Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore
Shri Vaishnav Institute of Science
Department of Chemistry
Name of Program: M.Sc. (Analytical Chemistry) (CBCS) (2021-2023)

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*
MSAN101	DC	Principles of Inorganic Chemistry	4	0	2	5	60	20	20	30	20

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 Educational Objectives (CEOs): The objective of the Organic chemistry course is
1. The purpose of the course is to make the students to understand the theoretical concepts and practical applications of Inorganic chemistry
2. To develop the understanding of different types of crystal lattice and VSEPR, MO theories, Chemistry of halogens and oxy, peroxy acids of Nitrogen, Phosphorus, Sulphur
3. Enable students to apply the concepts of advanced inorganic compounds to various research and industrial applicationsparticularly super acids, non-aqueous solvents
4. Applying practical aspects of inorganic chemistry in the research and development

Course Outcomes:
After completion of this course the students are expected to demonstrate the following skills, knowledge and attitudes. The student will demonstrate the following skills and capability,
CO1. This course on Inorganic chemistry will provide the conceptual understanding of different bonding theories and compounds of C, Si
CO2. The importance of HSAB concept, Non-aqueous solvents and student became aware of Precipitation phenomena and student will gain the practical knowledge of solvent extractions
CO3. The student will be able to learn the practical applications of EDTA titrations
CO4. Impart training in synthesis of inorganic material, characterization and chemical analysis

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.

UNIT II: Covalent bond

Valence bond theory, resonance, hybridisation, Bent's rules and energetics of hybridization, Determination of molecular shapes-VSEPR theory. MO theory, application to homo- and

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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: Important compounds of C, Si and Non-aqueous solvents

Compounds of Graphite. Chemistry of carbides, silicon, silica and silicates, zeolites. HSAB concept, Chemistry and applications of Superacids. Non-aqueous solvents, Reactions in following non-aqueous media: Liquid ammonia, anhydrous sulphuric acid, glacial acetic acid, anhydrous HF, bromine trifluoride, liquid sulphur dioxide and dinitrogen tetroxide.

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.

UNIT V: Titrations

Theories of redox indicators, titration curves, feasibility of redox titrations. Chelometric titrations- titration curves with EDTA, feasibility of EDTA titrations, indicators for chelometric titrations, selective masking and demasking techniques, industrial applications of masking. Sampling techniques, preparation of samples for analysis. Nature of errors, statistical treatment of errors, the T- and F-tests, significant figures, rejection of data.

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Text Books:

1. J.E Huheey, Keiter and Medhi: Inorganic Chemistry, Pearson Education.
2. Shriver, Atkins and Langford: Inorganic Chemistry OUP.
3. J.D.Lee: Concise Inorganic Chemistry, Blackwell Science.
4. B.E.Douglas, D.McDaniel& A. Alexander: Concepts & Models of Inorganic Chemistry, Wiley.

Reference Books:

1. W.W. Porterfield: Inorganic chemistry – A Unified Approach, Elsevier.
2. Kettle,S.F.A. (1996): Physical Inorganic Chemistry- Coordination Chemistry Approach, Spectrum, Academic Publishers, Oxford University Press.
3. Basolo,F. and Pearson, R.G (1967): Mechanism of Inorganic Reactions, John Wiley,NewYork.

List of Practical's: (If Practical Credit Shown in Syllabus)

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MSAN102	DC	Principles of Organic Chemistry	4	0	2	5	60	20	20	30	20

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Course Educational Objectives (CEOs): The objective of the Organic chemistry course is
1. To provide the current knowledge of Theoretical and practical aspects of Organic chemistry
2. Understanding the basic concepts about how the organic reactions are carried out and also to make the students understand the mechanisms of different organic reactions
3. To develop the understanding of Aromaticity concept and different methods of determining reaction mechanism including isotopic labelling, cross-over experiments
4. Imparting the knowledge of synthesis and biological activity of Heterocyclic compounds

Course Outcomes:
After completion of this course the students are expected to demonstrate following knowledge, skills and attitudes. The student can able to demonstrate the following,
CO1. Will gain the following knowledge of organic molecules with respect to structure, bonding, aromatic nature and reaction mechanism
CO2. The practical application of stereochemistry and isomerism in Pharmaceutical industries
CO3. Apply their understanding about the organic reactions of industrial significance with respect to the chemo-selectivity, region-selectivity and enantioselectivity
CO4. The student will able to synthesize an important heterocyclic compounds by two step organic synthesis and will learn recrystallization, chromatographic techniques

Syllabus:

Unit I: Electron Displacement
Introduction to Reaction mechanism, Aromaticity and Electron displacement: Inductive and Fieldeffects. Bond distances - Bond energies, delocalized bonds, Cross conjugation.Resonance effect and rules.Steric inhibition of resonance - Hyperconjugation - Hydrogen bonding - Effect ofstructure on the dissociation constant of acids and bases. Reactive Intermediates-Carbocations and its types, carbanions, free radicals, formation, structure and stability of the abovementioned reactive intermediates.

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Unit II: Reaction mechanisms

Substitution Reactions, Aliphatic Nucleophilic Substitution: S_N^1 and S_N^2 mechanisms - Effect of substrate structure, attacking nucleophile, leaving group and effect of solvents – Ambident nucleophiles and examples - Neighbouring group participation - S_N^imechanism - 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, S_N^1 mechanisms –Benzyne mechanism.

Unit III: Aromaticity and Bonds weaker than covalent

Concept of aromaticity, Huckel's rule, Homo-aromatic, Non-aromatic and Anti-aromatic systems. Aromaticity in benzenoid and non-benzenoid molecules. Homo and heteroannulenes. Physical methods to study aromaticity-UV, IR and ^{1}H NMR spectroscopy.

Addition compounds, crown ether complexes, cryptands, inclusion compounds, catenanes, fluxional molecules. Structure and reactivity of aromatic molecules, Effect of hydrogen bonding, resonance & inductive on strengths of acids, bases.

Unit IV: Methods of Determining Reaction Mechanism and Organic synthesis

Kinetic and non-kinetic methods, Identification of products, detection of intermediates, isotopic labelling, stereochemical evidences, cross-over experiments, Limitation of reactions, kinetic evidences and kinetic isotopic effects.

Organo-Silicon Compounds: Preparation and applications in organic synthesis; Applications of Pd (0) and Pd (II) complexes in organic synthesis- Suzuki and Sonogashira coupling, Heck reaction, Preparation and applications of lithium organocuparates.

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Unit V: Heterocyclic compounds

Structure, Nomenclature, synthesis and reactions of indole, carbozole, oxazole, imidazole 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. Advanced Organic Chemistry: Reactions, Mechanisms and Structure.J. March (2000), 5th edition, Wiley.
2. Organic Chemistry-P.Y.Bruice, Pearson Education Pvt. Ltd.,New Delhi.
3. Stereochemistry, Conformation and Mechanism-P.S.Kalsi, Wiley Eastern, New Delhi.
4. Advanced Organic Chemistry- R.A. Carey and R.J. Sundberg Plenum, New York.

Reference Books:

1.Stereochemistry of Carbon Compounds-E.L.Eliel, Tata McGraw Hill, New. Delhi.
2. Bansal,R.K (1975): Organic Reaction Mechanisms, Tata McGraw Hill.

List of Practical's: (If Practical Credit Shown in Syllabus)

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MSAN103	DC	Principles of Physical Chemistry	4	0	2	5	60	20	20	30	20

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Course Educational Objectives (CEOs): The aim of the Physical chemistry course is

1.To provide a clear and incisive treatment of fundamental principles at the post graduate level of Physical chemistry and its Industrial applications.
2. Students will gain the practical aspects of applied Quantum mechanics and Chemical kinetics.
3. To develop the understanding of ElectrochemistryandIndustrial electrochemical processes.
4. To explain many of the proposed hypotheses in terms of fundamental concepts.

Course Outcomes: The student will be able to demonstrate the following

CO1. Recall their knowledge on concepts of the Electrochemistry such as Nernst equation, Debye-Huckel limiting law and its applications
CO2. Became aware of the theoretical aspects of Electro chemical cells and its applications
CO3. Apply Activated complex theory of Chemical kinetics, its significance and learn the applications of rate law, rate equation for industrial process.
CO4. Design experiments of Physical chemistry using electrodialysis, electro flotation and electroplating further students will learn the practical applications of Electrochemistry

Syllabus:

Unit I: 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.

Unit II: Principles of electrochemistry

Conductivity of solutions and their measurement - the Arrhenius ionisation theory –

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transport numbers and mobility 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 atmo sphere, Debye-Huckel limiting law - dissociation constant of acids and bases.

Unit III: Electrochemistry of Cells and Analytical applications

Electromotive force - measurement of EMF – cell EMF and the cell reaction Reversible cells - types of half cells - classification of cells - the standard EMF of a cell –Electrochemical potential - standard electrode potentials - calculation of EMF of a cell. Nernst equation and its limitations. Analytical applications of Electrochemistry, Principles and applications of Polarography, Cyclic voltammetry, Coulometry, Amperometry.

Unit IV: 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 by Thermodynamic aspect. Study of kinetics of H-Br chain reaction, and decomposition of acetaldehyde.

Unit V: Industrial electrochemical processes

Water treatment and environmental protection – metal ion removal and metal recovery – electro-filtration of particulates from gases – electrodialysis – desalination – electro flotation. Electroplating – objectives – theory – method – electroplating of nickel – electroless plating – galvanizing –tinning.

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Text Books:

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 Physical Chemistry 8th Ed., Oxford University Press 2006.
5. Ball, D. W. Physical Chemistry, Cengage, India 2012.
6. D Fletcher, Industrial electrochemistry, Chapman and Hall, London 1982.

Reference Books:

1. Physical Chemistry, G. M. Barrow, International student edition, 2003.
2. Essentials of Nuclear Chemistry, H. J. Arnikar, New Age Publication Ltd., 1995.
3. Introduction to Nuclear Physics and Chemistry, B. G. Harwey, Prentice Hall, 1963.
4. C.Rajagopal and K. Vasu, Conversion Coatings, 1st Edn. Tata McGraw Hill, New Delhi (2000).

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Course Educational Objectives (CEOs): The prime aim of the analytical chemistry course is
1. Making students understand the insights of statistical methods in qualitative and quantitative analysis and acid-base equilibria, buffer solutions
2. To give practical knowledge of Chemical analysis, different analytical instruments and Good Laboratory Practice (GLP)
3. To develop the understanding of Volumetric analysis, gravimetric analysis learning the importance of Redox as well as Complexometric titrations
4. Impart training in operating different instruments used in the analysis of various chemical constituents, toxic metals and pollutants present in different samples

Course Outcomes: After completion of the course student can able to demonstrate
CO1. Analyze different errors in Chemical analysis by using statistical methods and Evaluate errors through statistical treatment of data through F-test, T-test
CO2. Adopt different analysis such as Volumetric and Gravimetric with Industrial applications
CO3. Apply and demonstrate the uses of Redox and Complexometric titrations
CO4. Practical evaluation of concentration of toxic metals in water samples, soil samples by using EDTA and with other analytical methods

Syllabus:

UNIT I: Data handling
Accuracy and precision, Error, types of error, systematic and random errors, minimization of errors, mean and standard deviations, reliability of results, confidence interval, comparison of results, student T test, F test, Comparison of two samples (Paired T test), correlation and regression, correlation coefficient and liner regression, Sampling, the basis of sampling, sampling procedure, sampling statistics.

UNIT II: Acid-Base Equilibria and Buffer Solutions:
Acid-base theories, pH definition and pH scale (Sorenson), and its significance, Hammett acidity function, pH at elevated temperatures, pH for aqueous solutions of very weak acid and base, pH for salts of weak acid and weak bases, polyproticacids. Buffer solutions,

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Buffer capacity, applications of buffers, Physiological buffers in living systems, buffers for biological and clinical measurements.

UNIT III: Chemical Analysis and GLP

Practical aspects of chemical analysis, Analysis of real samples - Choice of analytical method, Literature survey, Analysis of standard samples, preparing samples for analysis – preparing laboratory samples, moisture determination of samples, drying the analytical sample, decomposition and dissolution of sample and source of errors. Good laboratory Practices and implementation: Equipment's, Quality assurance practices, SOPs, reagents, solutions, test and controls, raw data analysis and GLP practices.

UNIT IV: Theory of Volumetric and Gravimetric Analysis

Introduction, Titrimetric analysis, classifications of reactions in titrimetric analysis, standard solutions, preparation of standard solutions, primary and secondary standards.Indicators, theory of indicators, Acid–base titrations in non-aqueous media.Gravimetric Analysis, Impurities in precipitates, Gravimetric calculations, precipitation equilibria (Solubility product, common ion effect, stoichiometry), organic precipitation.

UNIT V: Redox and Complexometric titrations

Principle and detection of equivalence point by visual, potentiometric methods. Applications of Redox titrations, use of Jones reductor, Karl Fisher reagent for water determination.

Complexometric titrations: Introduction, Principles, Titration curves, stability constants, use of EDTA for the determination of metals and practical considerations. Types of Complexometric Titrations (a) Direct Titration (b) Back Titration (c) Replacement titration (d) Indirect Titration (e) Applications of Complexometric Titrations.

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1. D.A. Skoog and D.M. West, Fundamental of Analytical Chemistry, Saunders College Publishing, Philadelphia, Holt, London.
2. R.L. Pecsok, L.D. Shields, T. Cairns and L.C. McWilliam, Modern Methods of Chemical Analysis, John Wiley & Sons, New York.
3. H.A. Strobel, Chemical Instrumentation: A Schematic Approach, Addison Wesley, Reading, Mass.
4. Analytical chemistry, G. D. Christian, Sixth Edition, Wiley publications.

Reference Books:

1. Instrumental Analysis, Y.H. Bauer, G.D. Christian, S.E. O'reilly, Allyn and Bacon Inc.
2. Treatise on Analytical Chemistry, Eds. I. M. Kolthoff and Others, Interscience Pub., (Series of volumes).
3. Electroanalytical Chemistry, J.J .Lingane, 5th Ed Interscience, New York (1999)
4. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, (A series of volumes)

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