SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Chemistry

Programme Code: SCHE

F.Y.B.Sc.

Syllabus for the Academic Year 2024-2025

based on the National Education Policy 2020

Preamble

Programme: BSc Chemistry

Chemistry - a vibrant and ever growing science that encompasses every aspect of our lives. The fascinating study of matter and its applications is vital in areas like drug designing, material science, nanotechnology and most importantly, 'green chemistry', areas that are beneficial to both humanity and the environment. Bachelor's degree in Chemistry is the culmination of in-depth knowledge of Inorganic, Organic and Physical chemistry, Analytical chemistry and specialized courses such as Pharmaceutical Chemistry, spectroscopy, Nanoscience, Forensic Science, Cosmeticology, Food chemistry, Dairy Chemistry, Environmental chemistry and so on.

The learning objectives are designed to provide a focused outcome based syllabus with an agenda to structure the teaching learning experiences in a more student centric manner. This programme helps learners in building a solid foundation for higher studies in Chemistry. The hands-on experience the students gain in Practical enable them to apply theoretical knowledge acquired to solve problems in everyday life, think critically and innovatively. The syllabus is designed so that the student starts from the basic concepts of chemistry and will gradually move towards the advanced level. They are given opportunities to improve their creativity, scientific writing and communication skills through assignments and other co-curricular activities in all the semesters. The credit courses on "Positive Health in Women" and "Innovation in Natural dyeing and Entrepreneurship Skills" offered by the department further enhances their life skills and helps them evolve as entrepreneurs.

Students completing this programme will be equipped with knowledge of the concepts of Chemistry, interpret data and present their findings to both the scientific community and laymen. Completion of this programme will also enable the learners to join teaching professions, conducting research in Industry and Government run research labs

PROGRAMME OBJECTIVES

PO1	The students are expected to understand the basic concepts in chemistry and be aware of the recent development in the subject area.
PO2	To inculcate critical thinking and scientific attitude in the students.
PO3	The students should be able to apply the theoretical knowledge and practical skills acquired to solve the real world problems and environmental issues.

PROGRAMME SPECIFIC OBJECTIVES

PSO1	**Core competency:** The chemistry graduates are expected to gain the theoretical and practical knowledge of the basic concepts in chemistry.

PSO2	**Skill development:** They would acquire necessary skills and training to pursue higher studies in the field of chemistry and to be an entrepreneur.
PSO3	**Responsible citizens:** The students will get trained to adopt and practice sustainable techniques for their personal growth and to address societal and environmental problems.

FACULTY: SCIENCE
COURSE: F.Y.B.Sc.
SEMESTER I

Course Code	Unit No	Name of the Unit	Credits
SCHE111	Unit 1 Physical Chemistry	1.1 Chemical Thermodynamics (5L)	2
		1.2 Chemical Kinetics (5L)	
	Unit 2 Inorganic Chemistry	2.1 Atomic structure (5L)	
		2.2 Periodic Table and periodicity (5L)	
	Unit 3 Organic Chemistry	3.1Classification and Nomenclature of Organic Compounds (5L)	
		3.2 Stereochemistry-I (5L)	
SCHE111P		Chemistry Practicals	2

FACULTY: SCIENCE
COURSE: F.Y.B.Sc.
SEMESTER II

Course Code	Unit No	Name of the Unit	Credits
SCHE122	Unit 1 Physical Chemistry	1.1 Ionic Equilibria (5L)	2
		1.2 Gaseous State (5L)	
	Unit 2 Inorganic Chemistry	2.1: Chemical Bond and Reactivity (7L)	
		2.2 Concept of Qualitative Analysis (3L)	
	Unit 3 Organic Chemistry	3.1 Bonding and Structure of organic compounds (4L)	
		3.2 Fundamentals of organic reaction mechanism (6L)	
SCHE122P		Chemistry Practicals	2

NAME OF THE COURSE	**Fundamentals of Chemistry-1**	
CLASS	**FYBSc**	
COURSE CODE	**SCHE111**	
NUMBER OF CREDITS	**2**	
NUMBER OF LECTURES PER WEEK	**2**	
TOTAL NUMBER OF LECTURES PER SEMESTER	**30**	
EVALUATION METHOD **TOTAL MARKS**	**CONTINUOUS ASSESSMENT** **20**	**SUMMATIVE ASSESSMENT** **30**

COURSE OBJECTIVES:

CO 1	To understand the fundamental concepts of thermodynamics and relationship among thermodynamic parameters
CO 2	To understand the fundamental concepts of chemical kinetics.
CO 3	To learn the basics of atomic structure and understand the shapes of orbital and assigning quantum numbers
CO 4	To study the correlation between chemical properties of elements and their position in the periodic table
CO 5	To get acquainted with the IUPAC rules of naming organic compounds,

CO6	To understand the stereochemistry and difference between the stereoisomers of the organic molecules

COURSE LEARNING OUTCOMES: The learner will be able to

CLO 1	Derive relationship between different thermodynamic variables and solve numericals based on data given
CLO 2	Interpret data obtained from various kinetic reactions and deduce order of reaction
CLO 3	Explain the shapes of atomic orbital and assign quantum number
CLO 4	Correlate the chemical properties of elements with their position in periodic table
CLO 5	Apply IUPAC rules for naming an organic compound
CLO 6	Identify and differentiate between the enantiomers, diastereoisomers, stereoisomers and geometrical isomers.

UNIT NO.	TOPIC	NO. OF LECTURES
I	**PHYSICAL CHEMISTRY**	**10 L**
	1.1 Chemical Thermodynamics 1.1.1 Thermodynamic terms: System, surrounding, boundaries, open, closed and isolated system, intensive and extensive properties, state functions and path functions, types of processes. 1.1.2 Zeroth law of thermodynamics 1.1.3 Concept of heat and work. 1.1.4 First law of thermodynamics: Internal energy (U) and enthalpy(H). Statement and mathematical relation. Sign conventions, calculations of heat (q), work (w), internal energy (U), and enthalpy (H) 1.1.5 Relation between heat capacities (Cp And Cv), Kirchoff equation. (Numericals expected wherever applicable)	**5 L**

	1.2 Chemical Kinetics 1.2.1 Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction. 1.2.2 Integrated rate equation of first and second order reactions (with equal initial concentration of reactants) (Numericals expected wherever applicable) 1.2.3 Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method (Numericals expected wherever applicable)	**5 L**
II	**INORGANIC CHEMISTRY**	**10L**
	2.1 Atomic structure 2.1.1 Historical perspectives of the atomic structure: i)Rutherford's Atomic Model, ii)Bohr's theory and its limitations iii)The atomic spectrum of hydrogen atoms. Structure of hydrogen atom. iv) De Broglie's relation and Heisenberg Uncertainty Principle v) Need for a new approach to atomic structure 2.1.2 Quantum Numbers 2.1.3 Many Electron system i) Penetration and shielding ii) Effective nuclear charge iii)Aufbau principle	**5L**
	2.2 Periodic Table and periodicity 2.2.1 Long form of Periodic Table; Classification for elements as main group, transition and inner transition elements. 2.2.2 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 electronegativity) (Numericals expected wherever applicable.)	**5L**
III	**ORGANIC CHEMISTRY**	**10L**
	3.1 Classification and Nomenclature of Organic Compounds 3.1.1 Recapitulation of basic rules of IUPAC nomenclature. 3.1.2 Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines; including their cyclic analogues.	**5L**

	3.2 Stereochemistry -I 3.2.1 Symmetry elements, Asymmetric carbon. Classification of stereoisomers: enantiomers & diastereomers, chirality versus stereogenicity. 3.2.2 Representation of stereoisomers: Flying-wedge model, Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3 dichlorobutane) and their interconversions.	**5 L**

REFERENCES:

1. Physical chemistry by McQuarrie
2. Physical Chemistry by Peter Atkins, Julio de Paula and James Keeler Concise Inorganic Chemistry by J.D.Lee
3. Inorganic Chemistry by D F Shriver and Peter Atkins
4. Organic Chemistry by Graham Solomons, Craig Fryhle
5. Organic Chemistry by Jonathan, Clayden,Greeves Warren oxford
6. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013
7. Stereochemistry By Nasipuri
8. Stereochemistry, P.S. Kalsi, 4thEdition, New age International Limited.

SEMESTER I CHEMISTRY PRACTICALS
Course Credit :2

NAME OF THE COURSE	**Fundamentals of Chemistry-1 Practical**
CLASS	**FYBSc**
COURSE CODE	**SCHE111P**
NUMBER OF CREDITS	**2**
NUMBER OF LECTURES PER WEEK	**4**
TOTAL NUMBER OF LECTURES PER SEMESTER	**60**

EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	-	50

COURSE OBJECTIVES:

CO 1	To calculate the concentration of solutions (dry experiment)
CO 2	To calibrate volumetric glasswares
CO 3	To learn preparation of standard solutions of various concentration
CO 4	To study kinetics of different reactions
CO 5	To learn the techniques of characterizing organic compounds

COURSE LEARNING OUTCOMES : The learner will be able to

CLO 1	Calculate the amount of solute to prepare standard solutions accurately.
CLO 2	Calibrate volumetric glasswares
CLO 3	Carry out analysis using volumetric methods
CLO 4	Perform chemical kinetics and predict order of reaction from the data
CLO 5	Characterize given organic compound

1.	**Principles of Chemical Calculations:** Expressing concentration of solutions: Normality, molarity, mole fractions, % composition (weight ratio, volume ratio, weight to volume ratio), ppm. (Numericals to be solved)
2.	**Calibration of volumetric glassware:** Burette, pipettes, standard flasks.
3.	**Volumetric Analysis:** 3.1 To prepare 0.1 N succinic acid and standardize the NaOH of two different concentrations. 3.2. To standardize commercial sample of HCl using borax and to write material safety data of the chemicals involved 3.3 To standardize commercial samples of NaOH using Potassium Hydrogen

	Phthalate and to write material safety data of the chemicals involved.
4.	**ThermoChemistry:** To determine enthalpy of dissolution of salt (like KNO_3, $CaCl_2$)
5.	**Chemical Kinetics:**To determine the rate constant for the hydrolysis of ester using HCl as catalyst.
6.	**Characterization of organic compounds** (6 Compounds: Solid/liquid) Preliminary test, Solubility/Miscibility test, Detection of elements, Detection of functional group and determination of physical constant. Compounds containing elements C,H, (O), N, S, X can be given for analysis.
	REFERENCES: 1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009. 2. 2.Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,

NAME OF THE COURSE	**Fundamentals of Chemistry-2**	
CLASS	**FYBSc**	
COURSE CODE	**SCHE122**	
NUMBER OF CREDITS	**2**	
NUMBER OF LECTURES PER WEEK	**2**	
TOTAL NUMBER OF LECTURES PER SEMESTER	**30**	
EVALUATION METHOD	**CONTINUOUS ASSESSMENT**	**SUMMATIVE ASSESSMENT**

TOTAL MARKS	**20**	**30**

COURSE OBJECTIVES:

CO 1	To understand concepts of ionic equilibria, pH and buffers
CO 2	To understand various laws applicable to ideal gases
CO 3	To understand the fundamental concepts of chemical bonding and reactivity
CO 4	To understand the fundamental concepts of organic chemistry and its effect on acidity, basicity, reactivity of organic compounds.

COURSE LEARNING OBJECTIVES: The learner will be able to

CLO 1	Calculate equilibrium constants and pH of aqueous solution and buffer from the given data
CLO 2	State ideal gas laws and solve numericals based on the laws
CLO 3	Interpret the shapes and structure of molecules on the basis of Sidwig Powell and VSEPR theories
CLO 4	Predict the acidity, basicity and reactivity of organic compounds.

UNIT NO.	TOPIC	NO. OF LECTURES
I	**PHYSICAL CHEMISTRY**	**10L**
	1.1 Ionic Equilibria 1.1.1 Electrolytes (Strong, moderate and weak), degree of ionization,ionization constant, factors affecting degree of ionization and ionic product of water, dissociation constants of mono-, di- and triprotic acid (derivation for monoprotic acid only) 1.1.2 Buffers: pH scale, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected wherever applicable)	5L

	1.2 Gaseous State 1.2.1 Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), ideal gases versus real gases, compressibility factor, Boyle's temperature 1.2.2 Deviation from ideal gas laws, reasons for deviation from ideal gas laws, Van der Waals' equation of state 1.2.3 Joule-Thomson effect: qualitative discussion and experimentation, inversion temperature. (Numericals expected wherever applicable)	**5L**
II	**INORGANIC CHEMISTRY**	**10L**
	2.1 Chemical Bond and Reactivity 2.1.1 Types of chemical bonds, comparison between ionic and covalent bonds, polarizability (Fajan's Rule), shapes of molecules, Sidgwick, Powell Theory 2.1.2 Introduction to VBT, VSEPR theory for AB_n type molecules with and without lone pair of electrons, isoelectronic principle, applications and limitations of VSEPR theory	6L
	2.2 Concept of Qualitative Analysis 2.3.1 Types of qualitative analysis. Concept of wet and dry test in inorganic analysis. 2.3.2 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). 2.3.3 Precipitation equilibria, effect of common ions, diverse ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds. (Balanced chemical equations) (Numericals expected wherever applicable.)	**4 L**
III	**ORGANIC CHEMISTRY**	**10L**
	3.1 Bonding and Structure of organic compounds: 3.2.1.Hybridization: hybridization of carbon,nitrogen and oxygen (sp^3, sp^2 , sp) in the following compounds.(alcohol, ether, aldehyde, ketone, carboxylic acid, ester, amine, imine, amide and cyanide) 3.2.2 Overlap of atomic orbitals: Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules.	**4L**
	3.2 Fundamentals of organic reaction mechanism	**6L**

	3.3.1 Lewis structure, Formal Charge,types of arrows, homolytic and heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity 3.3.2.Reactive intermediates: carbocation, carbanions and free radicals types ,structure, shape and their relative stability (primary, secondary, tertiary, allyl, benzyl) 3.3.3.Electronic Effects: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids including carbon acids and bases; their relative strengths.	

REFERENCES:

Physical chemistry by McQuarrie
Physical Chemistry by Peter Atkins, Julio de Paula and James Keeler Concise
Inorganic Chemistry by J.D.Lee
Inorganic Chemistry by D F Shriver and Peter Atkins
Organic Chemistry by Graham Solomons, Craig Fryhle
Organic Chemistry by Jonathan, Clayden,Greeves Warren
Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013

SEMESTER II CHEMISTRY PRACTICALS
Course Credit :2

NAME OF THE COURSE	**Fundamentals of Chemistry-2 Practical**
CLASS	**FYBSc**
COURSE CODE	**SCHE122P**
NUMBER OF CREDITS	**2**
NUMBER OF LECTURES PER WEEK	**4**
TOTAL NUMBER OF LECTURES PER SEMESTER	**60**

EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	-	50

COURSE OBJECTIVES:

CO 1	To understand the relevance of solubility product and common ion effect in qualitative analysis of inorganic salts
CO 2	To familiarize with concept of oxidation,reduction and redox titrations
CO 3	To introduce gravimetric methods of analysis
CO 4	To learn concepts of buffers and handling of pH meter
CO5	To learn CIP rules for absolute configuration of organic molecules

COURSE LEARNING OUTCOMES : Learner will be able to

CLO 1	Analyse and identify cations and anions from a given mixture of inorganic salts using semi micro techniques
CLO 2	Analyse and quantify the given compound by redox titration and gravimetric analysis.
CLO 3	Prepare buffers and determine their pH using pH meter.
CLO 4	Apply CIP rules for absolute configuration of organic molecules

1.	**Qualitative Analysis of simple salts (6mixtures) using sulphide scheme:** Semi micro inorganic qualitative analysis of a sample containing 2 cations and 2 anions Cations(Pb^{2+}, Cu^{2+} ,Al^{3+},Ba^{2+} ,Ca^{2+}, Sr^{2+}, Mg^{2+}, K^{+},NH_4^{+}) Anions (CO_3^{2-}, SO_4^{2-},NO_2^{-}, NO_3^{-},Cl^{--},Br^{--},I^{-})
2.	**Concept of Oxidation, Reduction and Redox reactions** (with reference to addition or removal of H_2 or O_2 and electronic concept) oxidizing and reducing reagents. Rules for assigning oxidation number (Numericals to be solved). Balancing redox equations using the oxidation number method.

3.	**Redox Titrations** 3.1 To determine the amount of iron (II) present in a given sample by titration against a standard aqueous potassium dichromate 3.2 To calculate the concentration of KMnO4 present in a given sample by titration against oxalic acid.
4.	**Gravimetric analysis:** 4.1 To Determine the percentage composition of a mixture of $BaSO_4$ and NH_4Cl 4.2 To determine the percentage composition of a mixture of ZnO and $ZnCO_3$. 4.3 To determine the percentage of water of crystallization for hydrated crystalline salts ($CuSO_4$, $ZnSO_4$)
5.	**pH metry** 5.1 Preparation and determination of pH for a buffer. 5.2 To determine dissociation constant of weak acid (Ka) using Henderson's equation (using the method of incomplete titration pH metrically)
6	**Stereochemistry Dry Experiment:** i) Geometrical isomerism in alkene and cycloalkanes: cis–trans and syn-anti molecules, E/Z notations ii) Nomenclature-relative and absolute configuration: D/L and R/S designations with two (similar and dissimilar) chiral-centres (as per C.I.P rules wherever applicable) RBPT Experiment on Optical activity, Specific Rotation, racemic mixture and resolution with Simulation (demonstration if possible)
	References 1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009. 2. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., 3. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996 4. Stereochemistry By Nasipuri 5. Stereochemistry, P.S. Kalsi, 4thEdition, New age International Limited.

ASSESSMENT DETAILS:

I. Continuous Assessment (CA): 20 marks

- One activity of 20 marks to be given in each semester.

II. Summative Assessment (SA): 30 marks

- All units of the syllabus will be covered in SA and will be given equal weightage.
- There is a single head of passing ; a student must get 20 marks out of 50 marks to clear the course. A student who fails will have to give an ATKT exam of 50 marks.
- An additional SA will be held for those who are absent, due to valid reasons, for the main/regular SA.

III. Practical Examination

- A 50 marks practical examination will be conducted at the end semester.
- The Examination will comprise of two experiments (20 marks + 20 marks), journal (5 marks) and assignment/ viva (5 marks)
- Practical is a separate head of passing. The learner will have to get 20 marks out of 50 marks to pass the examination.