Anekant Education Society's

**TULJARAM CHATURCHAND COLLEGE**
**of Arts, Science and Commerce, BARAMATI**
**(AUTONOMOUS)**

## Department of Chemistry

## Scheme of Course Structure (F. Y. B. Sc.) 2019-2020

| Sr. No | Class | Semester | Code | Paper | Paper Title | Credit | Exam | Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | F Y B Sc | I | CHEM1101 | Theory | Physical and Inorganic Chemistry- I | 2 | I / E | 50 + 50 |
| 2 | F Y B Sc | I | CHEM1102 | Theory | Organic and Inorganic Chemistry- I | 2 | I / E | 50 + 50 |
| 3 | F Y B Sc | II | CHEM1201 | Theory | Physical and Inorganic Chemistry- II | 2 | I / E | 50 + 50 |
| 4 | F Y B Sc | II | CHEM1202 | Theory | Organic and Inorganic Chemistry- II | 2 | I / E | 50 + 50 |
| 5 | F Y B Sc | Annual | CHEM1203 | Practical | Chemistry Practical- I | 4 | I / E | 50 + 50 |

**Department of Chemistry**

## SYLLABUS (CBCS) FOR F. Y. B. Sc. CHEMISTRY
## SEMESTER- I (2019-2020)

### CHEM1101: Physical and Inorganic Chemistry- I (2 Credits, 36 L)

**A. Learning Objective:**

1. To introduce basic concepts of mathematics useful to solve problems related to chemistry.
2. To adequate students with states of matter and their properties and basic methods of measurements.
3. To learn basic of mole concept, methods for expressing concentration of solution, preparation of standard solution and redox reactions.

**B. Learning Outcome:**

1. This course makes understanding of use of mathematical concepts in chemistry, correlation in chemical variables graphically.
2. Students should able to know states of matter, properties associated and measurement. Also the concepts like mole, molecular weight, equivalent weight, GMV relationship, standardization of solution and balancing the redox reactions should be understood.

### SECTION I: PHYSICAL CHEMISTRY (24 L)

**1. Chemical Mathematics (6 L)**

Functions and variables: Variables as function, variables used in chemistry
Logarithm - Characteristic and mantissa, Rules of logarithm, Change of sign and base, Problems based on pH and pOH calculations.
Derivative: Rules of differentiation, partial differentiation, problems related to chemistry,
Integration: Rules of integration, definite and indefinite, problems related to chemistry.
Graph of linear function: Equation of straight line, equation from data of graph, plotting the graph from the data of chemical properties, problems.

**2. Gaseous and Liquid States (8 L)**

Introduction: States of matter and their properties.
Gaseous state : Significance of ideal and kinetic gas equation (no derivation), Real gases- Compressibility factor, van der Waal's equation of state, critical constants, correlation between critical constants and van der Waal's constants.
Liquid state: Properties of liquids, vapor pressure and its measurement by isoteniscopic method, Viscosity and its measurements by Ostwald's viscometers, Liquid crystals: Introduction, their types and applications in various fields.

**3. Solid State (10 L)**

Definition of space lattice, unit cell;
Laws of crystallography – (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices (iii) Law of symmetry, Symmetry elements in crystals.
Fundamental crystal systems, Characteristic of simple cubic, face-centered cubic and body-centered cubic systems, Interplanar distances in cubic crystals, X-ray diffraction by crystals, Derivation of Bragg equation, Determination of crystal structure of NaCl, Numerical

## SECTION II: INORGANIC CHEMISTRY (12 L)

**1. Mole concept and Stoichiometry: (5 L)**

Mole concept - Determination of molecular weight by gram molecular volume relationship, problems based on mole concept

Methods of expressing concentration -strength, normality, molarity, molality, mole fraction, %w/v, %w/w, % v/v, ppt, ppm, ppb,

Standardization of solutions, primary and secondary substances, preparation of standard solutions of acids and bases, problems based on acid base titrations only

**2. Oxidation –Reduction: (7 L)**

Definitions to related terms like oxidation, reduction, oxidizing agent, reducing agent oxidation number, valency,

Balancing of redox reactions using oxidation number method and ion electron method,

Problems based on equivalent weight of oxidant and reductant.

**References:**


1. Physical Chemistry, P. W. Atkins, ELBS, 5th Edition.
2. Principles of Physical Chemistry, Maron and Prutton, 4th Edition.
3. Physical Chemistry, G. M. Barrow 4th Edition.
4. Quantum Chemistry, I. Levine, 5th Edition.
5. Essentials of Physical Chemistry, Bhal and Tuli,
6. Principles of Physical Chemistry, Puri, Sharma and Phathania
7. Mathematical Preparation of Physical Chemistry, F. Daniel, Mc Graw Hill.
8. Concise Inorganic Chemistry, J. D. Lee, 5th Edition
9. Concept and Models of Inorganic Chemistry, Douglus and Daniel, 3rd Edition
10. Inorganic Chemistry, James Hughey

**SEMESTER- I**

**CHEM1102: Organic and Inorganic Chemistry I (2 Credits, 36 L)**

**A. Learning Objective:**

1. To know the fundamental concepts which govern the structure, bonding, properties and reactivity of organic molecules such as covalent character, hybridization, bond angles, bond energies, bond polarities and shapes of molecules.
2. To become familiar with drawing of organic molecules and arrow pushing concept.
3. Students are expected to know common and IUPAC names, methods of preparation and chemical reactions of alkanes, alkenes, alkynes and homocyclic, aromatic hydrocarbons and application of Huckel's rule.
4. The students are expected to know structure, nomenclature, preparation and reactions of organic compounds.
5. To understand the use of possible reagents to bring about the given conversion with possible product and identify the major and minor products.
6. To know silent features of periodic table with reference to S-block elements (symbols electronic configuration, trends and properties). Separation method by using crown ether, compounds and applications of S block elements.

**B. Learning Outcome:**

1. This course makes understanding of structure, bonding, properties and reactivity of organic molecules.
2. Students are able to draw of organic molecules with arrow pushing concept, IUPAC names, and methods of preparation of organic compounds.
3. Students should know structure, nomenclature, preparation and reactions of organic compounds and use of possible reagents.
4. Students should know details about S block elements.

## SECTION I: ORGANIC CHEMISTRY (24 L)

### 1. Chemical Bonding, structure of Organic Molecules: (5 L)

Covalent bond, Hybridization - sp, $sp^2$ and $sp^3$ hybridization, Bond length, Bond angle, Bond energy, Inter and Intra molecular forces and their effects

Ref. 2: Pages 9 - 17, 20 – 29

Drawing organic molecules, zigzag structures, Lewis structure and formal charge, Arrow pushing concept

Ref. 1: Pages 31 - 36, 116 – 127

### 2. Chemistry of Hydrocarbons: (7 L)

Alkanes - Introduction, Nomenclature, Physical properties, Preparations, Reactions of alkanes, Analysis of alkanes

Ref. 2: Sec. 2.1 – 2.3, Sec. 3.6 – 3.12, Sec. 3.15 – 3.17, Sec. 3.18, 3.19, 3.30, 3.32, Sec. 3.34

Pages: 39 – 41, 86 – 94, 97 – 106, 118, 120, 122

Alkenes-Introduction, higher alkenes, Nomenclature, Physical properties, Preparations, Reactions of alkenes, Analysis of Alkenes
Ref. 2: Sec. 8.7 to 8.9, 8.11 to 8.13, Sec. 9.1, 9.2, 9.27
Pages: 282 – 285, 287 – 293, 309, 317 – 323, 360 - 362
Dienes - Structure & Properties, Conjugated dienes, Reactions of dienes, Analysis of dienes
Ref. 2: Sec. 11.17, 11.19, 11.21, 11.22, 11.26
Pages: 409 – 417, 421, 422
Alkynes: Introduction, Nomenclature, Physical properties, Preparation, Reactions & analysis of alkynes
Ref. 2: Sec. 12.1 - 12.8, 12.14
Pages: 425 – 434, 440
Introduction to homocyclic aromatic hydrocarbons (benzene), Huckel's rule of aromaticity, Reactions of benzene – Sulphonation, Nitration, Halogenation, Friedel Craft reactions
Ref. 2: Sec. 14.1 - 14.5, 14.10, 14.11, 14.12, Relevant pages from 15.1 – 15.21
Pages: 493 – 499, 504, 508 – 511, Relevant pages from 517 – 546

**3. Chemistry of functional groups (12 L)**
Alkyl halides: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of alkyl halides
Ref. 2: 5.3 – 5.7, 5.24
Pages: 167 – 174, 211
Alcohols: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of alcohols
Ref. 2: 6.1 – 6.5, 6.10, 6.11, 6.22
Pages: 211 – 218, 222 – 226, 243 – 244
Ethers: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of ethers
Ref. 2: 6.16 – 6.21, 6.23
Pages: 237 – 242, 244 - 245
Carboxylic acids: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of carboxylic acids
Ref. 2: 19.1 – 19.4, 19.6, 19.9, 19.21
Pages: 713 – 722, 725 – 728, 744 - 745
Amines: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of amines
Ref. 2: 22.1 – 22.5, 22.8, 23.1 – 23.3, 23.12, 23.19
Pages: 821 – 825, 828 – 830, 845 – 849, 866 – 869, 876 - 877
Phenols: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of phenols
Ref. 2: 24.1 – 24.3, 24.7, 24.8, 24.16
Pages: 889 – 893, 898 – 902, 912

## SECTION II: INORGANIC CHEMISTRY (12 L)

### 1. Chemistry of S- block elements (12 L)

Recapitulation of periodic table, special position of Hydrogen in the long form of periodic table, properties of S -block elements with reference to electronic configuration, extraction, trends and properties.

Introduction to crown ether and cryptans, separation of S- block elements using crown ethers.

Compounds of S- block elements: oxides, hydroxides, peroxides, superoxide, and halides.

Applications of S-block elements in industrial, biological and agricultural field.

Ref. 6 & 9.

### References


1. Organic Chemistry-Clayden, Oxford Uni. Press
2. Organic Chemistry-Morrison and Boyd, 6th Edn.
3. A guide book to Mechanism in Organic Chemistry-Peter Syke, 6th Edn.
4. Stereochemistry of Organic Compounds-Eliel Tata Mc Graw Hill 1989
5. Principles of Physical Chemistry by S.H. Marron & C.F. Pruton, 4th Edn.
6. Concise Inorganic Chemistry-J.D. Lee, 2nd Edition-Relevant pages.
7. Concept & model of Inorganic Chemistry-Douglas Mc Doniels, 3rd Edn.
8. New guide to Modern Valance Theory-G.I. Brown, 3rd Edn.
9. Inorganic Chemistry-James Hughey
10. General Chemistry - Raymand Chang

**SEMESTER- II**

**CHEM1201: Physical and Inorganic Chemistry II (2 Credits, 36 L)**

**A. Learning Objective:**

1. To introduce basic concepts in atomic structure: Bohr model, energy level diagrams, hydrogen spectra, related principles. Schrödinger equation is the basis of quantum chemistry that has been introduced for hydrogen atom.
2. To adequate students with basic concepts in thermodynamics, statements first law of thermodynamics, use of thermodynamic state functions and thermochemical calculations.
3. To learn basic principle and concepts of theories of overlapping of atomic orbitals. Types of hybridizations involving s , p and d orbitals.
4. To understand the basic of VSEPR theory, bonding and shapes of simple molecules.

**B. Learning Outcome:**

1. This course makes understanding of assumptions of Bohr model, atomic spectra, Schrödinger equation for hydrogen atom and related mathematical calculations.
2. Students should able to know elementary chemical thermodynamics, laws and state functions used in thermo chemical calculations.
3. Student should able to understand basic principle and concepts of overlapping of atomic orbital focusing on VSEPR theory for simple molecules.

**SECTION I: PHYSICAL CHEMISTRY (24 L)**

**1. Atomic Structure: (12 L)**

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, Heisenberg's uncertainty principle (without proof), wave equation, time independent Schrödinger equation, hydrogen atom (expressions only)., wave functions for s and p atomic orbital's,

**2. Chemical Thermodynamics: (12 L)**

Definitions of thermodynamic terms: System, surroundings etc. Types of systems, intensive and extensive properties, State and path functions, Thermodynamic processes, concept of heat and work

First Law of Thermodynamics: Statement, definition of internal energy and enthalpy, Heat capacity, heat capacities at constant volume and pressure and their relationship, Joule's law – Joule-Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isotheral and adiabatic conditions for reversible process.

Thermo chemistry: Standard state, standard enthalpy of formation – Hess's Law of heat summation and its applications, Heat of reaction at constant pressure and at constant volume, Enthalpy of neutralization, Bond dissociation energy and its calculation from thermochemical data, temperature dependence of enthalpy, Kirchhoff's equation

## SECTION II: INORGANIC CHEMISTRY (12 L)

**1. Chemical Bonding and Structure: (3 L)**
Recapitulation of bonds: Ionic, covalent, coordinate and metallic.
Types of overlaps: s-s. s-p ,p-p, p-d, d-d with examples, formation of sigma and pi bond.
Theories of bonding: Valence bond theory, Heitler –London theory, Pauling Slater theory.

**2. Concept of hybridization: (6 L)**
Definition and need of hybridization, steps involved in hybridization ,explanation of covalency of atom in the moles based on hybridization, types of hybridization involving in s, p and d orbital .

**3. The VSEPR Theory: (3 L)**
Introduction, need and assumptions of VSEPR theory, bonding and shapes of irregular molecules as – $ClF_3$, $BrF_3$, $Cl_2O$, $BrF_5$, $TeCl_4$, $XeO_3$, $XeOF_4$, limitations of VSEPR theory.

**References:**

1. Physical Chemistry, P. W. Atkins, ELBS, 5th Edition.
2. Principles of Physical Chemistry, Maron and Prutton, 4th Edition.
3. Physical Chemistry, G. M. Barrow 4th Edition.
4. Quantum Chemistry, I. Levine, 5th Edition.
5. Essentials of Physical Chemistry, Bhal and Tuli,
6. Principles of Physical Chemistry, Puri, Sharma and Phathania
7. Mathematical Preparation of Physical Chemistry, F. Daniel, Mc Graw Hill.
8. Concise Inorganic Chemistry, J. D. Lee, 5th Edition
9. Concept and Models of Inorganic Chemistry, Douglus and Daniel, 3rd Edition
10. Inorganic Chemistry, James Hughey

**SEMESTER- II**

**CHEM1202: Organic and Inorganic Chemistry II (2 Credits, 36 L)**

**A. Learning Objective:**

1. To understand concept of isomerism, types of isomers and their stereochemistry.
2. To find R/S configuration in compounds containing two Chiral centers.
3. To use different reagents in organic synthesis.
4. To know silent features of periodic table with reference to P-block elements (symbols electronic configuration, trends and properties). Structures of compounds and applications of P block elements and inter halogen compounds.

**B. Learning Outcome:**

1. This course makes understanding of concept of isomerism, types of isomers and their stereochemistry and R/S configuration in compounds containing two Chiral centers.
2. Students are able to use different reagents in organic synthesis.
3. Students should know details about P- block elements.

## SECTION I: ORGANIC CHEMISTRY (24 L)

### 1. Stereochemistry (12 L)

Concept of isomerism, types of isomers, representation of organic molecules (Projection formulae), conformational isomerism in alkanes (Ethane, propane and n-butane) with energy profile diagrams, Geometrical isomerism - Definition, conditions for geometrical isomers, physical and chemical properties, E/Z nomenclature of geometrical isomers, Optical isomers, chirality, optical isomerism with one asymmetric carbon atom, specific rotation, enantiomerism, R/S nomenclature R/S system nomenclature with wedge and Fischer representation of two chiral centres, erythro, threo, meso-diastereomers with R/S configuration.

Ref. 1, 2, 3,

Ref. 2: Relevant pages from Sec. 3.2 – 3.5, Sec.4.1 – 4.20, Sec. 8.6

Ref. 3: Relevant pages from Sec. 12.1 – 12.2 (Pages 318 – 321)

### 2. Reagents in Organic Synthesis (12 L)

Catalytic hydrogenation including liquid phase hydrogenation, Birch reduction, NaBH4, $LiAlH_4$, Sn/HCl, Oxidation reagents: $KMnO_4$, $K_2Cr_2O_7$, Jones reagent, PCC, per acids, $OsO_4$, synthesis and application of EAA and Malonic ester

Ref. 1 & 3

## SECTION II: INORGANIC CHEMISTRY (12 L)

### 1. Chemistry of P-Block Elements (12 L)

Position of elements in the periodic table, electronic configuration of elements, trends in properties like: atomic size, ionization potential, electro negativity, electron affinity, reactivity, oxidation state, anomalous behavior of first member of each group

Structure and Properties of - 1) Borates and Halides of Aluminium 2) Allotropes of Carbon 3) Oxyacids of Phosphorous and Sulphur 4) Interhalogen compounds

**References:**


1. Organic Chemistry-. Morrison and Boyd, 6th edition, prentice hall, 2001.
2. Stereochemistry of carbon compounds - E. L. Eliel
3. Reactions, rearrangements and reagents – S N Sanyal
4. Inorganic Chemistry-James Hughey
5. General Chemistry - Raymond Chang
6. Concise Inorganic Chemistry-J.D. Lee, 5th Edition-Relevant pages.
7. Concept & model of Inorganic Chemistry-Douglas Mc Daniels, 3rd edition.

**CHEM1203: Chemistry Practical Course (4 Credits)**

**1. Physical Chemistry: 7 Experiments.**

**2. Inorganic Chemistry: 7 Experiments.**

**3. Organic Chemistry: 7 Experiments.**

**1. Physical Chemistry (Minimum 7 experiments)**

1. Sketch the polar plot of S and P orbital's.
2. Plot the graph of following functions using excel / graph paper-
   a) Linear function b) Exponential function c) Logarithmic function
3. Assign the lattice structure of NaCl crystal by given data.
4. Determine the ionization potential of hydrogen atom using hydrogen spectrum.
5. Determine the gas constant R in various units by eudiometer method.
6. Determine the relative viscosity of given organic liquids by viscometer.
7. Determine $\Delta H$ and $\Delta S$ for the following chemical reactions

i) $Zn_{(s)} + CuSO_{4\,(aq)} \rightarrow Cu_{(s)} + ZnSO_{4\,(aq)}$

ii) $3Mg_{(s)} + 2\ FeCl_{3\,(aq)} \rightarrow 2\ Fe_{(s)} + 3\ MgCl_{2\,(aq)}$

8. Determine the heat of solution of $KNO_3$ / $NH_4Cl$

**2. Inorganic Chemistry (Minimum 7 experiments)**

1. Determine the hardness of water from a given water sample by EDTA method.
2. Analysis of mixed alkali by volumetric method.
3. Determine the number of water molecules of $BaCl_2.2H_2O$/ $MgSO_4.7H_2O$.
4. Standardization of NaOH solution and find the strength of given HCl solution.
5. Standardization of $KMnO_4$ solution and find the strength of given solution.
6. Inorganic Qualitative analysis (Four mixtures without phosphate and borate)

**3. Organic Chemistry (Minimum 7 experiments)**

1. Determine the amount of acetic acid in commercial vinegar volumetrically.
2. Determine amount of aspirin in APC tablet volumetrically.
3. Techniques: (Micro scale)
   i. Crystallization ii. Sublimation iii. Thin layer chromatography
4. Organic Qualitative analysis of single compound (at least one compound in each type):
   Type, Preliminary tests, and Physical constant

**References:**


1. Senior Practical physical chemistry, Khosala and Garg.
2. Experiments in Chemistry, D.V. Jahagirdar.
3. Textbook of qualitative analysis, A. I. Vogel 4th Edition
4. Textbook of practical organic chemistry, A .I. Vogel.