BHAKTA KAVI NARSINH MEHTA UNIVERSITY

JUNAGADH 362263

SYLLABUS

Faculty of Science

B.Sc. Chemistry

(Honours & Honours with Research)

Semester VIII

Under NEP-2020

Effective from June 2026

BHAKTA KAVI NARSINH MEHTA UNIVERSITY

Faculty of Science

Effective from June 2026

Subject: CHEMISTRY

SEMESTER- VIII

Common Structure

Sem-08 (UG-4th Year Honours & Honours with Research)

Summary of the Courses for B. Sc Chemistry Semester-VIII										
Sem	**Sr. No.**	**Category of Course**	**Course Title**	**Course Level**	**Credit**	**Teaching Hrs.**	**SEE Marks**	**CCE Marks**	**Total Marks**	**SEE-Exam Duration**
8	1	Major-21	Advanced Chemistry-405	6	4	4T	50	50	100	2T Hours
	2	Major-22	Advanced Chemistry-406	6	4	4T	50	50	100	2T Hours
	3	Major-23	Advanced Chemistry Practical-407	6	4	8P	50	50	100	8P Hours
	4	Minor-08	Minor Chemistry-402	6	4	2T+4P	50	50	100	2T Hours
	5	On the Job Training (OJT)		6	6	-	-	-	150	-
		OR								
		Major-24	Advanced Chemistry-408	6	4	2T+4P	50	50	100	2T Hours
		SEC	Research methodology in Chemistry-2	6	2	4P	25	25	50	2P Hours
		OR								
		RP	Dissertation/Project	6	4	8P	50	50	100	-
			Dissertation/Project Viva Voce	6	2	4P	25	25	50	6P Hours
				Total	**22**				**550**	

Semester Programme Objectives:

The overarching objectives of the B.Sc. Chemistry Honors 4th-year curriculum are designed to transition students from basic concepts to advanced specialized knowledge, industrial application, and independent research methodologies:

- Advanced Chemical Principles: To build an in-depth understanding of advanced organometallic chemistry, advanced chemical kinetics, electronic structures, and molecular photochemistry.
- Analytical & Industrial Competence: To equip students with the standard testing protocols, validation procedures, and analytical skills necessary for processing environmental samples (soil/water), pharmaceuticals, and petrochemical products.
- Practical Mastery & Laboratory Synthesis: To train students in high-level laboratory safety, complex multi-step coordination complex synthesis, quantitative estimations, and the extraction/purification of chemical moieties.
- Regulatory & Professional Literacy: To introduce critical industrial frameworks including Intellectual Property Rights (IPR), Indian Pharmacopeia guidelines, and laboratory standardization protocols.
- Research Methodology & Digital Capabilities: To foster skills in chemical literature searching, navigating scientific databases, handling chemical drawing software (e.g., ChemDraw), statistical data processing, and ethical scientific communication.

Semester Programme Learning Outcomes:

Upon successful completion of the Semester-VIII curriculum, students will achieve the following competencies across their core, minor, and skill-based courses:

- **Advanced Organic Synthesis & Photochemistry (Major-21):** Master transition-metal organometallic bonding rules (18\text{-electron rule}/EAN), explain industrial catalytic mechanisms (e.g., Monsanto, Ziegler-Natta), and solve mechanistic pathways for advanced organic rearrangements and photochemical cleavages (Norrish Type I/II).
- **Kinetics, Electrochemistry & Industrial Analysis (Major-22):** Evaluate rate equations for complex and fast reactions, apply electrochemical laws (Tafel equation) to commercial batteries, and run standard diagnostic quality tests on environmental (soil/water) and petrochemical samples.
- **Advanced Laboratory Practical (Major-23):** Synthesize and purify diverse transition metal coordination complexes, calibrate precision glassware, and perform quantitative purity assays on active pharmaceuticals (Aspirin, Paracetamol) and food matrices.
- **Spectroscopy & Nuclear Chemistry (Minor-08):** Interpret fundamental characterization data from NMR, IR, Mass Spectrometry, and XRD systems, calculate

nuclear decay kinetics and binding energies, and run essential soil and water quality testing.

- **IPR, Pharma & Qualitative Separation (Major-24 Elective):** Apply patentability criteria under the Indian Patent Act, conduct pharmacopeial dissolution and limit tests, and systematically isolate less common metal ions (W, Tl, Ti, Mo, Se, Zr, Th, Ce, V, Li) from complex mixtures.
- **Research Tools & Lab Safety (SEC):** Navigate global scientific databases (SciFinder, Scopus) using proper citation ethics, safely execute complex distillation and chromatography operations, and process experimental data using MS Office utilities.

Major Chemistry-21 (CHM405-4C/Advanced Chemistry-405)

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	8	**Total Practical Internal Marks**	-
Category of Course	Major-21	**Total Theory Internal Marks**	50
Course Credit	4	**External Theory Exam Marks**	50
Teaching Hours	4T	**Total Marks**	100
Course Code	CHM405-4C	**External Theory Exam Duration**	2- Hours Theory
Course Title	**Advanced Chemistry-405**		

Major Chemistry-21 (CHM405-4C/Advanced Chemistry-405)

Course Objectives:

1. Understand the structure, bonding, nomenclature, and electronic properties of organometallic compounds and their significance in modern chemistry.
2. Explain the mechanisms of fundamental organometallic reactions and catalytic processes involved in industrial and synthetic applications.
3. Develop a comprehensive understanding of important organic reactions and molecular rearrangements, including their mechanisms and synthetic utility.
4. Understand the principles of photochemistry, excited-state behavior, and the mechanisms of photochemical transformations in organic molecules.
5. Apply mechanistic concepts to analyze, predict, and solve problems related to organometallic, organic, and photochemical reactions.

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

1. Explain the classification, bonding, nomenclature, electron-counting methods (18-electron rule and EAN), and concepts of organometallic compounds.
2. Analyze the mechanisms of organometallic reactions such as ligand substitution, oxidative addition, reductive elimination, sigma-bond metathesis, and evaluate the role of organometallic catalysts in important industrial processes.
3. Describe and interpret the mechanisms, synthetic applications, and significance of important organic reactions and rearrangements including Appel, Mitsunobu, Michael addition, Wagner–Meerwein, Favorskii, Lossen, and related transformations.
4. Explain the fundamental principles of photochemistry, excited-state processes, and photochemical reactions of alkenes, carbonyl compounds, and unsaturated systems using mechanistic approaches.
5. Apply mechanistic and theoretical concepts to predict reaction pathways, products, and applications of organometallic, rearrangement, and photochemical reactions in organic synthesis and industrial chemistry.

Sem	Unit	Syllabus	Teaching Hours
8	**1**	**Structure and Bonding in Organometallic Compounds** Introduction, Classification based on Metal carbon bond, Hepticity,	**15**

		Classification of Ligands in organometallic chemistry: (carbonyls, nitrosyls, hydride and dihydrogen, phosphine, ethylene, and related ligands, cyclopentadiene and related ligands, alkyl, aryl, carbenes, carbynes, carbides), Nomenclature of Organometallic Compounds, 18 Electron rule and EAN, Concept of Isolobality and Isolobal Analouges	
	2	**Reaction Mechanism and catalytic process of organometallic complex** Reactions involving gain or loss of ligands, Ligand dissociation and substitution, Oxidative addition and C-H bond activation, Reductive elimination, and Pd-Catalyzed cross-coupling, Sigma bond metathesis, Organometallic catalysts: Catalytic deuteration, Hydroformylation, Monsanto acetic acid process, Tennessee–Eastman acetic anhydride process, Wacker (Smidt) process, Hydrogenation by Wilkinson's catalyst, Olefin metathesis, Fischer–Tropsch carbon chain growth, Ziegler–Natta polymerizations.	**15**
	3	**Some Important Reactions and Rearrangements** **Reactions:** Principal, mechanism and applications of: Appel reaction, Nef reaction, Prins reaction, Mitsunobu reaction, Vilsmeier-Haack reaction, Blanc Reaction, Michael addition. **Rearrangements:** Principal, mechanism and applications of: Wagner-Meerwein, Favorskii, Lossen rearrangement, Neber rearrangement, Baker-Venkataraman rearrangement.	**15**
	4	**Photochemical Reactions** Absorption of light by organic molecules, Jablonski diagram, properties of excited states and mechanism of excited state processes. (a) Photochemistry of alkenes and related compounds: Isomerization (cis-trans), Di-π- methane rearrangement. (b) Photochemistry of carbonyl compounds: Norrish type-I cleavage of acyclic, cyclic, and unsaturated carbonyl compounds, Norrish type-II cleavage. (c) Photocyclo-addition of ketones with unsaturated compounds (reaction with mechanism): Paterno-Buchi reaction, Barton reaction, Photodimerization of unsaturated ketones, Rearrangement of enones and dienones, Photo-Fries rearrangement.	**15**

Reference Books

1. The Organometallic Chemistry of the Transition Metals" by Robert H. Crabtree
2. Basic Organometallic Chemistry: Concepts, Syntheses, and Applications" by B.D. Gupta and Anil J. Elias
3. Organometallic Chemistry and Catalysis" by Didier Astruc
4. Modern Molecular Photochemistry of Organic Molecules, Nicholas J. Turro, V. Ramamurthy, Juan C. Scaiano
5. Organic Chemistry by G. Marc Loudon, Oxford University Press (2002).
6. Reaction Mechanism and Reagents in Organic Chemistry -- Gurdeep R. Chatwal.
7. Organic Chemistry by J. Clayden, N. Greeves, S. Warren, and P. Wothers, Oxford University Press (2000).

Major Chemistry-22 (CHM406-4C/Advanced Chemistry-406)

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	8	**Total Practical Internal Marks**	-
Category of Course	Major-22	**Total Theory Internal Marks**	50
Course Credit	4	**External Theory Exam Marks**	50
Teaching Hours	4T	**Total Marks**	100
Course Code	CHM406-4C	**External Theory Exam Duration**	2- Hours Theory
Course Title	**Advanced Chemistry-406**		

Major Chemistry-22 (CHM406-4C/Advanced Chemistry-406)

Course Objectives:

1. Understand the principles of chemical kinetics and the factors affecting reaction rates, including reaction mechanisms and photochemical processes.
2. Develop knowledge of electrochemical principles, ionic equilibria, activity coefficients, and the operation of commercial electrochemical cells.
3. Acquire practical and analytical skills for the qualitative and quantitative analysis of soil and water quality parameters.
4. Understand the composition, properties, and standard analytical methods used in the characterization of petroleum and petrochemical products.
5. Apply theoretical concepts and analytical techniques to solve problems related to kinetics, electrochemistry, environmental analysis, and petrochemical testing.

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

1. Explain the theories of chemical kinetics, reaction mechanisms, ionic reactions, unimolecular reactions, and photochemical kinetics, and evaluate factors influencing reaction rates.
2. Apply electrochemical principles to determine activity coefficients, decomposition potential, overvoltage phenomena, and analyze the working and applications of various commercial cells.
3. Perform and interpret soil analysis for physicochemical parameters and nutrient content, and evaluate soil quality for agricultural and environmental purposes.
4. Analyze water samples using standard methods for determining physical and chemical parameters, assess water quality, and compare results with national and international drinking water standards.
5. Evaluate the composition and quality of petroleum products and apply standard testing methods to determine their physicochemical properties and industrial suitability.

Sem	Unit	Syllabus	Teaching Hours
8	**1**	**Chemical Kinetics** Introduction, activated complex theory in terms of thermodynamic, influence of ionic strength and solvent properties on rate, Complex	**15**

		reactions: Opposing reactions (Reversible), Consecutive reactions, Parallel Reaction, kinetics of fast reaction, Ionic reactions, and salt effect. Unimolecular reactions: Lindemann-Christiansen hypothesis, Hinshelwood. Photochemical reactions: introduction, rate law, kinetics of photochemical reactions-kinetics of hydrogen-bromine, decomposition of HI and Anthracene reaction.	
	2	**Electrochemical cells** Introduction, Ostwald dilution law, Debye-Huckel theory of mean ionic activity co-efficient, Decomposition potential and its determination, over-voltage, hydrogen over-voltage, factors affecting over-voltage, importance of hydrogen over-voltage, Tafel equation. Numerical problems. Commercial cells: Fuel cell, lead accumulator, nickel iron accumulator, zinc silver accumulator.	**15**
	3	**Analysis of Soil and Water** Soil: Introduction, Importance of soil testing, Types of soils and analysis of soil for following parameter: pH, Electrical Conductance, Organic Carbon, Determination of Sodium, Potassium, Boron, Phosphorous. Water:Introduction, Sampling techniques, Preservation and Pre-concentration methods, Determination of following parameters: Total Acidity, Alkalinity, Free Carbon Dioxide, Chloride content, Calcium content, Magnesium content, Iron content, Silver content, Heavy Metals, DO, COD, BOD, National and International standards for drinking water.	**15**
	4	**Analysis of Petrochemical Products** Petroleum: Introduction, Definition, Composition, Test methods for following: Naphtha: Aniline and Mixed Aniline point, Composition, Density, Evaporation rate, Flash point, Velocity, Volatility, Appearance, Kauri-Butanol value. Gasoline: Additives, Composition, Corrosiveness, Density, Flash and Fire point, Volatility, Water and Sediments Kerosene: Acidity, Composition, Flash and Fire point, Pour point, Density, Viscosity, Water and Sediments Diesel: Acidity, Composition, Flash and Fire point, Pour point, Density, Viscosity, Water and Sediments Distillate.	**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, ArunBhahl,G. D. Tuli, (2005) Essetials 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. Soil Testing and Recommendation: A Text Book by R.K. Basak.
11. Manual on Soil, Plant and Water Analysis by Dhyan Singh, P.K. Chhonkar, and B.S. Dwivedi
12. Methods for Analysis of Petroleum Products by ASTM, International USA
13. Handbook of Petroleum Product Analysis by James G. Speight

Major Chemistry-23 (CHM407-4C/Advanced Chemistry-407)

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	8	**Total Practical Internal Marks**	50
Category of Course	Major-23	**Total Theory Internal Marks**	-
Course Credit	4	**External practical Exam Marks**	50
Teaching Hours	4T	**Total Marks**	100
Course Code	CHM407-4C	**External Practical Exam Duration**	8P Hours
Course Title	**Advanced Chemistry Practical-407**		

Major Chemistry-23 (CHM407-4C/Advanced Chemistry Practical-407)

Course Objectives:

1. Develop laboratory skills in the synthesis, purification, and characterization of coordination compounds and inorganic substances.
2. Understand the principles of coordination chemistry through the preparation of various transition metal complexes and the study of their properties.
3. Acquire proficiency in volumetric, gravimetric, and instrumental analytical techniques used for quantitative chemical estimations.
4. Develop competence in the standardization of reagents, calibration of laboratory apparatus, and accurate handling of analytical procedures.
5. Apply analytical methods for the quality assessment of pharmaceutical products, food samples, and industrial materials while maintaining good laboratory practices.

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

1. Synthesize a variety of coordination compounds and inorganic preparations using standard laboratory techniques and explain the underlying chemical principles involved.
2. Demonstrate practical understanding of coordination chemistry by preparing metal complexes of transition metals and interpreting their structural and chemical properties.
3. Perform quantitative chemical analyses through solution preparation, standardization, calibration, titrimetric methods, and estimation of metal ions and industrial chemicals.
4. Determine the purity and composition of pharmaceutical compounds and chemical samples using appropriate analytical methods and calculations.
5. Analyze food and drug samples for important quality parameters such as protein content, peroxide value, saponification value, starch content, iodine content, and reducing sugars, and interpret the analytical results accurately.

Sem	Unit	Syllabus	Teaching Hours
8	**1**	**Preparation of metal complexes: (Minimum 10)** 1. Preparation of $[VO(AcAc)_2]$. 2. Preparation of cis & trans $[Cr(Ox)_2(H_2O)]$. 3. Preparation of $[Co(Py)_2Cl_2]$. 4. Preparation of $[Cu(gly)_2]$ & $[Cu(acac)_2]$.	**60**

		5. Preparation of $[Cu(NH_3)_4]SO_4.H_2O$ 6. Preparation of $[Ni(NH_3)_6]Cl_2$ compare with $[Ni(H_2O)_6]Cl_2$. 7. Preparation of $[Fe(HCO_2)_2].2H_2O$. 8. Preparation of $[Ni(en)_3]Cl_2.2H_2O$ 9. Synthesis of bis(salicylidene)ethylene diamine cobalt (II) complex. 10. Synthesis of bis(8-quinolinol) bis(benzylidene)ethane-1,2-diamine Ni(II) complex. 11. Prussian blue **Inorganic Preparations: (Minimum 05)** 1. Ferrous ammonium sulphate from Ferrous Sulphate 2. Magnesium carbonate from Magnesium chloride 3. Zinc Phosphate from Zinc powder 4. Calcium carbonate from Calcium chloride 5. Malachite from copper sulphate. 6. Chrome yellow from lead nitrate.	
	2	**Analytical estimation** 1. Preparation and Standardization of solutions. 2. Calibration of glassware and apparatus. 3. To determine the % purity of Aspirin. 4. To determine the % of Zinc Oxide by reduce titration method. 5. To determine the amount of Calcium and Zinc in given sample. 6. To determine the volume strength of H_2O_2. 7. To determine the % purity of given Phthalic anhydride. 8. To determine the % purity of given Malic anhydride. 9. Estimation of Calcium and Magnesium in given sample. 10. To determine the amount of Tin from solder wire. **Analysis of Food and Drug (Minimum 05)** 1. % purity of Aspirin, Paracetamol, Valproic acid, Ascorbic acid etc. 2. Total protein content in milk. 3. Peroxide value of oil sample. 4. Saponification value of oil sample. 5. Percentage of starch content in turmeric powder. 6. Amount of iodine in the given iodized salt. 7. The percentage of reducing sugars in honey sample.	**60**

Reference Books

1. Svehla, G. (1996, Seventh edition) Vogel's Qualitative Inorganic Analysis. New Jersey: Pearson Education. (ISBN: 0582218667).
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. Pass G., Sutcliffe H., (1974 2nd edition) Practical Inorganic Chemistry: Preparations, Reactions, and Instrumental Methods. (ISBN: 9789401727440)
4. Marusak R. A., Doan K., Cummings S. D., (2007) Integrated approach to coordination chemistry an inorganic laboratory guide, (ISBN: 9780471464839)
5. Woollins D. (2006, 2nd edition) Inorganic Experiments, (ISBN: 978352730510)
6. Parsania P. H (2005, 1st ed) Experiments in Physical Chemistry, Granth Nirman Board. 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).

Minor Chemistry-8 (CHE402-4C/Minor Chemistry-402)

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	8	**Total Practical Internal Marks**	50
Category of Course	Minor-8	**Total Theory Internal Marks**	-
Course Credit	4 (2T + 2P)	**External Theory Exam Marks**	50
Teaching Hours	2T + 4P	**Total Marks**	100
Course Code	CHE402-4C	**External Theory Exam Duration**	2- Hours Theory
Course Title	**Minor Chemistry-402**		

Course Contents -Minor Chemistry-8 (CHE402-4C/Minor Chemistry-402)

Course Objectives:

1. Understand the fundamental principles and applications of important spectroscopic techniques used in chemical analysis and structure determination.
2. Develop a comprehensive understanding of nuclear chemistry, including nuclear structure, radioactivity, nuclear reactions, and their practical applications.
3. Acquire knowledge of nuclear decay processes, radioactive tracers, and quantitative calculations related to nuclear chemistry.
4. Develop practical skills in soil and water analysis using standard sampling, preparation, and analytical techniques.
5. Apply theoretical and experimental concepts to assess environmental quality and interpret analytical data obtained from soil and water samples.

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

1. Explain the basic principles, instrumentation, and applications of important spectroscopic techniques used for chemical characterization and analysis.
2. Describe nuclear structure, nuclear forces, binding energy, packing fraction, and interpret nuclear fission and fusion processes with suitable nuclear reactions.
3. Apply the principles of radioactivity, derive and solve problems related to nuclear decay kinetics, and explain the applications of radioactive tracers in dating techniques and scientific investigations.
4. Perform soil sample preparation and analyze important soil parameters such as pH, conductivity, organic carbon, nitrogen, phosphorus, and potassium using standard laboratory methods.
5. Conduct physical and chemical analyses of water samples, evaluate water quality parameters, and interpret analytical results for environmental monitoring and quality assessment.

Sem	Unit	Syllabus	Teaching Hours
8	**1**	**Introduction to some spectroscopic techniques** Nature of electromagnetic radiation, principle of spectroscopic analytical method and types of spectroscopic methods based on spectrum.	**15**

		X-Ray diffraction spectroscopy: Introduction and Principle, General applications. **Atomic Absorption spectroscopy:** Introduction, principle and Applications **Mossbauer spectroscopy**: Introduction and principle, Some applications. **Atomic absorption spectroscopy:** Introduction and principle, Some applications. **NMR**: Fundamental principle (equation), explanation of spectrum (eg; absolute ethanol) and its features (number, position, splitting (n+1) and intensity), General applications. **IR spectroscopy**: Types of fundamental vibrations and selection rule for IR and plot. General applications with some examples in daily life. **Mass spectrometry**: Basic principle, Nitrogen rule, mass spectrum, molecular ion and base peak, mass spectra of alkane.	
	2	**Nuclear Chemistry:** Introduction, fundamentals of nuclear forces and nuclear size, Packing fraction and Binding energy, Nuclear Fission (general introduction and nuclear reactions), Nuclear Fusion (general introduction and nuclear reactions), Radioactivity, Derivation of rate law of nuclear decay (with numerical), Radioactive Tracers (Carbon dating and Rock dating), Numerical.	**15**
	3	**Practical** **Soil Analysis:** Sample Preparation, pH analysis, Conductivity analysis, Organic Carbon analysis, Nitrogen analysis, Phosphorous analysis, Potassium analysis **Water Analysis:** Sample collection, Physical parameter (color, odor, taste, pH, turbidity and TDS), Chemical Parameter (Calcium, Magnesium, Sulphate, Sulphide, Sodium, Fluoride, Chloride, Nitrite, Nitrate, Alkalinity).	**60**

Reference Books

1. Introduction to Spectroscopy" by Donald L. Pavia
2. "Fundamentals of Molecular Spectroscopy" by C.N. Banwell & E.M. McCash
3. "Introduction to Spectroscopic Methods" by Dr. Timir Tripathi
4. Soil Testing and Recommendation: A Text Book by R.K. Basak
5. Manual on Soil, Plant and Water Analysis by Dhyan Singh, P.K. Chhonkar, and B.S. Dwivedi
6. Principles Of Soil And Water Analysis by Narayan Panda
7. Soil, Plant and Water Analysis by P.C. Jaiswal
8. A Text Book of Soil Analysis by T.C. Baruah & H.P. Barthakur
9. Modern Nuclear Chemistry by W. D. Loveland, D. J. Morrissey, and G. T. Seaborg
10. Essentials of Nuclear Chemistry by H. J. Arnikar
11. Nuclear Chemistry by Maheshwar Sharon and Madhuri Sharon.

Major Chemistry 24 (CHM408-4C) Advanced Chemistry-408 (OJT):

Course Level	6	**Total Internal Marks**	50
Programme	B. Sc. Chemistry	**Total External Marks**	50
Semester	8	**Total Practical Internal Marks**	50
Category of Course	Major Chemistry-24	**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-24 (CHM408-4C Advanced Chemistry 408)

Course Objectives:

1. Understand the fundamental concepts, legal framework, and significance of Intellectual Property Rights (IPR), particularly patents and their applications in science and technology.
2. Develop knowledge of pharmacopeial standards, pharmaceutical analysis, quality control procedures, and regulatory requirements for pharmaceutical products.
3. Acquire practical skills in performing physical, chemical, and pharmacopoeial tests for the evaluation of drug quality, purity, potency, and performance.
4. Develop competence in systematic inorganic qualitative analysis for the identification of common and less common metal ions in complex mixtures.
5. Apply analytical reasoning, laboratory techniques, and problem-solving skills in pharmaceutical and inorganic chemical analysis.

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

1. Explain the concepts, terminology, legislation, and significance of Intellectual Property Rights, and evaluate patentability criteria, including patent issues related to polymorphism and relevant case studies.
2. Describe pharmacopeial standards and perform various physical and chemical tests used in pharmaceutical analysis, including moisture determination, density measurements, limit tests, and assay procedures.
3. Evaluate the quality, purity, potency, and performance of pharmaceutical products through disintegration and dissolution testing using appropriate pharmacopeial methods and standards.
4. Apply systematic qualitative analysis techniques to identify and confirm the presence of common acidic and basic radicals in inorganic mixtures.
5. Analyze complex inorganic mixtures containing less common metal ions such as tungsten, thallium, titanium, molybdenum, selenium, zirconium, thorium, cerium, vanadium, and lithium through logical separation and confirmatory tests.

Sem	Unit	Syllabus	Teaching Hours
8	**1**	**Intellectual Property Rights (IPR)**	**15**

		Introduction, various Technical Terms, Legislation, IPA in India, Criteria for Patent, Patent for Polymorph, case studies.	
	2	**Pharmaceutical Analysis** Introduction to Pharmacopeia and Pharmacopeial analysis: Physical and chemical tests: Physical verification and colour test, Loss on drying, loss on ignition, Tape and Bulk Density, Determination of moisture, limit test for heavy metals, Limit test for Halogens, Purity and assay determination by classical methods, Concept for Potency determination. Introduction of Disintegration and Dissolution tests, types of Dissolution apparatus, Types of Dissolution media, Application.	**15**
	3	**Inorganic Qualitative Analysis (Minimum 15 mixtures)** Analysis of a mixture containing six radicals including one less common metal ion: W, Tl, Ti, Mo, Se, Zr, Th, Ce, V and Li.	**60**

Reference Books

1. Law Relating to Intellectual Property Rights by Dr. Neeraj Pandey and Dr. Khushdeep Dharni.
2. Law Relating to Intellectual Property by Dr. B.L. Wadehra.
3. The Intellectual Property Rights & Competition Law by K.D. Raju.
4. Indian Pharmacopeia, 2022, 9th Edition, Government of India, Ministry of Health and Welfare, Published by IPC, Ghaziabad.
5. Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists by David G. Watson.
6. A Textbook of Pharmaceutical Analysis by Dr. S. Ravi Shankar.
7. A Textbook of Pharmaceutical Drug Analysis by K.V. Subrahmanyam.
8. Svehla, G. (1996, Seventh edition) Vogel's Qualitative Inorganic Analysis. New Jersey: Pearson Education. (ISBN: 0582218667).

Research Methodology in Chemistry-II

Course Level	6	**Total Internal Marks**	25
Programme	B. Sc. Chemistry	**Total External Marks**	25
Semester	8	**Total Practical Internal Marks**	25
Category of Course	SEC	**Total Theory Internal Marks**	-
Course Credit	2	**External Practical Exam Marks**	25
Teaching Hours	4P	**Total Marks**	50
Course Code	SEC-7	**External Practical Exam Duration**	4- Hours Practical
Course Title	**Research Methodology in Chemistry-II**		

Course Contents –Research Methodology in Chemistry-II

Course Objectives:

1. Develop proficiency in the use of chemistry software for scientific writing, chemical structure drawing, and reaction scheme preparation.
2. Understand the application of ChemDraw and related software tools for representing chemical structures, mechanisms, stereochemistry, and laboratory assemblies.
3. Acquire skills in converting chemical structures into systematic names and vice versa, and in reproducing scientific content from research literature.
4. Develop competency in using MS Office tools, particularly MS Excel and MS PowerPoint, for data analysis, scientific documentation, and research communication.
5. Enhance scientific presentation and data interpretation skills through graphical analysis, statistical calculations, poster preparation, and seminar presentations.

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

1. Utilize chemistry software tools to draw chemical structures, reactions, mechanisms, laboratory assemblies, and chiral molecules accurately according to scientific conventions.
2. Apply ChemDraw functionalities to generate structure-to-name and name-to-structure conversions, create three-dimensional molecular representations, and reproduce reaction schemes from scientific literature.
3. Perform data entry, statistical calculations, graph plotting, and regression analysis using MS Excel for the interpretation of chemical and experimental data.
4. Prepare professional scientific presentations, posters, and seminar materials using MS PowerPoint for effective communication of research findings.
5. Integrate digital tools and software applications in chemical research, scientific writing, data analysis, and academic reporting with accuracy and efficiency.

Sem	Unit	Syllabus	Teaching Hours
8	**1**	**Research Methodology in Chemistry** **Theory /Demonstration** Literature Survey: Sources of information-primary, secondary,	**15**

		tertiary sources, Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents. Introduction to chemical abstracts, author index, and other indices with examples. Web resources, E-journals, journal access, citation index, impact factor, ONOS, E-books, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-Databases, ChemSpider, Science Direct, SciFinder, Scopus, etc. Methods of scientific research and writing scientific papers, reference writing using different reference management software. Writing ethics. Avoiding plagiarism. **Assignment/Practical** Format of Research Paper using MS Word and mini review. Research paper writing. Reporting practical and project work. Organizing a poster display. Giving an oral presentation.	
	2	**Research Methodology in Chemistry** **Theory /Demonstration** Separation and purification techniques commonly employed in chemical research for the isolation, purification, and characterization of chemical substances. Distillation techniques: simple distillation, steam distillation, fractional distillation of mixed components. Crystallization and fractional recrystallization techniques. Solvent Extraction Techniques, Chromatographic Techniques: TLC, Paper Chromatography, Column Chromatography. Safe working procedure and protective apparel for laboratory. Emergency procedure, first aid, laboratory ventilation. Safe storage and use of hazardous chemicals. Procedure for working with substances that pose hazards, flammable or explosive hazards. Safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system. **Assignment/Practical** Report and TLC of separated moieties. Report of distilled product. Summery and report of extraction and crystallization of moieties.	**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.

Dissertation/Project

Course Level	6	**Total Internal Marks**	-
Programme	B. Sc. Chemistry	**Total External Marks**	-
Semester	8	**Total Practical Internal Marks**	50
Category of Course	SEC	**Total Theory Internal Marks**	-
Course Credit	4	**External Practical Exam Marks**	50
Teaching Hours	8P	**Total Marks**	100
Course Code	RP	**External Practical Exam Duration**	-
Course Title	**Dissertation/Project**		

Dissertation/Project

Course Objectives:

1. To develop research skills and generate hypothesis on the basis of literature
2. To create new methodology or product by applying literature knowledge
3. To prepare a thesis draft and presenting the research work

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

1. Apply critical and analytical skills in a scientific and professional manner.
2. Plan and develop research project with critically apprising and interpretative published literature.
3. Synthesize knowledge and skills previously gained and applied to an in-depth study.
4. Compare and select from different research methodologies, methods and forms of analysis to produce a suitable research method.
5. Present the finding of their project in a written report.

Sem	Syllabus	Teaching Hours
8	**Dissertation/Project** The student shall pursue his/her dissertation/project work under university recognized research guide only. The student will be given the option of selecting a research problem in a preferred area that falls within the discipline of courses undertaken. The dissertation/project work could be conducted at the institute research laboratory. At the end of the semester, the student is required to submit his/her results in the form of a dissertation thesis. A student must submit 3 copies of his/her dissertation at the time of evaluation duly signed by candidate, guide and head of the institution. The thesis should include plagiarism certificate duly signed by candidate, guide and head of the institution. The format of the Dissertation thesis/project should be as under:	**120**

	The thesis should be typewritten on A4 size paper printed on both side in Times New Roman font with 12 size. A margin of at least 1.5 cm must be left at the left side of each page and a margin of 1.0 cm on the top, bottom, and right side of each page. The dissertation thesis shall arrange in the following sequence: Title, introduction of research problem, aims and objectives of the research undertaken, result and discussion, experimental section with characterization of compounds including spectral analysis, conclusion, and latest references as per the scopus index research journal format. The evaluation Dissertation thesis/Project will be carried out by concern research supervisor (internal) at the end of the semester.	

Dissertation/Project Viva Voce

Course Level	6	**Total Internal Marks**	-
Programme	B. Sc. Chemistry	**Total External Marks**	-
Semester	8	**Total Practical Internal Marks**	50
Category of Course	SEC	**Total Theory Internal Marks**	-
Course Credit	2	**External Viva Voce Exam Marks**	50
Teaching Hours	-	**Total Marks**	100
Course Code	RP	**External Viva Voce Duration**	06 Hours
Course Title	**Dissertation Viva Voce**		

Dissertation /Project Viva Voce		
Sem	**Syllabus**	**Teaching Hours**
8	Dissertation/Project viva voce will be carried out in the form of a presentation of his/her dissertation thesis. The presentation should include brief introduction, objective of research, scheme of research problem, result & discussion, spectra of compounds and conclusion of the present study. The evaluation of Dissertation/Project Viva Voce will be carried out during university practical examination by external examiner.	-

Evaluation Methods

Internal Evaluation Scheme (CCE)		
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**