SAURASHTRA UNIVERSITY

Re-Accredited Grade A by NAAC (CGPA 3.05)

SYLLABUS

B.Sc. CHEMISTRY

Semester I & II [CBCS]

Theory and Practical

[From June 2019]

B.Sc. CHEMISTRY
Semester I & II [CBCS]
Theory and Practical
[From June 2019]

- **Credits for each semester**
  - **Theory 6 Credits**
  - **Practicals 3 credits**

Note

- **BSc Chemistry Theory Syllabus for Semester I & II consists of five units each**
- **Total Marks for Chemistry Theory 100 { 70 Marks External & 30 Marks Internal}**
- **Equal weightage is given to all the units**
- **The question paper should also be drawn assigning equal weightage to all the units**
- **Total marks for Chemistry Practicals Marks 50 {35 Marks External & 15 Marks Internal}**

SEMESTER - I

SEMESTER-I: CHEMISTRY THEORY COURSE [C -101]

6- Credits: 100 Marks

UNIT-1

1. Atomic Structure and Periodic Properties **[4 Hours]**

Dual nature of electron: de-Broglie's equation, Heisenberg's Uncertainty Principle, quantum numbers, Aufbau Principle, Pauli's Exclusion Principle and Hund's Rule for electron configuration.

Periodicity in atomic properties and its causes, explanation of general trends of periodic properties: atomic and ionic radii, ionization potential, electronegativity and electron affinity.

2. Chemistry of s and p block elements **[4 Hours]**

Special characteristics such as metallic character, polarizing power, hydration energy, inert pair effect, relative stability of different oxidation state, Diagonal relationship of (1) lithium with magnesium (2) boron with silicon and (3) beryllium with aluminum, Anomalous behavior of Li, Be, Formation of complex compounds, catenation, allotropy (diamond and graphite-their structure, properties and its uses).

3. Adsorption **[4 Hours]**

Introduction, types of adsorption (physical and chemical), characteristics and factors affecting adsorption, Adsorption isotherm and Freundlich equation, Langmuir theory of adsorption: assumptions, derivation, modification in equation at very low and high pressure and applications of adsorption.

UNIT-2

4. Chemical bonding in covalent compounds **[12 Hours]**

Covalent bond: Valence bond theory and its limitations, Concept of hybridization: sp ($BeCl_2$), sp^2 (BF_3), sp^3 (SiH_4), sp^3d (PCl_5) and sp^3d^2 (SF_6).

Stereochemistry of inorganic molecules: Sidgwick Powell rule and VSEPR theory, Structure of molecules: $SnCl_2$, SO_4^{-2}, CO_3^{-2}

Basic concept of MO theory, bonding and anti-bonding molecular orbitals, gerade and ungerade molecular orbitals, σ - molecular orbital and σ* - molecular orbital, π-molecular orbital and π*- molecular orbital, Conditions for effective combinations of atomic orbitals Energy level diagrams of B_2, C_2, N_2, O_2, F_2, CO, NO, CO_2 (with s-p mixing and orbital interaction) with calculation of bond order and magnetic moment Comparison of MO theory and VB theory

UNIT-3

5. Basic Organic Chemistry and aliphatic hydrocarbons containing σ-bond **[12 Hours]**

Nomenclature of organic compounds (Only Acyclic - IUPAC-1993)

Electronic displacements: Inductive effect, electromeric effect, mesomeric effect and hyper conjugation. Applications of inductive effect to bond length, dipole-moment, reactivity of alkyl halides, relative strength of acid, basicity of amines

Homolytic and heterolytic fission, curly arrow rules
Reaction intermediates: Carbocation, carbanion, free radical, carbenes and benzynes (Formation by cleavage type, structure, relative stabilities, generation)
Types of organic reagents: Nucleophiles and electrophiles.
Types of organic reactions: Substitution, addition, elimination and rearrangement.
Nucleophilic substitution reaction mechanism (S_N1 & S_N2) for alkyl halides
Introduction to Stereochemistry: Configuration, Fischer projection formula, homomers and enantiomers, geometrical isomerism: cis–trans, C.I.P rules with E/Z notations.

UNIT-4

6. Aliphatic Hydrocarbons (Acyclic) **[12 Hours]**

Chemistry of alkanes:
Formation of alkanes: Wurtz reaction, Wurtz-Fittig reaction.
Free radical substitutions: Halogenation-relative reactivity and selectivity.
Hydrocarbons containing Carbon-Carbon π bonds:
Formation of alkene by Elimination reactions, dehydration of alcohol, dehydrohalogenation of alkyl halide, dehalogenation of vicinal and germinal dihalides
Mechanism of E1, E2, E1cb reactions, Saytzeff and Hofmann eliminations
Electrophilic addition reaction and its mechanism (Markownikov/Anti Markownikov rule)
Reactions of alkenes: Oxymercuration-demercuration, Hydroboration oxidation, Ozonolysis, Reduction (catalytic), Syn and anti-hydroxylation (oxidation), 1, 2- and 1,4 - addition reactions in conjugated dienes, Diels-Alder reaction.
Formation of alkynes: Dehydrohalogenation of vicinal and geminal dihalides, Dehalogenation of tetrahalides
Reactions of alkynes: Acidity, electrophilic addition reactions like halogenation, hydrohalogenation, hydration, hydroboration, addition of carbene and catalytic hydrogenation.
Nucleophilic addition with hydrogen cyanide and alcohol, hydration to form carbonyl compounds, alkylation of terminal alkynes.

UNIT-5

7. Catalysis **[3 Hours]**

Introduction, types of catalysis (homogeneous and heterogeneous), characteristics of catalysis, auto-catalysis, negative catalysis (Inhibitor), promoters, and catalytic poisoning
Activation energy and catalysis
Theories of catalysis: (1) Intermediate compound formation and (2) adsorption theory, active centers
Enzyme catalysis and its characteristics

8. Chemical Kinetics **[9 Hours]**

Concept of chemical kinetic: rate of chemical reaction, concentration dependence of reaction rate specific reaction rate constant, order and molecularity of the reaction.
Factors affecting rate of the reaction.
Definition, derivation of integrated rate equations for zero, first and second (same and different reactants) order reactions, their characteristics and half -life periods.

Determination of the order of reaction: (1) Hit and trial method (Integration method) and its limitations (2) Oswald's isolation method (3) Half-life period method (4) Graph method and (5) Van't Hoff differential method, Concept of activation energy, Derivation of Arrhenius equation and determination of activation energy by integrated equation and methods.
Theories of Reaction Rates: Collision theory and absolute reaction rate theory of bimolecular reactions and qualitative comparison.
Numericals

Reference Books

- UGC Inorganic Chemistry – Volume-I H. C. Khera (Pragati Prakashan).
- Concise Inorganic Chemistry - J. D. Lee.
- Coordination Chemistry- Gurdeep Chatwal and M. S. Yadav.
- Advanced Inorganic Chemistry by S. K. Agarwal & Keemti Lal (A Pragati Edition)
- Organic Reaction Mechanism, including Reaction Intermediates, , V. K. Ahluwalia, Ane's Chemistry active series
- Organic Chemistry, Vol-1, by Sultanat, Ane's Student Edition, Ane Book Pvt Ltd
- Undergraduate Organic Chemistry, Vol-1, Jagdamba Singh, L. D.S. Yadav, Pragati Prakashan, 8th edition-2013
- Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli and Arun Bahl, S. Chand & Co. New Delhi
- Elements of Physical Chemistry, B. R. Puri, L. R. Sharma and Madan Pathania, Vishal Publishing Co. Jalandhar.
- Physical Chemistry, B. K. Sharma, Goel Publication House. Meerut.
- Chemical Kinetics, G. R. Chatwal and Harish Mishra, Goel Publication House. Meerut.

SEMESTER - I

SEMESTER-I: CHEMISTRY PRACTICAL COURSE [C -102]

3- Credits: 50 Marks

Note Practical Examination:

- Total Marks : 50 Marks {35 Marks External & 15 Marks internal}
- Duration : 3½ hrs
- Two exercises to be performed:
  - **Exercise – I:** Organic Qualitative analysis : 20 Marks (2 Hrs)
  - **Exercise – II:** Volumetric Analysis : 15 marks (1½ Hr)

Exercise – I: Organic qualitative analysis **[20 marks]**

(Minimum 12 compounds should be given)

Compounds containing one functional group such as phenolic, carboxylic acid, ester, amide, nitro, amine, aldehyde, ketone, alcohol, halogen, anilide, carbohydrate and hydrocarbon.

List of compounds: Benzoic acid, cinnamic acid, phenol, α-naphthol, β-naphthol, acetone, ethyl methyl ketone, methyl acetate, ethyl acetate, naphthalene, aniline, nitrobenzene, benzamide, urea, thiourea, chloroform, acetanilide, carbon tetra chloride, chloro benzene, bromo benzene.

Exercise – II: Volumetric analysis **[15 Marks]**

1. Acid-base titrations

- To prepare a solution by dissolving 'x' g $NaHCO_3$ /Na_2CO_3 in 100 ml solution and determine its concentration in terms of normality and molarity using 0.1 N HCl solution.
- To determine the normality, molarity and g/lit of NaOH and HCl using 0.1 N Na_2CO_3 solution.
- To determine the normality, molarity and g/lit of each component in a given mixture of $NaHCO_3$ and Na_2CO_3 using 0.1N HCl solution.

2. Redox titrations

- To determine the normality, molarity and g/lit of each component in a mixture of $H_2C_2O_4.2H_2O$ and H_2SO_4 using 0.1 N $KMnO_4$ and 0.1N NaOH solution.
- To determine the normality, molarity and g/lit of each component in a mixture of $H_2C_2O_4.2H_2O$ and $K_2C_2O_4.H_2O$ using 0.1N NaOH and 0.1 N $KMnO_4$ solution
- To determine the normality, molarity and g/lit of $KMnO_4$ and $FeSO_4.7H_2O$ solution using 0.1 N $H_2C_2O_4.2H_2O$ solution.
- To determine the normality, molarity and g/lit of $FeSO_4$ $(NH_4)2SO_4.6H_2O$ and $K_2Cr_2O_7$ solutions using 0.1 N $KMnO_4$ solution.

SEMESTER - II

SEMESTER-II: CHEMISTRY THEORY COURSE [C -201]

6- Credits: 100 Marks

UNIT-1

1. Basics of ionic compounds **[6 Hours]**

Introduction, characteristics of ionic solids, Born Haber cycle and its application, Max Born equation, limiting radius ratio

Relation between radius ratio, co-ordination number and crystal structure

Derivation of r+/r- ratio in triangular, planar, square planar, body centered and tetrahedral crystal lattices. Defects in ionic crystals (stoichiometric and non-stoichiometric), study of N & P types of semi-conductors

2. Basics of Co-ordination Chemistry **[6 Hours]**

Werner theory, types of ligands (simple ligands, π-acid ligands, according to number of donating electrons, chelating ligands) with definition and examples

Co-ordination number and geometry related to co-ordination number.

Isomerism and its classification (structural and stereo isomerism)

Structural isomerism: (1) ionization and (2) hydration (3) co-ordination (4) co-ordination positions (5) polymerization and (6) linkage isomerism

Geometric/cis-trans isomerism in ML_4 and ML_6 types of complexes

UNIT-2

3. Chemistry of elements of 3d series **[6 Hours]**

Introduction, definition, electronic configuration, reversal of energies of 3d and 4s orbitals, physical properties such as atomic properties (atomic radii, Ionic radii, and ionization potential), metallic conductivity, melting point & boiling point, density, reducing properties, tendency of formation of alloys, catalytic properties, magnetic and spectral properties. Calculation of spin only magnetic momentum of inner orbital and outer orbital complexes $[NiCl_4]^{-2}$, $[Ni(CN)_4]^{-2}$, $[FeF_6]^{-4}$, $[Fe(CN)_6]^{-4}$

4. Solid State **[6 Hours]**

Forms of solids, unit cells, crystal systems, Bravais lattices

Laws of crystallography: (1) Law of Symmetry, (2) Law of constancy of interfacial angles and (3) law of rational indices

Miller and Weiss indices

Bragg's law X–Ray diffraction methods: Rotating crystal method and Powder method

Structures of NaCl and KCl

Numericals

UNIT-3

5. Cycloalkanes **[12 Hours]**

Introduction and classification of ring system (monocyclic and polycyclic, size, number of carbon atom common between the two rings)

IUPAC nomenclature of cycloalkanes (including simple spiro compounds, fused ring and bridged ring systems-bicyclic only)
Method of preparation of small ring cycloalkanes: Intra-molecular Wurtz's reaction, Simmons-Smith, Diels-Alder reaction
Chemical Properties of Cycloalkanes: Substitution Reactions, Addition Reactions, Baeyer's Strain Theory and its limitations (puckering)
Conformations, conformational analysis, conformation of ethane, propane and butane

UNIT-4

6. Aromatic Hydrocarbons [12 Hours]

Aromaticity: Criteria for (aromatic, non-aromatic and anti-aromatic), applications of Huckel's rule to simple annulene, cyclic carbocation/anion.
Electrophilic aromatic substitution reactions of benzene with mechanisms, theory of effect of substituents on reactivity and orientation (with resonating structures for activating and deactivating groups)
Electrophilic aromatic substitution reactions with mechanisms: Halogenation, nitration, sulphonation, Friedel-Crafts alkylation, Friedel-Crafts acylation

UNIT-5

7. Ionic Equilibrium [12 Hours]

Types of electrolytes, degree of dissociation and factors affecting degree of dissociation
Ionic product of water, dissociation constants of weak acids and bases
Common ion effect and calculation of concentrations of OH- ions (NH_4Cl+NH_4OH) and H+ ions (H_2S+HCl),
Solubility and solubility products of sparingly soluble salts
Applications of solubility product principle (solubility, whether precipitate out, salt out, and inorganic qualitative analysis)
Hydrolysis of salts: Definition of hydrolysis of salts, Salts of strong acids and bases.
Relation among Kh, Ka, or Kb and Kw. Degree of hydrolysis and pH of the solution of salts of weak acids and strong bases, salts of weak bases and strong acids and salts of weak bases and weak acids.
Buffer solutions: Definition and types of buffer solutions, Buffer action,
Derivation of Henderson-Hassel Balch equation
Numericals

Reference Books:

- UGC Inorganic Chemistry – Volume-II H. C. Khera (Pragati Prakashan)
- Coordination Chemistry- Gurdeep Chatwal and M. S. Yadav
- Advanced Inorganic Chemistry by S. K. Agarwala & Keemti Lal (A Pragati Edition)
- Concise of Inorganic Chemistry - J. D. Lee
- Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli and Arun Bahl, S. Chand & Co. New Delhi

- Elements of Physical Chemistry, B. R. Puri, L. R. Sharma and Madan Pathania, Vishal Publishing Co. Jalandhar.
- Physical Chemistry, B. K. Sharma, Goel Publication House. Meerut.
- Organic Reaction Mechanism, including Reaction Intermediates, , V. K. Ahluwalia, Ane's Chemistry active series.
- Organic Chemistry, Vol-1, by Sultanat, Ane's Student Edition, Ane Book Pvt Ltd
- Undergraduate Organic Chemistry, Vol-1, Jagdamba Singh, L.D.S.Yadav, Pragati Prakashan, 8th edition-2013

SEMESTER - II

SEMESTER-II: CHEMISTRY PRACTICAL COURSE [C -202]

3- Credits : 50 Marks

Note Practical Examination:

- Total Marks :50 Marks {35 Marks External & 15 Marks internal}
- Duration : 3½ hrs
- Two Exercises to be performed:
  - **Exercise – I:** Inorganic Qualitative analysis : 20 Marks (2 Hrs)
  - **Exercise – II:** Volumetric Analysis : 15 marks (1½ Hr)

Exercise-I: Qualitative Analysis of Inorganic Salts: **[20 Marks]**

(Minimum 12 salts-containing two radicals)

Inorganic salts containing anion (chloride, bromide, iodide, nitrate, nitrite, sulphate, sulphite, sulphide, carbonate, phosphate (soluble & insoluble), oxide, chromate and dichromate)

Exercise-II: Inorganic volumetric analysis **[15 Marks]**

(Standard solution should be given)

- Quantitative estimation of Cu^{2+} in a given $CuCl_2.2H_2O$ solution using 0.01M EDTA solution
- Quantitative estimation of Ni^{2+} in a given $NiSO_4.7H_2O$ solution using 0.01M EDTA solution
- Quantitative estimation of Zn^{2+} in a given $ZnCl_2$ solution using 0.01M EDTA solution
- Quantitative estimation of Fe^{2+} by dichromate method (Internal indicator method)
- Determination of total hardness of water by EDTA
- Determination of acetic acid in a commercial vinegar using 0.1M NaOH solution
- Determination of alkali in antacid using 0.1M HCl solution
- Analysis of some industrial product based on volumetric analysis

PAPER STYLE
INSTRUCTIONS

- B. Sc. Chemistry Syllabus for Semester I & II consists of FIVE units
- All units carry equal weightage (14 Marks each)
- There must be one question from each unit
- Each subtopic must be given due weightage in question paper
- 70 Marks for Semester End Examination (External) & 30 marks for Internal Examinations
- Time duration: 2 ½ Hours

Question 1: Answer the following (UNIT-1) **Total Marks: 14**

a) Four objective questions each of one Mark : 1x4 = 4
b) Answer any one out two each of two Marks: 1x2 = 2
c) Answer any one out two each of three Marks:1x3 =3
d) Answer any one out two each of five Marks: 1x5= 5

Question 2: Answer the following (UNIT-2) **Total Marks: 14**

a) Four objective questions each of one Mark : 1x4 = 4
b) Answer any one out two each of two Marks: 1x2 = 2
c) Answer any one out two each of three Marks:1x3 =3
d) Answer any one out two each of five Marks: 1x5= 5

Question 3: Answer the following (UNIT-3) **Total Marks: 14**

a) Four objective questions each of one Mark : 1x4 = 4
b) Answer any one out two each of two Marks: 1x2 = 2
c) Answer any one out two each of three Marks:1x3 =3
d) Answer any one out two each of five Marks: 1x5= 5

Question 4: Answer the following (UNIT-4) **Total Marks: 14**

a) a Four objective questions each of one Mark : 1x4 = 4
b) Answer any one out two each of two Marks: 1x2 = 2
c) Answer any one out two each of three Marks:1x3 =3
d) Answer any one out two each of five Marks: 1x5= 5

Question 5: Answer the following (UNIT-5) **Total Marks: 14**

a) a. Four objective questions each of one Mark : 1x4 = 4
b) Answer any one out two each of two Marks: 1x2 = 2
c) Answer any one out two each of three Marks:1x3 =3
d) Answer any one out two each of five Marks: 1x5= 5