BHAKTA KAVI NARSINH MEHTA UNIVERSITY

JUNAGADH 362263

SYLLABUS

Faculty of Science

B.Sc. Chemistry

(Honours & Honours with Research)

Semester VII

Under NEP-2020

Effective from June 2026

BHAKTA KAVI NARSINH MEHTA UNIVERSITY

Faculty of Science

Effective from June 2026

Subject: CHEMISTRY

SEMESTER- VII

Common Structure

Sem-07 (UG 4th Year Honours & Honours with Research)

Summary of the Courses for B. Sc Chemistry Semester-VII										
Sem	**Sr. No.**	**Category of Course**	**Course Title**	**Course Level**	**Credit**	**Teaching Hrs.**	**SEE Marks**	**CCE Marks**	**Total Marks**	**SEE-Exam Duration**
7	1	Major-17	Advanced Chemistry-401	6	4	4T	50	50	100	2T Hours
	2	Major-18	Advanced Chemistry-402	6	4	4T	50	50	100	2T Hours
	3	Major-19	Advanced Chemistry Practical-403	6	4	8P	50	50	100	8P Hours
	4	Minor-07	Minor Chemistry-401	6	4	2T+4P	50	50	100	2T Hours
	5	On the Job Training (OJT)		6	6	-	150	-	150	-
		OR								
		Major-20	Advanced Chemistry-404	6	4	2T+4P	50	50	100	4T Hours
		SEC-6	Research Methodology in Chemistry-1	6	2	4P	25	25	50	4P Hours
		OR								
		RP	Research Project Proposal	6	4	8P	50	50	100	-
			Research Project Proposal Viva Voce	6	2	4P	25	25	50	6P Hours
				Total	**22**				**550**	

Semester course Objectives

The foundational objectives of the Semester-7 curriculum are designed to transition students from core undergraduate chemistry to advanced specialized research and professional application.

- Advanced Core Knowledge: To provide deeply integrated knowledge of advanced chemical facts, theories, principles, and mechanism pathways across inorganic, bioinorganic, physical, and organic chemistry domains.
- Methodological Mastery: To cultivate expert cognitive and technical skills in modern chemical research methodologies, digital chemical software usage, statistical data handling, and scientific literature interpretation.
- Operational & Problem-Solving Capabilities: To empower students to synthesize theoretical concepts and deploy appropriate operational frameworks to troubleshoot complex analytical problems and generate targeted chemical solutions.
- Professional Skills & Employability: To build job-ready, workplace-ready, and entrepreneurial competencies in chemical processing, instrument data analysis, and laboratory management under strict safety regulations.
- Values & Research Ethics: To in still a disciplined commitment to ethical research conduct, environmental sustainability through green chemistry, and precise communication in professional peer networks.

Semester Learning Outcomes

Upon successful completion of the fourth-year Seventh Semester, students will demonstrate mastery across the following essential competency domains:

A. **Theoretical & Specialized Knowledge**

- Mechanistic Inorganic & Bioinorganic Systems: Differentiate and evaluate ligand substitutions, trans effects, and inner/outer sphere electron-transfer mechanics in coordination complexes. Explain the architecture, iron transport, and active-site dynamics of metalloproteins (e.g., hemoglobin, myoglobin, ferritin) and metalloenzymes (e.g., Cytochrome).
- Advanced Organic Transformations: Analyse the structures, generation methods, and synthetic utility of highly reactive organic intermediates (carbenes, nitrenes, enamines, ylides). Select and map precise pathways for specific oxidative reagents (Jones, Swern, Collins) and complex metal hydride reductions (Birch, DIBAL-H, 9-BBN).
- Physical & Thermal Principles: Articulate molecular partition functions using Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics to compute

thermodynamic values. Interpret materials' thermal transitions by managing physical principles behind TGA, DTA, and DSC curves.

- Green & Pharmaceutical Chemistry: Apply the 12 principles of Green Chemistry to configure sustainable alternative pathways using non-traditional solvents (ionic liquids, supercritical CO2) or microwave-assisted techniques. Evaluate the clinical, radiopharmaceutical, and chelation actions of target metal-ion combinations.

B. **Cognitive, Technical, & Practical Skills**

- Advanced Chemical Synthesis: Execute multi-step organic synthesis, purifications, and chemical yield optimizations for intricate compounds (e.g., paracetamol, aspirin, benzilic acid, Hantzsch-pyridines).

- Physicochemical & Instrumental Analytics: Operate and evaluate diagnostic analytical instruments across pH-metry, conductometry, potentiometry, polarimetry, and refractometry setups. Derive specific rates, activation energies, equilibrium values, optical purity, and adsorption isotherms from physical data arrays.

- Digital Research & Software Application: Leverage professional specialized software (e.g., ChemDraw) to map 3D molecular schemes, calculate exact masses, and predict underlying 1HNMR and 13C-NMR} spectra lines. Harness advanced features in MS Excel to run linear/non-linear regressions, compute least-square curve fittings, and digitize analytical titration profiles.

C. **Analytical Chemometrics & Decision-Making**

- Statistical Data Validation: Mitigate propagation uncertainties by applying standard statistical tests (F-test, t-test, chi-square- test), confidence limits of mean etc on experimental inputs.

- Method Evaluation Quality: Qualify analytical protocols against crucial regulatory method validation matrices: Limit of Detection (LOD), Limit of Quantification (LOQ), linearity range, accuracy, repeatability, and robustness.

D. **Generic Skills & Professional Communication**

- Data Compilation & Presentation: Gather, organize, and interpret complex quantitative datasets, presenting them with clarity via scientific posters or presentations to varied audiences.

- Scientific Writing Literacy: Conduct comprehensive scientific database reviews to assemble formal review abstracts, project grant outlines, and standard research manuscripts according to universal citation formats using reference tools.

Major Chemistry-17 (CHM401-4C/Advanced Chemistry-401)

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry (Honours)	**Total External Marks**	50
Semester	7	**Total Practical Internal Marks**	-
Category of Course	Major-17	**Total Theory Internal Marks**	50
Course Credit	4	**External Theory Exam Marks**	50
Teaching Hours	4T	**Total Marks**	100
Course Code	CHM401-4C	**External Theory Exam Duration**	2- Hours Theory
Course Title	**Advanced Chemistry-401**		

Major Chemistry-17 (CHM401-4C/Advanced Chemistry-401)

Course Objectives:

1. To understand reaction mechanisms of coordination compounds and bioinorganic systems.
2. To study biological functions of metal ions and metalloproteins.
3. To learn the chemistry and applications of reactive organic intermediates.
4. To understand the mechanism and synthetic utility of important organic reagents.

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

1. Describe and differentiate substitution, oxidation, and reduction mechanisms in coordination compounds, including trans effect, inner-sphere, and outer-sphere electron transfer processes.
2. Interpret the biological functions of major and trace elements and explain the structure and role of metalloproteins, vitamin B12, and metalloenzymes in biochemical systems.
3. Analyse the formation, stability, and reactivity of reactive organic intermediates and apply them to explain important organic transformations and rearrangement reactions.
4. Select appropriate oxidizing and reducing reagents for specific organic transformations and predict their reaction pathways, selectivity, and synthetic outcomes.
5. Integrate concepts from inorganic, bioinorganic, and organic chemistry to solve reaction-based and application-oriented chemical problems.

Sem	Unit	Syllabus	Teaching Hours
7	1	**Reaction Mechanism of Coordination Compounds** Substitution reaction & Mechanism in Octahedral Complex (S_N1& S_N2), Labile and inert complexes(concept of CFAE), Substitution reactionin square planar complexes, Trans Effect (Polarization theory and Pi Bonding Theory), Oxidation and Reduction reaction of Metal Complexes (Electron transfer – Inner sphere and Outer Sphere Mechasim)	**15**
	2	**Bioinorganic Chemistry** Introduction, Biological significance of Principle elements (Na, K, Mg,	**15**

		Ca, P, S), Na-K Pump, Biological significance of Trace elements (Cr, Fe. Min. Co. Cu, Zn), Introduction to Metalloporphyrin, The role of Hemoglobin and Myoglobin in biological system. Iron storage and Transport (Ferritin and Transferrin), Vitamin B_{12} and Co-enzyme B_{12}, Metalloenzymes: Carbonic anhydrase, Carboxypeptidase, Cytochrome P-450.	
	3	**Reactive Organic Intermediates and their applications** Introduction, Hybridization, Structure and preparations of intermediates: Carbene, Nitrene, Ylides (Nitrogen and Sulphur Ylide) and Enamines. Applications of Carbocation in Demjanov reaction, Carbanions in Robinson annulations, Free radical Kolbe electrolysis, Carbenes in Simmons smith reaction, Nitrenes in Schmidt rearrangement, Ylides in Sommelet Hauser reaction, and Enamines in Stork Enamine reaction.	**15**
	4	**Organic Reagents** General mechanism, selectivity, and important applications of the following reagents: (a) Oxidative Reagents: $K_2Cr_2O_7/H_2SO_4$ (Jones reagent), CrO_3-pyridine (Collin's reagent), hypervalent iodine reagents (HIO_4, $NaIO_4$,), Swern reagent, SeO_2, (b) Metal hydride reduction: Boron reagents (9-BBN), aluminium reagent (DIBAL-H), Li/Na-liquid NH_3 mediated reduction (Birch reduction) of aromatic compounds and acetylenes.	**15**

Reference Books

1. Miessler, G. L; Fischer, P. J.; Tarr, D. A.; (2014, sixth edition) Inorganic Chemistry, (ISBN: 978-0-321-81105-9).
2. Agarwala S. K.; Lal K.; (2009), Advanced Inorganic Chemistry, (ISBN: 978-81-8398-773-8).
3. Singh, A.; Singh, R.; (2005) Textbook of Inorganic Chemistry Vol. I & II. New Delhi: Campus Books International, (ISBN: 8180300714).
4. Housecroft C. E; Sharpe A. G.; (2005, 2nd edition) Inorganic Chemistry, (ISBN: 0130-39913-2).
5. House J. E; House K. A.; (2016, 3rd edition) Descriptive Inorganic Chemistry, (ISBN: 978-0-12-804697-5).
6. Ajaikumar; (2016 2nd edition) Organometallic &Bloinorganic Chemistry, Aaryush Education, (ISBN:978-81-930437-1)
7. Ahluwalia, V. K. (2011, Fourth edition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
8. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 1st Ed., Oxford University Press, 2001.
9. LászlóKürtip; Barbara Czakó (2004, First edition) Strategic Applications of Named Reaction in Organic Synthesis. Philadelphia: Elsevier Publishing company (ISBN: 9780124297852).
10. M.B. Smith & J. March, March's Advanced Organic Chemistry, 6thEd., John Wiley & Sons, New York, 2007.
11. F.A. Carey and R.A. Sundberg, Advanced Organic Chemistry, Part A and Part B, 5th Ed.,
12. McMurry, John E. (2011, Eight edition) *Organic Chemistry*. Boston: Cengage Learning (ISBN: 0840054440).
13. Smith, Michael B.; March, Jerry (2013, Seventh edition) *March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure*. Hoboken: Wiley-Blackwell (ISBN:

978-0-470-46259-1).
14. Bansal, Raj K. (2009, Fifth) *A Textbook of Organic Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2025-8).
15. T. W. Graham Solomons (2011, 10th edition) *Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 978-0-470-55659-7).

Major Chemistry-18 (CHM402-4C/Advanced Chemistry-402)

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	7	**Total Practical Internal Marks**	-
Category of Course	Major-18	**Total Theory Internal Marks**	50
Course Credit	4	**External Theory Exam Marks**	50
Teaching Hours	4T	**Total Marks**	100
Course Code	CHM402-4C	**External Theory Exam Duration**	2- Hours Theory
Course Title	**Advanced Chemistry-402**		

Major Chemistry-18 (CHM402-4C/Advance Chemistry-402)

Course Objectives:

1. Understand the principles and applications of statistical thermodynamics.
2. Study the classification, synthesis, properties, and applications of polymers.
3. Develop knowledge of chemometric and statistical methods for analytical data evaluation and method validation.
4. Learn the principles, instrumentation, and applications of thermal analysis techniques.

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

1. Explain statistical thermodynamics, molecular partition functions, and related thermodynamic properties.
2. Classify polymers, describe polymerization mechanisms, and correlate polymer structure with properties and applications.
3. Apply statistical and chemo metric tools for analytical data interpretation and method validation.
4. Evaluate analytical methods using parameters such as accuracy, precision, linearity, LOD, and LOQ.
5. Explain the principles and instrumentation of thermal analysis techniques (TGA, DTA, and DSC).
6. Analyse thermal behaviour and characterize simple and polymeric materials using thermal analytical methods.

Sem	Unit	Syllabus	Teaching Hours
7	1	**Statistical Thermodynamics** The concepts of Ensemble, Thermodynamic, probability and entropy, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Partition function, Molar partition function, Thermodynamic properties in term of molecular partition function for diatomic molecules, Monoatomic gases, Rotational, Translational, Vibrational and Electronic partition functions for diatomic molecules. Problems.	**15**
	2	**Polymers** Introduction, Classification of Polymers based on source, structure,	**15**

		molecular forces (Thermo plastic and thermosetting plastic) and modes of polymerization, Addition (Chain growth)- and condensation (Step growth) Polymerization, Type of addition Polymerization (i) Free Radical Polymerization (ii) Ionic Polymerization, Co-polymerization (Buna-S), Ziegler- Natta Polymerization, Stereo Chemistry of Polymer, Natural rubber, Vulcanized rubber, synthetic rubber (Neoprene, Buna-N), Bio-degradable and non-bio degradable polymer, (Synthesis of PHBV & Nylon-2-nylon-6), Number average molecular weight and weight average molecular weight, Poly Dispersity Index (PDI), only the name of methods use for determination of molecular mass of Polymers, Synthesis, properties and use of Nylon-6, Nylon-66, Terylene, Teflon, PAN, Bakelite, Melamine.	
	3	**Analytical Chemometrics** Propagation of measurement of uncertainties, useful statistical tests: Test of significance, f-test, t-test, chi-square-test, correlation coefficient, confidence limits of mean, comparison of mean with true values. Regression analysis (least square method for linear and nonlinear plots). Statistics of sampling and detection limit evaluation. Specific study for analytical method radiation by using validation parameters:(1) accuracy, (2) precision (repeatability and reproducibility), (3) linearity and range, (4) Limit of Detection (LOD) and Limit of quantification. (LOQ), (5) selectivity/specificity, and (6) Robustness and Ruggedness. Problems.	**15**
	4	**Thermal Methods of Analysis** Principle, theory and instrumentation of TGA, DTA and DSC. Factors affecting thermal analysis. Applications of thermal methods in various field of science. Various theories of thermal analysis for evaluation of kinetic parameters and analysis of simple and polymeric compounds.	**15**

Reference Books

1. Glasstone, Samuel. (2007) Textbook of Physical Chemistry: MCMILAN India Press (SBN: 033391-876-2).
2. Peter Atkins, Julio de Paula (2015) Physical chemistry: Thomson Press (ISBN: 019872872-7).
3. Gurdeep Raj (2014, Third edition) *Thermodynamics*. Meerut: GOEL publishing House (ISBN: 8187224886).
4. Gurtu, J. N. Gurtu,A. (2014, Twelfth edition) *Advanced Physical Chemistry*. Meerut: Pragati Prakashan (ISBN: 9350060191).
5. Barrow, Gordon M. (1996, Sixth edition) *Physical Chemistry*. New York: McGraw-Hill International. (ISBN: 0070051119).
6. V R Gowariker, (2012) Polymer *Chemistry*. New age International P limited. (ISBN: 978-0-85226-307-5).
7. Puri, Sharma, Pathamia, (2018, 47th edition) Principles of Physical Chemistry. Vishal Publishing Co. (ISBN: 978-93-82956-78-5).
8. B. S. Bahl, Arun Bhahl, G. D. Tuli, (2005) Essentials of Physical Chemistry. S. Chand & Company LTP. (ISBN: 81-219-0546-X).
9. Physical Chemistry, Ira N Levine (Tata McGraw-Hill Publishing Company, New Delhi,

Fifth Edition).
10. Physical Chemistry, Alberty and Stilby, (John Wiley & Sons, New York).
11. D. K. Chakrabarty and B. Viswanathan, Heterogeneous Catalysis, New Age, 2008.
12. Introduction to the principles of heterogeneous catalysis. J. M. Thomas and W. J. Thomas, Acad. press, London, 1967.
13. Chemical kinetics and catalysis G.M. Panchenkov and V. P. Lebedev., Mir publication, 1976.

Major Chemistry-19 (CHM403-4C/Advanced Chemistry-403)

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	7	**Total Practical Internal Marks**	50
Category of Course	Major-19	**Total Theory Internal Marks**	-
Course Credit	4	**External practical Exam Marks**	50
Teaching Hours	4T	**Total Marks**	100
Course Code	CHM403-4C	**External Practical Exam Duration**	8P Hours
Course Title	**Advanced Chemistry Practical-403**		

Major Chemistry-19 (CHM403-4C/Advance Chemistry Practical-403)

Course Objectives:

1. To develop practical skills in the synthesis, purification, and characterization of important organic compounds and reaction intermediates.
2. To understand and perform experiments related to physicochemical principles such as distribution law, chemical kinetics, adsorption, and thermodynamics.
3. To acquire proficiency in laboratory techniques, data collection, analysis, and interpretation of experimental results.
4. To enhance problem-solving abilities and scientific reasoning through experimental investigations in organic and physical chemistry.

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

1. Perform the synthesis, purification, and yield determination of various organic compounds using standard laboratory techniques.
2. Apply concepts of distribution law, chemical kinetics, adsorption, and thermodynamics to analyse experimental observations.
3. Determine physicochemical parameters such as equilibrium constants, reaction order, activation energy, adsorption constants, and thermodynamic properties from experimental data.
4. Interpret experimental results, perform calculations, and evaluate the validity of theoretical models and laws.
5. Demonstrate safe laboratory practices, proper handling of chemicals, and accurate scientific reporting of experimental work.

Sem	Unit	Syllabus	Teaching Hours
7	**1**	**Organic Synthesis: (Minimum 15)** 1. Phenyl urea from aniline 2. Hydro quinone diacetate from hydroquinone. 3. 1,2,3,4-Tetrahydrocarbazole from Cyclohexanone 4. p-Nitroacetanilide from p-Nitroaniline. 5. 7-Hydroxycoumarine from resorcinol.	**60**

		6. Hippuric acid from glycine. 7. Benzilic acid from Benzil 8. Phthalamide from phthlic anhydride. 9. Hantzsch-Pyridine Synthesis 10. Synthesis of Chalcone 11. Synthesis of Schiff's Base 12. Synthesis of Oxime Derivatives 13. Benzal-acetophenone from acetophenone/ Dibenzalacetone from Benzaldehyde 14. Iodoform from Acetone 15. Benzyl alcohol and Benzoic acid from Benzaldehyde 16. Synthesis of Paracetamol 17. Synthesis of Aspirin 18. Backmann rearrangement of Oxime derivative	
	2	**Physico chemical exercise:** **Partition Co-efficient:** 1. To study the distribution of benzoic acid between toluene & water at room temperature and hence to prove the dimerization of benzoic acid in benzene /toluene. 2. To determine equilibrium constant for the reaction between potassium iodide& iodine by the method of distribution. 3. Determine the formula of a complex between $Cu^{+2}$and NH_3 by distribution method. 4. Determine the equilibrium constant of the reaction $I^- + I_2 = I_3$by the distribution method. 5. To study the distribution co-efficient of succinic acid between ether and water. **Chemical Kinetics:** 1. To determine the order of the reaction by a fractional change method. 2. To determine the temperature coefficient and the energy of activation of the reaction between $KBrO_3$ and KI. 3. Autocatalytic reaction between $KMnO_4$ and oxalic acid. 4. To determine the reaction velocity constant for the reaction between acetone & iodine. 5. To determine the temperature coefficient and energy of activation of hydrolysis of methyl acetate catalyzed by HCl + KI by fractional change method. **Adsorption:** 1. To study the adsorption of aqueous oxalic acid solution by activated charcoal and examine the validity of Freundlich and Langmuir's adsorption isotherms. 2. To study the adsorption of I_2 from alcoholic solution by charcoal. **Thermodynamics:** 1. Heat of vaporization: To determine heat & entropy of	**60**

		vaporization of a given liquid by a kinetic approach. 2.To determine partial molar volume of sodium chloride in aqueous solution at room temperature. 3. To determine the heat of solution of the given acid by solubility method.	

Reference Books

1 Brian S. Furniss (1989, Fifth edition) Vogel's Textbook of Practical Organic Chemistry. Hoboken: John Willey & Sons (ISBN: 0-582-462363).

2 Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989) Vogel's Textbook of Quantitative Chemical Analysis. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).

3 Parsania P. H (2005, 1st edition) Experiments in Physical Chemistry, Granth Nirman Board.

4 Experimental Physical Chemistry by G. Peter Matthews, (Clarendon Press, Oxford, London).

5 Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, (New Age International Publishers, New Delhi).

6 Advanced Physical Chemistry Experiments by Gurtu and Gurtu, (Pragati Prakashan, Meerut).

7 Advanced Physico-Chemical Experiments by J. Rose, (Sir Isaac Pitman & Sons Ltd., London).

8 Experiments in Physical Chemistry by D. P. Shoemaker, C. W. Garland and J. W. Nibler, (McGraw Hill International Edition, London

9 A Laboratory Manual of Experiments in Physical Chemistry by D. Brennan and C. F. H. Tipper, (McGraw hill Publishing Company Ltd., London) .

10 Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, (Anjali Publication, Aurangabad)

11 Experimental Physical Chemistry by R. C. Das & B. Behera, (Tata McGraw hill Publishing Company Ltd., New Delhi).

12 W. J. Popiel, Laboratory Manual of Physical Chemistry, ELBS, London, 1970.

Minor Chemistry-7 (CHE401-4C/Minor Chemistry-401)

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	7	**Total Practical Internal Marks**	50
Category of Course	Minor-7	**Total Theory Internal Marks**	-
Course Credit	4 (2T + 2P)	**External Theory Exam Marks**	50
Teaching Hours	2T + 4P	**Total Marks**	100
Course Code	CHE401-4C	**External Theory Exam Duration**	2- Hours Theory
Course Title	**Minor Chemistry-401**		

Minor Chemistry-7 (CHE401-4C/Minor Chemistry-401)

Course Objectives:

1. To introduce the fundamental concepts, synthesis, characterization, and applications of nanomaterials.
2. To understand the principles, instrumentation, and applications of optical analytical techniques such as refractometry and polarimetry.
3. To develop practical skills in electro analytical methods including Conductometry, pHmetry, and potentiometry.
4. To train students in the measurement, analysis, and interpretation of physicochemical properties using modern analytical instruments.

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

1. Explain the classification, properties, synthesis methods, and characterization techniques of nanomaterials.
2. Describe the principles and applications of refractometry and polarimetry for qualitative and quantitative analysis.
3. Perform conductometric, pH-metric, potentiometric, refractometric, and polarimetric experiments accurately.
4. Determine physicochemical parameters such as dissociation constants, activity coefficients, rate constants, optical purity, refractive index, and molecular rotation.
5. Analyse experimental data, interpret instrumental results, and apply analytical techniques to solve chemical problems.

Sem	Unit	Syllabus	Teaching Hours
7	**1**	**Nanomaterial** Definition and Introduction of nanomaterial, Size effects, Importance of nanomaterials, Classification of nanomaterials, Properties of nanomaterial, Synthesis techniques of nanomaterials, Inorganic Nanoparticles and Nano porous Materials: Oxide, catalysis. Techniques for characterisation of nanoscale materials: SEM, TEM, XRD, AFM.	**15**

	2	**Optical Methods:** Refractive index: Introduction, Principle, Instrumentation, Measurement of refractive index, abbe refractometer, immersion refractometer, application. Polarimetry: Introduction, Principle, Instrumentation, optical purity, calculations.	**15**

Reference Books

1. Rao C. N. R; Muller A.; Cheetam A. K.; (2004) The Chemistry of Nanomaterials, Vol.1, and 2, Wiley – VCH.
2. Poole C. P.; Owens Jr. F. J.; (2003) Introduction to Nanotechnology Wiley Interscience.
3. Kenneth J. K. (2001) Nanoscale materials in Chemistry, Wiley Interscience.
4. Pradeep T.; (2007) Nano: The Essentials in understanding nanoscience and nanotechnology, Tata McGraw Hill.

Course Contents -Minor Chemistry Practicals-7			
Sem	**Unit**	**Syllabus**	**Teaching Hours**
7	**1**	**Practicals** **Conductometry: (any three)** 1. To determine concentration of mixture HCl+CH_3COOH + $CuSO_4$/HCl + Oxalic acid vs. NH_4Cl/NaOH by conductometricaly. 2. To determine the equivalent conductance of a strong electrolyte and to verify the Onsager's equation. 3. To determine the degree of hydrolysis and hydrolysis constant. 4. Determine the CMC of a surfactant by conductivity measurements. 5. To determine the Equivalence conductance and dissociation constant of strong electrolytes and weak electrolytes and hence to verify ostwald's distribution law. **pH metry: (any three)** 1. To determine normality and dissociation constant of tribasic acids using 0.1N NaOH by PHMetricaly 2. To determine the Hammett constant for p-amino/ nitro benzoic acid using 0.1N NaOH by PH-Metry. 3. To determine the standard oxidation potential of the Quinhydrone electrode. 4. To determine the acidic and basic dissociation constants of amino acid and its isoelectric point by pH-metry. 5. Determine the dissociation constant and strength of borax solution pHmetrically. **Potentiometry: (any three)** 1. Determination of dissociation constant of dibasic acids. 2. Determination of activity and activity coefficient of ions. 3. Redox titration- Fe^{2+} vs Ce^{4+}, I^- vs $KMnO_4$. 4. Determine the amount of ferrous sulphate / ferrous ammonium sulphate in given flask potentiometrically using cerric salt solution. 5. Determine the pseudo first order rate constant for bromination of N,	**60**

		N – dimethylaniline/phenol. **Refractometry: (any three)** 1. To study the variation of refractive index with composition of given liquid and to determine the % composition of unknown mixture. 2. Determine parachor/density/refractive index of binary solutions. 3. To determine the molar refractive index of a given salt. 4. To determine the electron polarization and electron polarizability of a given salt. 5. To determine refraction equivalents of carbon, hydrogen and chlorine atoms. **Polarimetry:** 1. To determine the specific & molecular rotation of glucose/ sucrose & hence intrinsic rotation and concentration of an unknown solution of optically active compound. 2. To determine the rate constant for the inversion of cane sugar. 3. To determine % composition of D-sucrose and tartaric acid in a given mixture.	

Reference Books

1. Rao C. N. R; Muller A.; Cheetam A. K.; (2004) The Chemistry of Nanomaterials, Vol.1, and 2, Wiley – VCH.
2. B. K. Sharma. "Instrumental method of chemical analysis"**24th** edition**,** GOEL publishing house Meerut .2005.
3. Gary D. Christian. "Analytical chemistry"**6th** editionJohn Wiley & sons, Inc. 2004
4. Skoog, Holler, Niemon, "principles of instrumental analysis"**5th**edition, Saunders college publisher.
5. Parsania P. H (2005, 1st edition) Experiments in Physical Chemistry, Granth Nirman Board.
6. Experimental Physical Chemistry by G. Peter Matthews, (Clarendon Press, Oxford, London).
7. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, (New Age International Publishers, New Delhi).
8. Advanced Physical Chemistry Experiments by Gurtu and Gurtu, (Pragati Prakashan, Meerut).
9. Advanced Physico-Chemical Experiments by J. Rose, (Sir Isaac Pitman & Sons Ltd., London).
10. Experiments in Physical Chemistry by D. P. Shoemaker, C. W. Garland and J. W. Nibler, (McGraw Hill International Edition, London
11. A Laboratory Manual of Experiments in Physical Chemistry by D. Brennan and C. F. H. Tipper,(McGraw hill Publishing Company Ltd., London) .
12. Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, (Anjali Publication, Aurangabad)
13. Experimental Physical Chemistry by R. C. Das & B. Behera, (Tata McGraw hill Publishing Company Ltd., New Delhi).
14. W. J. Popiel, Laboratory Manual of Physical Chemistry, ELBS, London, 1970.

Major Chemistry 20 (CHM404-4C) Advanced Chemistry-404 (OJT):

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	7	**Total Practical Internal Marks**	50
Category of Course	Major Chemistry-20	**Total Theory Internal Marks**	-
Course Credit	4 (2T + 2P)	**External Theory Exam Marks**	50
Teaching Hours	2T + 4P	**Total Marks**	100
Course Code	CHM404-4C	**External Theory Exam Duration**	2- Hours Theory
Course Title	**Advanced Chemistry-404**		

Course Contents –Major Chemistry-20 (CHM404-4C Advance Chemistry 404)

Course Objectives:

1. To understand the pharmaceutical applications of inorganic compounds, metal complexes, radioisotopes, and chelation therapy in medicine.
2. To develop knowledge of green chemistry principles and sustainable approaches for environmentally benign chemical synthesis.
3. To study green solvents, catalysts, alternative energy sources, and their applications in modern chemical processes.
4. To acquire practical skills in the separation, purification, and identification of organic compounds present in binary mixtures.

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

1. Explain the medicinal and pharmaceutical significance of inorganic compounds, metal complexes, radioisotopes, and chelating agents.
2. Apply the principles of green chemistry to design environmentally friendly and sustainable chemical processes.
3. Evaluate the use of green solvents, catalysts, and non-conventional energy sources in chemical synthesis.
4. Perform systematic separation and identification of mono- and bifunctional organic compounds from binary mixtures using appropriate techniques.
5. Demonstrate laboratory skills in qualitative organic analysis, purification, and characterization of organic compounds.

Sem	Unit	Syllabus	Teaching Hours
7	1	**Selected Topics Inorganic Pharmaceutical Chemistry** Introduction, Alkali and Alkaline earth metals as drug, pharmaceutical, application of boron and aluminium compounds, transition metal complexes as potential medicinal agent, Radioactive compounds and their clinical applications, Chelation therapy.	**15**
	2	**Green Chemistry:** Introduction, importance and twelve principles of Green Chemistry.	**15**

		Designing a green synthesis using these principles. Green Chemistry in day-to-day life. Green solvents (alternatives of organic solvents). Ionic liquids, supercritical fluids, CO_2 and H_2O and aqueous phase organic synthesis. Non-traditional greener alternative approaches: green reagents, catalysis, biocatalysis. Applications of non-conventional energy sources: Microwave, ultrasonic assisted synthesis, electro-synthesis and sunlight (UV), radiation assisted synthesis.	
	3	**Separation and Identification of mono/bi functional two component mixture of organic compounds (Minimum 15 mixtures)** (a) Two solid components using water, $NaHCO_3$, NaOH and HCl for separation (b) Liquid + liquid component - separation by physical method. (c) Liquid + solid component - separation by physical method.	**60**

Reference Books

1. Strohfeldt K. A., (2015) Essentials of inorganic chemistry: for students of pharmacy, pharmaceutical sciences and medicinal chemistry, (ISBN: 9780470665589)
2. Text Book of Inorganic Pharmaceutical Chemistry by Dr. Vaishali M. Patil, Dr. Neeraj Masand, and Ms. Shikha Kaushik
3. Inorganic Pharmaceutical Chemistry by Dr. K. G. Bothara
4. Inorganic, Medicinal & Pharmaceutical Chemistry by J.H. Block & E.B. Roche
5. Green Chemistry by V. K. Ahluwalia, Ane Books Pvt. Ltd.
6. Green Chemistry by K. R. Desai, Himalia Publishing House.
7. Instrumental Methods of Analysis by B. Sivasankar.

Research Methodology in Chemistry-I

Course Level	6	**Total Internal Marks**	25
Programme	B. Sc. Chemistry	**Total External Marks**	25
Semester	7	**Total Practical Internal Marks**	25
Category of Course	SEC	**Total Theory Internal Marks**	-
Course Credit	2	**External Practical Exam Marks**	25
Teaching Hours	2T	**Total Marks**	50
Course Code	SEC-5	**External Practical Exam Duration**	4- Hours Practical
Course Title	**Research Methodology in Chemistry-I**		

Course Contents –Research Methodology in Chemistry-I

Course Objectives:

1. To develop fundamental skills in chemical research methodology, literature survey, scientific writing, and research communication.
2. To familiarize students with reference management tools, citation practices, and research paper preparation.
3. To understand the principles and applications of common separation and purification techniques used in chemical research.
4. To acquire practical knowledge of chromatographic and extraction methods for the isolation, purification, and characterization of chemical substances.

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

1. Conduct literature surveys using scientific databases and prepare abstracts, mini-reviews, and research proposals.
2. Apply appropriate citation and referencing styles using reference management software.
3. Prepare and format scientific documents, research papers, and reports according to accepted standards.
4. Select and apply suitable separation and purification techniques such as distillation, crystallization, sublimation, solvent extraction, and chromatography.
5. Analyse and interpret experimental results obtained from purification and chromatographic techniques used in chemical research.

Sem	Unit	Syllabus	Teaching Hours
7	**1**	**Usage of Chemistry Software in Scientific writing** **Theory /Demonstration:** • Drawing chemical reactions, Structure drawing using templates, Structure to name and name to structure. • Drawing mechanism of reactions, Diagram of Assembly, Chiral	**15**

		Structure. • Reproducing reaction scheme from given research paper, 3D ChemDraw ultra **Assignment/Practical** • Deduce following from software: Name to structure, Structure to name, Generation of smile, Chemical Formula, Exact Mass, Molecular Weight, Elemental Analysis, Boiling Point, Melting Point, Critical Temp., Critical Pres., Critical Vol., Gibbs Energy, Log P, etc. • Predict ^{1}H-NMR and ^{13}C-NMR • Generate colourful view of molecules.	
	2	**Usage of MS Office in Chemistry Research** **Theory /Demonstration:** • Data entry, Statistical Calculations, Graph plotting and regression analysis using MS Excel, Creating a spreadsheet, entering and formatting information, applying basic functions and formulae to the data, drawing charts, tables and graphs, displaying the equation of graph along with the R value, incorporating tables and graphs in Word files, graphical solution of equations, concentration versus time graphs, spectral data, titration curves, etc. • Preparation of scientific presentations, Poster design and preparation of Seminar presentation using MS Power Point. **Assignment/Practical:** • Mean, standard deviation, least square curve fitting method for linear equation. • Plot the conductometric titration curve for a) strong acid vs strong base and b) weak acid vs strong base. • Plot the pH metric titration curve for a) strong acid vs strong base and b) weak acid vs strong base and determine the pKa of the weak acid. • Plot the graphs for the kinetics of first order reaction and determine the rate constant. Plot the UV-vis absorbance spectra and determine the molar absorption coefficient.	**15**

Reference Books

1 Brian S. Furniss (1989, Fifth edition) Vogel's Textbook of Practical Organic Chemistry. Hoboken: John Willey & Sons (ISBN: 0-582-462363).

2 Experimental Organic Chemistry by Laurence M. Harwood and Christopher J. Moody

3 Research Methodology: Methods and Techniques by C. R. Kothari

4 Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar.

Research Project Proposal

Course Level	6	**Total Internal Marks**	-
Programme	B. Sc. Chemistry	**Total External Marks**	-
Semester	7	**Total Practical Internal Marks**	100
Category of Course	SEC	**Total Theory Internal Marks**	-
Course Credit	4	**External Practical Exam Marks**	-
Teaching Hours	8P	**Total Marks**	100
Course Code	RP	**External Practical Exam Duration**	-
Course Title	**Research Project Proposal**		

Research Project Proposal

Course Objectives:

1. To develop fundamental skills in chemical research methodology, literature survey, scientific writing, and research communication.
2. To Analyze published literature
3. To Perform critical analysis of literature survey and established research scope
4. To Create research aims and objective
5. To Identify appropriate research methodology to full fill research objective
6. To Create research proposal in the prescribed format

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

1. Draw and prepare structures, diagrams, plots and reaction mechanism.
2. Carry out literature survey for research problem
3. Prepare and format scientific documents, research papers, and reports according to accepted standards.
4. Prepare a research proposal in standard format.

Sem	Unit	Syllabus	Teaching Hours
7	**1**	**Usage of Computer Software in Scientific writing and Illustration** • Drawing chemical reactions, Structure drawing using templates, Structure to name and name to structure and deduce various chemical properties. Drawing mechanism of reactions, Diagram of Assembly. • Deduce following from software: Name to structure, Structure to name, Generation of smile, Chemical Formula, Exact Mass, Molecular Weight, Elemental Analysis, Boiling Point, Melting Point, Critical Temp., Critical Pres., Critical Vol., Gibbs Energy, Log P, Predict ^{1}H-NMR and ^{13}C-NMR etc. • Data entry, Statistical Calculations, Graph plotting and regression	**15**

		analysis using MS Excel or equivalent software, Creating a spreadsheet, entering and formatting information, applying basic functions and formulae to the data, drawing charts, tables and graphs, displaying the equation of graph along with the R value. • Mean, standard deviation, least square curve fitting method for linear equation. **Scientific Writing and Usage of Office Software** • Plot the conductometric titration curve for a) strong acid vs strong base and b) weak acid vs strong base. Plot the pH metric titration curve for a) strong acid vs strong base and b) weak acid vs strong base and determine the pKa of the weak acid. Plot the graphs for the kinetics of first order reaction and determine the rate constant using MS Excel or equivalent software. • Preparation of scientific poster design and preparation of dissertation presentations with tables and graphs, graphical abstract, various equations, spectral data, etc. with office software. • Preparation of scientific presentations, Poster design and preparation of Seminar presentation using MS Power Point.	
	2	**Research Project Proposal Writing (Minimum 5000 words)** • The student shall pursue his/her dissertation/project work under university recognized research guide only. • Explanation of various research funding agencies (UGC, DBT, DST, CSIR, SERB, GUJCOST) & their research support schemes. • Training on how to write various aspects of research proposal in given format with one example. (Title, description of problem, review of related work, national & international status, rationale for taking up project, objective of proposal, methodology, references, year-wise work plan, budget estimation etc.) • Assign chemistry-based research problems and its literature review. • Preparation and submission of one research proposal for anyone funding agency. • Presentation (ppt) of the prepared research proposal including all aspects. • Viva voce will be based on the research proposal and its various aspects.	**15**

Reference Books

1 Research Methodology: Methods and Techniques by C. R. Kothari

2 Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar.

Research Project Proposal Viva Voce

Course Level	6	**Total Internal Marks**	-
Programme	B. Sc. Chemistry	**Total External Marks**	-
Semester	7	**Total Practical Internal Marks**	-
Category of Course	SEC	**Total Theory Internal Marks**	-
Course Credit	2	**External Practical Exam Marks**	50
Teaching Hours	-	**Total Marks**	50
Course Code	RP	**External Practical Exam Duration**	06 Hours
Course Title	**Research Project Proposal Viva Voce**		

Research Project/ Proposal Viva Voce		
Sem	**Syllabus**	**Teaching Hours**
7	• Research Project Proposal viva voce will be carried out in the form of a presentation of his/her research proposal prepared during SEM 7. The presentation should include brief introduction, objective of research, scheme of research problem, Proposed research work and methodology, referencing etc. of the present proposal study. • Research Project Proposal Viva Voce will be carried out during university practical examination by external examiner.	-

Evaluation Methods

Internal Evaluation Scheme		
No.	Particulars	Marks
1	(Mandatory) Mid Semester Internal Exam of 50% total internal marks (Practical or Theory to be decided from allotted internal evaluation marks in the course structure)	13/25 or 25/50
2	Attendance	3/5
3	Class Test	3/5
4	Open book exam/test	3/5
5	Open note exam/test	3/5
6	Self-test/ Online test	3/5
7	Assay/Article writting	3/5
8	Quizzes/Objective test	3/5
9	Class assignment	3/5
10	Home assignment	3/5
11	Reports Writing	3/5
12	Research/Dissertation	3/5
13	Case Studies	3/5
14	Viva/Oral exam	3/5
15	Group Discussion	3/5
16	Role Play	3/5
17	Paper presentation/Seminar	3/5
18	Language Lab work	3/5
19	Interview	3/5
20	Craft work	3/5
21	Co-curricular work	3/5
22	Field Assignment	3/5
23	Poster Presentation	3/5
24	Project Work	3/5
	Total	25/50

Note: Sr. No. 1 is mandatory. Select any 4/5 from Sr. No. 2 to 24 to make up the total marks internal marks 25 or 50. Student should secure 9 or18 Marks respectively for passing in internal Exam with total internal marks 25 or 50.

Paper Style External Theory Exam (50-marks)

External Assessment by University			
Que No	Particulars	From which unit	Marks
1	Attempt any two out of three questions	1	10
2	Attempt any two out of three questions	2	10
3	Attempt any two out of three questions	3	10
4	Attempt any two out of three questions	4	10
5	Attempt any two out of four questions	One question from each unit	10
	Total Marks		50

Paper Style External Practical Exam 50-Marks

Exercise	Particulars	Time	Marks
1	**Session-1**	**4 Hrs**	**25**
2	**Session-2**	**4 Hrs**	**25**
		8 Hrs	**50**

Note: The structure for Major-17, Major-18, Major-19 and Minor-07 will be as per the above.

Paper Style External Theory Exam (25-marks)

External Assessment by University			
Que No	Particulars	From which unit	Marks
1	Attempt any two out of three questions	1	10
2	Attempt any two out of three questions	2	10
3	Attempt any one out of two questions	1 from each unit	5
	Total Marks		25

Paper Style External Practical Exam 25-Marks

Exercise	Particulars	Time	Marks
1	**Session-1**	**4 Hrs**	**25**