Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

Shri Vaishnav Institute of Science

Choice Based Credit System (CBCS) in the light of NEP-2020

M.Sc. Chemistry

SEMESTER- I (2026-2028)

COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME					L	T	P	CREDITS
			THEORY			PRACTICAL					
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSCHC101	CORE	**Inorganic Chemistry**	**60**	**20**	**20**	**00**	**00**	**3**	**0**	**0**	**3**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

COURSE OBJECTIVES:

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

1. Understand the concepts of stereochemistry, bonding theories, and electronic structures in main group compounds and solids.
2. Explain the formation, stability, and reaction mechanisms of transition metal complexes in coordination chemistry.
3. Apply symmetry operations and group theory concepts for the classification and analysis of molecular structures.
4. Interpret the principles of Hard and Soft Acid–Base (HSAB) theory and the behavior of different solvents in inorganic chemistry.
5. Develop knowledge of important inorganic reagents and their applications in qualitative and quantitative inorganic analysis.
6. Enhance analytical, theoretical, and problem-solving skills related to advanced inorganic chemistry concepts. Explore the applications of artificial intelligence in inorganic chemistry.

Course Alignment with UNSDG:

The Course aims to fulfill the United Nations Sustainable Development Goals, **SDG 4 (Quality Education)**.

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M.Sc. Chemistry

SEMESTER- I (2026-2028)

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MSCHC101	CORE	**Inorganic Chemistry**	**60**	**20**	**20**	**00**	**00**	**3**	**0**	**0**	**3**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course outcomes: Upon successful completion of this unit, students will be able to:

CO-1	Explain stereochemistry and bonding in inorganic chemistry; analyze metal-ligand equilibria and reaction mechanism of transition metal complexes.
CO-2	Classify molecules into point groups and apply symmetry operations, matrix representations, and group theory principles to molecular systems.
CO-3	Interpret hard and soft acids and bases theory and classification and properties of non-aqueous solvents.
CO-4	Demonstrate the use of important inorganic reagents such as potassium bromate, potassium iodate, ceric sulphate, ammonium vanadate, and EDTA in inorganic analysis and Discuss the emerging role and future prospects of artificial intelligence in inorganic chemistry research and applications.
CO-5	They can predict potential applications of inorganic chemistry and practical utility to become good chemists.

Teaching Pedagogy:

T1	Classroom teaching (white board), Power Point Presentations, Interactive lectures.
T2	ABL activities, Assignments, Flip Class/ Seminars, Quizzes, Oral Viva-voce examination

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MSCHC101	CORE	**Inorganic Chemistry**	**60**	**20**	**20**	**00**	**00**	**3**	**0**	**0**	**3**

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Experiential Learning: Project Based Laerning (PBL) and Case Studies

Modules	Name	Experiment/ABL/PBL	Bloom Taxanomy
Module 1	Comparative Study of Metallic, Covalent and Superconducting Materials through Case Studies	Case Study	Analyze, Evaluate
Module 2	Determination of Stability Constants of Metal Complexes by pH-Metric/Colorimetric Method	Experiment	Apply, Analyze
Module 2	Case Study on Cisplatin and Other Transition Metal Complexes in Medicine	Case Study	Analyze, Evaluate
Module 3	Symmetry Analysis of Coordination Compounds and Molecular Structures using Group Theory Software	PBL	Apply, Analyze, Create
Module 4	Comparative Study of Hard and Soft Acids and Bases in Industrial	Case study	Analyze, Evaluate

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	and Biological Systems		
Module 5	Project on Industrial and Biological Applications of Coordination Complexes	PBL	Apply, Create, Evaluate
Module 5	Case Study on Applications of Artificial Intelligence in Inorganic Chemistry Research	Case study	Understand, Analyze, Evaluate

Assessment Tools

AT1-1	Quiz
AT1-2	Activity Based Learning
AT1-3	Midterm Exams
AT1-4	Flip Class
AT1-5	Seminar Presentation
AT1-6	Assignments
AT1-7	Poster and Research paper preparation and presentation.
AT1-8	Oral Viva-voce examination

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Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Prerequisites: Solid foundation in basic inorganic chemistry (periodic table, chemical bonding, hybridization, coordination chemistry etc.)

Module	Descriptors/Topics	Hours	Assessment tools
I	**Stereochemistry and Bonding in Main Group Compounds** Valence shell electron pair repulsion theory, Bent rule, Energetics of hybridization, dπ-pπ bonds, Walsh diagram, Some simple reactions of covalently bonded molecules, Bonding in solids: Metallic bonding, Classification of materials, Fermi level, Super conductivity.	9	Quiz Mid-term Exam Assignment
II	**Reactions in Metal Complexes** Metal-Ligand Equilibria in Solution: Thermodynamic stability, Stepwise stability constant, Overall stability constant, Relation between stepwise and overall stability constants, Factors affecting the stability of metal complexes; Reaction Mechanism of Transition Metal Complexes: Energy profile of a reaction, Inert and labile complexes, Reactions of metal complexes, Hydrolysis reactions: Acid hydrolysis, Base hydrolysis, Anation reactions, Marcus theory, Inner sphere and outer sphere reactions.	9	Mid-Term Quiz Assignment Oral Viva-voce
III	**Symmetry Elements and Group Theory** Symmetry element, Classification of elements into point groups, Matrix representation of symmetry operations, Groups, Multiplication table,	9	Mid-Term Quiz Assignment

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MSCHC101	CORE	**Inorganic Chemistry**	**60**	**20**	**20**	**00**	**00**	**3**	**0**	**0**	**3**

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	Classes of symmetry operations, Representation, The great orthogonality theorem.		Presentations Oral Viva-voce examination
IV	**Hard and Soft Acid Base Theory and Solvents** IKS Perspectives on Acids and Bases, Lewis's concept, Classification of Lewis acids and bases, HSAB principle, Symbiosis, Theoretical bases of Hardness and Softness, E and C equation, Donor number, Acceptor number, Donor complexes, Applications of HSAB concept. Classification of solvents, Properties of solvents.	9	Quiz Assignment Mid-Term Presentations
V	**Use of Inorganic Reagents in Inorganic Analysis and AI in Inorganic Chemistry** Potassium bromate, Potassium iodate, Ceric sulphate, Ammonium vanadate, Ethylene diamine tetra acetic acid. Computational Tools in Inorganic Chemistry, Future Perspectives of AI in Inorganic Chemistry.	9	Quiz Assignment Mid-Term
	Total Hours	45	

Additional Resources

A. **Value addition to course content/ Skill enhancement content:**

Training in scientific and review paper writing and data analysis.

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B. Remedial classes for slow learners: As per the AUMP SOP for slow and fast learners.

Suggested Readings:

Reference Books	1. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K., Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education. 2. Lee, J.D. Concise Inorganic Chemistry, ELBS. 3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A., Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press. 4.Day, M.C and Selbin,J (1985): Theoretical Inorganic Chemistry, 2ndEdition, Affiliated East West Press Pvt. Ltd. 5. Pimpalapure S. Jain R., Soni U., Dubey K. Inorganic Chemistry I, 4TH Edition, Pragati Prakashan.
Suggested e- resources (Websites/e-books)	Preview: Introduction to Group Theory | SWAYAM Preview: Symmetry and Group Theory | SWAYAM hsab theory - Google Search Metal-ligand equilibria in solution

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MSCHC101	CORE	**Inorganic Chemistry**	60	20	20	00	00	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Articulation Matrix (Mapping of COs with POs)

Course Outcomes	Correlation with POs												Correlation with PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	-	-	-	2	-	-	-	-			
CO2	3	3	3	2	-	-	-	2	-	-	-	-			
CO3	3	2	3	2	-	-	-	2	-	-	-	-			
CO4	3	3	3	3	3	2	1	2	2	2	-	-			
CO5	3	2	3	2		2	2	3	1	2	-	-			

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			THEORY			PRACTICAL					
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSCHC102	Core	Physical Chemistry	60	20	20	-	-	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

COURSE OBJECTIVES:

The student will have ability to:

1. To give basic knowledge of concept of Quantum mechanics & Principles of Electrochemistry.
2. To develop the understanding of Nuclear Chemistry.
3. Students will gain the practical aspects of Chemical kinetics
4. To provide understanding of fundamental principles at the post graduate level of practical approach of Physical chemistry and its Industrial applications.

Course Alignment with UNSDG:

The Course aims to fulfill the United Nations Sustainable Development Goals, **SDG 4 (Quality Education) and Goal-8 (Decent work and Economic Growth) .**

Course outcomes: After completion of the course, the student will be able to:

CO-1	Theoretical understanding of concept of quantum mechanics & Principles of Electrochemistry.
CO-2	Able to understand of the basics of Nuclear Chemistry and its application
CO-3	Became aware of practical aspects of Corrosion and Chemical kinetics.
CO-4	Student will be able to understand fundamental principles of practical approach of Physical chemistry and its Industrial applications.

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSCHC102	Core	Physical Chemistry	60	20	20	-	-	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Teaching Pedagogy:

T1	Classroom teaching (white board), Power Point Presentations, Interactive lectures, Inquiry-based teaching
T2	ABL activities, Assignments, Flip Class/ Seminars, Quizzes, Oral Viva-voce examination

Experiential Learning: Project Based Learning(PBL) and Case Studies

Modules	Name	Experiment/ABL/PBL	Bloom Taxonomy
Module 1	Solving Schrödinger Equation for Particle-in-a-Box and Visualization of Energy Levels	PBL	Apply, Analyse
Module 1	AI-based Visualization of Quantum Wave Functions and Probability Density	Case Study	Apply, Analyse, Evaluate
Module 2	Study of Ionic Activities and Activity Coefficients using Debye-Huckel Theory	PBL	Apply, Analyse
Module 2	Case Study on Conductometric Analysis of Water Samples	Case Study	All Levels
Module 3	Determination of Activation Energy using Arrhenius Equation	PBL	Apply
Module 3	Case Study on Explosive Reactions and Industrial Safety	Case Study	All Levels
Module 3	AI-assisted Prediction of Reaction Rates and Mechanisms	Case Study	Apply, Evaluate
Module 4	Comparative Study of Nuclear Fission and Fusion Reactions	PBL	Analyse, Evaluate
Module 4	Case Study on Nuclear Accidents and Environmental Impact	Case Study	All Levels
Module 5	Molecular Descriptor Generation using AI-based Software	PBL	Apply, Analyse
Module 5	Case Study on Deep Learning Applications in Chemistry	Case Study	All Levels
Module 5	Ethical AI in Chemistry: Opportunities and Challenges	Case Study	Evaluate, Create

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MSCHC102	Core	Physical Chemistry	60	20	20	-	-	3	0	0	3

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Assessment Tools

AT1-1	Quiz
AT1-2	Activity Based Learning
AT1-3	Midterm Exams
AT1-4	Flip Class
AT1-5	Seminar Presentation
AT1-6	Assignments
AT1-7	Poster
AT1-8	Oral Viva-voce examination
AT1-9	Industrial Visit Report

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MSCHC102	Core	Physical Chemistry	60	20	20	-	-	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Prerequisites: HSC Standard Mathematics, and BSc with Chemistry

Module	Descriptors/Topics	Hours	Assessment tools
I	**PRINCIPLES OF QUANTUM MECHANICS:** Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle.	12	Quiz Mid-term Exam Assignment
II	**PRINCIPLES OF ELECTROCHEMISTRY:** Conductivity of solutions and their measurement - the Arrhenius ionization theory - transport numbers and mobilities of ions - measurement of transport numbers - Hittorff method and moving boundary method - ionic activities and activity coefficients and their determination by various methods - Debye-Huckel-Onsager (DHO) theory - ionic atmosphere - Debye-Huckel limiting law - dissociation constant of acids and bases.	12	Mid-Term Quiz Assignment
III	**CHEMICAL KINETICS:** Complex Reactions: Reactions approaching equilibrium, steady state approximation, Rate laws for consecutive, opposing, and parallel reactions, explosive reactions. Kinetics of enzyme reactions. Activated complex theory: Reaction coordinate and the	12	Mid-Term Oral Viva-voce examination Presentation

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	transition state, potential energy surface, concentration of activated complex and rate constant, experimental observation of activated complex.		
IV	**NUCLEAR CHEMISTRY**: Radioactive decay and equilibrium, Nuclear reactions, Q-value, Cross-sections, Types of reactions, Nuclear models, Chemical effects of molecular transformations, Fission and Fusion reactions, Fission products and Fission yields, Radioactive techniques, tracer technique.	12	Quiz Assignment Presentation
V	**AI- IN CHEMISTRY:** Introduction to AI and its role in the field of chemistry, Molecular descriptors and finger prints, supervised learning in chemistry, deep learning in molecular properties, reaction prediction and retro synthesis,AI in drug discovery,Ethical AI and future trends.	12	Quiz Assignment Oral Viva-voce examination
	Total Hours	60	

Additional Resources

A. **Value addition to course content/ Skill enhancement content:** SWAYAM Plus- https://onlinecourses.nptel.ac.in/noc26_cy02/preview/Royal Society of Chemistry - Concepts in Physical Chemistry

B. **Remedial classes for slow learners:** As per the AUMP SOP for slow and fast learners.

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M.Sc. Chemistry

SEMESTER-I (2026-2028)

COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME					L	T	P	CREDITS
			THEORY			PRACTICAL					
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSCHC102	Core	Physical Chemistry	60	20	20	-	-	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Suggested Readings:

Reference Books	• Physical Chemistry, P. W. Atkins, ELBS, 1998. • Physical Chemistry, G. M. Barrow, International student edition, 2003. • Chandra, A. K. Introductory Quantum Chemistry, Tata McGraw-Hill 2001.
Suggested e- resources (Websites/e-books)	Preview: Elementary Electrochemistry | SWAYAM https://onlinecourses.nptel.ac.in/noc26_cy02/preview/Royal Society of Chemistry – Concepts in Physical Chemistry – Reference book covering thermodynamics, quantum chemistry, kinetics, electrochemistry, and molecular structure.

List of Practicals

1. Determination of Conductivity of Strong and Weak Electrolytes
2. Verification of Ostwald's Dilution Law for Weak Electrolytes
3. Determination of Dissociation Constant of Acetic Acid Conductometrically
4. Conductometric Titration of Strong Acid vs Strong Base
5. Verification of First Order Kinetics using Hydrolysis of Ester
6. Study of Effect of Temperature on Reaction Rate
7. To determine the relative strength of Chloroacetic acid and acetic acid by conductometric measurement.
8. To study kinetically the reaction rate of decomposition of iodide by H_2O_2.
9. To compare the strength of HCl and H 2 SO 4 by studying the kinetics of hydrolysis of ester.
10. Investigate the reaction between acetone and iodine. (Determination of effect of catalyst on reaction between acetone and iodine.)

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Choice Based Credit System (CBCS) in the light of NEP-2020

M.Sc. Chemistry

SEMESTER-I (2026-2028)

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MSCHC102	Core	Physical Chemistry	60	20	20	-	-	3	0	0	3

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Course Articulation Matrix (Mapping of COs with POs)

Course Outcomes	Correlation with POs												Correlation with PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	1				2		2	1	3	2	3
CO2	3	2	2	2	2				2		1	1	1	2	2
CO3	3	2	2	2	2				3		3	1		2	
CO4	3	3	2	3	2				1		2	1	2		3

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M.Sc (Chemistry)

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			THEORY			PRACTICAL					
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSCHC103	CORE	Organic Chemistry	60	20	20	-	-	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

COURSE OBJECTIVES:

The student will have ability to:

1. Understand the fundamental concepts of electron displacement, reaction mechanisms, and reactive intermediates in organic chemistry.
2. Explain substitution, addition, elimination, stereochemical, and free radical reactions.
3. Study the chemistry, synthesis, and applications of heterocyclic compounds and biologically important molecules.
4. Relate traditional Indian knowledge systems and Ayurvedic chemistry with modern organic chemistry concepts.
5. Apply AI-based computational and molecular visualization tools in studying organic reactions and drug design.

Course Alignment with UNSDG:

The Course aims to fulfill the United Nations Sustainable Development Goals:
This syllabus supports SDG 4 (Quality Education), **SDG 3** (Good Health and Well-Being) through the study of medicinal chemistry, Ayurvedic compounds, and pharmaceutical applications; **SDG 4** (Quality Education) by integrating AI tools, computational chemistry, and experiential learning methods; **SDG 9** (Industry, Innovation and Infrastructure) through the application of AI-assisted molecular modeling, cheminformatics, and drug design; **SDG 12** (Responsible Consumption and Production) by promoting sustainable use of natural products and green chemistry concepts; **SDG 13** (Climate Action) through emphasis on eco-friendly chemical practices and natural resources; and **SDG 15** (Life on Land) by

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M.Sc (Chemistry)

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highlighting the importance of medicinal plants, biodiversity, and traditional herbal resources.

Course outcomes: After completion of the course, the student will be able to:

CO-1	Interpret electron displacement effects, resonance, aromaticity, and stability of reactive intermediates.
CO-2	Predict mechanisms and products of substitution, addition, elimination, and free radical reactions.
CO-3	Analyze stereochemical behavior, chirality, optical activity, and stereoselective synthesis of organic compounds.
CO-4	Explain the structure, nomenclature, synthesis, and reactions of important heterocyclic compounds
CO-5	Use computational chemistry, AI tools, and cheminformatics techniques for molecular analysis and reaction prediction.

Teaching Pedagogy:

T1	Classroom teaching (white board), Power Point Presentations, Interactive lectures, Inquiry-based teaching
T2	ABL activities, Assignments, Flip Class/ Seminars, Quizzes, Oral Viva-voce examination

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Experiential Learning: Project Based Laerning(PBL) and Case Studies

Modules	Name	Experiment/ABL/PBL	Bloom Taxanomy
Module 1	Preparation and comparative study of natural dyes and herbal extracts to understand resonance, conjugation, and electron displacement effects.	PBL	Apply
Module 2	Study of stereochemistry and chirality in naturally occurring compounds such as camphor, menthol, caffeine, and alkaloids.	PBL	Apply
Module 3	Project on heterocyclic compounds used in pharmaceuticals and Ayurvedic medicines with molecular docking or bioactivity prediction.	PBL	Apply, Analyze
Module 4	Retrosynthetic analysis and reaction prediction using AI-enabled cheminformatics tools for selected organic compounds.	PBL	Apply, Analyze

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Module 5	Case study on traditional Indian medicinal formulations containing heterocyclic and aromatic compounds.	Case Study	All levels
Module 6	Case study on free radical reactions in industrial and biological processes.	Case Study	All Levels

Assessment Tools

AT1-1	Quiz
AT1-2	Problem solving Activity
AT1-3	Midterm Exams
AT1-4	Case Study
AT1-5	Seminar Presentation
AT1-6	Project Based Learning
AT1-7	Hands on Experiments
AT1-8	Oral Viva-voce examination
AT1-9	Industrial Visit Report

Prerequisites: Basic knowledge of Organic Chemistry including reaction mechanisms, stereochemistry, functional groups, bonding concepts, and fundamental spectroscopic techniques

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Module	Descriptors/Topics	Hours	Assessment tools
I	**ELECTRON DISPLACEMENT** Ancient Indian concepts of atomic structure and matter from Vaisheshika Sutra by Maharishi Kanada related to matter, atoms, and molecular interactions. Traditional preparation of natural dyes and herbal compounds demonstrating resonance and conjugation concepts. Introduction to Reaction mechanism, Aromaticity and Electron displacement: Inductive and field effects - Bond distances - Bond energies- Delocalized bonds - Cross conjugation - Rules of resonance - The resonance effect - Steric inhibition of resonance - Hyperconjugation - Hydrogen bonding - Effect of structure on the dissociation constant of acids and bases. Reaction mechanism introduction, Reactive Intermediates –Carbocations and its types, cabanions, free radicals, formation, structure, and stability of above-mentioned reactive intermediates. Use of AI-based molecular modeling software for visualization of electron displacement effects, resonance stabilization, and reactive intermediates. Machine learning approaches in predicting acidity/basicity and reaction pathways.	09	Quiz Case study Mid-term Exam Problem solving Exercise
II	**REACTION MECHANISMS** Study of traditional Indian medicinal preparations and natural product synthesis involving substitution reactions in alkaloids and	09	Mid-Term Hands on Experiments

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	herbal compounds mentioned in Charaka Samhita and Sushruta Samhita. Substitution Reactions, Aliphatic Nucleophilic Substitution: SN^1 and SN^2 mechanisms - Effect of substrate structure, attacking nucleophile, leaving group and effect of solvents -Ambident nucleophiles and examples - Neighbouring group participation – SN^1 mechanism - Nucleophilic substitution at allylic, vinylic and aliphatic trigonal carbons. Electrophilic Substitution: Introduction, SE^1 SE^2 and SEi mechanisms. Aromatic Electrophilic Substitution: Orientation - Reactivity - Mechanisms of Friedel - Craft reactions, Sulphonation and Gattermann - Koch formylation. AI-assisted reaction mechanism prediction, computational chemistry tools for studying SN1, SN2, electrophilic and nucleophilic substitution reactions, and use of virtual reaction simulators for mechanistic understanding.		
III	**ADDITION AND ELIMINATION REACTIONS** Traditional Indian techniques involving addition and elimination processes in preparation of medicinal and aromatic compounds. Applications of condensation reactions in synthesis of naturally	08	Mid-Term Hands on training Problem Solving Oral Viva-voce

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	occurring products used in Ayurveda. Elimination Reactions: α (Alpha) and β (Beta) eliminations - El, E2 and El CB mechanisms - Stereochemistry of elimination - Orientation of the double bond - Effects of the changes in the substrate, base, leaving group and reaction medium on El, E2 and E1CB reactions - Elimination versus substitution. Addition to carbon - carbon multiple bonds: Electrophilic, nucleophilic, and free radical additions. Addition to α, β unsaturated carbonyl groups - Michael addition of Grignard reagents and lithium dimethyl cuprate. Addition to carbonyl groups: Mechanisms of Aldol, Benzoin, Claisen and Dieckmann condensations - Perkin, Knoevenagel, Mannich, Cannizaro, Reformatsky and Darzen's reactions - Wittig reaction. Application of AI and cheminformatics in predicting stereochemistry and products of addition/elimination reactions. Use of AI-enabled retrosynthetic analysis tools for organic synthesis planning.		examination
IV	**STEREOCHEMISTRY AND FREE RADICAL REACTIONS** Concept of Chirality – Enantiotopic and diastereotopic atoms, Optical activity of biphenyl, allenes and spiranes - Stereospecific and Stereoselective synthesis - Resolution, racemization and	07	Quiz Assignment Problem Solving Hands on

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	asymmetric synthesis - Crams and prelog's rules. Geometrical Isomerism: E, Z nomenclature - Determination of configuration of geometrical isomers. Free Radical Reactions: Formation, detection and stability of free radicals - Free radical reactions - Halogenation, addition, oxidation, reduction and rearrangement reactions - Barton, Sandmeyer, Gomberg - Bachmann, Ullmann reactions. Importance of chirality in Ayurvedic drugs and natural products derived from medicinal plants used in Indian traditional medicine. Traditional knowledge of optical activity in naturally occurring compounds such as camphor and menthol. AI-based 3D molecular visualization tools for stereochemistry and chirality analysis. Computational prediction of stereoselective synthesis and free radical reaction pathways using machine learning algorithms.		training Presentation
V	**HETEROCYCLIC COMPOUNDS** Heterocyclic compounds present in natural alkaloids, caffeine-containing traditional Indian beverages, and medicinal plants used in Ayurveda. Study of naturally occurring coumarins and pyrimidines in herbal medicines. Structure, Nomenclature, synthesis, and reactions of indole, carbozole, oxazole and thiazole Pyrimidines - General chemistry and detailed study of uracil, thymine and cytosine. Purines - General chemistry and detailed study of uric acid and caffeine.	07	Quiz Assignment Oral Viva-voce examination

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	Coumarins. AI-driven drug design and molecular docking studies involving heterocyclic compounds. Use of bioinformatics and machine learning in predicting biological activity of heterocyclic molecules and pharmaceutical applications.		
	Total Hours	40	

Additional Resources

A Value addition to course content/ Skill enhancement content:

- Practical understanding of reaction mechanisms, stereochemistry and synthetic pathways.
- Exposure to modern organic synthesis techniques and green chemistry approaches.
- Skill enhancement in structure elucidation using spectroscopic methods such as IR, NMR and Mass Spectrometry.
- Training in laboratory safety, chemical handling and sustainable organic synthesis practices.
- Enhancement of analytical and research-oriented skills through case studies and project work.

SWAYAM Course:

NPTEL SWAYAM			

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B. Remedial classes for slow learners: As per the AUMP SOP for slow and fast learners.

Suggested Readings:

Reference Books	1. Organic Chemistry by Robert T. Morrison and Robert N. Boyd, Pearson Education. 2. A Guidebook to Mechanism in Organic Chemistry by Peter Sykes, Pearson Education. 3. Organic Chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren, Oxford University Press. 4. Advanced Organic Chemistry by Jerry March, Wiley Publications. 5. Organic Chemistry by T.W.G. Solomons and C.B. Fryhle, John Wiley & Sons. 6. Organic Chemistry Volume I by I.L. Finar, Pearson Education. 7. Organic Chemistry Volume II by I.L. Finar, Pearson Education. 8. Introduction to the Chemistry of Heterocyclic Compounds by R.M. Acheson, Wiley Publications. 9. Stereochemistry of Organic Compounds by D. Nasipuri, New Age International Publishers. 10. Organic Chemistry by Paula Yurkanis Bruice, Pearson Education.
Suggested e- resources (Websites/e-books)	1. NPTEL Chemistry Courses – Online lectures and study materials on organic chemistry, reaction mechanisms, stereochemistry, and heterocyclic chemistry. 2. SWAYAM Portal – Government of India online learning platform offering chemistry and AI-related courses. 3. □ National Digital Library of India (NDLI) – Access to e-books, journals, lecture notes, and research resources in chemistry.

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Course **Articulation Matrix (Mapping of COs with POs)**

Course Outcomes	Correlation with POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10		
CO1	3	2	2	1	3	2	1	2	3	3		
CO2	1	3	2	2	1	3	3	3	2	2		
CO3	3	2	3	2	3	2	2	3	2	1		
CO4	3	1	2	1	1	2	3	2	1	3		
CO5	2	2	1	1	2	3	3	1	1	2		

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MSCHC104	Core	Chemical Methods of Analysis	60	20	20	-	-	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

COURSE OBJECTIVES:

The student will have ability to:

1. To provide fundamental knowledge of statistics, separation techniques, and analytical chemistry for chemical sciences.
2. To develop understanding of classical and optical methods of analysis and their applications in research, industry, and problem-solving.
3. To enable students to understand and apply chemical methods of analysis through theoretical and practical approaches.
4. To integrate principles of Indian Knowledge Systems (IKS), Artificial Intelligence (AI), and digital tools in modern analytical chemistry.
5. To promote sustainable and environmentally responsible analytical practices aligned with Sustainable Development Goals (SDGs).

Course Alignment with UNSDG:

The Course aims to fulfill the United Nations Sustainable Development Goals, **SDG 4 (Quality Education).**

Course outcomes: After completion of the course, the student will be able to:

CO-1	Understand the concepts of statistics, separation techniques, and analytical chemistry relevant to chemical sciences.
CO-2	Apply classical and optical methods of analysis in research, industrial, and practical chemical applications.
CO-3	Use practical chemical methods of analysis along with AI tools and digital techniques for data analysis and interpretation.

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M.Sc. Chemistry

SEMESTER-I (2026-2028)

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CO-4	Relate traditional Indian analytical practices with modern analytical techniques.
CO-5	Adopt eco-friendly and sustainable analytical methods aligned with environmental sustainability and SDGs.

Teaching Pedagogy:

T1	Classroom teaching (white board), Power Point Presentations, Interactive lectures, Inquiry-based teaching
T2	ABL activities, Assignments, Flip Class/ Seminars, Quizzes, Oral Viva-voce examination

Experiential Learning: Project Based Laerning (PBL) and Case Studies

Modules	Name	Experiment/ABL/PBL	Bloom Taxanomy
Module 1	Traditional Indian Knowledge Systems (IKS) in Analytical Practices	Case Study	Understand
Module 1	Steps in Quantitative Chemical Analysis	PBL	Analyze
Module 2	Statistical Analysis and Validation in Chemistry	PBL	Apply
Module 2	Statistical Interpretation of	Case Study	Evaluate

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	Chemical Data		
Module 3	Principles of Chromatography	PBL	Understand Apply
Module 4	Redox and Complexometric Titrations	PBL	Apply
Module 4	Beer–Lambert Law and Spectrophotometry	PBL	Apply
Module 5	Introduction to AI and Digital Tools in Chemistry	Case Study	Understand
Module 5	Chemical Structure Drawing using ChemDraw and ACD/Labs	PBL	Apply

Assessment Tools

AT1-1	Quiz
AT1-2	Activity Based Learning
AT1-3	Midterm Exams
AT1-4	Flip Class
AT1-5	Seminar Presentation
AT1-6	Assignments
AT1-7	Poster

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1.

AT1-8	Oral Viva-voce examination
AT1-9	Industrial Visit Report

Prerequisites: Basic knowledge of analytical chemistry, chemical calculations, and laboratory techniques.

Module	Descriptors/Topics	Hours	Assessment tools
I	**Introduction to Analytical Chemistry:** Introduction to analytical chemistry, including traditional Indian practices **(IKS)**. Applications of analytical chemistry. Methods of quantitative analysis and selection of appropriate techniques. Fundamentals of chemical analysis and classification of analytical methods. Quantitative analysis and scale of operation. Steps involved in quantitative analysis and methods of determinations.	12	Quiz Mid-term Exam Assignment

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II	**Statistics for Chemists:** Introduction and significance of statistical analysis. Statistical analysis and validation including errors in chemical analysis. (systematic and random; additive, proportional, absolute, and relative). Accuracy and precision. Measures of central tendency and dispersion: mean, median, average deviation, and standard deviation. Correlation and regression analysis	12	Mid-Term Quiz Assignment
III	**Separation Techniques:** Chromatography: Introduction, Principles of chromatography, classification based on mobile phase (gas and liquid chromatography) and separation mechanisms (adsorption, partition, ion-exchange, and size-exclusion). Techniques such as thin layer chromatography (TLC), gas chromatography (GC), and high-performance liquid chromatography (HPLC). Applications in pharmaceutical, environmental, food, and biochemical analysis. Principles and techniques of fractional crystallization, fractional distillation, precipitation, and solvent extraction.	12	Mid-Term Oral Viva-voce examination Presentation

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IV	**Classical and Optical Methods of Analysis:** Principles of volumetric and gravimetric analysis. Primary and secondary standards, indicators, and types of titrations: acid–base, redox, precipitation, and complexometric titrations. Titration curves for monoprotic and polyprotic systems. Principles of precipitation, solubility product, precipitation equilibria, co-precipitation, and post-precipitation. Principles of colorimetry and spectrophotometry. Beer–Lambert law and its applications. Instrumentation of single and double beam spectrophotometers. Quantitative estimation methods: calibration curve, comparison, and standard addition methods. Applications of spectrophotometric analysis of metal ions using organic ligands.	12	Quiz Assignment Presentation
V	**Applications of AI in Analytical Chemistry:** Introduction to AI and digital tools in chemistry. Applications of AI in statistical analysis, error reduction, and interpretation of analytical data. Use of AI in chromatographic and spectrophotometric analysis, peak identification, and pattern recognition. Computer-assisted chemical structure drawing using ChemDraw and ACD/Labs. Applications of AI in pharmaceutical, environmental, and industrial analysis. .	12	Quiz Assignment Oral Viva-voce examination

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	Total Hours	60	

Additional Resources

A. Value addition to course content/ Skill enhancement content:

https://www.acdlabs.com/

Remedial classes for slow learners: As per the AUMP SOP for slow and fast learners.

Suggested Readings:

Reference Books	1. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House) 2. Analytical Chemistry: Problems and Solution-S. M. Khopkar (New Age International Publication) 3. Basic Concepts in Analytical Chemistry: S. M. Khopkar (New Age International Publication) 4. Advance Analytical Chemistry: Meites and Thomas: (Mc Graw Hill) 5. An Introduction to Separation Science: L. R. Shyder and C. H. Harvath (Wiley Interscience) 1. Sriram D and Yogeshwari P, Medicinal Chemistry; Pearson Education. 2. Ahluwalia V K, Chopra Madhu, Medicinal Chemistry; Ane Books India.
Suggested e- resources (Websites/e-books)	• https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/ /S000014ER/P000272/M027281/ET/1518515042paper2_Module1etext.pdf • https://nptel.ac.in/courses/104105084

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Course Articulation Matrix (Mapping of COs with POs)

Course Outcomes	Correlation with POs												Correlation with PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10					
CO1	3	2	3	1	2	1	-	2	1	1					
CO2	3	3	3	2	2	2	1	3	3	2					
CO3	2	3	3	3	3	1	2	3	2	2					
CO4	2	2	3	2	2	2	1	2	1	2					
CO5	2	3	3	2	2	3	2	3	3	2					

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