Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore
Shri Vaishnav Institute of Science
Department of Chemistry
Name of Program: M.Sc. (Chemistry) (CBCS) (2022-2024)

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY		PRACTICAL		
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
MSCH101	PG	CHEMICAL METHODS OF ANALYSIS	4	0	0	4	60	20	20	00	00

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:

1. To give basic knowledge of the concept of Statistics to chemists.
2. To develop an understanding of Chemistry Separation techniques and Analytical Chemistry.
3. Enable students to apply the concepts of Classical and Optical Methods of Analysis to various research and industrial applications.
4. The purpose of the course is to make the students to understand the concepts and practical applications of Chemical Methods of Analysis.

Course Outcomes:

After completion of this course the students are expected to demonstrate the following skills, knowledge, and attitudes. Student will be able to understand:

1. Theoretical understanding of concept of Statistics for Chemist.
2. Became aware of the Chemistry Separation techniques and Analytical Chemistry.
3. Students will be able to apply the concepts of Classical and Optical Methods of Analysis to various research and industrial applications.
4. The students will be able to understand the practical applications of Chemical Methods of Analysis

SYLLABUS:

UNIT I: INTRODUCTION TO ANALYTICAL CHEMISTRY

Applications of analytical chemistry. Methods of quantitative analysis, Selection of methods of analysis. Chemical analysis and analytical methods. Quantitative analysis and scale of operation.

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Shri Vaishnav Institute of Science
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Name of Program: M.Sc. (Chemistry) (CBCS) (2022-2024)

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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.

Various steps in quantitative analysis. Methods of analytical determinations.

UNIT II: STATISTICS FOR CHEMISTS

Introduction and significance of statistical analysis. Statistical analysis and validation: Errors in chemical analysis. Classification of errors-systematic and random, additive, proportional, absolute, and relative. Accuracy and precision.
Mean, median, average deviation, and standard deviation. Correlation coefficient and regression analysis. Applications of Computer in chemistry. Chemical structures drawing by ACD lab and ChemDraw.

UNIT III: SEPARATION TECHNIQUES

Chromatography: Introduction and Classification, Principles, Applications and Techniques used in Paper chromatography, Thin Layer chromatography Column chromatography, Gas chromatography, and HPLC. Ion exchange: Principle and technique. Types of ion exchangers. Ion exchange equilibria. Ion exchange capacity. Effect of complexing ions. Zeolites as ion exchangers. Principle and techniques of Fractional crystallization, Fractional distillation, Precipitation and Solvent extraction.

UNIT IV: CLASSICAL METHODS OF ANALYSIS

Volumetric analysis: General principle. Criteria for reactions used in titrations. Primary standards and secondary standards. Theory of indicators. Types of titrations with examples- Acid-base, precipitation, redox and complexometric. Titration curves for monoprotic and

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polyprotic acids and bases. Indicators are used in various types of titrations. Masking and demasking agents.

Gravimetric analysis: General principles and conditions of precipitation. Concepts of solubility, solubility product, and precipitation equilibria. Purity of precipitate: Co-precipitation and post-precipitation. Fractional precipitation. Precipitation from homogeneous solution. Particle size, crystal growth, colloidal state, aging, and peptization phenomena.

UNIT V: OPTICAL METHODS OF ANALYSIS

Spectrophotometry and Colorimetry: Principle of colorimetry. Beer's law, its verification, and deviations. Instrumentation in colorimetry and spectrophotometry (single and double beam). Sensitivity and analytical significance of molar extinction coefficient and λmax. Comparison method, calibration curve method, and standard addition method for quantitative estimation. Role of organic ligands in spectrophotometric analysis of metal ions.

Textbooks:

1. Quantitative analysis: Day and Underwood (Prentice-Hall of India)
2. Vogel's Textbook of Quantitative inorganic Analysis-Bassett, Denney, Jeffery and Mendham (ELBS)
3. Analytical Chemistry: Gary D. Christian (Wiley,India).
4. Instrumental Methods of Analysis: Willard, Merrit, Dean, Settle (CBS Publishers, Delhi, 1986)
5. Instrumental Methods of Chemical Analysis: Braun (Tata McGraw-Hill)
6. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)

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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)

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MSCH102	PG	PHYSICAL CHEMISTRY	4	0	0	4	60	20	20	0	0

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:

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 Corrosion and 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 OUTCOMES:

After completion of this course the students are expected to demonstrate the following skills, knowledge, and attitudes. Student will be able to understand:

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

SYLLABUS:

UNIT 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; wave functions, probability distribution functions, nodal properties, Extension to two- and three-dimensional boxes, separation of variables, degeneracy.

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MSCH102	PG	PHYSICAL CHEMISTRY	4	0	0	4	60	20	20	0	0

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.

UNIT II: PRINCIPLES OF ELECTROCHEMISTRY

Conductivity of solutions and their measurement - the Arrhenius ionisation 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.

UNIT 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 transition state, potential energy surface, concentration of activated complex and rate constant, experimental observation of activated complex. Thermodynamic aspect. Study of kinetics of chain reaction like H –Br reaction, decomposition of acetaldehyde.

UNIT IV: CORROSION

Introduction, Importance and principles, Forms of corrosion (Galvanic, Atmospheric, stress, microbial and soil). Techniques of Corrosion rate measurement (instrumental and non-instrumental). EMF series &Galvanic series and their limitations. Concept of mixed potential theory and its importance in terms of Kinetics (Tafel and Evans diagram), effect of oxidizer and passivity of corrosion. Protection against corrosion (Design improvement, Anodic and cathodic protection, inhibitors, coating).

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MSCH102	PG	PHYSICAL CHEMISTRY	4	0	0	4	60	20	20	0	0

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.

UNIT V: 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, Neutron activation analysis (NAA), Nuclear detectors.

TEXTBOOKS:

1. Chandra, A. K. Introductory Quantum Chemistry, Tata McGraw-Hill 2001.
2. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed., Elsevier: USA 2004.
3. Lowe, J. P. & Peterson, K., Quantum Chemistry, Academic Press 2005.
4. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press 2006.
5. Ball, D. W. Physical Chemistry, Cengage, India 2012.

REFERENCE BOOKS:

1. Physical Chemistry, P. W. Atkins, ELBS, 1998.
2. Physical Chemistry, G. M. Barrow, International student edition, 2003.
3. Essentials of Nuclear Chemistry, H. J. Arnikar, New Age Publication Ltd., 1995.
4. Introduction to Nuclear Physics and Chemistry, B. G. Harwey, Prentice Hall, 1963.

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MSCH103	PG	ORGANIC CHEMISTRY	4	0	0	4	60	20	20	0	0

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:

1. To give basic knowledge of concept of Electron Displacement and Reaction mechanism.
2. To develop the understanding of Addition, Elimination Reactions & Stereochemistry in organic chemistry.
3. Students will gain the conceptual aspects of Heterocyclic compounds and its mechanism.
4. To provide understanding of fundamental principles at the post graduate level of practical approach of Organic chemistry and its Industrial applications.

COURSE OUTCOMES:

After completion of this course the students are expected to demonstrate the following skills, knowledge, and attitudes. Student will be able to understand:

1. Theoretical understanding of concept of of Electron Displacement and Reaction mechanism
2. Able to understand of the basics of Addition, Elimination Reactions & Stereochemistry in organic chemistry.
3. Became aware of practical and conceptual aspects of Heterocyclic compounds and its mechanism
4. Student will be able to understand fundamentals of practical approach of Organic chemistry and its Industrial applications.

SYLLABUS:

UNIT I: ELECTRON DISPLACEMENT

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.

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MSCH103	PG	ORGANIC CHEMISTRY	4	0	0	4	60	20	20	0	0

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P – Practical; C - Credit;
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UNIT II: REACTION MECHANISMS

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, SE1 SE2 and SEi mechanisms. Aromatic Electrophilic Substitution: Orientation - Reactivity - Mechanisms of Friedel - Craft reactions, Sulphonation and Gattermann - Koch formylation. Aromatic Nucleophilic Substitution: SNAr, SN1 mechanisms - Benzyne mechanism.

UNIT III: ADDITION AND ELIMINATION REACTIONS

Elimation and Addition Reactions, 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 and its modifications.

UNIT 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 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, and Hunsdiecker reactions.

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UNIT V: HETEROCYCLIC COMPOUNDS

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. Coumarins - General chemistry and detailed study of umbelliferone

Text Books:

1. March,J (2000): Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 5thedition, Wiley.
2. Morrison, R.Tand Boyd, R.N (1992): Organic Chemistry, 6thedition, Pearson.

References

1. Nasipuri, D (2002): Stereochemistry of organic compounds-Principles and applications,, 2nd edition, New Age International.
2. Bansal,R.K (1975): Organic Reaction Mechanisms, Tata McGraw Hill.

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MSCH 104	PG	INORGANIC CHEMISTRY	4	0	0	4	60	20	20	0	0

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:

1. To give basic knowledge of concept of chemical bonds and bonding theories.
2. To develop the understanding of Solvents & Precipitation Phenomena in Inorganic chemistry.
3. Students will gain the conceptual aspects of Solid-State Chemistry.
4. To provide understanding of fundamental principles at the post graduate level of practical approach of Inorganic chemistry and its Industrial applications.

Course Outcomes:

After completion of this course the students are expected to demonstrate the following skills, knowledge, and attitudes. Student will be able to understand:

1. Theoretical understanding of concept of chemical bond and bonding theories.
2. Able to understand of the basics of Solvents & Precipitation Phenomena in Inorganic chemistry.
3. Student will be able to understand conceptual aspects and applications of Solid-State Chemistry
4. Became aware of practical approach of Inorganic chemistry and its Industrial applications.

Syllabus:

UNIT I: IONIC BOND

Properties of ionic substances, coordination number of an ion, structures of crystal lattices-NaCl, CsCl, ZnS and Rutile. Lattice energy- Born Lande equation, Born-Haber cycle, Uses of Born-Haber cycle for Lattice energy calculations. Ionic radii, methods of determining ionic radii, factors affecting ionic radii, radius ratio rule, percentage covalent character in ionic bonds, hydration energy and solubility of ionic solids.

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MSCH 104	PG	INORGANIC CHEMISTRY	4	0	0	4	60	20	20	0	0

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UNIT II: COVALENT BOND

Valence bond theory, resonance, hybridization, Bent's rules and energetics of hybridization, Determination of molecular shapes – VSEPR theory. MO theory, application to homo- and hetero-diatomic and triatomic molecules. Alkali and alkaline earth metal complexes of crown ethers, cryptands, and calixarenes and their biological significance. Chemistry of halogens and noble gas elements, interhalogens, psuedohalogens, oxyhalogen species, polyhalide ions, xenon oxides, and fluorides. Oxy- and peroxy acids of N, P, and S.

UNIT III: SOLVENTS

Classification of solvents -properties of ionising solvents -a general study of the typical reactions in liquid ammonia, sulphur dioxide, dinitrogen tetroxide, anhydrous hydrogen fluoride, sulphuric acid and acetic acid -solution in fused salts non-aqueous titrations. HSAB concept of acids and bases -acid, base strength and hardness and softness -symbiosis -theories of hardness and softness -electronegativity and hardness and softness.

UNIT IV: PRECIPITATION PHENOMENA

Precipitation from homogeneous solutions, organic molecules as precipitants in inorganic analysis. Solvent extraction of metal ions, nature of extractant, distribution law, partition coefficients, different types of extractions and applications.

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MSCH 104	PG	INORGANIC CHEMISTRY	4	0	0	4	60	20	20	0	0

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.

UNIT V: SOLID STATE CHEMISTRY

Close packing of atoms and ions FCC, HCP and BCC types of packing tetrahedral and octahedral void radius ratio -derivation -its influence on structures -representative structures of AB and AB., types of compounds- rock salt, calcium chloride, wurtzite, sine blende, rutile, fluorite, antifluorite, cadmium iodide and nickel arsenide. Structure of graphite and diamond - spinels normal and inverse types and perovskite structure

Textbooks:

1.Day, M.C and Selbin,J (1985): Theoretical Inorganic Chemistry, 2ndEdit ion, Affiliated East West Press Pvt. Ltd.
2.Cotton, F. A and Wilkinson, G (2009): Advanced Inorganic Chemistry,4thEdition, A Wiley-Inter science Publication, John–Wiley & Sons, USA.
3.Huheey, J.E (1983): Inorganic Chemistry, 3rd Edition, Harper & Row publisher, Singapore.

Reference Books:

1.Adamson, A.W (1975): Inorganic Photochemistry, John Wiley & Sons, NewYork.
2.Basolo F. and Pearson R.G (1967): Mechanism of Inorganic Reactions, John Wiley, NewYork.

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