



Progressive Education Society's
Modern College of Arts, Science and Commerce,
Ganeshkhind, Pune-411016 India
(Autonomous)
(Affiliated to Savitribai Phule Pune University)

DBT STAR Status

NAAC accredited A Grade



B.Sc. in Chemistry

A Three Year Degree Course

Choice Based Credit System (CBCS)

from

Academic Year 2022-23

Board of Studies-Chemistry

Department of Chemistry



Sem	Course Opted	Course Name	Credits
I	22-CH-101	Paper I: Physical and Analytical Chemistry	2
	22-CH-102	Paper II: Organic and Inorganic Chemistry	2
	22-CH-103	Chemistry Practical-I	1.5
II	22-CH-201	Paper I: Physical and Analytical Chemistry	2
	22-CH-202	Paper II: Organic and Inorganic Chemistry	2
	22-CH-203	Chemistry Practical-II	1.5



Equivalence with SPPU Syllabus

SPPU Syllabus	Modern College Autonomous Syllabus
CH-101 : Physical Chemistry (2 credit , 36 L) 50 Marks CH-202 : Analytical Chemistry (2 credit, 36 L) 50 Marks	22-CH-101 : Physical Chemistry and Analytical Chemistry (2 credit , 36 L) 50 Marks 22-CH-201: Physical Chemistry and Analytical Chemistry (2 credit , 36 L) 50 Marks
CH-102 : Organic Chemistry (2 credit, 36 L) 50 Marks CH-201 :Inorganic Chemistry (2 credit , 36 L) 50 Marks	22-CH-102 : Organic and Inorganic Chemistry (2 credit, 36 L) 50 Marks 22-CH-202: Organic and Inorganic Chemistry (2 credit, 36 L) 50 Marks
CH-103 : Chemistry Practical-I (1.5 Credit, 46.8 L) 50 marks CH-203 : Chemistry Practical-II (1.5 Credit, 46.8L)50 marks	22-CH-103 : Chemistry Practical-I (1.5 Credit, 46.8 L) 50 Marks 22-CH-203 :Chemistry Practical-II (1.5 Credit, 46.8 L) 50 Mark



F.Y.B.Sc – 2022 Pattern SEMESTER-I

22- CH-101: Paper 1: Physical and Analytical Chemistry (2 Credits, 36 Lectures.)

Course Outcomes:

- CO 1: Students will be able to plot graphs of linear, exponential and logarithmic function.
- CO 2: Students should be able to understand the concept of real and ideal gases.
- CO 3: Student should understand the concept of ionization process in acids and bases.
- CO4: Students should understand the perspectives of Analytical Chemistry.

Section-I Physical Chemistry (18L)

Chapter 1: Chemical Mathematics [04L]

Functions and variables: Variables as function, variables used in chemistry
Derivative: Rules of differentiation, problems related to chemistry, Integration: Rules of integration, problems related to chemistry. Graph: Plotting graphs of linear, exponential and logarithmic functions and their characteristics, sketching of s and p orbitals.

Learning Outcomes:

1. Student will be able to apply the rules of derivatives and will be able to solve the related problems.
2. Students should be able to sketch s and p orbitals.

Chapter 2: States of Matter [06L]

Introduction: States of matter and their properties. Gaseous states: Significance of ideal and kinetic gas equation (no derivation), Real gases Compressibility factor, Van der Waal's equation of state. Liquid state – Properties of liquids, Comparison between gaseous and solid states – Experimental determination of vapor pressure by isoteniscope method and viscosity by Ostwald method, liquid crystals and their applications.



Learning Outcomes:

1. Student should understand the behavior of gases.
2. Student should be able to solve problems regarding Van der Waal's equation and Critical constant and regarding P-V-T relations.

Chapter 3: Ionic Equilibria

[08L]

Ionic Equilibria of 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.

Learning Outcomes:

1. Students should understand the concepts of common ion effect and its applications.
2. Students will be able to solve the numerical problems on degree of hydrolysis and pH for different salts, buffer solutions

References:

1. Principles of Physical Chemistry. By Maron and Pruton 4th Ed. Oxford and IBH publication.
2. B S Bahl, G D Tuli, Arun Bahl, Essentials of Physical Chemistry

Section-II Analytical Chemistry (18L)

Chapter 4: Introduction to analytical chemistry

[04L]

What is analytical Chemistry, the analytical perspectives and Common analytical problems.

Learning Outcome:

- Students should understand the basic concepts of Analytical Chemistry



Chapter 5: Calculations used in Analytical Chemistry

[14L]

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

millimole and calculations and significant figures.

Chemical Stoichiometry – Empirical and Molecular Formulae, Stoichiometric Calculations,

Problems. Mole concepts and Stoichiometry

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 and problems.

Learning Outcomes:

- Students will be able to do the calculations of moles, molar concentrations and conversion of various units of concentrations.
- Students will understand the relation between molecular formula and empirical formula.
- Students will be able to understand the concept of Normality, Molarity, Molality, Normal solution, Molar solution, equivalent weight, ppm, and % w/v and % v/v.
- Students will able to solve the related problems.

References:

- Analytical Chemistry by G.D. Christian.
- Calculation of Analytical Chemistry by Hamilton, Simpson & Ellis 7th Edn.

22- CH-102: Paper 2: Organic and Inorganic Chemistry

(2 Credits, 36 Lectures)

Course Outcomes:

CO 1: Students will learn fundamentals of organic chemistry and functional group approach for aliphatic and aromatic hydrocarbons.

CO 2: Students will learn structure of atom and hence the reactivity, various theories for chemical bonding and applications of hybridization.



Section-I Organic Chemistry (18L)

Chapter 1: Fundamentals of Organic Chemistry: [9L]

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.

Learning Outcomes:

- Student should understand the fundamental concepts which govern the structure and bonding of organic molecules.
- Student should understand the properties and reactivity of organic compounds.
- Students will be able to distinguish the different reactive intermediates of organic compounds.

Chapter 2: Chemistry of Hydrocarbons: [9L]

Alkanes: (Up to 5 Carbons) Preparation methods: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis and Grignard reaction. 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. 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 tetrahalides and dehydrohalogenation of vicinal dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO_4 , ozonolysis and oxidation with hot alkaline KMnO_4 .

Learning Outcomes:

- Students will be able to give the IUPAC nomenclature of organic compounds for mono functional groups and draw structures.



- Students will be able to predict the conversion of one functional group into other functional group

References:

1. A guide book to Mechanism in Organic Chemistry by Peter Sykes, 6th Edition.
2. Organic Chemistry by Morrison & Boyd, 6th Edition
3. Organic Chemistry by J. Clayden, S. Warren *et al*

Section-II: Inorganic Chemistry (18L)

Chapter-3: Chemical bonding

[12L]

Attainment of stable configuration, Types of bonds ionic, covalent, co-ordinate and metallic,

Types of overlaps: s-s, p-p, s-p, p-d, d-d and their examples, Formation of sigma and pi bonds,

Theories of bonding- a) Valence Bond Theory, b) Heitler London Theory and c) Pauling Slater Theory, Concept of hybridization: Definition and need of hybridization, steps involved in hybridization, explanation of covalence of atoms in the moles based on hybridization, types of hybridization involving s, p and d orbitals.

Learning Outcomes:

- Students should understand basic principles of overlapping of atomic orbitals with specific shapes and size.
- Students will be able to learn various theories for chemical bonding and applications of hybridization.

Chapter-4: Experiential Learning: Hybridization of Orbitals

[6L]

Applications of hybridization: Geometries of molecules by making 3-D models viz:-

i) BeH_2 ii) BF_3 iii) $[\text{MnCl}_4]^{2-}$ iv) $[\text{Ni}(\text{CN})_4]^{2-}$ v) $\text{Fe}(\text{CO})_5$ vi) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$ vii) IF_7

VSEPR theory: Assumptions, need of theory, application of theory to explain geometry of irregular molecules by making 3D models of molecules like -

i) ClF_3 ii) Cl_2O iii) BrF_5 iii) TeCl_4 iv) XeO_3 v) XeOF_4



Learning Outcomes:

- Student will be able to learn various geometries of molecules by making their 3D models.
- Student should be able to explain the concept of hybridization and differentiation with overlap.

References:

- Concise Inorganic Chemistry by J.D. Lee 5th Edn.
- Basic Inorganic Chemistry by Cotton & Wilkinson.
- New guide to Modern Valence Theory By G.I. Brown

22-CH-103-Chemistry Practical-I

(1.5 Credits, 46.8 Lectures)

Course Outcomes:

CO 1: Importance of chemical safety and Lab safety while performing experiments in the laboratory.

CO 2: Techniques of pH measurements.

CO 3: Students should learn the geometry of molecules by making models.

Section A: Chemical and Lab Safety (Compulsory)

- A) a) Toxicity of the compounds used in chemistry laboratory.
b) Safety symbol on labels of pack of chemicals and its meaning
c) What is MSDS sheets? Find out MSDS sheets of at least hazardous chemicals ($K_2Cr_2O_7$, Benzene, cadmium nitrate, sodium metal etc.)
d) Precautions in handling of hazardous substances like conc. acids, ammonia, organic solvents, etc.

Section B: Physical and Analytical Chemistry (Any Three)

- a) To prepare solutions of given concentrations.
b) To standardize the given NaOH solution and find strength of HCl.
c) To determine the gas constant R an expression of it in different units by Eudiometric method.
d) To determine strength of $KMnO_4$.

Section C: Organic and Inorganic Chemistry (Any Three)

Each analysis is to be considered as one experiment.

- a) Purification Technique: Crystallization of organic compound from water.
b) Purification Technique: Distillation of organic.



- c) Inorganic Qualitative Analysis- one acidic radical and one basic radical (Two salts)

Section D: Experiential Learning Experiment (Three)

- a) Determination of hardness of water from the sample of water collected by students by EDTA method.
- b) To make 3D models of tetrahedral and trigonal geometries of organic molecules.
- c) 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

Project / Survey / Field Visit Report

References:

1. Qualitative Inorganic Analysis, Svehla, G. Vogel's Pearson Education.
2. Quantitative Chemical Analysis, Mendham, J. Vogel's Pearson.
3. Text book of Practical Organic Chemistry, Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G. Prentice-Hall, 5th edition.

F.Y.B.Sc – 2022 Pattern

SEMESTER-II

22-CH-201: Paper 1: Physical and Analytical Chemistry

(2 Credits, 36 Lectures.)

Course Outcomes:

- CO 1: Students will be able to understand theories related to atomic structure.
- CO 2: Students should understand the concepts of real and ideal gases.
- CO3: Student should understand the concept of ionization process in acids and bases.
- CO4: Students should understand the perspectives of Analytical Chemistry.
- CO5: Students will be able to apply thermodynamic principles to physical and chemical processes.
- CO6: Students will be able understand the basic concepts of pH and its significance.



Section-I Physical Chemistry (18L)

SEMESTER-II

Chapter 1: Atomic Structure

[08L]

Introduction, atomic spectrum of hydrogen, Bohr model of hydrogen atom- derivation of atomic radius and energy, energy level diagram of hydrogen atom, Failure of Classical mechanics- black body radiation, photoelectric effect, electron diffraction, atomic spectra, quantization of energy, de Broglie's hypothesis.

Learning Outcomes:

1. Students should understand the concept of black body radiation and photoelectric effect.
2. Student will be able to understand the concept of quantization of energy and duality of matter.

Chapter 2: Thermodynamics

[10L]

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 – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances and problems

Learning Outcomes:

- Calculations of enthalpy , Bond energy, Bond dissociation energy , resonance energy
- Natural changes are understood with the help of second and third laws of thermodynamics.
- Understand the application of thermodynamics.

References:

1. University General Chemistry. By C.N. R. Rao. Mc Millan Publication.
2. Principles of Physical Chemistry. By Maron and Pruton 4th Ed. Oxford and IBH Publication.
3. Physical Chemistry. By G.M. Barrow



Section-II Analytical Chemistry (18L)

Chapter 3: Qualitative Analysis of Organic Compounds [04 L]

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 test.

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

Chapter 4: Chromatographic Techniques –Paper and Thin Layer Chromatography [12L]

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 and 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

Chapter 5: pH -metry [02L]

Introduction, pH meter, Glass pH electrode- accuracy of pH measurement, Using pH meter –How does it works? Applications of pH meter.

Learning Outcomes:

- Students should know the types of chromatographic techniques and their principles.
- Students will learn about pH-metry and its applications.



References:

1. Analytical Chemistry by G.D. Christian.
2. Calculation of Analytical Chemistry by Hamilton, Simpson & Ellis 7th Edn.

22-CH- 202: Paper 2: Organic and Inorganic Chemistry

(2 Credits, 36 Lectures)

Course Outcomes:

- Students will learn Fundamentals of stereochemistry and the Concept of isomerism, types of isomers and representation of organic molecules.
- Students will learn Periodicity of elements and modern periodic law.
- Students should learn the aromaticity of benzenoid and heterocyclic compounds.
- Application of s-block elements: Industrial, biological and agricultural fields.

Section-I Organic Chemistry (18L)

Chapter-1: Stereochemistry

[12L]

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)

Learning Outcomes:

Students will understand

1. Concept of isomerism, types of isomers and representation of organic molecules.
2. Conformational isomerism in alkanes with energy profile diagram.
3. Concept of geometrical isomerism with E/Z nomenclature.
4. Understanding of optical activity, isomer number, tetrahedral carbon atom, concept of chirality, enantiomers, R/S nomenclature for single chiral centre.

Chapter-2: Introduction to Aromaticity and heterocyclic Compounds [06L]

- i) Aromaticity: Hückel's rule and Benzenoids (Benzene, Naphthalene and Anthracene)
- ii) Structure, Synthesis and Reactions of Furan, Pyroll and Thiophene



Learning Outcomes:

- Application of Huckel's rule to different organic compounds to find out aromatic /non aromatic characters.
- Students should know the synthesis and reactions of heterocyclic compounds.

References:

1. Organic Chemistry by Clayden, Oxford university press.
2. Organic Chemistry by Morrison & Boyd, 6th Edition.
3. Stereochemistry of carbon compounds by E.L.Elliel

Section-2: Inorganic Chemistry (18L)

Chapter-3: Periodic table and Periodicity of Elements

[09L]

Periodic table: Periodic table after 150 years, 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 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.

Learning Outcomes:

Students should learn the properties with respect to-

- Effective nuclear charge, shielding or screening effect; some numerical problems.
- Atomic and ionic size, crystal and covalent radii.
- Ionization energies.
- Electronegativity- definition, trend, Pauling electronegativity scale.
- Oxidation states of elements.

Chapter 4: Chemistry of s-block and Nobel gases Elements

[09L]

Recapitulation of periodic table, special position of hydrogen in the long form of the periodic table, properties of s-block elements w.r.t. electronic configuration, extraction, trends and properties, Introduction to crown ethers and cryptans,



separation of s-block elements using crown ethers, Compounds of s-block elements: oxides, hydroxides, peroxides, superoxides, Application of s-block elements in industrial, biological and agricultural fields.

Learning Outcomes:

Students Should Know:

- i) Position of noble gases elements in the periodic table.
- ii) Electronic configuration of s block elements and noble gases.
- iii) Chemical properties of s-block and noble gases

References:

1. Concise Inorganic Chemistry ELBS, J.D.Lee.
2. Basic Inorganic Chemistry, Cotton, F.A., Wilkinson, G. & Gaus, P.L. 3rd ed., Wiley

22-CH-203 Chemistry Practical-II

(1.5 Credits, 46.8 Lectures)

Course Outcomes:

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: The student will be able to design the experiments by their own innovative ideas through experiential learning experiments and projects.

Section A: Volumetric Analysis (Any one)

- 1a. Estimation of sodium carbonate and sodium hydrogen carbonate present in the mixture.
- 1b. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .

Section B: Physical and Analytical Chemistry (Any Three)

2. Determination of heat capacity of calorimeter for different volumes.
3. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
4. Study of the solubility of benzoic acid in water and determination of ΔH .
5. Purification Technique: Sublimation



Section C: Organic and Inorganic Chemistry (Any Four)

Each analysis is to be considered as one experiment.

6. Organic Qualitative Analysis (Element detection and physical constant)- Any 2 compounds
7. Bromination of acetanilide using KBr and Ceric ammonium nitrate in aqueous medium. (Green Chemistry Approach)
8. Semicarbazone derivative of aldehyde or ketone
9. Inorganic Qualitative Analysis- one acidic radical and one basic radical (Two salts)

Section D: Experiential Learning Experiments (Any three)

10. To determine amount of acetic acid in commercial vinegar.
11. Separation of constituents of mixtures by Chromatography: Measure the R_f value in each case (Two mixtures). Identify and separate the components of the sample collected by students (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acids) / pigments from plant extract.
12. To study applications of elements (any two) / compounds (any two) used in day to day life. OR

Project / Survey / Field Visit Report

References:

1. Qualitative Inorganic Analysis, Svehla, G. Vogel's Pearson Education.
2. Quantitative Chemical Analysis, Mendham, J. Vogel's Pearson.
3. Text book of Practical Organic Chemistry, Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G. Prentice-Hall, 5th edition.

