_2\text{SO}_4]\cdot 6\text{H}_2\text{O}$
- 3) Preparation of Dark red inorganic pigment:  $\text{Cu}_2\text{O}$
- 4) Synthesis of  $\text{FeSO}_4\cdot 7\text{H}_2\text{O}$

#### 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  $\text{FeSO}_4$  can be given in IQA experiments or for estimations at SY and TY level.

#### II] 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  $\text{KMnO}_4$ .

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

- 1) Estimation of Ca from calcium supplementary tablet by complexometric titration.
- 2) Estimation of acid neutralizing capacity of antacids like Gelusil tablet/ Gellusil syrup etc.
- 3) Estimation of selectively Cu(II) from brass alloy by iodometrically (Use  $\text{KIO}_3$  as primary standard for standardization of  $\text{Na}_2\text{S}_2\text{O}_3$  and **not**  $\text{K}_2\text{Cr}_2\text{O}_7$ ).

#### IV] To draw polar plots of s and p orbitals.

### Section B: Organic Chemistry

#### I] Organic Purification Techniques

1. Purification of organic compounds by i) crystallization (from water and alcohol) ii) distillation (Two Compounds), iii) Sublimation (micro technique).

#### II] Organic preparations: Derivatives

2. Preparations: Mechanism of various reactions involved to be discussed. Recrystallization, determination of melting point and calculation of quantitative yields to be done. (Any Two)
  - a) Bromination of Cinnamic acid using sodium bromide and Sodium bromate. (Green Chemistry Approach)

OR

- a) Bromination of acetanilide using KBr and Ceric ammonium nitrate in aqueous medium. (Green Chemistry Approach)
- 3) Semicarbazone derivatives of aldehydes and ketones
- 4) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

**Note:** Presence of extra element in the synthesized compound must be tested (Br and N in respective compound)

**N. B.:**

1. Use molar concentrations for volumetric /estimations/synthesis experiments.
2. Use optimum concentrations and volumes
3. Two burette method should be used for volumetric analysis ( Homogeneous mixtures )
4. Use of microscale technique is recommended wherever possible

### **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).

### **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

### **Course Outcome**

#### **CH- 101: Physical Chemistry**

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

#### **CH- 102: Organic Chemistry**

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

#### **CH- 201: Inorganic Chemistry**

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



**CH-202: Analytical Chemistry**

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

**Lab Course CH 103 and CH-203**

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 microscale techniques wherever required
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