Scheme of Instruction & Syllabi

For

Master of Science

In

Chemistry

Two Years CBCS M.Sc. Course in Chemistry

(Academic Session: 2026-27)

First Year

Department of Applied Sciences & Humanities

INVERTIS UNIVERSITY

Invertis Village

Bareilly-Lucknow NH-24, Bareilly-243123, India

Programme Outcomes (POs)

PO1: Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.

PO2: Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PO3: Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PO4: Students will be able to clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.

PO5: Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

PO6: Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.

PO7: Students will be able to function as a member of an interdisciplinary problem solving team.

PO8: The graduate has specific skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques.

PO9: Are able to use modern instrumentation and classical techniques, to design experiments, and to properly record the results of their experiment.

PO10: Are able to use modern library searching and retrieval methods to obtain information about a topic, chemical, chemical technique, or an issue relating to chemistry.

PO11: Students should be able to communicate scientific results in writing and in oral presentation.

PO12: Students should become proficient in their specialized area of chemistry and acquire the basic tools needed to carry out independent chemical research.

Programme Educational Objectives (PEO)

PEO-1: The Masters in Chemistry will extend your depth and breadth of knowledge in all branches of chemistry, suitable for a professional chemist capable of conducting research.

PEO-2: To carryout research in the trust areas of chemistry. Will be able to communicate effectively the scientific information and research results in written and oral formats, to both professional scientists and to the public.

PEO-3: To motivate critical thinking and analytical skills to solve complex chemical problems and the Ability to handle problems of practical relevance to society while complying with economical, environmental, ethical, and safety factors.

PEO-4: To practice chemistry by performance of experiments in the laboratory classes. To perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.

Study & Evaluation Scheme

M. Sc. CHEMISTRY (FIRST YEAR)

Semester-I

S.No.	Course Code	Subject	Periods			Evaluation Scheme			
			L	T	P	MSM	ESM	Total Marks	Credit
1	MCH101	Coordination Chemistry	3	1	-	30	70	100	4
2	MCH102	Intermediates and Reaction Mechanism	3	1	-	30	70	100	4
3	MCH103	Quantum Chemistry and Stat. Mechanics	3	1	-	30	70	100	4
4	MCH104	Analytical Chemistry-I	3	1		30	70	100	4
5	MCH151	Inorganic Chemistry Practi-cal-I	-	-	4	20	30	50	2
6	MCH152	Organic Chemistry Practical-I	-	-	4	20	30	50	2
7	MCH153	Physical Chemistry Practical-I	-	-	4	20	30	50	2
8	EPC001	WeXl AI Proficiency English Course	-	-	-	-	50	50	2
		Total	**12**	**4**	**12**	**180**	**420**	**600**	**24**

Semester-II

S.No.	Course Code	Subject	Periods			Evaluation Scheme			
			L	T	P	MSM	ESM	Total Marks	Credit
1	MCH201	Organometallic Chemistry and Bioinorganic Chemistry	3	1	-	30	70	100	4
2	MCH202	Pericyclic Reaction and Pho-tochemistry	3	1	-	30	70	100	4
3	MCH203	Electrochemistry, Chem. Ki-netics and Macromolecules	3	1	-	30	70	100	4
4	MCH204	Analytical Chemistry-II	3	1	-	30	70	100	4
5	MCH251	Inorganic Chemistry Prac-tical-II	-	-	4	20	30	50	2
6	MCH252	Organic Chemistry Practi-cal-II	-	-	4	20	30	50	2
7	MCH253	Physical Chemistry. Prac-tical-II	-	-	4	20	30	50	2
8	EPC002	WeXl AI Proficiency English Course	-	-	-	-	50	50	2
		Total	**12**	**4**	**12**	**180**	**420**	**600**	**24**

M. Sc. CHEMISTRY (SECOND YEAR)

SEMESTER -III

S.N	Course Code	Subject				Evaluation Scheme			Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH301	Supra molecular and Materials Chemistry	3	1	-	30	70	100	4
2	MCH302	Green Chemistry and Catalysis	3	1	-	30	70	100	4
3	MCH303	Molecular Spectroscopy and Group Theory	3	1	-	30	70	100	4
4	MCH304	Analytical Chemistry-III	3	1	-	30	70	100	4
5	MCH3011*	Advanced Inorganic Chemistry	3	1	-	30	70	100	4
6	MCH3012*	Stereochemistry and Heterocyclic Chemis-try							
7	MCH3013*	Advanced Physical Chemistry							
8	MCH3014*	Advanced Analytical Chemistry							
9	MCH351*	Inorganic Chemistry Practical-III	-	-	4	20	30	50	2
10	MCH352*	Organic Chemistry Practical-III							
11	MCH353*	Physical Chemistry Practical-III							
12	MCH354*	Analytical Chemistry Practical-I							
13	MCH355**	Field Pro-ject/Internship	-	-	-	30	70	100	4
		Total	**15**	**5**	**4**	**200**	**450**	**650**	**26**

***Student has to choose only one (theory + lab) in the specialization.**
****Students can carry out Field project/Internship after 2nd semester of the program**

SEMESTER IV

(Inorganic group)									
S.No.	Course Code	Subject	Evaluation Scheme						Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH4011	Spectroscopic Methods	3	1	-	30	70	100	4
2	MCH4012	Bioinorganic Chemistry	3	1	-	30	70	100	4
3	MCH4013	Analytical Techniques	3	1	-	30	70	100	4
4	MCH4014	Nuclear and Radio-chemistry	3	1	-	30	70	100	4
5	MCH451	Inorganic Chemistry Practical-IV	-	-	4	20	30	50	2
6	MCH452	Project Dissertation	-	-	-	50	150	200	8
		Total	**12**	**4**	**4**	**190**	**460**	**650**	**26**

(Organic group)									
S.No.	Course Code	Subject	Evaluation Scheme						Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH4021	Advanced Organic Synthesis	3	1	-	30	70	100	4
2	MCH4022	Natural Products	3	1	-	30	70	100	4
3	MCH4023	Spectroscopy	3	1	-	30	70	100	4
4	MCH4024	Medicinal Chemistry	3	1	-	30	70	100	4
5	MCH453	Organic Chemistry Practical-IV	-	-	4	20	30	50	2
6	MCH454	Project Dissertation	-	-	-	50	150	200	8
		Total	**12**	**4**	**4**	**190**	**460**	**650**	**26**

(Physical group)									
S.No.	Course Code	Subject	Evaluation Scheme						
			L	T	P	MSM	ESM	Total Marks	Credit
1	MCH4031	Advanced Electrochemistry	3	1	-	30	70	100	4
2	MCH4032	Photo and Radio Chemistry	3	1	-	30	70	100	4
3	MCH4033	Biophysical Chemistry	3	1	-	30	70	100	4
4	MCH4034	Crystallography	3	1	-	30	70	100	4
5	MCH455	Physical Chemistry Practical-IV	-	-	4	20	30	50	2
6	MCH456	Project Dissertation	-	-	-	50	150	200	8
		Total	**12**	**4**	**4**	**190**	**460**	**650**	**26**

(Analytical group)									
S.No.	Course Code	Subject	Evaluation Scheme						
			L	T	P	MSM	ESM	Total Marks	Credit
1	MCH4041	Separation Techniques	3	1	-	30	70	100	4
2	MCH4042	Polarography	3	1	-	30	70	100	4
3	MCH4043	Spectroscopic Techniques	3	1	-	30	70	100	4
4	MCH4044	Micro Analytical Techniques	3	1	-	30	70	100	4
5	MCH457	AnalyticalChemistry Practical-II	-	-	4	20	30	50	2
6	MCH458	Project Dissertation	-	-	-	50	150	200	8
		Total	**12**	**4**	**4**	**190**	**460**	**650**	**26**

SEMESTER-I

MCH101: Coordination Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: - Concept of Metal-Ligand Bonding in Transition Metal Complexes and Elec- tronic spectra of Transition Metal Complexes.

Course Objectives:

1. Develop a comprehensive understanding of metal–ligand bonding in transition metal complexes using Crystal Field Theory (CFT), Ligand Field Theory (LFT), and molecular orbital concepts.
2. Explain the stability, structure, and reactivity of coordination compounds by applying concepts such as stability constants, chelate effect, macrocyclic effect, and thermodynamic and kinetic principles.
3. Understand the mechanisms of ligand substitution and electron-transfer reactions in coordination compounds, including octahedral and square-planar complexes.
4. Acquire knowledge of modern coordination chemistry, including supramolecular chemistry, photo-inorganic chemistry, molecular devices, supramolecular reactivity, and catalysis.
5. Interpret the electronic spectra of transition metal complexes using Orgel diagrams, Tanabe–Sugano diagrams, charge-transfer spectra, and ligand field theory.
6. Correlate spectroscopic, magnetic, and structural properties of coordination compounds through crystal field parameters, Racah parameters, nephelauxetic effect, and metal–ligand orbital interactions.

Detailed Syllabus

Unit-1: Theories for Metal-Ligand Bonding in Complexes: Brief introduction of valence bond theory, Crystal field theory (tetrahedral, octahedral and square planer); Ligand field theory, Spectrochemical series, site selection in spinels, Jahn-Teller distortions; experimental evidence for metal-ligand orbital overlap; ligand field theory (tetrahedral, octahedral and square planer).
Unit-2: Colour and Electronic Transition: Angular momentum of electron, Microstates,

Ground state term symbol, selection rule (Loport and spin selection rule), Orgel diagram for transition metal complexes (tetrahedral and octahedral), Nephelauxetic series, Charge transfer spectra, Tanabe-Sugano diagram for transition metal complexes
Unit-3: Kinetics and Reaction Mechanism of Complex Reaction: Thermodynamic and kinetic stability, chelating effect, substitution reaction (octahedral, square planer and trigonal bipyramidal complexes), factors affecting the reactivity of square planar complexes, Trans effect and its theories, HOMO and LUMO of oxidant and reluctant, Electron transfer reactions (outer and inner sphere), cross reaction, remote attack, Two-electron transfers.
Unit-4: Magnetism: magnetic behaviour in metal complexes, magnetic moment, High spin-Low spin equilibria.
Text and Reference Books **Reference Books:** 1. Cotton, F. A., Wilkinson, G., Murillo, C. A. & Bochmann, M. Advanced Inorganic Chemistry, 6th Ed., John Wiley & Sons, New York, 1999. 2. Huheey, J. E., Keiter, E. A. & Keiter, R. L. Inorganic Chemistry: Principles of Structure and Reactivity, 4th Ed., HarperCollins College Publishers, New York, 1993. 3. Lever, A. B. P. Inorganic Electronic Spectroscopy, 2nd Ed., Elsevier Science Publishers, Amsterdam, 1984. 4. Dutta, R. L. Inorganic Chemistry, Vol. II, New Age International (P) Ltd., New Delhi, 2008. 5. Satpathy, K. C. Fundamentals of Coordination Chemistry, Books & Allied (P) Ltd., Kolkata, 2011.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Explain the nephelauxetic series.
CO2	Describe the metal-ligand orbital overlap.
CO3	Understand the applications for homonuclear and heteronuclear diatomic molecules.
CO4	Explain the charge transfer spectra.
CO5	Develop the electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes
CO6	Illustrate the supramolecular reactivity and catalysis.

MCH102: Intermediates and Reaction Mechanism

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Course Objectives:

1. To Understand the generation, stability, and structure of reactive intermediates.
2. To focus on *why* and *how* electrons move.
3. To learn the trapping of Intermediates.
4. To know the Curtin-Hammett control.
5. To teach students how to prove mechanisms using experimental and kinetic data.
6. To analyze the effect of solvent in reaction mechanism.

Detailed Syllabus

Unit-1: Carbocations: Classical (alkyl, allyl, benzyl) and non-classical (Norbornyl, 7-norbornenyl, and Phenonium ions), neighbouring group participation, ion-pairs, molecular rearrangements in acyclic. Stability and reactivity of bridge-head carbocations. Pinacol-Pinacolone, and Beckmann rearrangements.
Unit-2: Carbonions: Generation, structure and stability; ambident ions and their general reactions. Condensation reactions: Aldol, Claisen, Perkin, and Knoevenagel condensations. Michael Addition.
Unit-3: Radicals: Generation, structure, stability, and reactions; radical cations & radical anions. Hyperconjugation, resonance delocalization (allyl, benzyl etc.), Anti-Markovnikov addition of HBr (Peroxide Effect) and Birch Reduction.
Unit-4: Nitrenes: Generation (from Alkyl, Aryl, and Acyl Azides), structure and reactions of nitrenes. Hofmann Rearrangement: Conversion of primary amides to amines using Br_2/NaOH.
Unit-5: Benzyne: Generation, structure and properties.
Unit-6: Introduction to Reaction Mechanisms: Writing reaction mechanisms: Arrow pushing; Types of polar reactions; Radical reactions; Reac-

tion coordinate diagram; The Hammond Postulates; The Kinetic vs Thermodynamic Control; Curtin-Hammett control.
Unit-7: Nucleophilic Substitution at Saturated Carbon: Mechanism and stereochemistry of S_N1, S_N2 and S_Ni reactions. The reactivity effects of substrate structure, solvent effects, competition between S_N1 and S_N2 mechanisms.
Unit-8: Chemical Kinetics to Decipher Reaction Mechanisms An introduction to reaction kinetics; Deriving the rate laws; Distinguishing reaction mechanism using rate laws; Methods to monitor a reaction.
Text and Reference Books **Reference Books:** 1. Carey. F.A. & Sundbera, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004). 2. Modern Physical Organic Chemistry by Dennis A. Dougherty and Eric V. Anslyn. 3. Finar, I.L. & Finar, A.L. Organic Chemistry Vol. 2, Addison-Wesley (1998). 4. Final, I.L. Organic Chemistry Vol. I, Longman (1998).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Propose logical, step-by-step electron-pushing mechanisms for complex reactions.
CO2	Predict the stability and geometry of transient intermediates.
CO3	Understand the; radical reactions; reaction coordinate diagram.
CO4	Analyze the stereochemical and regiochemical outcomes of organic transformations.
CO5	Explain the reactions involving carbenes and carbenoids.
CO6	Explain the reactions mechanisms in different aspects

MCH103: Quantum Chemistry and Statistical Thermodynamic

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of quantum chemistry and statistics thermodynamics.

Detailed Syllabus

1. To know about Postulates and theorems of quantum mechanics.
2. To understand the angular momentum, rigid rotor.
3. To learn the Hydrogen atom, the variation theorem, perturbation theorem.
4. To learn the Huckel Molecular Orbital Theory of conjugated systems.
5. To know the particle distribution in different levels
6. To understand the construction of microlevels.

Unit-1: Quantum Chemistry: Fundamental background: Postulates and theorems of quantum mechanics, angular momentum, rigid rotor. The Schrödinger equation (Time dependent and time independent) and its exact solutions: The particle-in-a-box, Simple harmonic oscillation, Hydrogen atom, the variation theorem – Ritz variation principle. Perturbation theorem (First order and second order), Tunneling effect
Unit-2: Chemical Bonding: Born-Oppenheimer approximation. Variational treatment of hydrogen molecule ion. Valence bond and MO (LCAO) treatment of hydrogen molecule. Comparison of the MO and VB treatments. Extension of MO theory to other systems- Homonuclear and heteronuclear, Huckel Molecular Orbital Theory of conjugated systems, Calculation of properties- delocalization energy, bond order, Atomic structure: many electron wave functions, Pauli exclusion principle, Helium atom, atomic term symbols.
Unit-3: Statistical Thermodynamics: Fundamentals: Concept of distribution. Thermodynamic probability and most probable distribution.

Canonical and other ensembles. Types of statistics: Maxwell-Boltzmann. Bose-Einstein and Fermi-Dirac statistics. Idea of microstates and macrostates. Evaluation of translational, rotational and vibrational partition functions for monatomic, diatomic and polyatomic gases. Calculation of equilibrium constants of gaseous solutions in terms of partition function, perfect gas mixtures. Einstein and Debye theory for solid state.

Text and Reference Books

Reference Books:

1. R. K. Prasad, Quantum chemistry, New Age International Publishers, 4th Ediction (2010).
2. L McQuarrie, D.A. Statistical Mechanics Viva Books Pvt. Ltd.: New Delhi (2003).
3. Nash, L.K. Elements of Statistical Thermodynamics. 2nd Ed.,Addison Wesley (1974).
4. D.A. Mc Quarrie and J.D. Simon, Physical Chemistry: A Molecular Approach, (1998) Viva Books, New Delhi.
5. J.N. Murrell, S.F.A. Kettle and J. M. Tedder, Valence Theory, 2nd Edition (1965), John Wiley, New York.

Course Objectives:

Course Outcomes: After completing this course, students will be able to achieve the followings:

CO1	Illustrate the Schrödinger equation
CO2	Understand the atomic structure: many electron wave functions.
CO3	Describe the comparison of the MO and VB treatments.
CO4	Explain the extension of MO theory to other systems- Homonuclear and heteronuclear.
CO5	Identify the particle in different state
CO6	Analysis the energy level in different partition functions

MCH104: Analytical Chemistry-I

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Errors in Chemical Analysis and Statistical Evaluation of Data.

Course Objectives:

1. To know about method selection, Sample processing.
2. To understand the quantitative range (bispartite classification).
3. To learn the useful statistical test: test of significance.
4. To learn the comparison of mean with true values.
5. To know the practical limitations in use of buffers.
6. To understand the precipitation reaction and precipitation titrations.

Detailed Syllabus

Unit-1: Introduction: Definition, scope, and importance of analytical chemistry in research and industry Classification of analytical methods: classical vs. instrumental; qualitative vs. quantitative; macro, micro, semi-micro, and trace analysis, Sample preparation and processing: dissolution, digestion, extraction, pre-concentration, Steps in quantitative analysis (planning → sampling → analysis → data treatment → reporting), Accuracy and precision, Significant figures and rules of rounding in analytical calculations, Analytical method validation: specificity, linearity, range, robustness, ruggedness, Limit of detection (LOD) and limit of quantitation (LOQ) — concept and calculation, Good Laboratory Practices (GLP), quality assurance (QA) and quality control (QC) basics
Unit-2: Errors and Statistical Method of Analysis: Types of errors: systematic (determinate) and random (indeterminate); gross errors, Normal (Gaussian) distribution curve and its properties, Mean, standard deviation, variance, relative standard deviation, coefficient of variation, Confidence limits and confidence intervals, Tests of signifi-

cance: Student's t-test, F-test, Chi-square (χ^2) test, Q-test for rejection of outliers, Regression analysis — least squares method (linear calibration), Correlation coefficient and its interpretation, Propagation of errors in computed results (sums, products, and functions), Introduction to method validation parameters: recovery studies, robustness testing.
Unit-3: Chemical Equilibria in Analytical Systems: Thermodynamic basis of chemical equilibrium (ΔG, equilibrium constant), Activities and activity coefficients, ionic strength (Debye–Hückel theory), Effect of electrolytes on equilibrium constants, Charge balance and mass balance equations in complex systems , Construction of titration curves using equilibrium calculations and endpoint determination, redox equilibria and titration, acid base titration, complexometric titration and theory of indicators.
Unit-4: Buffer Solutions in Analytical Systems: Theory of buffer solutions and mechanism of buffer action, Henderson–Hasselbalch equation and its derivation, Effect of dilution and salt addition on buffer pH, Buffer index (buffer capacity) — definition and significance, Criteria and mathematical expression for maximum buffer capacity, Selection and application of pH buffers in analytical work, Practical limitations of buffers: temperature effects, dilution effects, ionic-strength/matrix interference, Metal-ion buffers and their role in complexometric analysis (e.g., masking, conditional stability), Biological buffers (Good's buffers): types, properties, and applications, Applications of buffers in titrimetry, spectrophotometry, and electroanalytical methods
Text and Reference Books **Reference Books:** 1. R.L. Pecsok, L.D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of ChemicalAnalysis*, 2nd Edition (1976), John Wiley, New York. 2. G.D. Christian, *Analytical Chemistry*, 5th Edition (1994), John Wiley & Sons, New York. 3. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, *Analytical Chemistry - An Introduction*, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the limit of detection and limit of quantitation.
CO2	Understand the ways of expressing accuracy and precision.
CO3	Explain the comparison of two standard values.
CO4	Develop the calculation of pH, Constructing titration curves.
CO5	Calculate the acid-base titrations and theory of pH indicators.
CO6	Illustrate the analytical methods.

MCH151: Inorganic Chemistry Practical-I

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
P	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Pre-requisite: Concept of develop the experimental skills.

Course Objectives:

1. To know about *trans*-Potassium diaquabis(oxalato)chromate(III)
2. To understand the Tris(acetylacetonato)manganese(III), $[Mn(acac)_3]$.
3. To learn the Pentaamminenitritocobalt(III) chloride, $[Co(ONO)(NH_3)_5]Cl_2$.

Detailed Syllabus

1. Preparation, purification and structural studies (magnetic, electronic and IR) of inorganic complex compounds:
   - (i) *trans*-Potassium diaquabis(oxalato)chromate(III), *trans*-$K[Cr(ox)_2(H_2O)_2]$
   - (ii) *cis*-Potassium diaquabis(oxalato)chromate(III), *cis*-$K[Cr(ox)_2(H_2O)_2]$
   - (iii) Tris(acetylacetonato)manganese(III), $[Mn(acac)_3]$.
   - (iv) Sodium hexanitritocobaltate(III), $Na_3[Co(ONO)_6]$.
   - (v) Pentaamminemonochlorocobalt(III) chloride, $[CoCl(NH_3)_5]Cl_2$.
   - (vi) Pentaammineaquacobalt(III) chloride, $[Co(H_2O)(NH_3)_5]Cl_3$ by using $[CoCl(NH_3)_5]Cl_2$ as starting material.
   - (vii) Pentaamminenitritocobalt(III) chloride, $[Co(ONO)(NH_3)_5]Cl_2$ by using $[CoCl(NH_3)_5]Cl_2$ as starting material.
   - (viii) Pentaamminenitrocobalt(III) chloride, $[Co(NO_2)(NH_3)_5]Cl_3$ by using $[Co(ONO)(NH_3)_5]Cl_2$ as starting material.
2. Semi-micro qualitative analysis of a mixture containing five cations of rare elements and insolubles:
   - (ii) Rare elements: Tl, W, Se, Mo, Ti, Zr, Ce, Th, V, U, Li

Insolubles: $PbSO_4$, $SrSO_4$, Al_2O_3, Cr_2O_3, Fe_2O_3, SnO_2, TiO_2, ThO_2, $WO_3.xH_2O$
Text and Reference Books **Reference Books:** 1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the semi-micro qualitative analysis of a mixture containing five cations of rare elements.
CO2	Understand the rare elements: Tl, W, Se, Mo.
CO3	Explain the rare elements: Ti, Zr, Ce, Th, V, U, Li.
CO4	Develop the pentaamminemonochlorocobalt(III) chloride, $[CoCl(NH_3)_5]Cl_2$.
CO5	Analyse the *cis*-Potassium diaquabis(oxalato)chromate(III), *cis*-$K[Cr(ox)_2(H_2O)_2]$
CO6	Illustrate the sodium hexanitritocobaltate(III), $Na_3[Co(ONO)_6]$.

MCH152: Organic Chemistry Practical-I

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Concept of Identification of compounds having one or more functional groups.

Course Objectives:

1. To know about neutralization equivalent of organic acids.
2. To understand the Identification of compounds.
3. To learn the intermediates involving up to two steps H_2O.

Detailed Syllabus

1. Determination of neutralization equivalent of organic acids.
2. Identification of compounds having one or more functional groups.
3. Preparation of compounds and intermediates using green solvent.

Text and Reference Books

Reference Books:

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the determination of neutralization equivalent of organic acids.

CO2	Understand the identification of compounds having one or more functional groups
CO3	Explain the identification of compounds having one or more functional groups
CO4	Develop the identification of compounds having one or more functional groups
CO5	Calculate the identification of compounds having one or more functional groups
CO6	Illustrate the identification of compounds having one or more functional groups.

MCH153: Physical Chemistry Practical-I

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Concept of enhance the physical chemistry experiments skills.

Course Objectives:

1. To know about Saponification of ethyl acetate with sodium hydroxide by chemical method.
2. To understand the Conductometric titration of KCl with $AgNO_3$.
3. To learn the Molecular weight of a non-electrolyte by cryoscopic method.

Detailed Syllabus

1. Saponification of ethyl acetate with sodium hydroxide by chemical method.
2. Comparison of acid strengths through acid catalyzed methyl acetate hydrolysis.
3. Energy of activation of acid catalyzed hydrolysis of methyl acetate.
4. Distribution coefficient of I_2 between two immiscible solvents.
5. Conductometric titration of a weak acid with strong base.
6. Conductometric titration of a mixture of weak and strong acids.
7. Potentiometric titration of a strong acid with strong base using quinhydrone electrode.
8. Conductometric titration of KCl with $AgNO_3$.
9. Molecular weight of a non-electrolyte by cryoscopic method.
10. Plateau of GM tube and study of counting statistics.

Text and Reference Books

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Free-

man & Co.: New York (2003).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the Comparison of acid strengths through acid catalyzed methyl acetate hydrolysis.
CO2	Understand the energy of activation of acid catalyzed hydrolysis of methyl acetate
CO3	Explain the potentiometric titration of a strong acid with strong base using quinhydrone electrode.
CO4	Develop the conductometric titration of KCl with $AgNO_3$
CO5	Calculate the distribution coefficient of I_2 between two immiscible solvents.
CO6	Illustrate the conductometric titration of a weak acid with strong base.

SEMESTER-II

MCH201: Organometallic Chemistry and Bioinorganic Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of acid and base hydrolysis and elimination reactions and inorganic compounds by IR, Raman, NMR, EPR.

Course Objectives:

1. Understand the fundamental concepts of organometallic chemistry, including metal–carbon bonding, ligand classification, and electron counting rules.
2. Explain the structure, bonding, preparation, and reactivity of metal carbonyls using molecular orbital concepts and spectroscopic techniques.
3. Interpret the structure and bonding of boranes, carboranes, metalloboranes, and metal clusters using Wade's and related electron counting rules.
4. Develop the ability to analyze organometallic compounds using concepts such as isolobal analogy, synergic bonding, and skeletal electron counting.
5. Understand the role of metal ions and coordination compounds in biological systems, including oxygen transport and energy metabolism.
6. Relate principles of organometallic and bioinorganic chemistry to modern research, catalysis, medicinal chemistry, and materials science.

Detailed Syllabus

Unit-1: Fundamental Bonding & Electron Count:

History and definition of organometallic compounds; nature of the metal–carbon bond. Classification of carbon-based ligands by donor atom/hapticity; σ-donor and π-acceptor ligands. 18-electron

(EAN) and 16-electron rules — derivation, usefulness and limitations; applications to metal carbonyls and other complexes. Isolobal analogy and isoelectronic relationships, with representative examples. Bonding models in σ- and π-complexes: synergic bonding (donation + back-donation)
Unit-2: Metal Carbonyls: Preparation, structure, and properties; bonding in metal carbonyls, variants of CO bridging, vibrational spectra of metal carbonyls, principal reaction types of metal carbonyls, Carbonyl metal halides
Unit-3: Ring, Cage and Cluster Compounds Higher boranes and carboranes, Lipscomb`s topological concept, styx rule, Wade`s rule, skeletal electron counting, Wade – Mingos – Lauher rule. Bonding in metalloboranes and metallocarboranes. Low nuclearity (M2, M3) carbonyl clusters.
Unit-4: Bioinorganic Chemistry: Principles of coordination chemistry related to bioinorganic chemistry, Essential and trace metal ions in biological systems, Porphyrin and related ligands, ATP as energy source, oxidative phosphorylation and phosphorylation of glucose. Transport and storage of dioxygen: Structure and function of hemoglobin, myoglobin, hemocyanin and hemerythrin. Synthetic oxygen carriers.
Text and Reference Books Reference Books: 1. Cotton, F. A., Wilkinson, G., Murillo, C. A. & Bochmann, M. *Advanced Inorganic Chemistry*, 6th Ed., John Wiley & Sons, New York, 1999. 2. Miessler, G. L., Fischer, P. J. & Tarr, D. A. *Inorganic Chemistry*, 5th Ed., Pearson Education, Boston, 2014. 3. Elschenbroich, C. *Organometallics*, 3rd Ed., Wiley-VCH, Weinheim, 2006. 4. Dutta, R. L. *Inorganic Chemistry, Vol. II*, New Age International (P) Ltd., New Delhi, 2008. 5. Das, A. K. & Das, M. *Fundamentals of Inorganic Chemistry, Vol. II*, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2014.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Apply electron counting rules (18-electron/EAN), isolobal analogy, and bonding models to predict the stability and structure of organometallic compounds.
CO2	Analyze the preparation, bonding, vibrational spectra, and chemical reactions of metal carbonyl complexes.
CO3	Interpret the structures and electron-counting schemes of boranes, carboranes, metallobo-

	ranes, and low-nuclearity metal clusters.
CO4	Explain the coordination chemistry underlying biological systems, including metalloproteins and oxygen transport mechanisms.
CO5	Evaluate the role of biologically important metal ions, ATP, oxidative phosphorylation, and synthetic oxygen carriers in living systems.
CO6	Integrate theoretical concepts of organometallic and bioinorganic chemistry to solve advanced chemical problems and interpret current research literature.

MCH202: Pericyclic and Photochemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Pericyclic reactions and Photochemistry

Course Objectives:

1. To know about the concepts of pericyclic reactions.
2. To learn about the electrocyclic and cycloaddition reactions with multiple examples.
3. To learn the sigmatropic and Ene reaction.
4. To know the Cheletropic reactions.
5. To recognize the principles of photochemistry and diverse types of photochemical reactions.
6. To know the photo-oxidation and reduction reactions

Detailed Syllabus

Unit-1: Pericyclic Reactions: Woodward-Hoffmann rules; Cycloaddition [2+2] and [4+2], and electrocyclic reactions. Sigmatropic rearrangements, Ene reactions and Cheletropic reactions; 1,3-Dipolar cycloaddition.
Unit-2: Photophysical Processes: Jablonskii diagram, energy pooling, exciplexes, ex-

cimers, photosensitization, quantum yield, solvent effects. Stern volume plots, delayed fluorescence Stern-volmer plot, delayed fluorescence, etc.
Unit-3: Photochemistry of Alkenes: cis-trans isomerization, non-vertical energy transfer: photochemical additions; reactions of 1.3-.1,4- and1,5-dienes. Dimerizations.
Unit-4: Photochemistry of Carbonyl Compounds: Norrish type I & II reactions (cyclic and acyclic); α, β-unsaturated ketones; β, γ-unsaturated ketones; cyclohexenones (conjugated); cyclohexadienones (cross-conjugated & conjugated); Paterno—Buchi reactions:
Unit-5: Photochemistry of Aromatic Compounds: Isomerizations, Dewar and prismanes in isornerization. Singlet oxygen reactions: Photo Fries rearrangement of ethers and anilides; Barton reaction, Hoffman-Loefller-Freytag reaction.

Text and Reference Books

Reference Books:

1. Singh, J., & Singh, J. (2024). Photochemistry and Pericyclic Reactions (6th ed.). New Age International.
2. Sankararaman, S. (2005). Pericyclic Reactions: A Textbook: Reactions, Applications and Theory.
3. Turro, N. J., Ramamurthy, V., & Scaiano, J. C. (2010). Modern Molecular Photochemistry of Organic Compounds. University Science Books.
4. March, J. Advanced Organic Chemistry John Wiley & Sons (1992).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the concepts of pericyclic reactions.
CO2	Understand the reaction mechanism of electrocyclic and cycloaddition
CO3	Explain the Ene reaction
CO4	Calculate the sigmatropic rearrangements.
CO5	Describe the principles of photochemistry
CO6	Illustrate photo-oxidation and reduction reactions

MCH203: Electrochemistry, Chemical Kinetics and Macromolecules

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of electrochemistry, kinetics and macromolecules.

Course Objectives:

1. To know about concept of conductivity.
2. To learn the electrolytic conductivity and the Debye-Hückel-Onsangar treatment.
3. To learn the collision theory and potential energy surfaces.
4. To understand the corrosion and kinetics of electrode reactions.
5. To know the photochemical process.
6. To understand the mass and volume density in polymer sample

Detailed Syllabus

Unit-1: Electrochemistry: Electrochemical cells, Nernst equation and applications of Debye-Huckel-theory, Electrolytic conductivity and the Debye-Hückel-Onsangar treatment, electrified interfaces, concentration cells, over potential, kinetics of electrode reactions; irreversible electrode processes. Butler-Volmer equation under near equilibrium and non-equilibrium conditions, exchange current density, Tafel plot, polarizable and non-polarizable interfaces
Unit-2: Kinetics: Theories of reaction rates: Collision theory. Potential energy surfaces (basic idea). Kinetics of complex reactions (reversible, simultaneous and consecutive), Transition state theory, chain reactions: dynamic chain (Hydrogen-Bromine reaction, decomposition of ethane), branched chain (Hydrogen-Oxygen reaction). Fast reaction kinetics, Stern-Valmer equation

Unit-3: Macromolecules:, Concepts of number average and mass average molecular weights, Polydispersity index, Kinetics of addition and condensation polymerization, Methods of determining molecular weights (osmometry, viscometry, sedimentation equilibrium methods)

Text and Reference Books

Reference Books:

1. J. O. M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 2 A & B, 2 nd Ed. Plenum Press, New York (1998).
2. Puri, Sharma and Pathaniya, Principle of Physical Chemistry, Vishal Publication Co. (2013).
3. K. J. Laidler, Chemical Kinetics, 3rd Edition, Horper and Row, 1987.
4. A. Kumar and S. K. Gupta, Fundamentals of Polymer Science and Engineering, Tata Mcgraw Hill, 1978.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	To know the basic knowledge of conductivity
CO2	Develop the non-equilibrium conditions, exchange current density.
CO3	Explain the Butler-Volmer equation under near equilibrium.
CO4	Understand the mechanistic approach in various types of reaction
CO5	Describe the concepts of number average.
CO6	Understand the methods of determining molecular weights (osmometry, viscometry, sedimentation equilibrium methods).

MCH204: Analytical Chemistry-II

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of polarography and atomic spectroscopy.

Course Objectives:

1. To know about current-voltage relationship.
2. To understand the atomic emission spectrometry
3. To learn the molecular luminescence spectroscopy.
4. To learn the principle of chromatography.
5. To know the differential Thermal Analysis (DTA).
6. To understand the heat flow, enthalpy, mass change, and decomposition.

Detailed Syllabus

Unit-1: Cell Components: Working electrodes (solid, DME, microelectrodes), reference electrodes (SCE, Ag/AgCl), and counter electrodes. Cyclic Voltammetry (CV): Triangular waveform generators, sweep rates, peak current (i_p) formulas, and evaluation of reversible/irreversible systems. Electrochemical Impedance Spectroscopy (EIS): AC circuit analogs, Nyquist plots, Bode plots, and equivalent circuit fitting software.
Unit-2: Atomic Spectroscopy: Powder X-ray Diffraction (PXRD): Sample preparation, phase identification, and qualitative analysis. Single-Crystal X-ray Diffraction (SCXRD): Crystal mounting, data collection strategies, indexing, and structure solution. Atomic Absorption Spectroscopy (AAS): Radiation Sources, Sample Introduction & Atomizers, Wavelength Selectors, and trace metal analysis in environmental (water, soil), pharmaceutical, biological, and food samples.
Unit-3: Molecular Spectroscopy: UV-visible molecular absorption spectrometry (instrumentation and application), Mass spectroscopy, Molecular luminescence spectroscopy (fluorescence, phosphorescence, chemiluminescence)
Unit-4: Separation Methods: Principles and theory of chromatography, Classification: ad-

sorption, partition, ion-exchange, size-exclusion chromatography, Planar chromatography: paper chromatography and thin-layer chromatography (TLC), Column chromatography and packing techniques, GC-MS, HPLC-MS, Applications in pharmaceuticals, environmental and food analysis
Unit-5: Thermal Analysis: Thermodynamics and Kinetics: Basic principles of heat flow, enthalpy, mass change, and decomposition. Comparative study: Quick overview of TGA, DTA, DSC, TMA (Thermomechanical Analysis), and DMA (Dynamic Mechanical Analysis). Thermogravimetric Analysis (TGA): TG curves, Derivative Thermogravimetry (DTG). Differential Thermal Analysis (DTA). Differential Scanning Calorimetry (DSC): Glass transitions, melting points, crystallization, polymorphism, and purity determination. Factors affecting thermal analysis (heating rate, sample size, atmosphere). Applications of thermal methods in material characterization, polymers, pharmaceuticals, and inorganic compounds
Text and Reference Books **Reference Books:** 1. D.A. Skoog, *Principles of Instrumental Analysis*, 5th Edition (1998), Saunders College Publishing, Philadelphia, London. 2. G.W. Ewing, *Instrumental Methods of Chemical Analysis*, 5th Edition (1978), McGraw Hill Books Co., New York. 3. R.L. Pecsok, L.D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of Chemical-Analysis*, 2ndEdition (1976), John Wiley, New York. 4. J.H. Kennedy, *Analytical Chemistry: Principles*, 2nd Edition (1990), Saunders Holt, London.

Course Outcomes:

After completing this course, students will be able to achieve the followings

CO1	Explain the Cell Components and cyclic voltammetry
CO2	Describe the trace metal analysis in environmental (water, soil), pharmaceutical, biological, and food samples.
CO3	Explain the fluorescence, phosphorescence
CO4	Explain the Column chromatography and packing techniques.
CO5	Describe the thermal methods in material characterization, polymers, pharmaceuticals, and inorganic compounds.
CO6	Briefly describe the AC circuit analogs, Nyquist plots, Bode plots.

MCH251: Inorganic Chemistry Practical-II

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Concept of develop the inorganic chemistry experiments skills.

Course Objectives:

1. To know about Quantitative separation and determination of the pairs of metal ions using gravimetric method.
2. To understand the Separation of a mixture of cations/anions by paper chromatographic technique using aqueous/non-aqueous media.

Detailed Syllabus

1. Quantitative separation and determination of the following pairs of metal ions using gravimetric and volumetric methods:
   (i) Ag^{+} (gravimetrically) and Cu^{2+} (volumetrically),
   (ii) Cu^{2+} (gravimetrically) and Zn^{2+} (volumetrically),
   (iii) Fe^{3+} (gravimetrically) and Ca^{2+} (volumetrically) and
   (iv) Mg^{2+} (gravimetrically) and Ca^{2+} (volumetrically)
2. Separation of a mixture of cations/anions by paper chromatographic technique using aqueous/non-aqueous media:
   (i) Pb^{2+} and Ag^{+} (aqueous & non-aqueous media)
   (ii) Co^{2+} and Cu^{2+} (non-aqueous medium)
   (iii) Cl^{-} and I^{-} (aqueous-acetone medium)
   (iv) Br^{-} and I^{-} (aqueous-acetone medium)

Text and Reference Books

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the quantitative separation and determination of the pairs of metal ions using gravimetric and volumetric methods i) Ag^{+} (gravimetrically) and Cu^{2+} (volumetricaly).
CO2	Understand the Describe the quantitative separation and determination of the pairs of metal ions using gravimetric and volumetric methods
CO3	Explain the quantitative separation and determination of the pairs of metal ions using gravimetric and volumetric method Cu^{2+} (gravimetrically) and Zn^{2+} (volumetrically),
CO4	Develop the quantitative separation and determination of the pairs of metal ions using gravimetric and volumetric method Mg^{2+} (gravimetrically) and Ca^{2+} (volumetrically)
CO5	Separation of a mixture of cations/anions by paper chromatographic technique using

	aqueous/non-aqueous media: Pb^{2+} and Ag^{+} (aqueous & non-aqueous media)
CO6	Illustrate the separation of a mixture of cations/anions by paper chromatographic technique using aqueous/non-aqueous media Br^{-} and I^{-} (aqueous-acetone medium)

MCH252: Organic Chemistry Practical-II

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: -

Concept of develop the organic compound preparation skills.

Course Objectives:

1. To know about Preparation of compounds involving not more than two steps.
2. To understand the Systematic identification of mixtures containing two different compounds.

Detailed Syllabus

1. Preparation of compounds involving not more than two steps.
2. Systematic identification of mixtures containing two different compounds.

Text and Reference Books

Reference Books:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the preparation of picric acid.
CO2	Understand the preparation of p-nitro toluene.
CO3	Explain the systematic identification of mixtures containing two different compounds miture-1.
CO4	Develop the explain the systematic identification of mixtures containing two different compounds miture-2.
CO5	Calculate the explain the Systematic identification of mixtures containing two different compounds miture-3.
CO6	Illustrate the explain the Systematic identification of mixtures containing two different compounds miture-4.

MCH253: Physical Chemistry. Practical-II

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Pre-requisite: Develop the physical chemistry experimental skills.

Course Objectives:

1. To know about Rate constant of acid catalyzed hydrolysis of sucrose by polarimetric method.
2. To understand the Rate constant of acid catalyzed hydrolysis of sucrose by chemical method.
3. To learn the Phase diagram of a binary organic system (Naphthalene and Diphenyl).
4. Determination of solubility and solubility product of sparingly soluble salt conductometrically.

Detailed Syllabus

1. Rate constant of acid catalyzed hydrolysis of sucrose by polarimetric method.
2. Rate constant of acid catalyzed hydrolysis of sucrose by chemical method.
3. Rate constant of $FeCl_3$-catalyzed H_2O_2 decomposition by gasometric method.
4. Degree of hydrolysis of urea hydrochloride by kinetics method.
5. Equilibrium constant of $KI + I_2 \Leftrightarrow KI_3$ by distribution method.
6. Phase diagram of a binary organic system (Naphthalene and Diphenyl).
7. Determination of solubility and solubility product of sparingly soluble salt conductometrically.
8. Potentiometric titration of a redox system (ferrous ammonium sulfate with $K_2Cr_2O_7$).
9. Adsorption of acetic acid on charcoal to verify Freundlich adsorption isotherm.
10. Determination of half-life of a radionuclide.

Text and Reference Books

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the equilibrium constant of KI + $I_2 \Leftrightarrow KI_3$ by distribution method.
CO2	Understand the adsorption of acetic acid on charcoal to verify Freundlich adsorption isotherm.
CO3	Explain the potentiometric titration of a redox system (ferrous ammonium sulfate with $K_2Cr_2O_7$).
CO4	Develop the rate constant of $FeCl_3$-catalyzed H_2O_2 decomposition by gasometric method.
CO5	Determination of half-life of a radionuclide.
CO6	Illustrate the degree of hydrolysis of urea hydrochloride by kinetics method.

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AI English Proficiency

Adaptive Syllabus — Bands 1 to 9

Listening·Speaking·Reading·Writing

1-Year Programme·2 Semesters·Powered by AI FluentEdge

How to Read This Syllabus

Each band section lists **5 units per skill**. The first **2 units are mandated** — these form the assessed curriculum (120 lessonspersemester).Units3–5areoptionalenrichmentthatstudentsareencouragedtocompletebutcarrynomarks.

✓ **Mandated**	Assessed · contributes to 10-mark Course Completion component
Optional	Encouraged enrichment · no marks attached · unlocked on platform

Programme Overview — All Bands

BETBaselinedetermineseachstudent'sstartingbandindependentlyforeachskill.Studentsbeginfromtheirdiagnosed band and complete the 2 mandated units of that level each semester.

Band	CEFR	Platform Level	MandatedUnits(per skill)	Lessons / Skill	Total Lessons
Bands 1–3	A1	Beginner	Unit 1 &2	30	120
Band 4	A2	Elementary	Unit 1 &2	30	120

Band 5	B1	Intermediate	Unit 1 &2	30	120
Bands 6–7	B2	Upper-Intermediate	Unit 1 &2	30	120
Band 8	C1	Advanced	Unit 1 &2	30	120
Band 9	C2	Proficient	Unit 1 &2	30	120

Note:StudentsatBands1,2,and3allbeginatBeginnerlevel.StudentsatBands6and7beginatUpper-Intermediate.Platform unlocks adaptive progression within and across levels.

Bands 1, 2 &3

CEFR: A1 · Beginner

✓ **Mandated:** Units 1 & 2 per skill · 30 lessons/skill · 120 lessons total per semester

Optional: Units 3, 4 & 5 per skill (encouraged, ungraded)

Bands1,2,and3aregroupedtogetherattheBeginnerlevel(CEFRA1).Studentsareplacedwithinthislevelatdifferentstart ingpoints by the BET Baseline — Band 1 at the earliest point, Band 3 slightly further in — but all cover the same mandated units.

Listeni ng	Unit Name	Lessons	Status	Sub-topics
1	Workplace Greetings	15	✓ **Mandated**	15
2	Basic Instructions	15	✓ **Mandated**	15
3	Office Objects	15	**Optional**	15
4	Simple Schedules	15	**Optional**	15
5	Basic Requests &Medication	15	**Optional**	14

Spe akin g	Unit Name	Lessons	Status	Sub-topics
1	Introducing Yourself	15	✓ **Mandated**	13
2	Talking About Daily Tasks	15	✓ **Mandated**	12
3	Asking for Directions	15	**Optional**	8
4	Making Simple Requests & IT Support	15	**Optional**	29
5	Following Up	15	**Optional**	2

Rea din g	Unit Name	Lessons	Status	Sub-topics
1	Reading Simple Emails	15	✓ **Mandated**	15
2	Following Return Policy Instructions	15	✓ **Mandated**	15
3	Following Simple Financial Documents	15	**Optional**	15
4	Understanding Office Signs & Workplace Etiquette	15	**Optional**	22
5	Regulatory Documents	15	**Optional**	2

Writ ing	Unit Name	Lessons	Status	Sub-topics
1	Writing a Short Job Description	15	✓ **Mandated**	5
2	Writing a Simple Email	15	✓ **Mandated**	10
3	Writing Basic Instructions	15	**Optional**	10
4	Taking Simple Work Notes	15	**Optional**	8

5	Meeting Follow-up	15	**Optional**	6

Band 4

CEFR: A2 · Elementary

✓ **Mandated:** Units 1 & 2 per skill · 30 lessons/skill · 120 lessons total per semester

Optional: Units 3, 4 & 5 per skill (encouraged, ungraded)

Listening	Unit Name	Lessons	Status	Sub-topics
1	Scheduling Meetings	15	✓ **Mandated**	15
2	Email Follow-ups	15	✓ **Mandated**	15
3	Work Routines	15	**Optional**	15
4	Office Roles	15	**Optional**	10
5	Basic Phone Calls & Handling Complaints	15	**Optional**	12

Speaking	Unit Name	Lessons	Status	Sub-topics
1	Scheduling Meetings	15	✓ **Mandated**	15
2	Writing and Responding to Emails	15	✓ **Mandated**	12
3	Work Roles and Responsibilities	15	**Optional**	12
4	Giving Feedback on Tasks	15	**Optional**	8
5	Talking About Company Policies	15	**Optional**	9

Reading	Unit Name	Lessons	Status	Sub-topics
1	Reading Company Policies	15	✓ **Mandated**	15
2	Understanding Meeting Agendas	15	✓ **Mandated**	15
3	Reading Customer Inquiries	15	**Optional**	15
4	Internal Office Communication	15	**Optional**	15
5	Understanding Workflow Charts	15	**Optional**	15

Writing	Unit Name	Lessons	Status	Sub-topics
1	Writing Follow-Up Emails	15	✓ **Mandated**	15
2	Summarizing Workplace Tasks	15	✓ **Mandated**	15
3	Creating Short Reports	15	**Optional**	15
4	Writing Formal Meeting Invitations	15	**Optional**	15
5	Describing Company Policies	15	**Optional**	15

Band 5

CEFR: B1 · Intermediate

✓ **Mandated:** Units 1 & 2 per skill · 30 lessons/skill · 120 lessons total per semester

Optional: Units 3, 4 & 5 per skill (encouraged, ungraded)

Listening	Unit Name	Lessons	Status	Sub-topics
1	Client Calls	15	✓ **Mandated**	15
2	Daily Briefings	15	✓ **Mandated**	15
3	Handling Complaints	15	**Optional**	15
4	Meeting Agendas	15	**Optional**	15
5	Team Discussions	15	**Optional**	15

Speaking	Unit Name	Lessons	Status	Sub-topics
1	Team Discussions	15	✓ **Mandated**	15
2	Handling Client Communication	15	✓ **Mandated**	15
3	Managing Workplace Challenges	15	**Optional**	15
4	Giving Performance Feedback	15	**Optional**	15
5	Handling Workplace Negotiations	15	**Optional**	15

Reading	Unit Name	Lessons	Status	Sub-topics
1	Analyzing Business Reports	15	✓ **Mandated**	15
2	Reading Project Proposals	15	✓ **Mandated**	15
3	Understanding Corporate Emails	15	**Optional**	15
4	Reviewing Meeting Minutes	15	**Optional**	15
5	Handling Client Requests	15	**Optional**	15

Writing	Unit Name	Lessons	Status	Sub-topics
1	Writing Business Proposals	15	✓ **Mandated**	15
2	Composing Structured Workplace Emails	15	✓ **Mandated**	15
3	Drafting Performance Reviews	15	**Optional**	15
4	Summarizing Client Feedback	15	**Optional**	15
5	Writing Detailed Project Updates	15	**Optional**	15

Bands 6 &7

CEFR: B2 · Upper-Intermediate

✓ **Mandated:** Units 1 & 2 per skill · 30 lessons/skill · 120 lessons total per semester

Optional: Units 3, 4 & 5 per skill (encouraged, ungraded)

Bands6and7aregroupedtogetherattheUpper-Intermediatelevel(CEFRB2).Studentsareplacedatdifferentstartingpointswithin this level based on their BET score, but both cover the same mandated units.

Listening	Unit Name	Lessons	Status	Sub-topics
1	Strategy Meetings	15	✓ **Mandated**	15
2	Budget Discussions	15	✓ **Mandated**	15
3	Project Feedback	15	**Optional**	15
4	Performance Reviews	15	**Optional**	15
5	Internal Memos	15	**Optional**	15

Speaking	Unit Name	Lessons	Status	Sub-topics
1	Strategy Meetings	15	✓ **Mandated**	15
2	Budget Discussions	15	✓ **Mandated**	15
3	Handling Corporate Presentations	15	**Optional**	15
4	Reviewing Project Proposals	15	**Optional**	15
5	Discussing Market Trends	15	**Optional**	15

Reading	Unit Name	Lessons	Status	Sub-topics
1	Reading Financial Reports	15	✓ **Mandated**	15
2	Understanding Competitive Analysis	15	✓ **Mandated**	15
3	Reviewing Business Strategies	15	**Optional**	15
4	Evaluating Employee Performance Reports	15	**Optional**	15
5	Reading Corporate Case Studies	15	**Optional**	15

Writing	Unit Name	Lessons	Status	Sub-topics
1	Drafting Strategic Plans	15	✓ **Mandated**	15
2	Writing Executive Summaries	15	✓ **Mandated**	15
3	Composing High-Level Business Reports	15	**Optional**	15
4	Writing Structured Financial Forecasts	15	**Optional**	15

5	Preparing Official Corporate Documentation	15	**Optional**	15

Band 8

CEFR: C1 · Advanced

✓ **Mandated:** Units 1 & 2 per skill · 30 lessons/skill · 120 lessons total per semester

Optional: Units 3, 4 & 5 per skill (encouraged, ungraded)

Listening	Unit Name	Lessons	Status	Sub-topics
1	Negotiation Strategies	15	✓ **Mandated**	14
2	Financial Analysis	15	✓ **Mandated**	15
3	Business Development	15	**Optional**	15
4	Policy Changes	15	**Optional**	15
5	Crisis Management	15	**Optional**	15

Speaking	Unit Name	Lessons	Status	Sub-topics
1	Negotiation Strategies	15	✓ **Mandated**	15
2	Financial Analysis Discussions	15	✓ **Mandated**	15
3	Business Development Talks	15	**Optional**	15
4	Crisis Communication	15	**Optional**	15
5	Discussing Global Business Policies	15	**Optional**	15

Reading	Unit Name	Lessons	Status	Sub-topics
1	Reviewing Investment Proposals	15	✓ **Mandated**	15
2	Analyzing Global Business Trends	15	✓ **Mandated**	15
3	Understanding Market Research Reports	15	**Optional**	15
4	Reading International Trade Agreements	15	**Optional**	15
5	Corporate Risk Assessments	15	**Optional**	15

Writing	Unit Name	Lessons	Status	Sub-topics
1	Writing Complex Business Case Studies	15	✓ **Mandated**	15
2	Preparing International Trade Analysis	15	✓ **Mandated**	15
3	Drafting Industry Regulatory Reports	15	**Optional**	15
4	Writing Professional Negotiation Scripts	15	**Optional**	15
5	Composing Thought Leadership Articles	15	**Optional**	15

Band 9

CEFR: C2 · Proficient

✓ **Mandated:** Units 1 & 2 per skill · 30 lessons/skill · 120 lessons total per semester

Optional: Units 3, 4 & 5 per skill (encouraged, ungraded)

List eni ng	Unit Name	Lessons	Status	Sub-topics
1	Boardroom Debates	15	✓ **Mandated**	15
2	Industry Forecasts	15	✓ **Mandated**	15
3	Investor Meetings	15	**Optional**	15
4	Competitive Analysis	15	**Optional**	15
5	International Mergers	15	**Optional**	15

Spe aking	Unit Name	Lessons	Status	Sub-topics
1	Boardroom Debates	15	✓ **Mandated**	15
2	Industry Forecasts	15	✓ **Mandated**	15
3	Investor Meetings	15	**Optional**	15
4	Competitive Analysis	15	**Optional**	15
5	International Mergers	15	**Optional**	15

Rea ding	Unit Name	Lessons	Status	Sub-topics
1	Reading Boardroom Briefings	15	✓ **Mandated**	15
2	Analyzing International Mergers	15	✓ **Mandated**	15
3	Reviewing High-Stakes Legal Contracts	15	**Optional**	15
4	Reading Complex Financial Audits	15	**Optional**	15
5	Understanding Multinational Business Strategies	15	**Optional**	15

Writ ing	Unit Name	Lessons	Status	Sub-topics
1	Writing Global Business Transformation Whitepapers	15	✓ **Mandated**	15
2	Composing Investment Proposals	15	✓ **Mandated**	15
3	Drafting Multinational Expansion Strategies	15	**Optional**	15
4	Preparing High-Impact Financial Reports	15	**Optional**	15
5	Writing Regulatory Compliance Case Studies	15	**Optional**	15