

ST. XAVIER'S COLLEGE (AUTONOMOUS)

AHMEDABAD

Chemistry Syllabus for Four-Year Undergraduate Programme as per National Education Policy (NEP-2020) (Semester I)



(EFFECTIVE FROM JUNE 2023)

ST. XAVIER'S COLLEGE (Autonomous), AHMEDABAD
CHEMISTRY
Theory syllabus

PROGRAMME SPECIFIC OUTCOMES

PSO1: Knowledge: Apply the principles of analytical, organic, inorganic and physical chemistry to solve basic chemical problems locally and globally

PSO2: Laboratory skills: Employ classical and modern laboratory techniques in the performance and documentation of experiments, suitable for a chemical industry or a chemistry graduate program.

PSO3: Environmental concern: Practice environmentally benign chemistry

PSO4: Employability/future prospects: Develop problem-solving skills and aptitude that are highly valuable to employers and entrepreneurship skills for self-employment

PSO5: Scientific communication: Have effective written and oral scientific communication skills, especially the ability to transmit complex technical information in a clear and concise manner

St. Xavier's College (Autonomous), Ahmedabad

Syllabus of Semester – I of the following department under Faculty of Science based on Under Graduate Curriculum Framework - 2023 to be implemented from the Academic Year 2023-24.

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

Course	Title	Content	Hours/week	Credit
DSC-1 (Theory)	General Chemistry –I (Theory)	U-1: Selected Reactions of Hydrocarbons U-2: Inorganic chemistry U-3: Physical Chemistry U-4: Chemistry of selected carbonyl compounds and quantitative analysis in organic chemistry	4 hrs	4
DSC-1 (Lab)	Chemistry Practical-I	1: Inorganic Qualitative Analysis 2: Inorganic preparation, Volumetric Analysis, and Investigative projects	8 hrs	4
Minor-1 (Theory)	Basics of Chemistry-1	U-1A: Addition and substitution reaction U-1B: Atomic Structure and Chemical Bonding U-2A: Thermodynamics and Chemical kinetics U-2B: Carbonyl compound and quantitative organic analysis	2 hrs	2
Minor-1 (Lab)	Basics of Chemistry (Lab)	1: Volumetric Analysis (Acid and Base) 2: Inorganic Qualitative Analysis	4 hrs	2
SEC	Separation methods in Chemistry	U-1: Physical Methods of separation (Distillation) U-2: Introduction to Solvent Extraction U-3: Introduction to chromatography U-4: Specific Chromatographic techniques	4 hrs	2
MDC + IDC	Integrated Chemistry-1 Chemistry in Daily Life	U-1A: Addition and substitution reaction U-1B: Atomic Structure and Chemical Bonding U-2A: Thermodynamics and Chemical kinetics U-2B: Carbonyl compound and quantitative organic analysis U-1: Food U-2: Essential Oils U-3: Water & Soil	4 hrs	4
AEC	English	(To be offered by the concerned subject Department)		
VAC		(To be offered by the concerned subject Department)		

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FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

BSc. (Hons.) Chemistry
Category – IV

Major Course – 1: General Chemistry –I (Theory)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
CH – 1501:General Chemistry –I (Theory)	4 (60 hr)	0	0	10 + 2 from a recognized board in any stream	Basic knowledge of chemistry

LEARNING OBJECTIVES (LO)

LO 1: To understand the mechanisms involved and predict products formed in the addition and elimination reactions as well as substitution reactions of unsaturated hydrocarbons

LO 2: To understand the fundamentals of quantum mechanics and chemical bonding to describe atomic structure and molecular structure

LO3: To interpret the role of entropy in various thermodynamic processes and also apply the principles of chemical kinetics to derive the rate equations for various types of reactions

LO 4: To understand the principles in qualitative analysis of organic compounds

LO 5: To understand the synthesis and reaction of aldehydes and ketones

COURSE OUTCOMES (CO)

On Completion of this course, the student will be able to-

CO1: Remember the mechanisms involved and predict products formed in the addition and elimination reactions as well as substitution reactions of unsaturated hydrocarbons

CO2: Recognize and apply the fundamentals of quantum mechanics and chemical bonding to describe atomic structure as well as molecular structure

CO3: Interpret the role of entropy in various thermodynamic processes and also apply the principles of chemical kinetics to derive the rate equations for various types of reactions

CO4: Apply the principles of some selected quantitative analysis methods to derive information regarding organic compounds

CO5: Remember the some selected nucleophilic addition reactions and synthesis of a aldehydes and ketones

Unit-1: SELECTED REACTIONS OF HYDROCARBONS

(15 L)

(A) Addition reactions of C-C double bond and triple bonds

9 marks

Electrophilic and free radical additions on alkenes; Markownikoff's rule, peroxide effect, hydroboration-oxidation and oxymercuration-reduction, Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with KMnO_4 and OsO_4 ,

Electrophilic additions on alkynes: mechanisms involved in hydrogenation, nucleophilic addition reactions of alkynes

(B) Substitution and elimination reactions

Substitution reaction: $\text{S}_\text{N}1$ and $\text{S}_\text{N}2$ nucleophilic substitutions with mechanism. Elementary treatment of (free radical substitution reaction (cf. Alkane), Electrophilic aromatic substitution reaction (cf. Nitration), substitution at the allylic positions of alkenes. Elimination reaction: $\text{E}1$ and $\text{E}2$ reactions, The Saytzeff rule, Hofmann elimination (Only introduction, without mechanism)

Unit-2: INORGANIC CHEMISTRY

(15 L)

(A) Atomic Structure and wave Mechanics:

Idea of de-Broglie's matter wave (dual nature) and Heisenberg's uncertainty principle Schrodinger wave equation, Normalized and Orthogonal wave, quantum numbers and their significance, radial and angular wave functions, shapes of s, p and d orbitals and characteristics. Variation of orbital energies with atomic number and energy level diagram

(B) Chemical Bonding

(I) Ionic bonding:

(1) Lattice energy :- Definition, Born-Landé equation (derivation not required), factors affecting lattice energy, Solvation energy and solubility of ionic solid, covalent nature of ionic compound, Polarizing power and Polarizability of ions, Fajan's rule.

(II) Covalent bonding:

(1) Valence bond theory and its Limitations (2) Various types of hybridization and shapes of simple inorganic molecules and ions (such as NH_3 , H_3O^+ , SF_4 , SF_6 , PCl_5 , ClF_3 , I_3^- , NH_4^+ , BF_4^- , XeF_4 , XeF_6) by Valence Shell Electron pair Repulsion (VSEPR) Theory.

Unit-3: PHYSICAL CHEMISTRY

(15 L)

(A) Thermodynamics

Limitations of first law and need for the second law, Entropy- its physical significance, entropy of gas

and calculation of entropy for different processes. Entropy change during phase change, entropy of mixing of ideal gases, entropy change in reversible and irreversible process.

(B) Chemical kinetics

Derivation of second order rate reaction constant for $(a=b)$ and $(a \neq b)$. Derivation of third order equation $(a=b=c)$, Determination of half life time for the 2nd and 3rd order reaction. Kinetics of opposing and consecutive reaction. Kinetics of Enzyme catalysed reaction.

Unit-4: CHEMISTRY OF SELECTED CARBONYL COMPOUNDS AND QUANTITATIVE ANALYSIS IN ORGANIC CHEMISTRY (15 L)

(A) Chemistry of aldehydes & ketones

Introduction, Nomenclature, Properties, of aldehydes and ketones. Preparation of aldehydes, and ketones (HCHO, CH₃CHO, C₆H₅CHO, CH₃COCH₃ etc). Nucleophilic addition reactions of ketone and aldehyde. Aldol, Cross aldol and Cannizarro reaction.

(B) Quantitative Analysis and Determination of Molecular Formula:

Determination of Nitrogen by Kjeldahl's method and Kjeldahl's method modified with boric acid. Molecular weight of organic acid by Ag-salt method and organic base by Chloroplatinate method, Numerical based on empirical and molecular formula

Suggestive Reading:

- Elements of Quantum Mechanics by Michael D. Fayer, Oxford University Press, Indian Edition.
- Concise Inorganic Chemistry by J. D. Lee, 5/E, Oxford University Press, Indian Edition.
- Basic Inorganic Chemistry by F. A. Cotton and G. Wilkinson, Wiley publication.
- Inorganic Chemistry by Shriver & Atkins, 4/E, Oxford University Press, Indian Edition.
- Introductory Quantum Chemistry by A. K. Chandra, 4/E, Tata McGraw Hill Publishing Company Limited, New Delhi.
- Organic Chemistry by G. Marc Loudon, 4/E, 2010, Oxford University Press, Indian Edition,
- Organic Chemistry by Robert Thornot Morrison, Robert Neilson Boyd, 6/E, 1992, Prentice Hall of India Pvt Ltd, New Delhi.
- Text book of Organic Chemistry by P. L. Soni and H. M. Chawla, 26/E, 1995, Sultan Chand & Sons Publication, New Delhi.
- Text book of Organic Chemistry by P. S. Kalsi, 1999, MacMillan of India Pvt. Ltd.
- Organic Chemistry by Bhupinder Mehta, Manju Mehta, Prentice Hall of India Pvt. Ltd, New Delhi.
- Elements of Physical Chemistry by Peter Atkins & Julio De Paula, 5/E, Oxford University Press, Indian Edition.
- Physical Chemistry by P. W. Atkins, 7/E, 2002, Oxford University Press, Indian Edition.
- Physical Chemistry by W. J. Moore, 1996, 6/E, MacGraw Hill Publication.
- Principle of Physical Chemistry by Puri, Sharma & Pathania, 41/E, Vishal Publishers.
- Essentials of Physical Chemistry by Bahl & Tuli, 22/E, S.Chand publication New Delhi
- Advanced Physical Chemistry by Gurdeep Raj, 19/E, Goel Publishing House Meerut.

Suggested Online Links/Readings:

<https://swayam.gov.in>

[https://www.iscnagpur.ac.in/knowledge_learning_files/5.7 General Open Access e-Resources.pdf](https://www.iscnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf)

<https://ndl.iitkgp.ac.in>

<https://nptel.ac.in/course.html>

Pedagogy:

1. Lecture method with teaching aids.
2. Audio-Visual Teaching mode with Projector Method.
3. Dialogue and context-based class.
4. Assignments, Learning seminar, Class Test etc.
5. Open Online Sources and Tutorials.

MODE OF EVALUATION:

Evaluation will be divided in two parts.

ASSESSMENT	MARKS
INTERNAL	
Attendance	05
Research Assignment	10
Continuous Internal Assessment I and II	35
TOTAL	50 marks
EXTERNAL	
End Semester Exam	50 marks

Students will prepare and submit hard copy of synopsis of the topic of Research Assignment on allotted topics. These Submission will be evaluated on the basis of personal viva on the synopsis submitted by each student. On the bases of synopsis submitted+ Viva + overall impressions they will be marked out of 10 marks). A short discussion for moderation of the marks by staff involved before submission is done.

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FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

BSc. (Hons.) Chemistry
Category – IV

Major Course – II: Chemistry Practicals – 1 (Lab)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
CH – 150 2 L: Chemistry Practical-I	0	0	4 (60 hr)	10 + 2 from a recognized board in any stream	Basic Knowledge of Chemistry, observation and Analytic skills

LEARNING OBJECTIVES (LO)

- LO1:** To learn and Perform semi-micro qualitative analysis of inorganic salts to identify the cation and anion
- LO2 :** To understand and learn the principles of titrimetric analysis to determine the concentration of unknown acid or base
- LO3:** To understand the chemistry of preparations of double salt
- LO4:** To Learn basics of K_{sp} , common ion effect and ionic equilibrium
- LO5:** To learn basics of simple chromatographic techniques.

COURSE OUTCOMES (CO):

On Completion of this course, the student will be able to-

- CO1:** Perform semi-micro qualitative analysis of inorganic salts to identify the cation and anion
- CO2:** Use the principles of titrimetric analysis to determine the concentration of unknown acid or base
- CO3:** To perform the preparation of mixed salts
- CO4:** To perform experiments to study ionic equilibria
- CO5:** To perform simple chromatographic experiments for separation of ions

Part-(1) Inorganic Qualitative Analysis (Two Radicals) (Minimum eighteen Salts)

Water Soluble and Insoluble Inorganic salts of following cations and anions:

Cations : K^+ , NH_4^+ , Mg^{2+} , Ba^{2+} , Ca^{2+} , Sr^{2+} , Fe^{2+} , Fe^{3+} , Al^{3+} , Cr^{3+} , Zn^{2+} , Mn^{2+} , Co^{3+} , Pb^{2+} , Cu^{2+} .

Anions : S^{2-} , SO_4^{2-} , CO_3^{2-} , PO_4^{3-} , CrO_4^{2-} , Cl^- , Br^- , I^- , NO_3^- , O^{2-}

Part- (II) Inorganic preparation, Volumetric Analysis, and Investigative projects.**(A) Inorganic Preparations**

1. Potash alum
2. Mohr's salt
3. Potassium tris oxalate aluminate
4. Sodium thiosulphate ($Na_2S_2O_3$)

(B) Volumetric Analysis.

1. Calibration and use of apparatus.
2. Preparation of solution of different molarity and normality of titrants.
3. Titration of weak acid (Oxalic acid) and strong base.
4. Titration of weak acid (Succinic Acid) and strong base.
5. Titration of Na_2CO_3 and HCl
6. To determine the strength of ammonia in ammonia salt by volumetric analysis
7. To determine the strength of a mixture of NaOH and Na_2CO_3 present in the solution.
8. To determine the strength of a mixture $NaHCO_3$ and Na_2CO_3 present in the solution.

(c) Investigative projects

1. To study the Ksp of $Ca(OH)_2$ with common ion effect using NaOH or any alkali solution.
2. Find out the strength of antacid with volumetric titration.
3. Paper chromatography of Cu^{2+} , Pb^{2+} and Cd^{2+}

Suggested Reading:

- Vogel's Textbook of Quantitative Chemical analysis Revised by G. H. Jeffery, J. Bassett, J.Mendham & R. C. Denney, 5/E, ELBS (English Language Book Society) Longman.
- Analytical Chemistry by Dhruva Charan Dash, PHI Learning Private Ltd, 2011 New Delhi. .
- Analytical Chemistry by Gary D. Christian, 4/E, John Wiley & Sons.
- Advanced Practical Inorganic Chemistry by Gurdeep Raj, 9/E, Goel Publishing House, Meerut.
- Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, 5/E, Orient Longman Ltd..

MODE OF EVALUATION:

SR. NO.	EXAM PATTERN	INTERNAL EXAM		EXTERNAL EXAM	
		SESSION I	SESSION II	SESSION I	SESSION II
1	Practical/Performance	25	20	(20 Marks Inorg + 5 que slip)=25	(15 Volu + 10 Prep)=25
2	Attendance	0	05	00	00
	Total	25	25	25	25
	Grand Total	25+25= 50 marks		25+25= 50 marks	