

Krantiguru Shyamji Krishna Verma

Kachchh University

Mundra Road

BHUJ: 370 015



SYLLABUS (NEP)

M. Sc. Semester-I:

CHEMISTRY

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

With effect from June-2026 (and thereafter)

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**Credit Framework and course code for (PG-FIRST Year) M.Sc. (SEM-I)
Chemistry Programme.**

Year	Semester	Course Code	Paper Title	Credits	Marks		Total
					CA	UA	
M.Sc. First Year	I	MJCHE:101 (Theory)	Inorganic Chemistry	4	50	50	100
		MJCHE:102 (Theory)	Organic Chemistry	4	50	50	100
		MJCHE:103 (Theory)	Physical Chemistry	4	50	50	100
		MJCHE:104 (Theory)	Spectroscopy and Separation Techniques	4	50	50	100
		Total Credits (Major)		16			400
		OJT- MJCHE:105(P)	Combined Chemistry Practical	4	75	75	150
		OJT-SEC/ MJCHE:106 (Theory)	Research Methodology-I	2	25	25	50
		Total Credits Alternate of OJT		6			200
		Total Credits		22			600

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

KACHCHH UNIVERSITY: BHUJ

M.Sc. (CHEMISTRY): NEP: SEMESTER: I

PAPER NAME:	PAPER CODE NO:
Inorganic Chemistry	MJCHE-101
Organic Chemistry	MJCHE-102
Physical Chemistry	MJCHE-103
Analytical Chemistry	MJCHE-104

Total Marks: 50, Passing standard: 20 Marks [Time: 120 minutes]

PATTERN OF EXTERNAL EXAMINATION QUESTION PAPER

FOR SEMESTER-END EXAMS

TOTAL: 50 MARKS

Questions	Section	Marks
Question-1 (Unit-I)	(Descriptive - Essay type – Short notes with internal option)	12 marks
Question-2 (Unit-II)	--do--	12 marks
Question-3 (Unit-III)	--do--	12 marks
Question – 4 (Unit-I, II & III)	Total 09 short questions of 2 mark, each unit will have 03 questions. Students will attempt any 07 out of 09	14 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.*
- *The language of the question papers shall be English.*
- *Practical Examination for total exercise time will be 2 hrs.*

Total Marks: 150, Passing standard: 40%

[50%Internal+50%External, i.e. 75 Marks internal+ 75 Marks External]

FOR EXTERNAL EXAMINATION

PAPER NAME:	PAPER CODE NO:
COMBINE PRACTICAL (OJT)	MJCHE-105 (P)
Total Marks: 75	Passing Marks: 30
Time: 6 hrs /Day	Total Two day for External Examination

UNIVERSITY (EXTERNAL) QUESTION PAPER STYLE FOR OJT-SEC MJCHE:106 (THEORY) PAPER: (TOTAL = 25 Marks) <u>PASSING STANDARD 40% (10 marks)</u>
PAPER CODE: OJT-SEC/CHE:106 PAPER NAME: RESEARCH METHODOLOGY
<u>University Examination Question Paper Style:</u> Total Seven Questions each of 5 marks (either one or sub questions) from all two units. Student has to attempt any five of them.

KACHCHH UNIVERSITY: BHUJ**M.Sc. (CHEMISTRY): NEP: SEMESTER: I****PAPER NAME: INORGANIC CHEMISTRY****PAPER CODE NO: MJCHE:101****[Total Credits: 4]****[Total Marks: 100 (Internal 50 + External 50)]**

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:	20 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. Brillouin theorem, Koopman's theorem, models of chemical bonding- Molecular orbital (MO) and Valence bond (VB) theories, application to diatomic molecules such as, H_2 , H_2^+ etc. Walsh diagrams and molecular geometry.	
UNIT-II	Inorganic Reaction Mechanisms	20 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	Electron Spin Resonance Spectroscopy and Moss Bauer Spectroscopy	20 Hours

	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. Introduction of Moss Bauer effect, Isomer shift, Magnetic hyperfine interactions, Applications of the technique to the studies of (i) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (ii) Sn^{+2} and Sn^{+4} compounds – nature of M-L bond, co-ordination number, structure and (iii) detection of oxidation state and in equivalent MB atoms.	
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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 McGraw 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 McGraw 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
M.Sc. (CHEMISTRY): NEP: SEMESTER: I
PAPER NAME: ORGANIC CHEMISTRY
PAPER CODE NO: MJCHE:102

[Total Credits: 4]

[Total Marks: 100 (Internal 50 + External 50)]

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:	20 Hours
	Carbocations: Classical and non-classical, neighbouring 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, Types of free radical reactions, free radical substitution mechanism, allylic halogenations (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation. Carbenes: Formation and structure, reactions involving carbenes and carbenoids. Nitrenes: Generation, structure and reactions of nitrenes.	
UNIT-II		20 Hours
	(A) SELECTED ORGANIC REACTIONS AND REAGENTS:	15Hours
	REACTIONS: Favorskii, Stork-enamine, Michael addition, Mannich, Ene, Hofmann-Löffler-Freytag, Shapiro, Chichibabin and Wittig reaction, Robinson annulation, REAGENTS: Gilman's reagent, Lithium dimethyl cuprate, Dicyclohexyl carbodiimide (DCC), Lithium diisopropylamine (LDA), 1,3-dithiane (reactivity umpolung), Trimethyl silyl iodide (TMS-I), Baker Yeast, Phase-transfer catalysts.	
	(B) AROMATICITY:	5 Hours
	Concept of Aromaticity, non-aromaticity and antiaromaticity, NMR in aromatic character, Hückel's rule and its limitations, non-benzenoid compounds (aromaticity), annulenes, fulvenes, fulvalenes, azulenes.	
UNIT-III	ELIMINATION REACTIONS AND ADDITION REACTIONS:	20 Hours

	Mechanism and orientation, reactivity, mechanism and orientation in pyrolytic elimination, Reactions–dehydration of alcohols, Shapiro reaction, conversion of epoxide to olefines, dehalogenation of vicinal halide, Hoffman and Saytzeff eliminations, Bredt's Rule, Pyrolytic Eliminations- Cope and Chugaev eliminations. Addition reactions: Mechanisms, Orientation and Reactivity, Markonikoff and anti-Markonikoff additions, Reactions including Hydro-Halo, Hydro-Hydroxy, Hydro-Alkoxy, Dihydro, Dihydroxy, dihalo, ozonolysis, Woodward-Prevost Hydroxylation.	
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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
M.Sc. (CHEMISTRY): NEP: SEMESTER: I
PAPER NAME: PHYSICAL CHEMISTRY
PAPER CODE NO: MJCHE:103

[Total Credits: 4]

[Total Marks: 100 (Internal 50 + External 50)]

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	ELECTROCHEMISTRY	20 Hours
	Thermodynamics of electrified interfaces Lipmann's Equation, Gouy-Chapman Theory, Polarization and Overvoltage, Butler-Volmer equation, Principle of polarography, Equation of polarographic wave, Ilkovič equation, zeta potential, Factors effecting limiting current, The half wave potential, Application of polarography, Electromotive series ad its application, concentration polarization, elimination of polarization, Electromotive force of polarization. Decomposition potential, Factors affecting overvoltage.	
UNIT-II	ADVANCED NUCLEAR CHEMISTRY	20 Hours
	Introduction, Nuclear properties-nuclear radius, columbic and nuclear potential spin and angular momentum, magnetic moment, nuclear binding energy, nuclear models-shell model, liquid drop model, Fermi gas model, collective model, radioactive decay, nuclear reactions, evaporation, spallation, fragmentation, fission and fusion reactions, accelerators, use of radioisotopes as tracers.	
UNIT-III	SOLID STATE	20 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. Solid-state chemistry by N. B. Hannay, Englewood Cliffs, N.J., Prentice-Hall.
8. Principles of the Solid State by H. V. Keer, New Age International (P) Ltd., Publishers
9. Reaction Kinetics by Michael J. Pilling and Paul W. Seakins, Oxford University Press
10. An Introduction to Electrochemistry by Samuel Glasstone, East-West Press Private, Limited
11. Choppin, G., Liljenzin, J. O., Rydberg, J., & Ekberg, C. (2013). Radiochemistry and nuclear chemistry (4th ed.). Academic Press.
12. Loveland, W. D., Morrissey, D. J., & Seaborg, G. T. (2017). Modern nuclear chemistry (2nd ed.). John Wiley & Sons.
13. Krane, K. S. (1988). Introductory nuclear physics. John Wiley & Sons.
14. Arnikar, H. J. (1995). Essentials of nuclear chemistry (4th ed.). New Age International.

KACHCHH UNIVERSITY: BHUJ**M.Sc. (CHEMISTRY): NEP: SEMESTER: I****PAPER NAME: SPECTROSCOPIC AND SEPARATION TECHNIQUES****PAPER CODE NO: MJCHE:104****[Total Credits: 4]****[Total Marks: 100 (Internal 50 + External 50)]**

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:	20 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, Lament'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	20 Hours
	(a) High Performance Liquid Chromatography:	10 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:	10 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:	20 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.	

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

M.Sc. (CHEMISTRY): NEP: SEMESTER: I

PAPER NAME: COMBINED CHEMISTRY PRACTICALS

PAPER CODE NO: OJT/CHE:105 (P)

[Total Marks: 150 (Internal 75 + External 75)]

[Passing Standard: 40 % of External and 40 % of Internal Evaluation]

Course Outcomes (COs):

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

- Practical skills of synthesis of metal complexes and separate radicals qualitatively.
- The course will provide ability to students to get hands on training on instruments of Physical Chemistry.

PRACTICAL EXERCISES FOR EXTERNAL EXAMINATION [75 Marks]

[1] Inorganic Chemistry:	
1. Preparation of Metal Complexes.	20 marks
2. Qualitative Analysis: Six radicals' separation with one less common ion.	20 marks
[2] Physical Chemistry: (anyone / two) 20 marks	
Physical Chemistry:	
1. Conductometry:	Mono and bi protic acids, mixtures of acids against strong / weak bases, argentometric, complexometric, replacement titrations, verification of Onsager's equation, dissociation of weak acids.
2. Refractometry:	Binary mixtures and solids.
3. Polarimetry:	Optically active compounds.
4. Partition coefficient:	Dimerization of acids, I-I ₂ system, Cu ₂ -NH ₃ complexes.
5. Potentiometric:	Acid-base, redox and argentometric titrations.
6. pH-metry:	Acid-base titration, pK _a of acids.
7. Spectrophotometry:	Lambert-Beer's law, binary mixture, kinetics of iodination etc.
8. Chemical Kinetics:	Energy coefficient of II nd order reactions.
[3] Viva Voce Examination: 15 marks	

Note: Certified Journals are mandatory for entry in the practical exam.

Duration of Practical: 6 Hrs.

Day 1:	Inorganic Chemistry and Viva	40 marks
Day 2:	Physical Chemistry and Viva	35 marks
Time:	6 hours on each day..	

KACHCHH UNIVERSITY: BHUJ

FIRST YEAR M.Sc.: NEP: SEMESTER: I (CHEMISTRY)

PAPER NAME: RESEARCH METHODOLOGY

PAPER CODE NO: OJT-SEC/ CHE:106

[Total Credits: 2]

[Total Marks: 50 (External: 25) + (Internal:25)]

[Passing Standard: 40 % of External and 40 % of Internal Evaluation]

Course Outcomes (COs): After the completion of the course, the students will be able to: Understand methods to undertake research, ways to collect data and interpret the same, ways to do survey of literature.		
UNIT-I	Introduction of Research Methodology:	20 Hours
	Meaning of research, Objectives of research, motivation in research, Types of research, Research Approaches, significance of research, research method vs methodology, research and scientific method, importance of knowing how research is done, research process, criteria of good research, problems encounter by researchers in India. Art of literature review, user of ICT in effective literature review,	
UNIT-II	Defining Research Problem	20 Hours
	What is research problem? selecting the problem / formulation of problem, developing research plan, meaning of research design, necessity of defining the problem, Technique involved in defining a problem, an illustration, conclusion. Meaning of research design, need for research design, features of good design, important concepts relating to research design, different research designs, basic principles of experimental design, selection of relevant variables, validity of experiments.	

REFERENCE BOOK:

1. Research Methodology: Methods and Techniques by Kothari, C R, Garg, Gaurav, ISBN: 978-93-89802-55-9, 2024
2. "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell and J. David Creswell,
3. Taxmann's Research Methodology by Rabi N. Subudhi, Sumita Mishra, Malabika Sahoo, 2024
4. Research Methodology in Chemical Sciences Experimental and Theoretical Approach Editors: Tanmoy Chakraborty, Lalita Ledwani, ISBN: 9781771881272, E-Book ISBN: 9781498728607

SUMMARY OF THE SEMESTER -1

PAPER CODE	PAPER NAME	CREDITS	INTERNAL* 50%	EXTERNAL 50%	TOTAL MARKS
MJCHE:101	INORGANIC CHEMISTRY	04	50	50	100
MJCHE:102	ORGANIC CHEMISTRY	04	50	50	100
MJCHE:103	PHYSICAL CHEMISTRY	04	50	50	100
MJCHE:104	SPECTROSCOPIC & SEPARATION TECHNIQUES	04	50	50	100
MJCHE:105	COMBINED PRACTICALS	04	75	75	150
MJCHE:106	RESEARCH METHODOLOGY-I	02	25	25	50
TOTAL		22	300	300	600
Internal Assessment contains Assignments / Projects / Seminars / Presentations / Practical Recorded Journal etc. whatever assign by the concern Faculty along with Written Examination.					



Dr. Jyotindra J. Bhatt
Chairman
BOS (Chemistry)



DEAN
FACULTY OF SCIENCE
SKV KACHCHH UNIVERSITY
BHUU-KACHCHH-370001

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BHUJ: 370 015



SYLLABUS (NEP)
M. Sc. Semester II:
CHEMISTRY

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

With effect from June-2026 (and thereafter)

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Credit Framework and course code for M.Sc. (SEM-II) Chemistry
Programme

KSKV KACHCHH UNIVERSITY-NEP M.Sc. CHEMISTRY-SEMESTER-II SYLLABUS-2026

Year	Semester	Course Code	Paper Title	Credits	Marks		Total
					CA	UA	
First Year	II	MJCHE:201 (Theory)	Inorganic Chemistry	4	50	50	100
		MJCHE:202 (Theory)	Organic Chemistry	4	50	50	100
		MJCHE:203 (Theory)	Physical Chemistry	4	50	50	100
		MJCHE:204 (Theory)	Advanced Analytical Chemistry	4	50	50	100
		Total Credits (Major)		16			400
		OJT/ MJCHE:205(P)	Combined Chemistry Practical	4	75	75	150
		SEC/ MJCHE:206 (Theory)	Research Methodology -II	2	25	25	50
		Total Credits Alternate of OJT		6			200
		Total Credits		22			600

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

KACHCHH UNIVERSITY: BHUJ

M.Sc. (CHEMISTRY): NEP: SEMESTER: II

PAPER NAME:	PAPER CODE NO:
Inorganic Chemistry	MJCHE-201
Organic Chemistry	MJCHE-202
Physical Chemistry	MJCHE-203
Advanced Analytical Chemistry	MJCHE-204

Total Marks: 50, Passing standard: 20 Marks [Time: 120 minutes]

PATTERN OF EXTERNAL EXAMINATION QUESTION PAPER

FOR SEMESTER-END EXAMS

TOTAL: 50 MARKS

Questions	Section	Marks
Question-1 (Unit-I)	(Descriptive - Essay type – Short notes <i>with internal option</i>)	12 marks
Question-2 (Unit-II)	--do--	12 marks
Question-3 (Unit-III)	--do--	12 marks
Question – 4 (Unit-I, II & III)	Total 09 short questions of 2 mark, each unit will have 03 questions. Students will attempt any 07 out of 09	14 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.
- Practical Examination for exercise time will be 2 hrs and total 12 hrs during two days. Also, any exercise/viva day may vary on any out of two days schedule.

Total Marks: 150, Passing standard: 40%

[50%Internal+50%External, i.e. 75 Marks internal+ 75 Marks External]

FOR EXTERNAL EXAMINATION

PAPER NAME:	PAPER CODE NO:
COMBINE PRACTICAL (OJT)	MJCHE-205 (P)
Total Marks: 75	Passing Marks: 30
Time: 6 hrs /Day	Total Two day for External Examination

UNIVERSITY (EXTERNAL) QUESTION PAPER STYLE

FOR OJT-SEC MJCHE:106 (THEORY) PAPER: (TOTAL = 25 Marks)

PASSING STANDARD 40% (10 marks)

PAPER CODE: OJT-SEC/CHE:206

PAPER NAME: RESEARCH METHODOLOGY-II

University Examination Question Paper Style:

**Total Seven Questions each of 5 marks (either one or sub questions) from all two units.
Student has to attempt any five of them.**

KSKV KACHCHH UNIVERSITY, BHUJ M.Sc. NEP- SEMESTER- II (CHEMISTRY) PAPER NAME: INORGANIC CHEMISTRY PAPER CODE NO: MJCHE-201 TOTAL CREDITS:04 TOTAL MARKS: 100 [(Internal) 50 + (External) 50]		
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	SYMMETRY AND GROUP THEORY IN CHEMISTRY:	20 Hours
	Representation of groups – some properties of matrices and vectors, the great Orthogonality theory and its consequences, character tables, Wave functions as the basis for irreducible representations, direct product, identifying non-zero matrix elements, application of symmetry to molecular orbitals, hybrid orbitals, and molecular vibrations.	
UNIT-II	(A) MAGNETOCHEMISTRY:	10 Hours
	Brief review of different types of magnetic behaviour, spin-orbit coupling, quenching of orbital angular momenta, measurement of magnetic susceptibility using Gouy and Faraday methods, spin crossover; Structural effects: ionic radii and Jahn-Teller effect; magnetic properties of Lanthanides and Actinides and splitting of f-orbitals in octahedral field.	
	(B) CHEMISTRY OF D AND F BLOCK ELEMENTS:	10 Hours
	Term symbols for metal ions, Russel-Saunders states, Crystal field theory and splitting in O_h , T_d , D_{4h} and C_{4v} systems, Orgel and Tanabe-Sugano diagrams, determination of Dq and Racah parameters, Spectrochemical series and effects of covalency, nephelauxetic series, cluster compounds of d-block elements, poly-oxometallates of Ru, Os, Mo.	
UNIT-III	ORGANOMETALLIC COMPOUNDS:	20 Hours
	Introduction and nature of bonding in organometallic compounds of transition metals; σ -bonded organo transition metal compounds, general characteristics, chemical reactions, bonding and structure; π -bonded organometallic compounds: (a) η^2 -alkene complexes; preparative methods, physical and chemical properties, bonding and structure; (b) η^3 -allyl (or enoyl) complexes preparation, physical and chemical properties.	

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.

KSKV KACHCHH UNIVERSITY, BHUJ M.Sc.: NEP: SEMESTER: II (CHEMISTRY) PAPER NAME: ORGANIC CHEMISTRY PAPER CODE NO: MJCHE-202 TOTAL CREDITS:04 TOTAL MARKS: 100 [(Internal)50 + (External) 50]	
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	REACTIVE INTERMEDIATES IN MOLECULAR REARRANGEMENTS:	20 Hours
	Molecular Rearrangement involving Non-Classical Carbocation: Neighbouring group participation by $\pi(\pi)$ and $\sigma(\sigma)$ bonds. Molecular Rearrangement involving Carbocation: Wagner-Meerwein, Pinacol-Pinacolone, Demjanov and Beckmann Rearrangement. Molecular Rearrangement involving Carbanion: Favorskii, Benzil-Benzilic Acid, Stevens and Sommelet-Hauser Rearrangement. Molecular Rearrangement involving Free radical: Rieme-Tiemann, Fries Rearrangement Molecular Rearrangement involving Nitrene: Curtius, Schmidt, Lossen and Hoffmann Rearrangement Molecular Rearrangement involving Carbene: Wolf Rearrangement.	
UNIT-II	(A) ORGANIC PHOTOCHEMISTRY:	10 Hours
	Introduction to photochemical reactions, cis-trans isomerisation, Paterno-Buchi reaction, Norrish type I & II reaction, photoreduction of Ketones, di pi methane rearrangement, photochemistry of arenes, Barton reaction.	
	(B) GREEN CHEMISTRY & SUSTAINABLE PROCESSES	
	12 Principles of Green Chemistry, Atom Economy, E-factor, Biomass Valorization: Agricultural waste to Biofuels /Chemicals, Solvent-free & Microwave assisted syntheses for Pharma, Heterogeneous & Bio catalysis - Industry case studies, Life Cycle Assessment (LCA): Basics and applications	
	(C) METHODS IN ORGANIC SYNTHESIS:	10 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:	20 Hours
	Main features of pericyclic reactions; Woodward-Hoffman rules, correlation diagram and FMO approaches; Electrocyclic reactions – conrotatory and dis	

	rotatory motions for $4n$ and $4n+2$ systems; Cycloadditions – Antara facial and Supra facial additions, $[2+2]$ and $[4+2]$ reactions ($h\nu$ and Δ), 1,3- dipolar cycloadditions and Chelotropic reactions; Sigma tropic $[i, j]$ shifts of C-H and C-C bonds; Somme let-Hauser, Claisen, thio-Claisen, Cope and aza-Cope rearrangements.	
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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 Parashar: 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**M.Sc.: NEP: SEMESTER: II (CHEMISTRY)****PAPER NAME: PHYSICAL CHEMISTRY****PAPER CODE NO: MJCHE-203****TOTAL CREDITS:04****TOTAL MARKS: 100 [(Internal) 50 + (External) 50]**

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	20 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	20 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	20 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-Inter-science.
11. Surface Chemistry, Theory and Industrial Applications by L. I. Osipow, New York, Reinhold Pub. Corp.
12. Surfactants and Interfacial Phenomena, Milton J. Rosen, (Wiley Inter-science, Third Edition)

KACHCHH UNIVERSITY: BHUJ**M.Sc.: NEP: SEMESTER: II (CHEMISTRY)****PAPER NAME: ADVANCED ANALYTICAL CHEMISTRY****PAPER CODE NO: MJCHE-204****TOTAL CREDITS:04****TOTAL MARKS: 100 [(Internal) 50 + (External) 50]**

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:	20Hours
	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:	20 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:	20 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

M.Sc.: NEP: SEMESTER: II (CHEMISTRY)

PAPER NAME: COMBINED CHEMISTRY PRACTICALS

PAPER CODE NO: MJ-CHE:205 (P)

[Total Marks: 150 (External Evaluation: 75 + Internal Evaluation: 75)]

Passing Standard: 40% External and 40% of Internal Evaluation

Course Outcomes (COs):

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

- Practical skills of synthesis organic compounds and separate organic compounds qualitatively.
- The course will provide ability to students to get hands on training on volumetric analysis and basic chromatography techniques.

[I] Organic Chemistry:

- | | |
|--|-----------------|
| 1. One or two steps Organic synthesis. | 20 marks |
| 2. Separation and qualitative analysis of binary mixture | 20 marks |

[II] Volumetric exercises and Chromatography: **20 marks**

1. Volumetric Practicals based on food analysis:
(Milk, Honey, Oil, Tea-leaves, Turmeric powder etc.),
2. Drug Analysis: Aspirin, Benzyl benzoate, Ascorbic acid, etc. (any one)
3. Paper Chromatography – Ascending or Descending – separation of Amino acids / Inorganic radicals (any one)

Viva Voce Examination: **15 marks**

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: **6 Hrs.**

Day 1:	Organic Separation, volumetric exercise and viva	45 marks
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Day 2:	Organic Preparation and Chromatography	30 marks
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Time:	6 hours on each day.
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K.S.K.V. KACHCHH UNIVERSITY, BHUJ
M.Sc.-NEP- SYLLABUS- SEMESTER-II (CHEMISTRY)
Paper Code: SEC/MJCHE:206 (Theory)
Paper Title: RESEARCH METHODOLOGY- II

[Total Credits: 02]

[Total Marks: 50 (Internal 25 + External 25)]

Passing Standard: 40 % of External and 40% of Internal Evaluation

Course Outcomes (COs): After the completion of the course, the students will be able to: Understand methods to undertake research, ways to collect data and interpret the same, ways to do survey of literature.		
UNIT-I	METHODS OF DATA COLLECTION:	20 Hours
	Collection of primary data, observation method, Interview method, collection of data, through questionnaires, collection of data through schedules, difference between questionnaires and schedules, some other method of data collection, collection of secondary data, selection of appropriate method for data collection, role of computer in research. AI tools for data collection.	
UNIT-II	PROCESSING AND ANALYSING DATA:	20 Hours
	Processing operations, solving problems in processing, types of analysis, statistics in research, measures of central tendency, measures of dispersion, measures of asymmetry, measures of relationship (Bivariate Analysis, Multivariate Analysis), significance of writing thesis, different types of research writing, guidelines of writing good thesis.	

REFERENCE BOOK:

1. Research Methodology: Methods and Techniques by Kothari, C R, Garg, Gaurav, ISBN: 978-93-89802-55-9, 2024
2. Data Collection Methods for Researchers by Malay Jayantkumar Bhatt; LAP LAMBERT Academic Publishing (ISBN: 978-620-7-47239-0)
3. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by Creswell, John W., Creswell, J. David; SAGE Publications, ISBN: 978-1071817941, 2023.
4. Research Methodology: A Step-by-Step Guide for Beginners by Kumar, Ranjit; SAGE Publications, ISBN: 978-1529788444, 2024.
5. Social Research Methods by Bryman, Alan; Oxford University Press, ISBN: 978-0199689453, 2016.
6. Research Methods for Business: A Skill-Building Approach by Sekaran, Uma, Bougie, Roger; John Wiley & Sons, ISBN: 978-1119741030, 2020.

7. Discovering Statistics Using IBM SPSS Statistics by Field, Andy; SAGE Publications, ISBN: 978-1529798795, 2024.
8. Statistical Methods for the Social Sciences by Agresti, Alan, Finlay, Barbara; Pearson Education, ISBN: 978-0134507101, 2018.
9. Research Methods: The Basics by Walliman, Nicholas; Routledge, ISBN: 978-0367697537, 2021.
10. Interpreting Qualitative Data by Silverman, David; SAGE Publications, ISBN: 978-1529732102, 2021.

SUMMARY OF THE SEMESTER -II

PAPER CODE	PAPER NAME	CREDITS	INTERNAL* 50%	EXTERNAL 50%	TOTAL MARKS
MJCHE:201	INORGANIC CHEMISTRY	04	50	50	100
MJCHE:202	ORGANIC CHEMISTRY	04	50	50	100
MJCHE:203	PHYSICAL CHEMISTRY	04	50	50	100
MJCHE:204	ADVANCED ANALYTICAL CHEMISTRY	04	50	50	100
MJCHE:205	COMBINED PRACTICALS	04	75	75	150
MJCHE:206	RESEARCH MEHTODOLOGY-II	02	25	25	50
TOTAL		22	300	300	600
Internal Assessment contains Assignments / Projects / Seminars / Presentations / Practical Recorded Journal etc. whatever assign by the concern Faculty along with Written Examination.					



Dr. Jyotindra J. Bhatt
Chairman
BOS (Chemistry)



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