

Krantiguru Shyamji Krishna Verma

Kachchh University

Mundra Road

BHUI: 370 001



SYLLABUS (NEP)

B. Sc. (Honours) Semester VII: (Seven)

CHEMISTRY

(With Research)

**Curriculum as per UGC Guideline
Framed according to National Education Policy (NEP)-2020**

With effect from June-2026 (and thereafter)

Structure of the Question Paper (Theory) for the University Exam

KACHCHH UNIVERSITY: BHUJ

FOURTH YEAR B.Sc. (Honours): NEP: SEMESTER: VII (SEVEN)
CHEMISTRY(With Research)

PAPER NAME: Organic/ Spectroscopy and Separation Techniques
/Physical/Inorganic Chemistry /RP

PAPER CODE NO: MAJ CHE-701/703/705, MIN CHE-707

Total Marks: 35, Passing standard: 14 Marks [Time: 90 minutes]

*RP/Dissertation Paper of 6 credit evaluate separately.

PATTERN OF QUESTION PAPER FOR SEMESTER-END EXAMS

Questions	Section	Marks
Question-1 (Unit-I)	(Descriptive - Essay type - Short notes <i>with internal option</i>)	10 marks
Question-2 (Unit-II)	--do--	10 marks
Question-3 (Unit-III)	--do--	10 marks
Question – 4 (Unit-I, II & III)	Total 06 short questions of 1 mark, each unit will have 2 questions. students will attempt any 05 out of 06	05 Marks

- *Question 4 may include one-line answers/ two-line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures/ fill in the blanks/ multiple choice question/ one word answer/ match the pairs/Chemical reaction etc.*
- *RP/Dissertation/practical work or other activity (Given by teacher or as a part of Syllabus) will be mandatory for all the students.*
- *The language of the question papers shall be English.*



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: ORGANIC CHEMISTRY
PAPER CODE NO: MAJ CHE-701

Course Outcomes (COs):		
Upon successful completion of these papers' students will learn about concepts of Organic Chemistry, like reactive intermediates, aromaticity, name reactions and reagents, free radicals. This study will be helpful in further study, competitive exams and industries.		
UNIT-I	REACTIVE INTERMEDIATES:	15 Hours
	Carbocations: Classical and non-classical, neighboring group participation, ion-pairs, molecular rearrangements in acyclic, monocyclic and bicyclic systems, stability and reactivity of bridge-head carbocations. Carbanions: Generation, structure and stability, ambient ions and their general reactions; HSAB principle and its applications. Radicals: Generation, structure, stability and reactions, cage effects; radical-cations & radicalanions. Carbenes: Formation and structure, reactions involving carbenes and carbenoids. Nitrenes: Generation, structure and reactions of nitrenes.	
UNIT-II		15 Hours
	(A) SELECTED ORGANIC REACTIONS AND REAGENTS:	10 Hours
	Favorski, Stork-enamine, Michael addition, Mannich, ene, Hofmann-Löffler-Freytag, Shapiro, Chichibabin and Wittig reaction, Robinson annulation, Gilman's reagent, Lithium dimethyl cuprate, Dicyclohexyl carbodimide, Lithium diisopropylamine, 1,3-dithiane (reactivity umpolung), Trimethyl silyl iodide, Baker Yeast, Phase-transfer catalysts.	
	(B) AROMATICITY:	5 Hours
	Concept of Aromaticity, non-aromaticity and antiaromaticity, NMR in aromatic character, Huckel's rule and its limitations, non-benzonoid compounds (aromaticity), annulenes, fulvenes, fulvalenes, azulenes.	
UNIT-III	FREE RADICAL REACTIONS:	15 Hours
	Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, reactivity in the attacking radicals, the effect of solvents on reactivity, allylic halogenations (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation.	



REFERENCE BOOKS :

1. Finar I L : Organic Chemistry, Vol 1 (The Fundamental Principles) 6th Ed Longman (1973).
2. Finar I L : Organic Chemistry, Vol 2 (Stereochemistry and chemistry of Natural Products) 6th Ed Longman (1973).
3. March Jerry : Advanced Organic Chemistry, 4th Ed, Wiley Eastern Ltd., New Delhi (1985).
4. V K Ahluwalia, R K Parasar : Organic Reaction Mechanism, 2nd Ed.
5. G R Chatwal : Reaction Mechanism and Reagents in Organic Chemistry.
6. Morrison R T and Boyd R N : Organic Chemistry, Prentice Hall of India Pvt Ltd., 6th Ed (2003).
7. J P Trivedi : Reaction Intermediates in Organic chemistry, University Granth Nirman Board, Ahmedabad.
8. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
9. Principles in Organic Synthesis, R.O.C. Norman and J.M. Coxon.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY

PAPER NAME: ORGANIC CHEMISTRY PRACTICAL

PAPER CODE NO: MAJ CHE-702P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks: 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- Practical skills of synthesis of molecules and their analysis.
- The course will provide ability to students to synthesis of organic compounds and their spectral studies.

➤ **ORGANIC PREPARATION:**

1. Preparation of Organic Compounds: 1 and 2 stage preparation.

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: SPECTROSCOPY AND SEPARATION TECHNIQUES
PAPER CODE NO: MAJ CHE-703

Course Outcomes (COs):		
Upon successful completion of this paper students will learn about Analytical chemistry concept like Mass Spectrometry, High Performance Liquid Chromatography, Gas Liquid Chromatography, Hyphenated Techniques e.g. GC–MS, LC–MS, HPTLC.. This study will be helpful in further study, competitive exams and industries.		
UNIT-I	Mass Spectrometry:	15 Hours
	Introduction, basic theory, Principle, schematic diagram, instrumentation of Mass spectrometry; Nitrogen rule, Important terms: Molecular ion peak, Metastable peak, Base peak, Relative intensity, etc.; General fragmentation rules for prominent peaks in EI spectra, Heterolytic fragmentation, Homolytic fragmentation and McLafferty rearrangement., Molecular weight determination using mass spectra, Molecular formula determination using mass spectra, Lement's A, A+1, A+2 classification based on relative abundance, Mass spectra of hydrocarbons, alkenes, aromatic and alkyl hydrocarbons, alcohols, ethers, ketones, aldehydes, acids, amides.	
UNIT-II	Chromatography	15 Hours
	(a) High Performance Liquid Chromatography:	7 Hours
	Definition, Principle and Basics of Chromatography, Basic terminology: Normal phase chromatography, Reverse phase chromatography, isocratic elution, gradient elution, R _f value, partition coefficient, Adsorption Chromatography, Partition Chromatography, degassing, Introduction, Principle, Block diagram, instrumentation and Applications of HPLC, Preparative HPLC, fraction collector, Mobile phase selection, Problems related to theoretical plates, resolution, capacity factors, selectivity factors etc., Advantages and Dis advantages of HPLC technique, Basic of affinity chromatography.	
	(b) Gas Liquid Chromatography:	8 Hours
	Basic terminology: Theoretical Plates, HETP, Eddy diffusion, Retention time, Dead time, Capacity factor, Peak tailing, Resolution, Introduction, Principle, block diagram, Instrumentation and Applications of GLC, comparison between GLC and HPLC, Rate theory, Plate theory, Advantages and Dis advantages of GC technique.	
UNIT-III	Hyphenated Techniques:	15 Hours
	Introduction, Principle, Theory, Instrumentation, and Applications of: GC–MS (Gas Chromatography–Mass Spectrometry), LC–MS (Liquid	

	Chromatography–Mass Spectrometry), HPTLC (High-Performance Thin-Layer Chromatography), LC–MS/MS (Tandem LC–MS), Interface Requirements for GC–MS and LC–MS, Comparison between HPTLC and TLC (Thin-Layer Chromatography), Introduction of Soft and hard ionisation techniques.	
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Reference Books:

- (1) Bartt L et al : Vogel's Textbook of Quantitative Inorganic Analysis, ELBS 6th Ed.
- (2) Sharma B K : Instrumental methods of Chemical Analysis, Goel Publishing House.
- (3) Silverstein R M, Bassler G C : Spectrometric Identification of Organic Compounds, John Wiley.
- (4) Sharma Y R : Elementary Organic Spectroscopy, Jalandhar.
- (5) Kalsi P S : Spectroscopy of Organic Compounds, New Age International Ltd.
- (6) Sethi P D, High Performance Liquid Chromatography.
- (7) Skoog D A., Loary J I and Saunder W B, Principles of Instrumental Analysis.
- (8) Skoog D A, West D M, Holler F J and Saunder W B, Fundamentals of Analytical Chemistry.
- (9) Sethi P D, HPTLC.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: SPECTROSCOPY AND SEPARATION TECHNIQUES
PRACTICALS
PAPER CODE NO: MAJ CHE-704P
Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- Qualitatively and quantitatively analyze unknown organic, inorganic, metal, natural etc compounds.
Practical skills in the field and laboratory experiments in Analytical qualitative and quantitative analysis.
- The course will provide ability to student to identify and quantify any chemical compound.

➤ **Chromatography:**

1. Column Chromatography
2. TLC and Prep. TLC
3. Paper Chromatography: Ascending, Circular paper chromatography and 2D Paper Chromatography

➤ **JOURNAL**

➤ **VIVA**

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Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: PHYSICAL CHEMISTRY
PAPER CODE NO: MAJ CHE-705

Course Outcomes (COs):		
Upon successful completion of these papers' students will learn about concepts of Physical Chemistry, like chemical kinetics, electrochemistry, and solid state. This study will be helpful in further study, competitive exams and industries.		
UNIT-I	CHEMICAL KINETICS	15 Hours
	Theories of reaction rates: The collision theory of reaction rates, The transition state theory of reaction rates and its limitations, Theories of Unimolecular gas reactions: Lindemann theory, Kinetics of some complex reactions: Reversible reactions (only first order opposed by first order), Consecutive reactions, thermal and photochemical chain reactions (HBr), kinetics of branched chain reaction, Kinetics of reactions in solution, kinetics of Enzyme catalysed reactions and oscillatory reactions	
UNIT-II	ELECTROCHEMISTRY	15 Hours
	Electrodes and electrochemical cell, Nernst equation, Debye-Hackle Theory (Mathematical Derivation), Thermodynamics of electrified interfaces Lipmann's Equation, Debye-Falkenhagen effect, Wein effect, electrical double layer, Overvoltage, types of overvoltage, measurement of overvoltage, Factors affecting overvoltage, importance of overvoltage, Exchange current density, Polarization, Butler-volmer equation, tafel equation.	
UNIT-III	SOLID STATE	15 Hours
	Crystalline and amorphous solids, x-ray diffraction, Bragg equation (derivation), experimental method single crystal method and powder method, Band theory of solids, and energy band theory of conductors, semiconductors and insulators, extrinsic semiconductors, superconductivity LTSC and HTSC, Defects in crystals, calculation of Schottky and Frenkel defects using statistical method, metal excess defects, metal deficient defects, line defects.	

REFERENCE BOOKS

1. Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith, Oxford University Press, 6th Edition.
2. Physical Chemistry, Ira N Levine Tata McGraw-Hill Publishing Company, New Delhi, Fifth Edition.
3. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, and M. S. Pathania, Vishal Publishing Co., Delhi.
4. Advanced physical chemistry, Gurdeep Raj 35th revised edition, Goel publishing house.
5. Advanced physical chemistry by J.N.Gurtu, A.Gurtu, 11th edition, Pragati prakashan.



6. Modern Electrochemistry, Vol. I and Vol. II by J. O. M. Bockris and A. K. N. Reddy, Plenum press
7. Chemical Kinetics by K. J. Laidler, Mc-Graw Hill Publisher
8. Solid-state chemistry by N. B. Hannay, Englewood Cliffs, N.J., Prentice-Hall.
9. Principles of the Solid State by H. V. Keer, New Age International (P) Ltd., Publishers
10. Reaction Kinetics by Michael J. Pilling and Paul W. Seakins, Oxford University Press
11. An Introduction to Electrochemistry by Samuel Glasstone, East-West Press Private, Limited



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: PHYSICAL CHEMISTRY PRACTICAL
PAPER CODE NO: MAJ CHE-706P
Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks:30

Course Outcomes (COs):

On completion of this course, the students will be able to perform/do independently:

- Examine the rate & order of the reaction from experimental & graphical data.
- Determine relative strengths of acids.
- Determine Energy of activation and Temperature coefficient.
- To acquire skills in the operation of Potentiometer and conductometric titrimetry.

➤ **PHYSICO CHEMICAL EXERCISE (ANY SIX)**

One exercise be given from the following to the candidate at the examination:

● **Conductometry**

1. Titrate a given mixture of HCl, acetic acid and CuSO_4 against NaOH solution conductometrically.
2. To determine the equivalent conductance of a strong electrolyte and hence to verify the Onsager's equation
3. To study the complexation of Ni^{2+} with EDTA.
4. To determine the concentration of hydrochloric acid and oxalic acid in given mixture conduct metrically

● **Potentiometry**

1. To determine the normality and dissociation constants of a given dibasic acid by potentiometry.
2. To determine the normality of each halide in the mixture of halides.
3. To determine the standard redox potential and thermodynamic parameters of the Fe^{2+} ion.
4. To determine the concentration of KI by potentiometry

● **Chemical Kinetics**

1. To determine the reaction velocity constant for the reaction between acetone and iodine.
2. To determine heat and entropy of vaporization of a given liquid by a kinetic approach.
3. To determine the kinetic parameters and the temperature coefficient of the reaction between potassium persulphate ($\text{K}_2\text{S}_2\text{O}_8$) and potassium iodide (KI).
4. To determine the kinetic parameters and the temperature coefficient of the reaction between KBrO_3 and KI

➤ **JOURNAL**



➤ VIVA

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: INORGANIC CHEMISTRY
PAPER CODE NO: MIN CHE-707

Course Outcomes (COs):

Upon successful completion of these papers' students will learn about concepts of Quantum Mechanics and its applications, Inorganic Reaction Mechanisms, Chemical Bonding. This study will be helpful in further study, competitive exams and industries.

UNIT-I	Quantum Mechanics and its applications :	15 Hours
	Basic vector algebra, matrix, determinant, eigen value equations, quantum mechanical operators, orthogonal functions, Schmidt's orthogonalization technique. Planck's quantum theory, wave particle duality, uncertainty principle, postulates of quantum mechanics, Schrodinger equation, free particle, particle in a box, degeneracy, harmonic oscillator, rigid rotator, the hydrogen atom, angular momentum, electron spin, spin-orbit coupling. Born-Oppenheimer approximation, Hartree-Fock method, Brillouin theorem, Koopman's theorem, Roothan's equations, models of chemical bonding- Molecular orbital (MO) and Valence bond (VB) theories, application to diatomic molecules such as, H_2 , H_2^+ etc. Quantitative MO theory-Huckel - electron theory and its application to ethylene, butadiene and benzene, energy levels of di- and tri- atomic molecules. Walsh diagrams and molecular geometry.	
UNIT-II	Inorganic Reaction Mechanisms	15 Hours
	Mechanisms of substitution reactions of tetrahedral, square planar, trigonal bipyramidal, square pyramidal and octahedral complexes. Potential energy diagrams, transition states and intermediates, isotope effects, Berry's pseudo rotation mechanism, factors affecting the reactivity of square planar complexes, Swain-Scott equation, Trans effect and its application to synthesis of complexes.	
UNIT-III	Chemical Bonding :	15 Marks
	LCAO-MO theory, Metallic bonding, band theory, hydrogen bonding, VSEPR model. Bonding in alloys, intermetallic compounds. Bonding in non-transition element compounds.	



REFERENCE BOOKS:

1. Cotton F A and Wilkinson G : Advanced inorganic chemistry, 5th Ed, J. Wiley & sons, New York (1988).
2. Concept and Models of Inorganic Chemistry, Bodie Douglas, Darl McDaniel, John Alexander 3. Chandra A K : Introductory Quantum Chemistry, 3rd Ed Tata Magrow Hill, New Delhi (1988).
4. Basolo F and Pearson R G : Mechanism of Inorganic Reactions, 2nd Ed, J. Wiley & Sons, New York (1988).
5. Chandra M : Atomic structure and Chemical Bonding (including molecular spectroscopy), 3rd Ed, Tata Magrow Hill, New Delhi (1991).
6. Chatwal & Anand : Quantum Mechanics, Himalaya Publishing House. Katakis, D. & Gordon, G. Mechanism of Inorganic Reactions John Wiley & Sons: N. Y (1987).
7. Tobe, M. in Inorganic Reaction Mechanisms F. C. Wadlington, Ed., Thomas Nelson: London (1973).
8. Inorganic Chemistry, J.E. Huhey, Harpes & Row.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: INORGANIC CHEMISTRY-PRACTICAL
PAPER CODE NO: MIN CHE-708P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks: 30

Course Outcomes (COs):

- On completion of this course, the students will be able to perform/do independently:
- Practical skills in the field of Inorganic chemistry.
 - The course will provide ability to student to separation and identify of negative and positive radicals.
 - Improve knowledge about separation of Inorganic Qualitative Analysis of radicals..

➤ **Inorganic Chemistry:**

Qualitative Analysis: Six radicals' separation with one less common ion

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.

UNIVERSITY PRACTICAL EXAM PATTERN

There will be a Three Exercise in each practical, as under, total of **15 Marks**.

(1) Practical exercise (10 marks) (2) Viva (3 marks) (3) Practical Journal (2 marks)

Duration of Exam: 2 Hrs.

Examiner will submit marks out of 15 to university.

Passing standard: 6 Marks out of 15 Marks.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: Research Project /Dissertation
PAPER CODE NO: RP CHE-709

Title	Credit
Research Project /Dissertation	Total credit: 06

*Please refer 3.5 of SOP page no. 74



Dr. Jyotindra J. Bhatt
Chairman
BOS (Chemistry)



DEAN
FACULTY OF SCIENCE
KSKY KACHCHH UNIVERSITY
BHUJ-KACHCHH-370001



Krantiguru Shyamji Krishna Verma

Kachchh University

Mundra Road

BHUI: 370 001



SYLLABUS (NEP)

B. Sc.(Honours) Semester VII: (Seven)

CHEMISTRY

(Without Research)

**Curriculum as per UGC Guideline
Framed according to National Education Policy (NEP)-2020**

With effect from June-2026 (and thereafter)

**Credit Framework and course code for Fourth Year (SEM-VII) B.Sc. (Honours)
Chemistry Programme. (Without Research)**

Year	Semester	Course Code	Paper Title	Credits	Marks		Total
					CA	UA	
Fourth Year	VII	MAJ CHE-701 (Theory)	Organic Chemistry	3	35	35	70
		MAJ CHE-702P (Practical)	Organic Chemistry - PRACTICAL	1	15	15	30
		MAJ CHE-703 (Theory)	Spectroscopy and Separation Techniques	3	35	35	70
		MAJ CHE-704P (Practical)	Spectroscopy and Separation Techniques - PRACTICAL	1	15	15	30
		MAJ CHE-705 (Theory)	Physical Chemistry	3	35	35	70
		MAJ CHE-706P (Practical)	Physical Chemistry - PRACTICAL	1	15	15	30
		Total Credits (Major)		12			300
		MIN CHE-707 (Theory)	Inorganic Chemistry	3	35	35	70
		MIN CHE-708P (Practical)	Inorganic Chemistry PRACTICAL	1	15	15	30
		Total Credits (Minor)		4			100
		MAJ CHE-709 (Theory)	Applied Chemistry	3	35	35	70
		MAJ CHE-710P (Practical)	Applied Chemistry Practical	1	15	15	30
		SEC CHE-711 P (Practical)	SEC based Practical	2	25	25	50
		Total Credits OJT *(MAJ CHE ,SEC -OR- only OJT CHE)		6			150
		Total Credits		22			550

Structure of the Question Paper (Theory) for the University Exam



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY

**PAPER NAME: Organic/ Spectroscopy and Separation Techniques /Physical/
Applied Chemistry (OJT)**

PAPER CODE NO: MAJ CHE-701/703/705, MIN CHE-707

Total Marks: 35, Passing standard: 14 Marks [Time: 90 minutes]

PATTERN OF QUESTION PAPER

FOR SEMESTER-END EXAMS

Questions	Section	Marks
Question-1 (Unit-I)	(Descriptive - Essay type - Short notes <i>with internal option</i>)	10 marks
Question-2 (Unit-II)	--do--	10 marks
Question-3 (Unit-III)	--do--	10 marks
Question – 4 (Unit-I, II & III)	Total 06 short questions of 1 mark, each unit will have 2 questions. students will attempt any 05 out of 06	05 Marks

- *Question 4 may include one-line answers/ two-line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures/ fill in the blanks/ multiple choice question/ one word answer/ match the pairs/Chemical reaction etc.*
- *OJT/Theory paper/practical work or other activity (Given by teacher or as a part of Syllabus) will be mandatory for all the students.*
- *The language of the question papers shall be English.*



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: ORGANIC CHEMISTRY
PAPER CODE NO: MAJ CHE-701

Course Outcomes (COs):		
Upon successful completion of these papers' students will learn about concepts of Organic Chemistry, like reactive intermediates, aromaticity, name reactions and reagents, free radicals. This study will be helpful in further study, competitive exams and industries.		
UNIT-I	REACTIVE INTERMEDIATES:	15 Hours
	Carbocations: Classical and non-classical, neighboring group participation, ion-pairs, molecular rearrangements in acyclic, monocyclic and bicyclic systems, stability and reactivity of bridge-head carbocations. Carbanions: Generation, structure and stability, ambient ions and their general reactions; HSAB principle and its applications. Radicals: Generation, structure, stability and reactions, cage effects; radical-cations & radicalanions. Carbenes: Formation and structure, reactions involving carbenes and carbenoids. Nitrenes: Generation, structure and reactions of nitrenes.	
UNIT-II		15 Hours
	(A) SELECTED ORGANIC REACTIONS AND REAGENTS:	10 Hours
	Favorski, Stork-enamine, Michael addition, Mannich, ene, Hofmann-Löffler-Freytag, Shapiro, Chichibabin and Wittig reaction, Robinson annulation, Gilman's reagent, Lithium dimethyl cuprate, Dicyclohexyl carbodimide, Lithium diisopropylamine, 1,3-dithiane (reactivity umpolung), Trimethyl silyl iodide, Baker Yeast, Phase-transfer catalysts.	
	(B) AROMATICITY:	5 Hours
	Concept of Aromaticity, non-aromaticity and antiaromaticity, NMR in aromatic character, Huckel's rule and its limitations, non-benzonoid compounds (aromaticity), annulenes, fulvenes, fulvalenes, azulenes.	
UNIT-III	FREE RADICAL REACTIONS:	15 Hours
	Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, reactivity in the attacking radicals, the effect of solvents on reactivity, allylic halogenations (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation.	



REFERENCE BOOKS :

1. Finar I L : Organic Chemistry, Vol 1 (The Fundamental Principles) 6th Ed Longman (1973).
2. Finar I L : Organic Chemistry, Vol 2 (Stereochemistry and chemistry of Natural Products) 6th Ed Longman (1973).
3. March Jerry : Advanced Organic Chemistry, 4th Ed, Wiley Eastern Ltd., New Delhi (1985).
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5. G R Chatwal : Reaction Mechanism and Reagents in Organic Chemistry.
6. Morrison R T and Boyd R N : Organic Chemistry, Prentice Hall of India Pvt Ltd., 6th Ed (2003).
7. J P Trivedi : Reaction Intermediates in Organic chemistry, University Granth Nirman Board, Ahmedabad.
8. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
9. Principles in Organic Synthesis, R.O.C. Norman and J.M. Coxon.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: ORGANIC CHEMISTRY PRACTICAL
PAPER CODE NO: MAJ CHE-702P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks: 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- Practical skills of synthesis of molecules and their analysis.
- The course will provide ability to students to synthesis of organic compounds and their spectral studies.

➤ **ORGANIC PREPARATION:**

1. Preparation of Organic Compounds: 1 and 2 stage preparation.

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: SPECTROSCOPY AND SEPARATION TECHNIQUES
PAPER CODE NO: MAJ CHE-703

Course Outcomes (COs):		
Upon successful completion of this paper students will learn about Analytical chemistry concept like Mass Spectrometry, High Performance Liquid Chromatography, Gas Liquid Chromatography, Hyphenated Techniques e.g. GC-MS, LC-MS, HPTLC.. This study will be helpful in further study, competitive exams and industries.		
UNIT-I	Mass Spectrometry:	15 Hours
	Introduction, basic theory, Principle, schematic diagram, instrumentation of Mass spectrometry; Nitrogen rule, Important terms: Molecular ion peak, Metastable peak, Base peak, Relative intensity, etc.; General fragmentation rules for prominent peaks in EI spectra, Heterolytic fragmentation, Homolytic fragmentation and McLafferty rearrangement., Molecular weight determination using mass spectra, Molecular formula determination using mass spectra, Lement's A, A+1, A+2 classification based on related abundance, Mass spectra of hydrocarbons, alkenes, aromatic and alkyl hydrocarbons, alcohols, ethers, ketones, aldehydes, acids, amides.	
UNIT-II	Chromatography	15 Hours
	(a) High Performance Liquid Chromatography:	7 Hours
	Definition, Principle and Basics of Chromatography, Basic terminology: Normal phase chromatography, Reverse phase chromatography, isocratic elution, gradient elution, Rf value, partition coefficient, Adsorption Chromatography, Partition Chromatography, degassing, Introduction, Principle, Block diagram, instrumentation and Applications of HPLC, Preparative HPLC, fraction collector, Mobile phase selection, Problems related to theoretical plates, resolution, capacity factors, selectivity factors etc., Advantages and Dis advantages of HPLC technique, Basic of affinity chromatography.	
	(b) Gas Liquid Chromatography:	8 Hours
	Basic terminology: Theoretical Plates, HETP, Eddy diffusion, Retention time, Dead time, Capacity factor, Peak tailing, Resolution, Introduction, Principle, block diagram, Instrumentation and Applications of GLC, comparison between GLC and HPLC, Rate theory, Plate theory, Advantages and Dis advantages of GC technique.	
UNIT-III	Hyphenated Techniques:	15 Hours
	Introduction, Principle, Theory, Instrumentation, and Applications of: GC-MS (Gas Chromatography-Mass Spectrometry), LC-MS (Liquid	

	Chromatography–Mass Spectrometry), HPTLC (High-Performance Thin-Layer Chromatography), LC–MS/MS (Tandem LC–MS), Interface Requirements for GC–MS and LC–MS, Comparison between HPTLC and TLC (Thin-Layer Chromatography), Introduction of Soft and hard ionisation techniques.	
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Reference Books:

- (1) Bartt L et al : Vogel's Textbook of Quantitative Inorganic Analysis, ELBS 6th Ed.
- (2) Sharma B K : Instrumental methods of Chemical Analysis, Goel Publishing House.
- (3) Silverstein R M, Bassler G C : Spectrometric Identification of Organic Compounds, John Wiley.
- (4) Sharma Y R : Elementary Organic Spectroscopy, Jalandhar.
- (5) Kalsi P S : Spectroscopy of Organic Compounds, New Age International Ltd.
- (6) Sethi P D, High Performance Liquid Chromatography.
- (7) Skoog D A., Loary J I and Saunder W B, Principles of Instrumental Analysis.
- (8) Skoog D A, West D M, Holler F J and Saunder W B, Fundamentals of Analytical Chemistry.
- (9) Sethi P D, HPTLC.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: SPECTROSCOPY AND SEPARATION TECHNIQUES
PRACTICALS
PAPER CODE NO: MAJ CHE-704P
Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- Qualitatively and quantitative analyze unknown organic, inorganic, metal, natural etc compounds.
Practical skills in the field and laboratory experiments in Analytical qualitative and quantitative analysis.
- The course will provide ability to student to identify and quantify any chemical compound.

➤ **Chromatography:**

1. Column Chromatography
2. TLC and Prep. TLC
3. Paper Chromatography: Ascending, Circular paper chromatography and 2D Paper Chromatography

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: PHYSICAL CHEMISTRY
PAPER CODE NO: MAJ CHE-705

Course Outcomes (COs):		
Upon successful completion of these papers' students will learn about concepts of Physical Chemistry, like chemical kinetics, electrochemistry, and solid state. This study will be helpful in further study, competitive exams and industries.		
UNIT-I	CHEMICAL KINETICS	15 Hours
	Theories of reaction rates: The collision theory of reaction rates, The transition state theory of reaction rates and its limitations, Theories of Unimolecular gas reactions: Lindemann theory, Kinetics of some complex reactions: Reversible reactions (only first order opposed by first order), Consecutive reactions, thermal and photochemical chain reactions (HBr), kinetics of branched chain reaction, Kinetics of reactions in solution, kinetics of Enzyme catalysed reactions and oscillatory reactions	
UNIT-II	ELECTROCHEMISTRY	15 Hours
	Electrodes and electrochemical cell, Nernst equation, Debye-Hackle Theory (Mathematical Derivation), Thermodynamics of electrified interfaces Lipmann's Equation, Debye-Falkenhagen effect, Wein effect, electrical double layer, Overvoltage, types of overvoltage, measurement of overvoltage, Factors affecting overvoltage, importance of overvoltage, Exchange current density, Polarization, Butler-volmer equation, tafel equation.	
UNIT-III	SOLID STATE	15 Hours
	Crystalline and amorphous solids, x-ray diffraction, Bragg equation (derivation), experimental method single crystal method and powder method, Band theory of solids, and energy band theory of conductors, semiconductors and insulators, extrinsic semiconductors, superconductivity LTSC and HTSC, Defects in crystals, calculation of Schottky and Frenkel defects using statistical method, metal excess defects, metal deficient defects, line defects.	

REFERENCE BOOKS

1. Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith, Oxford University Press, 6th Edition.
2. Physical Chemistry, Ira N Levine Tata McGraw-Hill Publishing Company, New Delhi, Fifth Edition.
3. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, and M. S. Pathania, Vishal Publishing Co., Delhi.
4. Advanced physical chemistry, Gurdeep Raj 35th revised edition, Goel publishing house.
5. Advanced physical chemistry by J.N. Gurtu, A. Gurtu, 11th edition, Pragati prakashan.



6. Modern Electrochemistry, Vol. I and Vol. II by J. O. M. Bockris and A. K. N. Reddy, Plenum press
7. Chemical Kinetics by K. J. Laidler, Mc-Graw Hill Publisher
8. Solid-state chemistry by N. B. Hannay, Englewood Cliffs, N.J., Prentice-Hall.
9. Principles of the Solid State by H. V. Keer, New Age International (P) Ltd., Publishers
10. Reaction Kinetics by Michael J. Pilling and Paul W. Seakins, Oxford University Press
11. An Introduction to Electrochemistry by Samuel Glasstone, East-West Press Private, Limited



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: PHYSICAL CHEMISTRY PRACTICAL
PAPER CODE NO: MAJ CHE-706P
Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks:30

Course Outcomes (COs):

On completion of this course, the students will be able to perform/do independently:

- Examine the rate & order of the reaction from experimental & graphical data.
- Determine relative strengths of acids.
- Determine Energy of activation and Temperature coefficient.
- To acquire skills in the operation of Potentiometer and conductometric titrimetry.

➤ **PHYSICO CHEMICAL EXERCISE (ANY SIX)**

One exercise be given from the following to the candidate at the examination:

● **Conductometry**

1. Titrate a given mixture of HCl, acetic acid and CuSO₄ against NaOH solution conductometrically.
2. To determine the equivalent conductance of a strong electrolyte and hence to verify the Onsager's equation
3. To study the complexation of Ni²⁺ with EDTA.
4. To determine the concentration of hydrochloric acid and oxalic acid in given mixture conduct metrically

● **Potentiometry**

1. To determine the normality and dissociation constants of a given dibasic acid by potentiometry.
2. To determine the normality of each halide in the mixture of halides.
3. To determine the standard redox potential and thermodynamic parameters of the Fe²⁺ ion.
4. To determine the concentration of KI by potentiometry

● **Chemical Kinetics**

1. To determine the reaction velocity constant for the reaction between acetone and iodine.
2. To determine heat and entropy of vaporization of a given liquid by a kinetic approach.
3. To determine the kinetic parameters and the temperature coefficient of the reaction between potassium persulphate (K₂S₂O₈) and potassium iodide (KI).
4. To determine the kinetic parameters and the temperature coefficient of the reaction between KBrO₃ and KI

➤ **JOURNAL**



➤ VIVA

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: INORGANIC CHEMISTRY
PAPER CODE NO: MIN CHE-707

Course Outcomes (COs):

Upon successful completion of these papers' students will learn about concepts of Quantum Mechanics and its applications, Inorganic Reaction Mechanisms, Chemical Bonding. This study will be helpful in further study, competitive exams and industries.

UNIT-I	Quantum Mechanics and its applications :	15 Hours
	Basic vector algebra, matrix, determinant, eigen value equations, quantum mechanical operators, orthogonal functions, Schmidt's orthogonalization technique. Planck's quantum theory, wave particle duality, uncertainty principle, postulates of quantum mechanics, Schrodinger equation, free particle, particle in a box, degeneracy, harmonic oscillator, rigid rotator, the hydrogen atom, angular momentum, electron spin, spin-orbit coupling. Born-Oppenheimer approximation, Hartree-Fock method, Brillouin theorem, Koopman's theorem, Roothan's equations, models of chemical bonding- Molecular orbital (MO) and Valence bond (VB) theories, application to diatomic molecules such as, H_2 , H_2^+ etc. Quantitative MO theory-Huckel - electron theory and its application to ethylene, butadiene and benzene, energy levels of di- and tri- atomic molecules. Walsh diagrams and molecular geometry.	
UNIT-II	Inorganic Reaction Mechanisms	15 Hours
	Mechanisms of substitution reactions of tetrahedral, square planar, trigonal bipyramidal, square pyramidal and octahedral complexes. Potential energy diagrams, transition states and intermediates, isotope effects, Berry's pseudo rotation mechanism, factors affecting the reactivity of square planar complexes, Swain-Scott equation, Trans effect and its application to synthesis of complexes.	
UNIT-III	Chemical Bonding :	15 Marks
	LCAO-MO theory, Metallic bonding, band theory, hydrogen bonding, VSEPR model. Bonding in alloys, intermetallic compounds. Bonding in non-transition element compounds.	



REFERENCE BOOKS:

1. Cotton F A and Wilkinson G : Advanced inorganic chemistry, 5th Ed, J. Wiley & sons, New York (1988).
2. Concept and Models of Inorganic Chemistry, Bodie Douglas, Darl McDaniel, John Alexander 3. Chandra A K : Introductory Quantum Chemistry, 3rd Ed Tata Magrow Hill, New Delhi (1988).
4. Basolo F and Pearson R G : Mechanism of Inorganic Reactions, 2nd Ed, J. Wiley & Sons, New York (1988).
5. Chandra M : Atomic structure and Chemical Bonding (including molecular spectroscopy), 3rd Ed, Tata Magrow Hill, New Delhi (1991).
6. Chatwal & Anand : Quantum Mechanics, Himalaya Publishing House. Katakis, D. & Gordon, G. Mechanism of Inorganic Reactions John Wiley & Sons: N. Y (1987).
7. Tobe, M. in Inorganic Reaction Mechanisms F. C. Wadington, Ed., Thomas Nelson: London (1973).
8. Inorganic Chemistry, J.E. Huhey, Harpes & Row.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: INORGANIC CHEMISTRY-PRACTICAL
PAPER CODE NO: MIN CHE-708P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks: 30

Course Outcomes (COs):

On completion of this course, the students will be able to perform/do independently:

- Practical skills in the field of Inorganic chemistry.
- The course will provide ability to student to separation and identify of negative and positive radicals.
- Improve knowledge about separation of Inorganic Qualitative Analysis of radicals..

➤ **Inorganic Chemistry:**

Qualitative Analysis: Six radicals' separation with one less common ion

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.

UNIVERSITY PRACTICAL EXAM PATTERN

There will be a Three Exercise in each practical, as under, total of **15 Marks**.

(1) Practical exercise (10 marks) (2) Viva (3 marks) (3) Practical Journal (2 marks)

Duration of Exam: 2 Hrs.

Examiner will submit marks out of 15 to university.

Passing standard: 6 Marks out of 15 Marks.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: Applied Chemistry/OJT
PAPER CODE NO: MAJ CHE-709

***Note: Here OJT full paper Include Applied Chemistry theory, practical and Skill based practical are continuing evaluated with same code and shall be counted Six credits.**

Course Outcomes (COs):		
Upon successful completion of these papers, students will learn about the 12 principles of Green Chemistry and sustainable chemical pathways, the basic mechanics and molecular weight distribution of Polymer Chemistry, and structural analysis via Electron Spin Resonance and Mössbauer Spectroscopy. This study will be helpful in further study, competitive exams, and chemical industries.		
UNIT-I	Green Chemistry	15 Hours
	Definition, need, and goals of green chemistry. Detailed study of the 12 principles of Green Chemistry with real-world chemical examples. Concept of Atom Economy, mathematical derivation and calculation of percentage atom economy, E-factor, and environmental quotient. Limitations of volatile organic solvents and their alternatives - Supercritical fluids, ionic liquids, and aqueous-phase reactions. Principles of biocatalysis and phase-transfer catalysis. Basics of Microwave-assisted synthesis (principles, open and closed vessels, reactions in water/solvent-free) and Ultrasound-assisted (sonochemical) synthesis. Green vs. traditional synthesis of Ibuprofen, Adipic Acid, and Catechol.	
UNIT-II	Polymer Chemistry	15 Hours
	Definitions of monomer, polymer, copolymer, degree of polymerization, functionality, and tactical arrangements (Isotactic, Syndiotactic, Atactic). Mechanics of Addition polymerization (Free-radical, Cationic, and Anionic mechanisms) and Condensation (Step-growth) polymerization. Concept of average molecular weight: Number average and Weight average molecular weights. Polydispersity Index (PDI) and its significance. Glass Transition Temperature—definition, measurement, and factors affecting. Synthesis, properties, and applications of Polyethylene (HDPE/LDPE), Polyvinyl Chloride (PVC), Polystyrene, Nylon-6,6, and Polyethylene Terephthalate (PET). Environmental impacts of plastics; synthesis and applications of biodegradable polymers like Poly Lactic Acid (PLA) and Polyhydroxyalkanoates (PHAs/PHBV).	
UNIT-III	Matter, Surfaces & Nano materials	15 Hours
	Introduction to Nano materials: Properties of matter at Nano scale, synthesis methods (Top-down and Bottom-up approaches), green synthesis of nanoparticles using plant extracts or microbes.	

	Surface Characterization Tools: Elementary ideas, working principles, and applications of X-ray Diffraction (XRD) for crystal structures, and Scanning Electron Microscopy (SEM) for surface morphology. Thermal Analysis: Thermo gravimetric Analysis (TGA) — Principle, instrumentation, and reading a thermal degradation curve for polymers or complexes.	
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REFERENCE BOOKS:

1. Green Chemistry: Environmental Friendly Alternatives – Rashmi Sanghi and M.M. Srivastava. (Narosa Publishing House)
2. Green Chemistry: Theory and Practice – Paul T. Anastas and John C. Warner. (Oxford University Press)
3. Polymer Science – V.R. Gowariker, N.V. Viswanathan, and Jayadev Sreedhar. (New Age International Publishers)
4. Textbook of Polymer Science – Fred W. Billmeyer. (Wiley India Pvt. Ltd.)
5. Physical Methods for Chemists – Russell S. Drago. (Saunders College Publishing)
6. Inorganic Chemistry: Principles of Structure and Reactivity – James E. Huheey, Ellen A. Keiter, and Richard L. Keiter. (Pearson Education)



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: Applied Chemistry PRACTICAL
PAPER CODE NO: MAJ CHE-710P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- Synthesize organic targets using solvent-free or aqueous eco-friendly alternative laboratory configurations
 - Perform solution-based synthesis of resins and measure physical properties like molecular weight profiles of polymers using viscometric workflows.
 - Extract and evaluate natural biopolymers safely from readily available biological matrices.
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1. Preparation of Azomethine / Schiff base by mortar-pestle grinding technique using p-toluidine and o-vanillin.
 2. Acetylation of primary amine (aniline or p-toluidine) using zinc dust/acetic acid in an eco-friendly aqueous medium.
 3. Co-friendly bromination of Acetanilide using potassium bromide and potassium bromate instead of liquid molecular bromine.
 4. Laboratory preparation of Urea-Formaldehyde resin or Phenol-Formaldehyde (Bakelite) plastic matrix.
 5. Determination of the molecular weight of Polyvinyl Alcohol (PVA) or Methyl Cellulose using an Ostwald viscometer.
 6. Interpretation of provided data sheets/graphs of XRD, SEM spectra for a given material.
 7. Preparation of Silver or Zinc nanoparticles using a completely green biological route (leaf extract or microbial culture supernatant etc. or any other).

➤ **JOURNAL**

➤ **VIVA**

UNIVERSITY PRACTICAL EXAM PATTERN

There will be a Three Exercise in each practical, as under, total of **15 Marks**.

(1) Practical exercise (10 marks) (2) Viva (3 marks) (3) Practical Journal (2 marks)

Duration of Exam: 2 Hrs.

Examiner will submit marks out of 15 to university.

Passing standard: 6 Marks out of 15 Marks.



KACHCHH UNIVERSITY: BHUJ
THIRD YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY

PAPER NAME: SKILL BASED PRACTICAL

PAPER CODE NO: SEC CHE-711P

Marks: External Evaluation: 25, Internal Evaluation: 25. Total Marks 50

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- Understand and Practical Application Knowledge about Chemical Drawing software, Use MS Excel.
- Also know about Web & Tools for Literature Search.
- How to do Citation & Referencing.

➤ **Cheminformatics tools:**

1. Chemical Drawing

- Drawing chemical reaction, Structure drawing using templates, Structure to name and name to structure.
- Drawing mechanism of reaction, Diagram of Assembly, Chiral Structure.
- Reproducing reaction scheme from given research paper, structure annotation tools or chemistry drawing software.
- Use of MS Excel for plotting and statistical analysis.

2. Web & Tools for Literature Search

- Research Journals & publications.
- Citation & Referencing.

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the College Internal test. If a student does not Sign the certified journal at the exam, he/she will not be allowed for the exam.

UNIVERSITY PRACTICAL EXAM PATTERN FOR – SEC CHE-711P

There will be a Three Exercise in practical, as under, Total of **25 Marks**.

(1) Exercise- (20 marks) (2) Viva (3 marks) (3) Practical Journal (2 marks)

Duration of Exam: 2 Hrs.

Passing standard: 10 Marks out of 25 Marks.



-OR-



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VII (SEVEN)
CHEMISTRY
PAPER NAME: OJT IN MAJOR SPECIFIC COURSE
PAPER CODE NO: OJT CHE-709
Credit: 6

Title	Credit
ON THE JOB TRAINING	Total credit: 06

The credit weightage for Internship/Apprenticeship/OJT is suggested to be 30 hrs. per credit if they have only practical exposure or lab-based activities. Accordingly, the students must dedicate the required number of hours for the same. The guidelines offer scope for providing hands-on learning with classroom experience. In case of field visit or experiential learning, 1 credit is equivalent to 40-45 Hours.

Both HEIs & Industries can decide mutually for the duration of classroom lecture and industry visit.

Credit allocation:

		For earning 6 credit
Lab based activities or practical exposure	30hrs/ credit	180 hrs for paper
Field visit or experimental learning	40-45 hrs/credit	240-270 hrs per paper
Please refer 3.4.2 & 3.4.3 of SOP page no. 71		

Evaluation:

- **Marking system will be 60% and 40% for Supervisor and faculty respectively. 60% of the marking should be given by the external supervisor while 40% internal assessment will be based on viva and report submission.**
- **Report** of the training will be must for proper documentation.
- **Certificate** from SKP will be required on successful completion.

General Rules:

- The Internship or skill earning can be from any organization/industry/Govt. body/NGO/any other institute/ SKP (Skill Knowledge Provider) etc.
- For Industry or other institute internship please refer 3.4.3 of SoP.
- The concerned can issue a certificate or letter for work completion after successful completion of OJT activities by students.



Dr. Jyotindra J. Bhatt
Chairman
BOS (Chemistry)

Krantiguru Shyamji Krishna Verma

Kachchh University

Mundra Road

BHUI: 370 001



SYLLABUS (NEP)

B. Sc. (Honours) Semester VIII: (EIGHT)

CHEMISTRY

(With Research)

**Curriculum as per UGC Guideline
Framed according to National Education Policy (NEP)-2020**

With effect from June-2026 (and thereafter)

**Credit Framework and course code for Fourth Year (SEM-VIII) B.Sc. (Honours)
Chemistry Programme. (With Research)**

Year	Semester	Course Code	Paper Title	Credits	Marks		Total
					CA	UA	
Fourth Year	VIII	MAJ CHE-801 (Theory)	Organic Chemistry	3	35	35	70
		MAJ CHE-802P (Practical)	Organic Chemistry - PRACTICAL	1	15	15	30
		MAJ CHE-803 (Theory)	Advanced Analytical Chemistry	3	35	35	70
		MAJ CHE-804P (Practical)	Advanced Analytical Chemistry - PRACTICAL	1	15	15	30
		MAJ CHE-805 (Theory)	Physical Chemistry	3	35	35	70
		MAJ CHE-806P (Practical)	Physical Chemistry - PRACTICAL	1	15	15	30
		Total Credits (Major)		12			300
		MIN CHE-807 (Theory)	Topics in Modern Inorganic Chemistry	3	35	35	70
		MIN CHE-808P (Practical)	Topics in Modern Inorganic Chemistry PRACTICAL	1	15	15	30
		Total Credits (Minor)		4			100
		RP CHE-809	Research Project /Dissertation	6			
		Total Credits RP		6			150
		Total Credits		22			550



Structure of the Question Paper (Theory) for the University Exam

KACHCHH UNIVERSITY: BHUJ

FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY

PAPER NAME: Organic/ Advanced Analytical/Physical/ Topics in Modern
Inorganic Chemistry/RP

PAPER CODE NO: MAJ CHE-801/803/805, MIN CHE-807

Total Marks: 40, Passing standard: 16 Marks [Time: 90 minutes]

*RP/Dissertation Paper of 6 credit evaluate separately.

PATTERN OF QUESTION PAPER

FOR SEMESTER-END EXAMS

Questions	Section	Marks
Question-1 (Unit-I)	(Descriptive - Essay type - Short notes <i>with internal option</i>)	10 marks
Question-2 (Unit-II)	--do--	10 marks
Question-3 (Unit-III)	--do--	10 marks
Question - 4 (Unit-I, II & III)	Total 06 short questions of 1 mark, each unit will have 2 questions. students will attempt any 05 out of 06	05 Marks

- *Question 4 may include one-line answers/ two-line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures/ fill in the blanks/ multiple choice question/ one word answer/ match the pairs/Chemical reaction etc.*
- *RP/dissertation/practical work or other activity (Given by teacher or as a part of Syllabus) will be mandatory for all the students.*
- *The language of the question papers shall be English.*



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: ORGANIC CHEMISTRY
PAPER CODE NO: MAJ CHE-801

Course Outcomes (COs):

Upon successful completion of these papers' students will learn about concepts of Organic Chemistry, like Rearrangement Reactions, Organic Photochemistry, Methods in Organic Synthesis, Pericyclic Reactions. This study will be helpful in further study, competitive exams and industries.

UNIT-I	(A) Rearrangement Reactions:	15 Hours
	Formation and stability of carbonium ions, carbanion, carbenes, nitrenes, radicals and arynes. Rearrangement involving carbonation (Wagner-Meerwein, Pinacol-Pinacolone rearrangement), reaction involving acyl cation, PPA cyclization and Fries rearrangement, rearrangement of carbenes (Wolff & Arndt-Eistert synthesis), rearrangement of nitrenes (Hoffman, Curtius, Schmidt, Lossen, Beckman rearrangement).	8 Hours
	(B) Organic Photochemistry:	
	Introduction to photochemical reactions, cis-trans isomerisation, Paterno-Buchi reaction, Norrish type I & II reaction, photoreduction of Ketones, dipimethane rearrangement, photochemistry of arenes, Barton reaction.	7 Hours
UNIT-II	Methods in Organic Synthesis	15 Hours
	Organosilicon Compounds: Preparation and applications in organic synthesis; Applications of Pd(0) and Pd(II) complexes in organic synthesis- Stille, Suzuki and Sonogashira coupling, Heck reaction and Negishi Coupling, Preparation and applications of lithium organocuprates.	
UNIT-III	Pericyclic Reactions:	15 Hours
	Main features of pericyclic reactions; Woodward-Hoffman rules, correlation diagram and FMO approaches; Electrocyclic reactions – conrotatory and disrotatory motions for $4n$ and $4n+2$ systems; Cycloadditions – antarafacial and suprafacial additions, $[2+2]$ and $[4+2]$ reactions (hv and Δ), 1,3- dipolar cycloadditions and chelotropic reactions; Sigmatropic $[i,j]$ shifts of C-H and C-C bonds; Sommelet-Hauser, Claisen, thio-Claisen, Cope and aza-Cope rearrangements.	



REFERENCE BOOKS:

1. Finar I L : Organic Chemistry, Vol 1 (The Fundamental Principles) 6th Ed Longman (1973).
2. Finar I L : Organic Chemistry, Vol 2 (Stereochemistry and chemistry of Natural Products) 6th Ed Longman (1973).
3. March Jerry : Advanced Organic Chemistry, 4th Ed, Wiley Eastern Ltd., New Delhi (1985).
4. V K Ahluwalia, R K Parasar : Organic Reaction Mechanism, 2nd Ed.
5. P S Kalsi : Stereochemistry of Organic Compounds.
6. S M Mukherjee : Pericyclic Reactions.
7. J Coxon and B Halton : Introduction to Photochemistry.
8. Carey, F.A. & Sundberg, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).
9. Carruthers, W. Modern Methods of Organic Synthesis Cambridge University Press (1971).



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY

PAPER NAME: ORGANIC CHEMISTRY PRACTICAL

PAPER CODE NO: MAJ CHE-802P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- Determine the given organic mixture based on the qualitative analysis.
- Practical skills in the field and laboratory experiments in qualitative analysis.
- The course will provide ability to students to analyze any organic mixture analysis.

➤ **Organic spotting two component mixture separation.**

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: ADVANCED ANALYTICAL CHEMISTRY
PAPER CODE NO: MAJ CHE-803

Course Outcomes (COs):		
Upon successful completion of these papers, students will learn about concepts of Analytical Chemistry, instrumental analytical methods, Fluorimetry and Phosphorimetry, drug dissolution, principle and instrumentation of thermal methods (DSC, TGA, DTA). This study will be helpful in further study, competitive exam and industries.		
UNIT-I	Fluorimetry and Phosphorimetry:	15 Hours
	Definition of Luminescence, fluorescence, phosphorescence, Principle, origin of fluorescence and phosphorescence spectra, Jablonski diagram showing electronic transitions, variables affecting fluorescence and phosphorescence spectra, instrumentation, relationship between fluorescence intensity and concentration of sample, Comparison between fluorimeter and phosphorimeter, Comparison between Spectrophotometer and phosphorimeter, and applications.	
UNIT-II	Dissolution study of Pharmaceutical Drugs	15 Hours
	Introduction of Formulation analytical development laboratory, Classification of pharmaceutical dosage forms, Introduction of drug dissolution study, terminology: Drug dissolution, rate of drug dissolution, Diffusion, Dialysis, Ultra Centrifugation, osmosis, polymorphism, Generic drugs, Placebo, Stages in the dissolution testing process, USP Dissolution Apparatus classification and instrumentation, sampling, Conditions Affected Drug Dissolution and Release, physicochemical properties related to drug dissolution study, Advantages and disadvantages of dissolution apparatus and Applications, Force degradation study of pharmaceutical dosage forms.	
UNIT-III	Thermal Methods	15 Hours
	Basic terminology: Thermal analysis, Glass transition temperature, melting, specific heat capacity, enthalpy, Cold crystallization, Introduction, Principle, theory, instrumentation and applications of thermogravimetry (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC), variable affecting thermal analysis.	



REFERENCE BOOKS :

1. Skoog D A, West D M : Fundamentals of Analytical Chemistry, Thomson Asia Pvt Ltd. 8th Ed, (2004).
2. Bartt L et al : Vogel's Textbook of Quantitative Inorganic Analysis, ELBS 6th Ed.
3. Sharma B K : Instrumental methods of Chemical Analysis, Goel Publishing House.
4. Mahindru S N : Food Analysis, Swan Publishing House, 23rd Ed.
5. Khopkar S M: Basics concepts of Analytical Chemistry, Wiley Eastern
6. Physical Methods in Chemistry, R.S. Drago, Saunders College.
7. Modern Spectroscopy, J.M. Hollas, John Wiley.
8. Instrumental Methods of Analysis, H.H. Willard, East West Press.
9. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 4th Edition;
David Bruns, Edward Ashwood , Carl Burtis



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: ADVANCED ANALYTICAL CHEMISTRY PRACTICAL
PAPER CODE NO: MAJ CHE-804P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- The course will provide the ability to study Pharmaceutical Analysis.
- To gain knowledge about drug solubility, dosage form assay study, content uniformity study, impurity study.

➤ **Pharmaceuticals Analysis (Pharmaceutical drug and dosage form analysis):**

1. Pharmaceutical drug solubility study
2. Pharmaceutical dosage form assay study
3. Pharmaceutical dosage form content uniformity study
4. Pharmaceutical dosage form impurity study

➤ **Three short questions related to practical's only**

➤ **JOURNAL**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: PHYSICAL CHEMISTRY
PAPER CODE NO: MAJ CHE-805

Course Outcomes (COs):		
Upon successful completion of these papers' students will learn about concepts of Physical Chemistry, like statistical thermodynamics, chemical thermodynamics, surface chemistry. This study will be helpful in further study, competitive exam and industries.		
UNIT-I	STATISTICAL THERMODYNAMICS	15 Hours
	Thermodynamics probability and entropy, ensembles, distribution laws of Maxwell–Boltzmann (MB), Bose–Einstein (BE) and Fermi–Dirac (FD), partition functions, translational, rotational, vibrational and electronic partition functions for diatomic molecules, calculation of thermodynamic functions in terms of partition function internal energy, heat capacity, entropy, work function, pressure, heat content, free energy, third law of thermodynamics and equilibrium constants, numerical.	
UNIT-II	CHEMICAL THERMODYNAMICS	15 Hours
	Nernst heat theorem and its applications to gaseous system, Third law of thermodynamics and its applications to evaluate absolute entropies of solids, liquids and gases and for calculations of free energy changes and equilibrium constants of reactions, Chemical affinity and its applications, methods for determining the chemical affinity of a reaction- Gibbs Helmholtz equation, E.M.F. Method, Van't Hoff equation, Vapour pressure method, Partial molar quantities and their determination by direct method, apparent molar properties, method of intercepts, Chemical potential and its physical significance, variation of chemical potential with temperature and pressure, chemical potential of ideal gases and solutions.	
UNIT-III	SURFACE CHEMISTRY	15 Hours
	Adsorption, Multilayer Adsorption, the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation. Derivation of Langmuir equation from BET equation. Explanation of different adsorption isotherms, Adsorption at the surface of liquid: Gibbs' adsorption isotherms (derivation). Insoluble surface films on liquid, Micelles : Surface active agents, classification of surface active agents, micellization, critical micelle concentration (CMC), Determination of critical micelle concentration, factors affecting the CMC, thermodynamics of micellization Numerical.	

REFERENCE BOOKS

1. An Introduction to Chemical Thermodynamics, R. P. Rastogi and P. R. Misra, (Vikas Publishing House Pvt.Ltd.
2. Fundamentals of Chemical Thermodynamics, M. L. Lakhanpal, Tata McGraw-Hill Publishing Company, New Delhi.
3. Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith, Oxford University Press, 6th Edition.
4. Physical Chemistry, Ira N Levine Tata McGraw-Hill Publishing Company, New Delhi, Fifth Edition.
5. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, and M. S. Pathania, Vishal Publishing Co., Delhi.
6. Advanced physical chemistry, Gurdeep Raj 35th revised edition, Goel publishing house.
7. Advanced physical chemistry by J.N.Gurtu, A.Gurtu, 11th edition, Pragati prakashan.
8. Statistical thermodynamics by M.C.Gupta, revised 2nd edition, New Age International publishers
9. Thermodynamics, statistical thermodynamics and kinetics by T.Engle and P.Reid, Pearson India.
10. Physical Chemistry of Surfaces by A. W. Adamson, A. P. Gast 6th Edition. Wiley-Interscience.
11. Surface Chemistry, Theory and Industrial Applications by L. I. Osipow, New York, Reinhold Pub. Corp.
12. Surfactants and Interfacial Phenomena, Milton J. Rosen, (Willey Interscience, Third Edition)



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: PHYSICAL CHEMISTRY PRACTICAL
PAPER CODE NO: MAJ CHE-806P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- The course will provide ability to study Lambert-Beer law.
- student will have basic knowledge of viscosity and can determine molecular weight of polymer
- Practical skills in the field and laboratory experiments in physical chemistry

➤ **PHYSICO CHEMICAL EXERCISE (ANY SIX)**

One exercise be given from the following to the candidate at the examination

- **pH metry**

1. To determine the concentration and dissociation constants of a given dibasic acid.
2. To determine the dissociation constant of acetic acid. (buffer method)
3. To determine the concentration of oxalic acid and acetic acid in the given mixture.
4. To determine the concentration of a given phosphoric acid solution and its dissociation constants.

- **Spectrophotometry**

1. To examine Lambert-Beer law in concentrated solutions.
2. To study the rate of iodination by spectrophotometrically.
3. To determine the composition of a binary mixture containing potassium permanganate and potassium dichromate.

- **Polarimetry**

1. To determine the concentration of an unknown solution of optically active compounds
2. To determine the specific and molecular rotation of optically active compound and hence intrinsic rotation
3. To determine the rate constant for inversion of cane sugar

- **Viscosity**

1. To find the relative and absolute viscosity of the given liquid at the room temperature.
2. To find the concentration of the given mixture, consisting of two liquids A and B by viscosity measurements.
3. To calculate the molecular weight of a high polymer by means of viscosity measurements.



➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: Topics in Modern Inorganic Chemistry
PAPER CODE NO: MIN CHE-807

Course Outcomes (COs):		
Upon successful completion of these papers, students will learn about the foundational theories of Nuclear Chemistry, the structures and synthetic catalytic cycles of Organometallic Compounds, and advanced inorganic characterization tools via Electron Spin Resonance and Mössbauer Spectroscopy. This study will be highly beneficial for further study, competitive exams, and industrial applications.		
UNIT-I	Nuclear Chemistry	15 Hours
	Liquid drop model, nuclear shell model, magic numbers, nuclear stability, N/Z ratio, mass defect, and packing fraction. Natural and artificial radioactivity, radioactive decay kinetics (half-life, average life), radioactive equilibrium (transient and secular). Bethe's notation, types of nuclear reactions (stripping, pickup, spallation, fission, and fusion). Nuclear reactors, Q-value, and cross-section of nuclear reactions. Radiocarbon dating and use of radioisotopes as tracers in medicine, agriculture, and reaction mechanisms.	
UNIT-II	Organometallic Compounds	15 Hours
	Definition, classification, and nomenclature of organometallic compounds. The 18-electron rule (Effective Atomic Number - EAN) and its exceptions in transition metal complexes. Synthesis, structure, and bonding (synergic effect) in mononuclear and polynuclear metal carbonyls. Vibrational spectra (IR) as a tool for structural elucidation. Metal nitrosyls and structural types (linear vs. bent). Synthesis, properties, structure, and bonding in Ferrocene (MO diagram approach). Transition metal-alkyl, -alkene, and -alkyne complexes. Homogeneous catalysis mechanisms—Oxidative addition, reductive elimination, migratory insertion. Industrial applications: Wilkinson's catalyst (hydrogenation), Hydroformylation (Oxo process), and Ziegler-Natta polymerization.	
UNIT-III	Electron Spin Resonance Spectroscopy and Moss Bauer Spectroscopy	15 Hours
	<i>Electron Spin Resonance (ESR):</i> Introduction and technique of ESR, interaction between nuclear spin and electron spin: hyperfine splitting, Zeeman levels, ESR spectrum when one electron is influenced by a single proton and one electron delocalized over two equivalent protons, difference between ESR and NMR. <i>Mössbauer (MB) Spectroscopy:</i> Introduction of Moss Bauer effect, Isomer shift, Magnetic hyperfine interactions, Applications of the technique to the studies of: bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, Sn^{2+} and Sn^{4+}	



	compounds – nature of M-L bond, co-ordination number, structure and detection of oxidation state and in equivalent MB atoms.	
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REFERENCE BOOKS:

1. Inorganic Chemistry: Principles of Structure and Reactivity – James E. Huheey, Ellen A. Keiter, and Richard L. Keiter. (Pearson Education)
2. Physical Methods for Chemists – Russell S. Drago. (Affiliated East West Press Pvt. Ltd.)
3. Structural Methods in Inorganic Chemistry – E.A.V. Ebsworth, David W.H. Rankin, and Stephen Cradock. (Blackwell Scientific Publications)
4. Organometallic Chemistry – R.C. Mehrotra and A. Singh. (New Age International Publishers)
5. Essentials of Nuclear Chemistry – H.J. Arnikaar. (New Age International Publishers)
6. Selected Topics in Inorganic Chemistry – Wahid U. Malik, G.D. Tuli, and R.D. Madan (S. Chand Publishing).
7. Instrumental Methods of Chemical Analysis – G.R. Chatwal and S.K. Anand (Himalaya Publishing House).



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: Topics in Modern Inorganic Chemistry
PRACTICAL
PAPER CODE NO: MIN CHE-808P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

Upon successful completion of this practical course, students will be able to:

- Demonstrate proficiency in advanced synthetic laboratory techniques, including crystallization, filtration, washing, and drying of coordination compounds.
- Apply stoichiometric principles to calculate the theoretical and percentage yields of prepared inorganic complexes.
- Understand the chemistry behind ligand substitution, oxidation-reduction, and stabilization of unusual oxidation states in transition metal complexes.
- Analyze and characterize the synthesized complexes using classical methods.

➤ **Preparation of Metal Complexes (at least six).**

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.

UNIVERSITY PRACTICAL EXAM PATTERN

There will be a Three Exercise in each practical, as under, total of **15 Marks**.

(1) Practical exercise (10 marks) (2) Viva (3 marks) (3) Practical Journal (2 marks)

Duration of Exam: 2 Hrs.

Examiner will submit marks out of 15 to university.

Passing standard: 6 Marks out of 15 Marks.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: Research Project /Dissertation
PAPER CODE NO: RP CHE-809
Credit: 6

Title	Credit
Research Project /Dissertation	Total credit: 06

*Please refer 3.5 of SOP page no. 74



Dr. Jyotindra J. Bhatt
Chairman
BOS (Chemistry)



DEAN
FACULTY OF SCIENCE
KSKV KACHCHH UNIVERSITY
BHUJ-KACHCHH-370001



Krantiguru Shyamji Krishna Verma

Kachchh University

Mundra Road

BHUI: 370 001



SYLLABUS (NEP)

B. Sc. (Honours) Semester VIII: (EIGHT)

CHEMISTRY

(Without Research)

**Curriculum as per UGC Guideline
Framed according to National Education Policy (NEP)-2020**

With effect from June-2026 (and thereafter)



**Credit Framework and course code for Fourth Year (SEM-VIII) B.Sc. (Honours)
Chemistry Programme. (Without Research)**

Year	Semester	Course Code	Paper Title	Credits	Marks		Total
					CA	UA	
Fourth Year	VIII	MAJ CHE-801 (Theory)	Organic Chemistry	3	35	35	70
		MAJ CHE-802P (Practical)	Organic Chemistry - PRACTICAL	1	15	15	30
		MAJ CHE-803 (Theory)	Advanced Analytical Chemistry	3	35	35	70
		MAJ CHE-804P (Practical)	Advanced Analytical Chemistry - PRACTICAL	1	15	15	30
		MAJ CHE-805 (Theory)	Physical Chemistry	3	35	35	70
		MAJ CHE-806P (Practical)	Physical Chemistry - PRACTICAL	1	15	15	30
		Total Credits (Major)		12			300
		MIN CHE-807 (Theory)	Topics in Modern Inorganic Chemistry	3	35	35	70
		MIN CHE-808P (Practical)	Topics in Modern Inorganic Chemistry PRACTICAL	1	15	15	30
		Total Credits (Minor)		4			100
		OJT	On the job training / Field Training/ Lab based activities or practical exposure	6	60	90	150
		Total Credits OJT		6			150
		Total Credits		22			550



Structure of the Question Paper (Theory) for the University Exam

KACHCHH UNIVERSITY: BHUJ

**FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY**

**PAPER NAME: Organic/ Advanced Analytical/Physical/ Topics in Modern
Inorganic Chemistry**

PAPER CODE NO: MAJ CHE-801/803/805, MIN CHE-807

Total Marks: 40, Passing standard: 16 Marks

***OJT Paper of 6 credit evaluate separately.**

PATTERN OF QUESTION PAPER

FOR SEMESTER-END EXAMS

Questions	Section	Marks
Question-1 (Unit-I)	(Descriptive - Essay type - Short notes <i>with internal option</i>)	10 marks
Question-2 (Unit-II)	--do--	10 marks
Question-3 (Unit-III)	--do--	10 marks
Question – 4 (Unit-I, II & III)	Total 06 short questions of 1 mark, each unit will have 2 questions. students will attempt any 05 out of 06	05 Marks

- *Question 4 may include one-line answers/ two-line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures/ fill in the blanks/ multiple choice question/ one word answer/ match the pairs/Chemical reaction etc.*
- *OJT/Practical work or other activity (Given by teacher or as a part of Syllabus) will be mandatory for all the students.*
- *The language of the question papers shall be English.*



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: ORGANIC CHEMISTRY
PAPER CODE NO: MAJ CHE-801

Course Outcomes (COs):		
Upon successful completion of these papers' students will learn about concepts of Organic Chemistry, like Rearrangement Reactions, Organic Photochemistry, Methods in Organic Synthesis, Pericyclic Reactions. This study will be helpful in further study, competitive exams and industries.		
UNIT-I	(A) Rearrangement Reactions:	15 Hours
	Formation and stability of carbonium ions, carbanion, carbenes, nitrenes, radicals and arynes. Rearrangement involving carbonation (Wagner-Meerwein, Pinacol-Pinacolone rearrangement), reaction involving acyl cation, PPA cyclization and Fries rearrangement, rearrangement of carbenes (Wolff & Arndt-Eistert synthesis), rearrangement of nitrenes (Hoffman, Curtius, Schmidt, Lossen, Beckman rearrangement).	8 Hours
	(B) Organic Photochemistry:	
	Introduction to photochemical reactions, cis-trans isomerisation, Paterno-Buchi reaction, Norrish type I & II reaction, photoreduction of Ketones, dipimethane rearrangement, photochemistry of arenes, Barton reaction.	7 Hours
UNIT-II	Methods in Organic Synthesis	15 Hours
	Organosilicon Compounds: Preparation and applications in organic synthesis; Applications of Pd(0) and Pd(II) complexes in organic synthesis- Stille, Suzuki and Sonogashira coupling, Heck reaction and Negishi Coupling, Preparation and applications of lithium organocuprates.	
UNIT-III	Pericyclic Reactions:	15 Hours
	Main features of pericyclic reactions; Woodward-Hoffman rules, correlation diagram and FMO approaches; Electrocyclic reactions – conrotatory and disrotatory motions for $4n$ and $4n+2$ systems; Cycloadditions – antarafacial and suprafacial additions, $[2+2]$ and $[4+2]$ reactions (hv and Δ), 1,3- dipolar cycloadditions and chelotropic reactions; Sigmatropic $[i,j]$ shifts of C-H and C-C bonds; Sommelet-Hauser, Claisen, thio-Claisen, Cope and aza-Cope rearrangements.	



REFERENCE BOOKS:

1. Finar I L : Organic Chemistry, Vol 1 (The Fundamental Principles) 6th Ed Longman (1973).
2. Finar I L : Organic Chemistry, Vol 2 (Stereochemistry and chemistry of Natural Products) 6th Ed Longman (1973).
3. March Jerry : Advanced Organic Chemistry, 4th Ed, Wiley Eastern Ltd., New Delhi (1985).
4. V K Ahluwalia, R K Parasar : Organic Reaction Mechanism, 2nd Ed.
5. P S Kalsi : Stereochemistry of Organic Compounds.
6. S M Mukherjee : Pericyclic Reactions.
7. J Coxon and B Halton : Introduction to Photochemistry.
8. Carey, F.A. & Sundberg, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).
9. Carruthers, W. Modern Methods of Organic Synthesis Cambridge University Press (1971).



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: ORGANIC CHEMISTRY PRACTICAL
PAPER CODE NO: MAJ CHE-802P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- Determine the given organic mixture based on the qualitative analysis.
- Practical skills in the field and laboratory experiments in qualitative analysis.
- The course will provide ability to students to analyze any organic mixture analysis.

➤ **Organic spotting two component mixture separation.**

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: ADVANCED ANALYTICAL CHEMISTRY
PAPER CODE NO: MAJ CHE-803

Course Outcomes (COs):		
Upon successful completion of these papers, students will learn about concepts of Analytical Chemistry, instrumental analytical methods, Fluorimetry and Phosphorimetry, drug dissolution, principle and instrumentation of thermal methods (DSC, TGA, DTA). This study will be helpful in further study, competitive exam and industries.		
UNIT-I	Fluorimetry and Phosphorimetry:	15 Hours
	Definition of Luminescence, fluorescence, phosphorescence, Principle, origin of fluorescence and phosphorescence spectra, Jablonski diagram showing electronic transitions, variables affecting fluorescence and phosphorescence spectra, instrumentation, relationship between fluorescence intensity and concentration of sample, Comparison between fluorimeter and phosphorimeter, Comparison between Spectrophotometer and phosphorimeter, and applications.	
UNIT-II	Dissolution study of Pharmaceutical Drugs	15 Hours
	Introduction of Formulation analytical development laboratory, Classification of pharmaceutical dosage forms, Introduction of drug dissolution study, terminology: Drug dissolution, rate of drug dissolution, Diffusion, Dialysis, Ultra Centrifugation, osmosis, polymorphism, Generic drugs, Placebo, Stages in the dissolution testing process, USP Dissolution Apparatus classification and instrumentation, sampling, Conditions Affected Drug Dissolution and Release, physicochemical properties related to drug dissolution study, Advantages and disadvantages of dissolution apparatus and Applications, Force degradation study of pharmaceutical dosage forms.	
UNIT-III	Thermal Methods	15 Hours
	Basic terminology: Thermal analysis, Glass transition temperature, melting, specific heat capacity, enthalpy, Cold crystallization, Introduction, Principle, theory, instrumentation and applications of thermogravimetry (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC), variable affecting thermal analysis.	



REFERENCE BOOKS :

1. Skoog D A, West D M : Fundamentals of Analytical Chemistry, Thomson Asia Pvt Ltd. 8th Ed, (2004).
2. Bartt L et al : Vogel's Textbook of Quantitative Inorganic Analysis, ELBS 6th Ed.
3. Sharma B K : Instrumental methods of Chemical Analysis, Goel Publishing House.
4. Mahindru S N : Food Analysis, Swan Publishing House, 23rd Ed.
5. Khopkar S M: Basics concepts of Analytical Chemistry, Wiley Eastern
6. Physical Methods in Chemistry, R.S. Drago, Saunders College.
7. Modern Spectroscopy, J.M. Hollas, John Wiley.
8. Instrumental Methods of Analysis, H.H. Willard, East West Press.
9. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 4th Edition; David Bruns, Edward Ashwood , Carl Burtis



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: ADVANCED ANALYTICAL CHEMISTRY PRACTICAL
PAPER CODE NO: MAJ CHE-804P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- The course will provide the ability to study Pharmaceutical Analysis.
- To gain knowledge about drug solubility, dosage form assay study, content uniformity study, impurity study.

➤ **Pharmaceuticals Analysis (Pharmaceutical drug and dosage form analysis):**

1. Pharmaceutical drug solubility study
2. Pharmaceutical dosage form assay study
3. Pharmaceutical dosage form content uniformity study
4. Pharmaceutical dosage form impurity study

➤ **Three short questions related to practical's only**

➤ **JOURNAL**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If a student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: PHYSICAL CHEMISTRY
PAPER CODE NO: MAJ CHE-805

Course Outcomes (COs):

Upon successful completion of these papers' students will learn about concepts of Physical Chemistry, like statistical thermodynamics, chemical thermodynamics, surface chemistry. This study will be helpful in further study, competitive exam and industries.

UNIT-I	STATISTICAL THERMODYNAMICS	15 Hours
	Thermodynamics probability and entropy, ensembles, distribution laws of Maxwell–Boltzmann (MB), Bose–Einstein (BE) and Fermi–Dirac (FD), partition functions, translational, rotational, vibrational and electronic partition functions for diatomic molecules, calculation of thermodynamic functions in terms of partition function internal energy, heat capacity, entropy, work function, pressure, heat content, free energy, third law of thermodynamics and equilibrium constants, numerical.	
UNIT-II	CHEMICAL THERMODYNAMICS	15 Hours
	Nernst heat theorem and its applications to gaseous system, Third law of thermodynamics and its applications to evaluate absolute entropies of solids, liquids and gases and for calculations of free energy changes and equilibrium constants of reactions, Chemical affinity and its applications, methods for determining the chemical affinity of a reaction- Gibbs Helmholtz equation, E.M.F. Method, Van't Hoff equation, Vapour pressure method, Partial molar quantities and their determination by direct method, apparent molar properties, method of intercepts, Chemical potential and its physical significance, variation of chemical potential with temperature and pressure, chemical potential of ideal gases and solutions.	
UNIT-III	SURFACE CHEMISTRY	15 Hours
	Adsorption, Multilayer Adsorption, the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation. Derivation of Langmuir equation from BET equation. Explanation of different adsorption isotherms, Adsorption at the surface of liquid: Gibbs' adsorption isotherms (derivation). Insoluble surface films on liquid, Micelles : Surface active agents, classification of surface active agents, micellization, critical micelle concentration (CMC), Determination of critical micelle concentration, factors affecting the CMC, thermodynamics of micellization Numerical.	



REFERENCE BOOKS

1. An Introduction to Chemical Thermodynamics, R. P. Rastogi and P. R. Misra, (Vikas Publishing House Pvt.Ltd.
2. Fundamentals of Chemical Thermodynamics, M. L. Lakhanpal, Tata McGraw-Hill Publishing Company, New Delhi.
3. Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith,Oxford University Press, 6th Edition.
4. Physical Chemistry, Ira N Levine Tata McGraw-Hill Publishing Company, New Delhi, Fifth Edition.
5. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, and M. S. Pathania, Vishal Publishing Co., Delhi.
6. Advanced physical chemistry, Gurdeep Raj 35th revised edition, Goel publishing house.
7. Advanced physical chemistry by J.N.Gurtu, A.Gurtu, 11th edition, Pragati prakashan.
8. Statistical thermodynamics by M.C.Gupta, revised 2nd edition, New Age International publishers
9. Thermodynamics,statistical thermodynamics and kinetics by T.Engle and P.Reid, Pearson India.
10. Physical Chemistry of Surfaces by A. W. Adamson, A. P. Gast 6th Edition. Wiley-Interscience.
11. Surface Chemistry, Theory and Industrial Applications by L. I. Osipow, New York, Reinhold Pub. Corp.
12. Surfactants and Interfacial Phenomena, Milton J. Rosen, (Willey Interscience, Third Edition)



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: PHYSICAL CHEMISTRY PRACTICAL
PAPER CODE NO: MAJ CHE-806P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

After the completion of the course, the students will be able to:

- The course will provide ability to study Lambert-Beer law.
- student will have basic knowledge of viscosity and can determine molecular weight of polymer
- Practical skills in the field and laboratory experiments in physical chemistry

➤ **PHYSICO CHEMICAL EXERCISE (ANY SIX)**

One exercise be given from the following to the candidate at the examination

● **pH metry**

1. To determine the concentration and dissociation constants of a given dibasic acid.
2. To determine the dissociation constant of acetic acid. (buffer method)
3. To determine the concentration of oxalic acid and acetic acid in the given mixture.
4. To determine the concentration of a given phosphoric acid solution and its dissociation constants.

● **Spectrophotometry**

1. To examine Lambert-Beer law in concentrated solutions.
2. To study the rate of iodination by spectrophotometrically.
3. To determine the composition of a binary mixture containing potassium permanganate and potassium dichromate.

● **Polarimetry**

1. To determine the concentration of an unknown solution of optically active compounds
2. To determine the specific and molecular rotation of optically active compound and hence intrinsic rotation
3. To determine the rate constant for inversion of cane sugar

● **Viscosity**

1. To find the relative and absolute viscosity of the given liquid at the room temperature.
2. To find the concentration of the given mixture, consisting of two liquids A and B by viscosity measurements.
3. To calculate the molecular weight of a high polymer by means of viscosity measurements.



➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: Topics in Modern Inorganic Chemistry
PAPER CODE NO: MIN CHE-807

Course Outcomes (COs):

Upon successful completion of these papers, students will learn about the foundational theories of Nuclear Chemistry, the structures and synthetic catalytic cycles of Organometallic Compounds, and advanced inorganic characterization tools via Electron Spin Resonance and Mössbauer Spectroscopy. This study will be highly beneficial for further study, competitive exams, and industrial applications.

UNIT-I	Nuclear Chemistry	15 Hours
	Liquid drop model, nuclear shell model, magic numbers, nuclear stability, N/Z ratio, mass defect, and packing fraction. Natural and artificial radioactivity, radioactive decay kinetics (half-life, average life), radioactive equilibrium (transient and secular). Bethe's notation, types of nuclear reactions (stripping, pickup, spallation, fission, and fusion). Nuclear reactors, Q-value, and cross-section of nuclear reactions. Radiocarbon dating and use of radioisotopes as tracers in medicine, agriculture, and reaction mechanisms.	
UNIT-II	Organometallic Compounds	15 Hours
	Definition, classification, and nomenclature of organometallic compounds. The 18-electron rule (Effective Atomic Number - EAN) and its exceptions in transition metal complexes. Synthesis, structure, and bonding (synergic effect) in mononuclear and polynuclear metal carbonyls. Vibrational spectra (IR) as a tool for structural elucidation. Metal nitrosyls and structural types (linear vs. bent). Synthesis, properties, structure, and bonding in Ferrocene (MO diagram approach). Transition metal-alkyl, -alkene, and -alkyne complexes. Homogeneous catalysis mechanisms—Oxidative addition, reductive elimination, migratory insertion. Industrial applications: Wilkinson's catalyst (hydrogenation), Hydroformylation (Oxo process), and Ziegler-Natta polymerization.	
UNIT-III	Electron Spin Resonance Spectroscopy and Moss Bauer Spectroscopy	15 Hours
	<i>Electron Spin Resonance (ESR):</i> Introduction and technique of ESR, interaction between nuclear spin and electron spin: hyperfine splitting, Zeeman levels, ESR spectrum when one electron is influenced by a single proton and one electron delocalized over two equivalent protons, difference between ESR and NMR.	



	<i>Mössbauer (MB) Spectroscopy:</i> Introduction of Moss Bauer effect, Isomer shift, Magnetic hyperfine interactions, Applications of the technique to the studies of: bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, Sn^{2+} and Sn^{4+} compounds – nature of M-L bond, co-ordination number, structure and detection of oxidation state and in equivalent MB atoms.	
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REFERENCE BOOKS:

1. Inorganic Chemistry: Principles of Structure and Reactivity – James E. Huheey, Ellen A. Keiter, and Richard L. Keiter. (Pearson Education)
2. Physical Methods for Chemists – Russell S. Drago. (Affiliated East West Press Pvt. Ltd.)
3. Structural Methods in Inorganic Chemistry – E.A.V. Ebsworth, David W.H. Rankin, and Stephen Cradock. (Blackwell Scientific Publications)
4. Organometallic Chemistry – R.C. Mehrotra and A. Singh. (New Age International Publishers)
5. Essentials of Nuclear Chemistry – H.J. Arnikaar. (New Age International Publishers)
6. Selected Topics in Inorganic Chemistry – Wahid U. Malik, G.D. Tuli, and R.D. Madan (S. Chand Publishing).
7. Instrumental Methods of Chemical Analysis – G.R. Chatwal and S.K. Anand (Himalaya Publishing House).



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: Topics in Modern Inorganic Chemistry
PRACTICAL
PAPER CODE NO: MIN CHE-808P

Marks: External Evaluation: 15, Internal Evaluation: 15. Total Marks 30

Course Outcomes (COs):

Upon successful completion of this practical course, students will be able to:

- Demonstrate proficiency in advanced synthetic laboratory techniques, including crystallization, filtration, washing, and drying of coordination compounds.
- Apply stoichiometric principles to calculate the theoretical and percentage yields of prepared inorganic complexes.
- Understand the chemistry behind ligand substitution, oxidation-reduction, and stabilization of unusual oxidation states in transition metal complexes.
- Analyze and characterize the synthesized complexes using classical methods.

➤ **Preparation of Metal Complexes (at least six).**

➤ **JOURNAL**

➤ **VIVA**

Note: Journals are to be signed regularly by the concerned teacher and finally certified before the Internal/External test. If student does not bring the certified journal at the exam, he/she will not be allowed for the exam.

Duration of Practical: 2 Hrs.

UNIVERSITY PRACTICAL EXAM PATTERN

There will be a Three Exercise in each practical, as under, total of **15 Marks**.

(1) Practical exercise (10 marks) (2) Viva (3 marks) (3) Practical Journal (2 marks)

Duration of Exam: 2 Hrs.

Examiner will submit marks out of 15 to university.

Passing standard: 6 Marks out of 15 Marks.



KACHCHH UNIVERSITY: BHUJ
FOURTH YEAR B.Sc.: NEP: SEMESTER: VIII (EIGHT)
CHEMISTRY
PAPER NAME: OJT IN MAJOR SPECIFIC COURSE
PAPER CODE NO: OJT CHE-809
Credit: 6

Title	Credit
ON THE JOB TRAINING	Total credit: 06

The credit weightage for Internship/Apprenticeship/OJT is suggested to be 30 hrs. per credit if they have only practical exposure or lab-based activities. Accordingly, the students must dedicate the required number of hours for the same. The guidelines offer scope for providing hands-on learning with classroom experience. In case of field visit or experiential learning, 1 credit is equivalent to 40-45 Hours.

Both HEIs & Industries can decide mutually for the duration of classroom lecture and industry visit.

Credit allocation:

		For earning 6 credit
Lab based activities or practical exposure	30hrs/ credit	180 hrs for paper
Field visit or experimental learning	40-45 hrs/credit	240-270 hrs per paper
Please refer 3.4.2 & 3.4.3 of SOP page no. 71		

Evaluation:

- **Marking system will be 60% and 40% for Supervisor and faculty respectively. 60% of the marking should be given by the external supervisor while 40% internal assessment will be based on viva and report submission.**
- **Report** of the training will be must for proper documentation.
- **Certificate** from SKP will be required on successful completion.

General Rules:

- The Internship or skill earning can be from any organization/industry/Govt. body/NGO/any other institute/ SKP (Skill Knowledge Provider) etc.
- For Industry or other institute internship please refer 3.4.3 of SoP.
- The concerned can issue a certificate or letter for work completion after successful completion of OJT activities by students.




Dr. Jyotindra J. Bhatt
 Chairman
 BOS (Chemistry)



