SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Affiliated to the University of Mumbai

Programme: Science

Chemistry

F.Y.B.Sc. CHEMISTRY (DSC)

Syllabus for the Academic Year 2024-2025 based on the National Education Policy 2020

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

DEPARTMENT OF CHEMISTRY

COURSE DETAILS FOR DSC:

	SEMESTER 1		SEMESTER 2
TITLE	Fundamentals of Chemistry - I		Fundamentals of Chemistry - II
TYPE OF COURSE - DSC	**DSC-1**		**DSC-2**
CREDITS	**4**		**4**

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Preamble:

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

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PROGRAMME OBJECTIVES

PO 1	The students are expected to understand the basic concepts in chemistry and be aware of the recent development in the subject area.
PO 2	To inculcate critical thinking and scientific attitude in the students.
PO 3	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 OUTCOMES

PSO 1	**Core competency:** The chemistry graduates are expected to gain theoretical and practical knowledge of the basic concepts in chemistry.
PSO 2	**Skill development:** They would acquire necessary skills and training to pursue higher studies in the field of chemistry and to be an entrepreneur.
PSO 3	**Responsible citizens:** The students will get trained to adopt and practice sustainable techniques for their personal growth and to address societal and environmental problems.

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Programme:Sciences **CHEMISTRY**	**Semester – 1**
Course Title: Fundamentals of Chemistry-I	**Course Code: SCHE111**

COURSE OBJECTIVES:

1. To understand the fundamental concepts of thermodynamics and chemical kinetics.
2. To clarify the basics of atomic structure and understand the shapes of orbital and assigning quantum numbers and correlate the chemical properties of elements with their position in the periodic table.
3. To get acquainted with the IUPAC rules of naming organic compounds and understand the stereochemistry and difference between the stereoisomers of the organic molecules.

COURSE OUTCOMES:

The learner will be able to :

1. derive relationship between different thermodynamic variables and solve numericals based on data given and interpret data obtained from various kinetic reactions and identify order of reaction.
2. explain the shapes of atomic orbital and assign quantum numbers and correlate the chemical properties of elements with their position in the periodic table.
3. apply IUPAC rules for naming an organic compound, identify and differentiate between the enantiomers, diastereoisomers, stereoisomers and geometrical isomers, interconvert the projection formulae.

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Theory Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**1 Hour**	**30 marks**
	Continuous Assessment	**--**	**20 marks**

UNIT 1 **Physical Chemistry**	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)	10 Hours
	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)	

UNIT 2 **Inorganic Chemistry**	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	10 Hours
	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.)	
UNIT 3 **Organic Chemistry**	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.	10 Hours

	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.	

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PRACTICAL **Course Title: Fundamentals of Chemistry-I Practical**	**Course Code: SCHE111P**

COURSE OBJECTIVE:

1. To develop skills in calibration of volumetric glassware to ensure accuracy and precision in quantitative chemical analysis.
2. To train students in the preparation of standard solutions of exact normality, emphasizing proper techniques, calculations, and handling of reagents.
3. To introduce the principles of chemical kinetics and enable students to determine and predict the order of reactions using experimental data.
4. To provide practical knowledge of volumetric analysis techniques, including titrimetric methods for quantitative determination of substances.
5. To impart fundamental techniques for the characterization of organic compounds, including identification based on physical and chemical properties.

COURSE OUTCOMES:

The learner will be able to :

1. calibrate volumetric glassware.
2. prepare standard solutions of exact normality.
3. perform chemical kinetics and predict order of reaction from the data.
4. carry out analysis using volumetric methods.
5. characterize given organic compounds by using a microscale method.

Lectures per week (1 Lecture is 120 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**4 Hours**	**50 marks**
	Continuous Assessment	**--**	

	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)	60 hours
	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.	

ASSESSMENT DETAILS:

1. Continuous Assessment (CA): Any one activity / assignment / test of 20 marks
2. Summative Assessment (SA): Theory exam of 30 marks – One hour duration
3. Summative Assessment (SA): Practical exam of 50 marks – Four hours duration

REFERENCES:

Theory

1. Physical chemistry by McQuarrie (ISBN no.1891389505)
2. Physical Chemistry by Peter Atkins, Julio de Paula and James Keeler (ISBN; 9780198769866)
3. Concise Inorganic Chemistry by J.D.Lee(ISBN 13:978-8126575547)
4. Inorganic Chemistry by D F Shriver and Peter Atkins
5. Organic Chemistry by Graham Solomons, Craig Fryhle(ISBN;9814-12-613-6)
6. Organic Chemistry by Jonathan, Clayden,Greeves Warren (ISBN:13) oxford-198503466
7. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013

Practical

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

SOPHIA COLLEGE FOR WOMEN (EMPOWERED AUTONOMOUS)

Programme: Sciences **CHEMISTRY**	**Semester – 2**
Course Title: Fundamentals of Chemistry-II	**Course Code: SCHE122**

COURSE OBJECTIVES:

1. To understand concepts of ionic equilibria, pH and buffers and different laws applicable to gases
2. To understand the fundamental concepts of chemical bonding and reactivity and inorganic qualitative analysis
3. To understand the fundamental concepts of organic chemistry and its effect on acidity, basicity, reactivity, bonding and geometry of organic compounds.

COURSE OUTCOMES:

The learner will be able to :

1. calculate equilibrium constants and pH of aqueous solution and buffer from the given data and state ideal gas laws and solve numericals based on the laws.
2. interpret the shapes and structure of molecules on the basis of Sidwig Powell and VSEPR theories and comprehend the chemical basis for identification of inorganic radicals.
3. apply the fundamental concepts to predict the acidity, basicity, reactivity, bonding and geometry of organic compounds.

Theory Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Semester Assessment**	**1 Hour**	**30 marks**
	Continuous Assessment	**--**	**20 marks**

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UNIT 1 Physical Chemistry	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)	10 hours
	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)	
UNIT 2 Inorganic Chemistry	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	10 hours
	2.2	**Concept of Qualitative Analysis** 2.2.1 Types of qualitative analysis. Concept of wet and dry test in inorganic analysis. 2.2.2 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).	

		2.2.3 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.)	
UNIT 3 Organic Chemistry	3.1	**Bonding and Structure of organic compounds:** 3.1.1.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) 3.1.2 Overlap of atomic orbitals: Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules.	10 Hours
	3.2	**Fundamentals of organic reaction mechanism** 3.2.1 Lewis structure, Formal Charge,types of arrows, homolytic and heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity 3.2.2.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.	

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PRACTICAL COURSE **Course Title: Fundamentals of Chemistry-II Practical**	**Course Code: SCHE122P**

COURSE OBJECTIVES:

1. To develop analytical skills for the systematic identification of cations and anions in inorganic salt mixtures using semi-micro qualitative analysis techniques.
2. To train students in quantitative chemical analysis through redox titration and gravimetric methods for accurate estimation of compounds.
3. To provide practical understanding of buffer solutions, including their preparation and accurate pH determination using a pH meter.
4. To introduce stereochemical concepts in organic chemistry, enabling students to apply CIP (Cahn–Ingold–Prelog) rules for determining absolute configuration of organic molecules.

COURSE OUTCOMES:The learner will be able to

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

Lectures per week (1 Lecture is 120 minutes)	**2**
Total number of Hours in a Semester	**60**
Credits	**2**

Evaluation System	**Summative Assessment**	**4 Hours**	**50 marks**
	Continuous Assessment	**--**	-

	1	**Qualitative Analysis of simple salts (6 mixtures) 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^{-})	60 hours
	2	**Concept of Oxidation, Reduction and Redox reactions** (with reference to addition or removal of H_2or 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)	

ASSESSMENT DETAILS:

1. Continuous Assessment (CA): Any one activity / assignment / test of 20 marks
2. Summative Assessment (SA): Theory exam of 30 marks – One hour duration
3. Summative Assessment (SA): Practical exam of 50 marks – Four hours duration

REFERENCES:

Theory

1. Physical Chemistry a Molecular Approach by McQuarrie Donald A. (second edition)
2. Physical Chemistry by Peter Atkins, Julio de Paula and James Keeler (eleventh edition)
3. Concise Inorganic Chemistry by J.D.Lee (fifth edition)
4. Inorganic Chemistry by D F Shriver and Peter Atkins (fifth edition)
5. Organic Chemistry by Graham Solomons, Craig Fryhle
6. Organic Chemistry by Jonathan, Clayden,Greeves Warren
7. Organic Chemistry Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013

Practicals

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