College of Arts, Science & Commerce (Autonomous)

SIES

RISE WITH EDUCATION

NAAC REACCREDITED "A" GRADE

Sion (West), Mumbai – 400022.

Department of Chemistry

Program: B.Sc.

Discipline Specific Course in Chemistry

Syllabus for F.Y.B.Sc. Semester I and II

(To be implemented from 2023 – 2024)

Credit Based Semester and Grading System
National Education Policy

Discipline Specific Course (DSC) in Chemistry

CHEMISTRY – I

SEMESTER – I		
1	**:**	**Chemical Thermodynamics, Chemical Kinetics and Liquid states**
2	**:**	**Periodic Table and periodicity, Chemical bonding and Redox Reactions**
3	**:**	**Fundamental of Organic Chemistry and reaction mechanism of Unsaturated Hydrocarbons**
1	**:**	**Chemistry Practical**

SEMESTER – II		
1	**:**	**Chemical, Ionic Equilibria and Molecular Spectroscopy**
2	**:**	**Qualitative Analysis, Acid Base concepts and comparative chemistry**
3	**:**	**Stereochemistry**
1	**:**	**Chemistry Practical**

CHEMISTRY – I

Course Code:

Credits: 3

SEMESTER – I

Unit – 1, 1Hr /Week		15 H
1 Chemical Thermodynamics, Chemical Kinetics and Liquid states		**15 H**
1.1	**Chemical Thermodynamics:** **Thermochemistry:** Heats of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, Hess's law of constant heat summation, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equation. (Numericals expected).	**5 H**
1.2	**Chemical Kinetics:** Rate of reaction, rate constant, measurement of reaction rates. Order and molecularity of reaction. Integrated rate equation of first order reaction and integrated rate of second order reactions (with equal and unequal initial concentration of reactants). Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method. (Numerical expected)	**5 H**
1.3	**Liquid State:** Surface tension: Introduction, methods of determination of surface tension by drop number method. Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer. Refractive index: Introduction, molar refraction and polarizability, determination of refractive index by Abbe's refractometer. (Numerical expected)	**5 H**

Unit – 2, 1Hr/Week		**15 H**
2 Periodic table and periodicity, chemical bonding and redox reactions.		**15 H**
2.1	**Periodic Table and periodicity:** Quantum Numbers, Aufbau principle, Pauli's Exclusion principle and Hund's rule, shapes of s, p and d – orbitals Long form of Periodic Table; Classification for elements as main group, transition and inner transition elements. Periodicity in the following properties: Atomic and ionic size, electron gain enthalpy, ionization enthalpy, effective nuclear charge (Slater's rule), electronegativity, Pauling, Mulliken and Allred - Rochow electronegativities. (Numerical problems expected, wherever applicable).	**4 H**
2.2	**Chemical Bonding: Non-Directional Bonding (Ionic Bonding)** Types of chemical bond, Ionic Bond, Formation of Ionic Bond, Lattice Energy, Factors affecting lattice energy, Born – Landé Equation, Born – Haber Cycle and its Application, Solvation energy, Kapustinskii equation. (Numericals to be included).	**5 H**
2.3	**Chemical Bonding: Directional Bonding – Orbital Approach (Covalent Bonding)** 2.2.1 Types of covalent bonds, polarizability (Fajan's Rule), Covalent Bonding: The Valence Bond Theory- Introduction and basic tenets. 2.2.2 Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system. 2.2.3 Bonding in Polyatomic Species: The role of Hybridization and types of hybrid orbitals-*sp, sp^2, sp^3, sp^3d, sp^2d^2, sp^2d and sp^3d^2*.	**3 H**
2.4	**Oxidation and Reduction**: Oxidizing and Reducing agents, Oxidation number, Rules to assign Oxidation numbers with examples ions like oxalate, permanganate and dichromate. Balancing redox reactions by ion electron method and oxidation number method.	**3 H**
Unit – 3, 1Hr/Week		**15 H**
1 Fundamental of Organic Chemistry and Reaction Mechanism of Unsaturated Hydrocarbons		**15 H**
1.1	**Bonding and Structure of organic compounds**: Hybridization: sp^3, sp^2, sp hybridization of carbon and nitrogen; sp^3 and sp^2 hybridization of oxygen in organic compounds, shapes and geometry of organic molecules. Shapes of molecules, Influence of hybridization on bond properties.	**4 H**

1.2	**Fundamentals of organic reaction mechanism:** **Electronic Effects**: Electronic Effects and their applications. organic acids and bases, their relative strengths (Aliphatic and aromatics). **Carbocations, Carbanions and Free radicals**: Types (primary, secondary, tertiary, allyl, benzyl), their shape and relative stability.	**3 H**
1.3	**Unsaturated Hydrocarbons:** Formation of alkenes and alkynes by elimination reactions: Mechanism of E1, E2, E1CB, reactions. Saytzeff and Hofmann rule. Electrophilic addition reactions of alkenes and their mechanisms: Markownikoff/ Anti Markownikoff addition, Oxymercuration - demercuration reaction, hydroboration-oxidation, ozonolysis, Reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2 and 1, 4 addition reactions in conjugated dienes and Diels-Alder reaction, Allylic and benzylic bromination using N-bromosuccinimide.	**8 H**

SUGGESTED REFERENCE FOR PHYSICAL CHEMISTRY

1. A text book of Physical Chemistry by K. L. Kapoor.
2. Essentials of Physical Chemistry by B.S. Bahl, Arul Bahl and G.D. Tuli.
3. Chemical Kinetics by Keith J. Laidler.

SUGGESTED REFERENCE FOR INORGANIC CHEMISTRY

1. J. Barrett and A. Malati, 'Fundamentals of Inorganic Chemistry', East-West Press Edition (2006).
2. C.M. Day and Joel Selbin, 'Theoretical Inorganic Chemistry', Affiliated East West Press Pvt. Ltd., (1985).
3. J.D.Lee, Concise 'Inorganic Chemistry', 5th edition, Blackwell Science Ltd., (2005).
4. James E. Huheey, 'Inorganic Chemistry', 3rd edition, Harper & Row, Publishers, Asia, Pte Ltd., (1983).
5. R.J. Gillespie and I. Hargittai, The VSEPR Model of Molecular Geometry,Dover Publication,(2012).

SUGGESTED REFERENCE FOR ORGANIC CHEMISTRY

1. Organic Chemistry: S.H. Pine McGraw Hill. Kogakusha Ltd.
2. Advance Organic Chemistry: Jerry March, Wiley Eastern Ltd.
3. Organic Chemistry: T.W.G. Solomons, C. B. Fryhle, 2000 John Wiley and Sons.
4. Organic Chemistry: Morrison and Boyd, Allyn& Bacon Inc.
5. Organic Chemistry: Francis A. Carey, 1996 3rd Ed. McGraw Hill.
6. Fundamentals of Organic Chemistry: G. Mare Loudon, 2002 4th Edition.
7. Organic Reactions with Mechanism: S.P. Bhutani, Ane book Pvt. Ltd.

PRACTICAL COURSE DSC CHEMISTRY LABORATORY

Course Code:

Credits: 1 Credits (2 hours)

	Chemistry Practical – I
1.1	**PHYSICAL CHEMISTRY:**
	(A) Chemical Kinetics: a) To study hydrolysis of methyl acetate. b) To study reaction between $K_2S_2O_8$ and KI (with equal initial concentration). **(B) Thermo-chemistry:** a) To determine enthalpy of dissolution of salt (KNO_3). **(C) Viscometry:** a) To investigate the molecular weight of PVA using Ostwald's visometer
1.2	**INORGANIC**
	Inorganic Volumetric Analysis: a) To determine the percentage composition of solution of $Na_2CO_3$and $NaHCO_3$. b) To determine the strength of commercial sample of HCl using borax. c) To analyze commercial sample of Organic acid. d) To determine the percentage of copper(II) present in a given sample by titration against a standard aqueous solution of sodium thiosulfate (iodometry titration). e) To prepare standard solution of potassium dichromate and succinic acid.
1.3	**ORGANIC CHEMISTRY:**
	Purification of Organic Compound (at least 2 to 3 compounds with choice of solvent and melting point to be shown)

SUGGESTED REFERENCE:

1. Vogel's Qualitative and quantitative Inorganic Analysis, G.Svehla, 7th Ed, Longman (2001). Analytical Chemistry, Christian, WSE / Wiley.
2. Basic concepts of Analytical Chemistry, S. M. Khopkar, New Age International (P) Ltd.
3. Quantitative Analysis, R.A Day &A.L Underwood, Prentice Hall Publication.
4. Inorganic Chemical Analysis in the laboratory –A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry.
5. Textbook of Quantitative Inorganic Analysis -Vogel A.I., 5th Edition.
6. Chemical Analysis in the laboratory - A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry.

CHEMISTRY – I

Course Code:

Credits: 3

SEMESTER – II

Unit – 1, 1Hr/Week		**15 H**
1. Chemical, Ionic Equilibria and Molecular Spectroscopy		**15 H**
1.1	**Chemical Equilibria:** Reversible and irreversible reactions, law of mass action, dynamic equilibria. Equilibrium constant (Kc and Kp), Application of equilibrium constant, relationship between Kc and Kp, Le Chatelier's principle, factors affecting chemical equilibrium and application (Numericals expected)	**5 H**
1.2	**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 and its applications, dissociation constants of mono-, di- and triprotic acid (exact treatment for monoprotic acid) (Numericals expected). Buffers: Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected).	**7 H**
1.3	**Molecular Spectroscopy:** Electromagnetic radiation, electromagnetic spectrum, Planck's equation. Interaction of electromagnetic radiation with matter: Absorption, emission, scattering, fluorescence, electronic, vibrational and rotational transitions, Beer-Lambert's law (Numericals expected).	**3 H**
Unit – 2, 1Hr/Week		**15 H**
2 Qualitative Analysis, Acid Base concepts and comparative chemistry of transition elements		**15 H**
2.1	**Concept of Qualitative Analysis:** Types of qualitative analysis: Macro analysis, semi-micro analysis, micro analysis and ultra-micro analysis. Testing of Gaseous Evolutes, Role of Papers impregnated with reagents in qualitative analysis (with reference to papers impregnated with starch iodide, potassium dichromate, lead acetate, dimethylglyoxime and oxine reagents).	**4 H**

	Precipitation equilibria, effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds. (Balanced chemical equations and numerical problems expected.)	
2.2	**Acid Base Theories:** Arrhenius theory, Lowry-Bronsted concept, Lewis concept, Solvent-Solute system (auto ionization) concept of acids and bases, Lux Flood concept, Hard and Soft acids and bases (HSAB). Applications of HSAB concept. Applications of acid base chemistry in: i) Understanding organic reactions like Friedel Craft's (acylation/alkylation) reaction ii) Volumetric analysis with special reference to calculation of titration curve involving strong acid and strong base.	**4 H**
2.3	**Chemistry of oxidation reduction reactions** Reduction potentials, Electrochemical series and its applications. Redox stability in water i) Latimer and Frost Diagrams (Ebsworth diagram) ii) pH dependence of redox potentials. Applications of redox chemistry i) Extraction of elements: (example: isolation of copper by auto reduction) ii) Redox reagents in volumetric analysis: a) I_2 b) $KMnO_4$ iii) Titration curves: (x) Single electron systems as in Ce(IV) against Fe(II). (y) Multi electron systems as in $KMnO_4$ against Fe(II).	**3 H**
2.4	**Comparative Chemistry of the transition metals:** **2.1.1** Position in the periodic table; Natural occurrence principle ores and minerals; **2.1.2** Significance of special stability of d^0, d^5 and d^{10} leading to variable oxidation states, unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium and chromium.) **2.1.3** Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry and ability for charge transfer. **2.1.4** Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons, equation for spin only and spin-orbital magnetism in terms of Bohr magneton (No derivation of relevant equations expected), reasons for quenching of orbital moments.	**4 H**

Unit – 3, 1Hr/Week		15 H
Stereochemistry		**15 H**
3.1	**Representation of configuration**: Flying wedge, Fischer, Newman and Sawhorse Projection formulae. The interconversion of the formulae using suitable examples.	**4 H**
3.2	**Geometrical isomerism** in cycloalkane, C = C and C = N systems, cis–trans and syn-anti isomerism E / Z notations with CIP rules. **Optical Isomerism**: Optical Activity, Specific Rotation, Chirality / Asymmetry, Enantiomers, Molecules with two similar and dissimilar chiral-centres, diastereoisomers, meso structures, erythro, threo, racemic mixture and resolution.	**4 H**
3.3	**Relative and absolute configuration**: D/L and R/S designations.	**2 H**
3.4	**Conformational Analysis of alkanes and cycloalkanes:** Conformation analysis of alkanes, Relative stability with energy diagrams. Types of cycloalkanes and their relative stability, types of strains, Baeyer strain theory, Conformation analysis of cyclohexane: Chair, Half-chair, Boat and Twist boat forms, Relative stability with energy.	**5 H**

SUGGESTED REFERENCE FOR PHYSICAL CHEMISTRY

1. Principle of the Solid state by H. V. Keer.
2. A text book of Physical Chemistry by Negi Anand.
3. Physical Chemistry by Thomas Engel and Philip Reid.
4. Physical Chemistry by G. W. Castellan.
5. Principle of Physical Chemistry by Maron and Pruton.

SUGGESTED REFERENCE FOR INORGANIC CHEMISTRY

1. B.Douglas, D.H. McDaniel and J.J.Alexander, *Concepts and Models of Inorganic Chemistry*, 2nd edition, John Wiley & Sons, (1983).
2. GaryWulfsberg, *Inorganic Chemistry*; Viva Books PA Ltd., New Delhi; (2002).
3. W. W. Porterfield, *Inorganic Chemistry-An Unified Approach*, Academic press (1993).
4. D.F.Shriver, P.W.Atkins and C.H. Langford, Inorganic Chemistry, 3rd edition Oxford University Press, (1999).
5. AsimK.Das, *Fundamental Concepts of Inorganic Chemistry*,(Volumes-I,II and III) CBS Pub. (2000).
6. N.N.Greenwood and A.Earnshaw, Chemistry of Elements, Pergamon, (1984).
7. P. K. Dutta, 'General and Inorganic Chemistry',Levant Books,15thEdition, (2003).

SUGGESTED REFERENCE FOR ORGANIC CHEMISTRY

1. Stereochemistry of Organic Compound: E. L. Eliel and S.H. Wilen, Wiley.
2. Stereochemistry: V.M. Potapov, Mir Publishers, Moscow.
3. Stereochemistry Conformation and Mechanism: P.S. Kalsi, Wiley Eastern Ltd.
4. Stereochemistry of Organic Compound: Principles and Applications: D. Nasipuri, Wiley Eastern Ltd.
5. Stereochemistry and Mechanism: David Whittaker, Oxford Chem. Series.

PRACTICAL COURSE DSC CHEMISTRY LABORATORY

Course Code:

Credits: 1 Credits (2 hours)

1	Chemistry Practical – I
1.1	**Physical**
	a) **pH meter**: Preparation of buffer solution and standardization of pH meter. b) **Colorimetry**: Verification of Beer – Lambert's law using $KMnO_4$.
1.2	**Inorganic Chemistry**
	Qualitative analysis: Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions. Cations (from amongst): Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Al^{3+}, Cr^{3+}, Mn^{2+}, Mg^{2+}, K^{+}, NH_4^{+}. Anions (From amongst):CO_3^{2-}, S^{2-}, SO_3^{2-}, NO_2^{-}, NO_3^{-}, Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}. (*Scheme of analysis should avoid use of sulphide ion in any form for precipitation / separation of cations.)*
1.3	**Organic Chemistry**
	Qualitative analysis: Characterization of organic compound containing C, H, (O), N, S, X elements.

SUGGESTED REFERENCE

1. Chemical Analysis in the laboratory –A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry.
2. Textbook of Quantitative organic Analysis -Vogel A.I.

MODALITY OF ASSESSMENT

I] THEORY EXAMINATION PATTERN:

Theory examination: 75 Marks per Paper

(A) Internal Assessment - 25 Marks

Internal Assessment	25 Marks

Duration - **Internal** examinations shall be of **1 Hours** duration

(B)Semester End Theory Assessment - 50 Marks

Semester End Theory Examination	50 Marks

Duration - **Semester End Theory** examinations shall be of **2 Hours** duration

Marks distribution pattern for theory examination:

Semester End Examination	Paper I
Internal Assessment	**25**
Theory	**50**
Total Marks	**75**

II] PRACTICAL EXAMINATION PATTERN:

Scheme of examination: There will be no internal assessment for practical.

A candidate will be allowed to appear for the semester end practical examination only if the candidate submits a **certified journal** at the time of practical examination or a certificate from the Head of the Department/Institute to the effect that the candidate has completed the practical course of that semester of F.Y.B.Sc. Chemistry as per the minimum requirement.

The duration of the practical examination will be three and half hours per experiment. The questions on slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of chemistry.

Note: Minimum 75% experiments of prescribed syllabus should be completed in the 1st and 2nd semester. Certified journal is a must to be eligible to appear for the semester end practical examination, failing which they will not be allowed to appear for the examination.

Semester end practical examination: 50 Marks per Paper

Sr. No.	Practical Examination	Total Marks
		Paper I
1.	Experimental work	40
2.	Journal	05
3.	Viva Voce	05
Practical Marks		50

Overall Examination and Marks Distribution Pattern

Semester End Examination	Paper I
Internal Assessment	25
Theory	50
Practical	50
Total Marks	125