Scheme of Instruction & Syllabi

For

Master of Science

In

Chemistry

Two Years CBCS M.Sc. Course in Chemistry

(Academic Session: 2020-21)

First Year

Department of Applied Sciences & Humanities

INVERTIS UNIVERSITY

Invertis Village

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

Head
Department of Applied Science
Invertis University, Bareilly (U.P.)

Dean
Faculty of Science
Invertis University, Bareilly (U.P.)

MSc (Chemistry)

INVERTIS UNIVERSITY BAREILLY

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 characterisation 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.

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15-10-20

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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.

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Study & Evaluation Scheme

M.Sc. CHEMISTRY (FIRST YEAR)

Semester-I

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH101	Inorganic Chemistry-I	3	1	-	30	70	100	4
2	MCH102	Organic Chemistry-I	3	1	-	30	70	100	4
3	MCH103	Physical Chemistry-I	3	1	-	30	70	100	4
4	MCH104	Analytical Chemistry-I	3	1		30	70	100	4
5	MCH152	Inorganic Chemistry Practical-I	-	-	3	20	30	50	2
6	MCH153	Organic Chemistry Practical-I	-	-	3	20	30	50	2
7	MCH154	Physical Chemistry Practical-I	-	-	3	20	30	50	2
		Total	**12**	**4**	**9**	**180**	**370**	**550**	**22**

Semester-II

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Credit
			L	T	P	MSM	ESM	Total	
1	MCH201	Inorganic Chemistry-II	3	1	-	30	70	100	4
2	MCH202	Organic Chemistry-II	3	1	-	30	70	100	4
3	MCH203	Physical Chemistry-II	3	1	-	30	70	100	4
4	MCH204	Analytical Chemistry-II	3	1	-	30	70	100	4
5	MCH252	Inorganic Chemistry Practical-II	-	-	3	20	30	50	2
6	MCH253	Organic Chemistry Practical-II	-	-	3	20	30	50	2
7	MCH254	Physical Chemistry. Practical-II	-	-	3	20	30	50	2
		Total	**12**	**4**	**9**	**180**	**370**	**550**	**22**

15-10-20

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Head

VICE CHANCELLOR

SEMESTER-I

MCH101: Inorganic 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 Metal-Ligand Bonding in Transition Metal Complexes and Electronic spectra of Transition Metal Complexes.

Course Objectives:

1. To learn and understand the basic concepts of inorganic chemistry.
2. To learn Lewis acids and bases, usanovich concept, CFSE and MOT.
3. To understand the Jahn-Teller distortions.
4. To learn supramolecular and photoinorganic chemistry.
5. To learn the orgelenergy level and tanabe-sugano diagrams.
6. To learn calculation of ligand-field parameters.

Detailed Syllabus

Section – A: Metal-Ligand Bonding in Transition Metal Complexes:

Unit-1: Crystal field splitting diagrams in complexes of low symmetry; Spectrochemical and Nephelauxetic series; thermodynamic and structural effects; site selection in spinels, Jahn-Teller distortions; experimental evidence for metal-ligand orbital overlap; ligand field theory.

Unit-2: Molecular orbital theory of octahedral complexes, brief introduction to Angular Overlap Model. MOT and its applications for homonuclear and heteronuclear diatomic molecules.

Unit-3: Supramolecular and photoinorganic chemistry, supramolecular devices, supramolecular reactivity and catalysis

Section – B: Electronic spectra of Transition Metal Complexes:

Unit-4: Spectroscopic ground states; Orgelenergy level and Tanabe-Sugano diagrams for transition metal complexes, Charge transfer spectra; electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes and calculation of ligand-field parameters.

Text and Reference Books

Reference Books:

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edn. (1999), John Wiley & Sons, New York.
2. James E. Huheey, *Inorganic Chemistry*, 4th Edn. (1993), Addison-Wesley Pub. Co., New York.
3. R.S. Drago, *Physical Methods in Inorganic Chemistry*, International Edn. (1971), Affiliated East-West Press, New Delhi.
4. Keith F. Purcell and John C. Kotz, *Inorganic Chemistry*, W. B. Sauders Com. (1987), Hong Kong.

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: Organic 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 molecular symmetry and chirality and stereoisomerism.

Course Objectives:

1. To know about racemic modification.
2. To understand the cram's rule, prelog's and hotea's rules.
3. To learn the qualitative correlation between conformation and reactivity.
4. To learn the Stereogenicity, chirogenicity.
5. To know the reactivity effects of substrate structure.
6. To understand the molecular rearrangements in acyclic.

Detailed Syllabus

Unit-1: Molecular symmetry and chirality: Symmetry operations and symmetry elements, point group.
Unit-2: Stereoisomerism: Classification, racemic modification, molecules with one, two or more chiral centres; E-Z nomenclature. Axial and planar chirality and helicity (P & M), Stereochemistry and configurations of allenes, spiranes, alkylidine cycloalkanes, catenanes, biphenyls,bridged biphenyls. Asymmetric induction: cram's rule, prelog's and hotea's rules; dynamic stereochemistry, qualitative correlation between conformation and reactivity, curtin hammett principle.
Unit-3: Topicity and prostereoisomerism: Topicity of ligands and faces and their nomenclature; Stereogenicity, chirogenicity, and pseudoasymmetry, stereogenic and prochiral centres.
Unit-4: Nucleophilic Substitution at Saturated Carbon: Mechanism and Stereochemistry of S_N1,S_N2, S_Ni and S_Nii' reactions. The reactivity effects of substrate structure, solvent effects, competition between S_N1 and S_N2 mechanisms. **Common Organic Reaction Intermediates**
Unit-5: Carbocations: Classical and non-classical, neighbouring group participation, ion-pairs, molecular rearrangements in acyclic. Stability and reactivity of bridge-head carbocations.
Unit-6: Carbonions: Generation, structure and stability, ambident ions and their general reactions; HSAB principle and its applications.
Unit-7: Radicals: Generation, structure, stability and reactions, radical-cations &radical-anions. Molecular dissymmetry and chiroptical properties: linear and circulary polarized lights, circular birefringernce and circular dichorism, ORD and CD curves, cotton effect. The axial haloketone rule, octant diagrams, helicity and Lowe's rule. Application of ORD and CD to structural and stereochemical problems.

Unit-7: Nitrenes: Generation, structure and reactions of nitrenes. **Carbenes:** formation and structure, reactions involving carbenes and carbenoids.
Unit-8: Nitrenes: generation, structure and reactions of nitrenes. **Electrophilic Aromatic Substitution:** Arenium ion mechanism, orientation and reactivity in monosubstituted benzene rings, ortho/ para ratio. Ipso substitution.

Text and Reference Books

Reference Books:

1. Carey. F.A. & Sundbera, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).
2. Eliel, E.L. Stereochemistry of Carbon Compounds Textbook Publishers (2003).
3. Finar, I.L. & Finar, A.L. Organic Chemistry Vol. 2, Addison-Wesley (1998).
4. Final-,1.L. Organic Chemistry Vol. I, Longman (1998).

Course Outcomes:

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

CO1	Describe the molecular rearrangements in acyclic.
CO2	Understand the neighbouring group participation.
CO3	Explain the HSAB principle and its applications.
CO4	Develop the axial haloketone rule, octant diagrams, helicity and Lowe's rule.
CO5	Explain the reactions involving carbenes and carbenoids.
CO6	Illustrate the Arenium ion mechanism, orientation and reactivity in monosubstituted benzene rings.

MCH103: Physical 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 quantum chemistry and symmetry point groups.

Course Objectives:

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.
4. To learn the Huckel Molecular Orbital Theory of conjugated systems.
5. To know the delocalization energy, bond order, alternant and non-alternant hydrocarbons.
6. To understand the construction of molecular orbitals.

Detailed Syllabus

Unit-1: Quantum Chemistry: Fundamental background: Postulates and theorems of quantum mechanics, angular momentum, rigid rotor. The Schrödinger equation and its exact solutions: The particle-in-a-box, Hydrogen atom, the variation theorem – Ritz variation principle. Atomic structure: many electron wave functions, Pauli exclusion principle, Helium atom, atomic term symbols.

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, alternant and non-alternant hydrocarbons.

Unit-3: Symmetry point groups:
Determination of point group of a molecule, representations, the great orthogonality theorem, character table, construction of character tables for c2v and c3v groups, symmetry adapted atomic basis sets, construction of molecular orbitals.

Text and Reference Books

Reference Books:

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

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

CO1	Describe the comparison of the MO and VB treatments.
CO2	Understand the atomic structure: many electron wave functions.
CO3	Explain the extension of MO theory to other systems- Homonuclear and heteronu-clear.
CO4	Develop the construction of character tables for c2v and c3v groups.
CO5	Calculate the great orthogonality theorem.
CO6	Illustrate the Schrödinger equation.

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 of Analytical chemistry and chemical analysis, Classification of analytical methods, Method selection, Sample processing, Steps in a quantitative analysis, Quantitative range (bispartite classification), Data organisation, Analytical validations, Limit of detection and limit of quantitation, The tools of analytical chemistry and good lab practices.
Unit-2: Errors in Chemical Analysis and Statistical Evaluation of Data: Systematic and randomerrors, Accuracy and precision, Ways of expressing accuracy and precision, Normal error curve and its equation, Propagation of error, Useful statistical test: test of significance, the F test, the student 't' test, the chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least square method for linear plots), statistics of sampling and detection limit evaluation.
Unit-3: Concept of Equilibrium: Solvents and solutions, general treatment of equilibria in aqueous medium involving monoprotic weak acid and weak base, and salts of weak acids and weak bases. Activity and concentration, Effect of electrolytes on chemical equilibria, Calculation of pH, Constructing titration curves from charge balance and mass balance equations, Acid-base titrations and theory of pH indicators, Complexation equilibria and complexometric titrations, Redox equilibria and redox titration, Theory of redox indicators, Precipitation reaction and precipitation titrations and theory of adsorption indicators.
Unit-4: Buffer Solutions: Theory of buffer solution, dilution and salts effects on the pH of a buffer, Buffer index, Criteria and expression of maximum buffer capacity, Application of pH buffers, Preparation of buffer solutions of known ionic strength (Typical examples). Practical limitations in use of buffers, Metal ion buffers and their applications, biological buffers and their applications.

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.

MCH152: Inorganic 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 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 in-organic 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), $Na_3[Co(ONO)_6]$.

MCH153: 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.

Preparation of compounds and intermediates involving up to two steps H_2O.

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.

MCH154: 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. Freeman & 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: Inorganic 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 acid and base hydrolysis and elimination reactions and inorganic compounds by IR, Raman, NMR, EPR.

Course Objectives:

1. To know about prediction of reactivity of octahedral.
2. To understand the of crystal field activation energy.
3. To learn the acid hydrolysis.
4. To learn the microscopic techniques.
5. To know the structure preference energy.
6. To understand the Raman, NMR, EPR.

Detailed Syllabus

Unit-1: Kinetics and Mechanism of Substitution Reactions: Nature of substitution reactions, prediction of reactivity of octahedral, tetrahedral and square-planar complexes in terms of crystal field activation energy and structure preference energy, rates of reactions, acid and base hydrolysis and enimation reactions.
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: Electron transfer reactions in Inorganic metal complexes, Outer sphere and Inner sphere electron transfer, Marcus theory of electron transfer, calculation of rate constant using Marcus electron transfer theory, synthetic application of electron transfer reactions from metal complexes.
Unit-4: Application of Spectroscopy in Inorganic Chemistry: Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.

Text and Reference Books

Reference Books:

1. Cotton, F.A. Chemical Applications of Group Theory Wiley Interscience: N.Y (1990).
2. Jaffe, H.H. & Orchin. M. S•mmery in Chemist)), Dover Publications (2002).
3. Hatfield, W.F. & Palmer, R.A. Problems in Structural Inorganic Chemisry W. A. Benjamin, Inc.: N.Y (1971).
4. Hatield, W.E. & Parker, W.E. Symmetry in Chemical Bonding & Structure C. E. Merrill Publishing Co.: USA (1974).
5. Bishop, D.M. Group Theo)), and Chemistry, Clarendon Press: Oxford, U.K, (1973).

6. Shriver, D. F., Atkins, P. W. & Langford, C. H. Inorganic Chemistry,2nd Ed., Oxford Univ. Press (1998).

Course Outcomes:

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

CO1	Describe the acid and base hydrolysis and elimination reactions.
CO2	Understand the vibrational spectra of metal carbonyls.
CO3	Explain the prediction of reactivity of octahedral.
CO4	Develop the carbonyl metal halides.
CO5	Calculate the rates of reactions.
CO6	Illustrate the electron spectroscopy and microscopic techniques.

MCH202: Organic 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 NMR spectroscopy and methods in organic synthesis.

Course Objectives:

1. To know about effect of external magnetic field.
2. To understand the structural elucidation of simple and complex compounds.
3. To learn the isotopic mass peaks, relative intensity.
4. To learn the cycloaddition [2+2] and [4+2].
5. To know the Cheletropic reactions.
6. To understand the applications of lithium organocuparates.

Detailed Syllabus

Unit-1: NMR spectroscopy Spectroscopy: natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei; the spinning nucleus, effect of external magnetic field. precessional motion and frequency. Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect: Integrals of protons. spin-spin coupling, splitting theory. Magnitude of coupling constant; Simple, virtual and complex spin-spin coupling; Chemical and magnetic equivalence, proton exchange, factors affecting the coupling - First and non-first order spectra; Simplification of complex spectra (solvent. effect, field effect, double resonance and lanthanide shift reagents) and NOE experiments (NOESY, HOESY, ROESY, etc.) Applications of PMR in structural elucidation of simple and complex compounds.
Unit-2: MASS: Theory, instrumentation, and modifications, Unit mass and molecular ions; Important terms- singly, doubly/multiple charged ions, metastable peak, base peak, isotopic mass peaks, relative intensity. Combined problems on UV, IR, NMR and MASS
Unit-3: Pericyclic Reactions **Introduction to Conservation of Orbital Symmetry in Pericylic Reactions:** Woodward-Hoffmann rules; cycloaddition [2+2] and [4+2], and electrocylic reactions. Prototropic and Sigmatropic rearrangements, Ene reactions and Cheletropic reactions; 1,3-Dipolar cycloaddition.
Unit-4: Methods in Organic Synthesis Preparation and applications of lithium organocuparates. Reductions: Stereochemistry, stereoselection and mechanism of catalytic hydrogenation and metal-liquid ammonia reductions. Hydride transfer rea-

gents: Sodium borohydride, sodium cyanoborohydride, lithium aluminium hydride and alkoxy substituted LAH reducing agents, DIBAL; Applications of hydroboration (reductions, oxidations and cabonylations): diborane. ApplicationS of Pd(0) and Pd(II) complexes in organic synthesis, shells.

Text and Reference Books

Reference Books:

1. Carruthers, W. Modern Methods of Organic Synthesis Cambridge University Press (1971).
2. Kemp, W. Organic Spectroscopy 3rd Ed., W.H. Freeman & Co. (1991).
3. Silverstein, R.M. Bassler. G.C. & Morrill, T.C. Spectroscopic Identfication of Organic Compounds John Wiley & Sons (1981).
4. March, J. Advanced Organic Chemisty John Wiley & Sons (1992).

Course Outcomes:

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

CO1	Describe the energy transitions, Chemical shift.
CO2	Understand the magnitude of coupling constant.
CO3	Explain the simplification of complex spectra.
CO4	Develop the double resonance and lanthanide shift reagents.
CO5	Calculate the sigmatropic rearrangements.
CO6	Illustrate the LAH reducing agents.

MCH203: Physical 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 statistical and classical thermodynamics and electrochemistry.

Course Objectives:

1. To know about concept of distribution.
2. To understand the canonical and other ensembles.
3. To learn the collision theory. Potential energy surfaces.
4. To learn the electrolytic conductivity and the Debye-Hückel-Onsangar treatment.
5. To know the cyclic voltammetry.
6. To understand the corrosion. kinetics of electrode reactions.

Detailed Syllabus

Unit-1: Statistical and Classical 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. Third law of thermodynamics, Residual entropy.
Unit-2: Kinetics: Theories of reaction rates: Collision theory. Potential energy surfaces (basic idea). Kinetics of complex reactions (reversible, simultaneous and consecutive), chain reactions; dynamic chain (Hydrogen-Bromine reaction, decomposition of ethane), branched chain (Hydrogen-Oxygen reaction.
Unit-3: Electrochemistry: Electrochemical cells, Nernst equation and applications of Debye-Huckel-theory, Electrolytic conductivity and the Debye-Hückel-Onsangar treatment, electrified interfaces, overpotential, corrosion. kinetics of electrode reactions; irreversible electrode processes. Cyclic voltammetry, Butler-Volmer equation under near equilibrium and non-equilibrium conditions, exchange current density, Tafel plot, polarizable and non-polarizable interfaces.
Unit-4: Surface chemistry: Interphase region, curved surfaces. Thermodynamics of surfaces: Gibbs adsorption isotherm, heat and entropy of adsorption. Surface film on liquids, electrokinetic phenomena.
Unit-5: Macromolecules: Concepts of number average and mass average molecular weights. Methods of determining molecular weights (osmometry, viscometry, sedimentation equilibrium methods).

Text and Reference Books

Reference Books:

1. Lowe, J.P. & Peterson, K. Quantum Chemistry Academic Press (2005).
2. McQuarrie, D.A. Quantum Chemistry Viva Books Pvt. Ltd.: New Delhi (2003).
3. Mortimer, R.G. Mathematics for Physical Chemistry 2nd Ed. Elsevier (2005).
4. Modern Electrochemistry, Vol. 2 A & B, J.O'M. Bockris and A. K. N. Reddy, 2 nd Ed. Plenum Press, New York (1998).
5. Quantum Chemistry, I.N. Levine, 5th Edition (2000), Pearson Educ., Inc. New Delhi.

Course Outcomes:

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

CO1	Describe the concepts of number average.
CO2	Understand the methods of determining molecular weights (osmometry, viscometry, sedimentation equilibrium methods).
CO3	Explain the Butler-Volmer equation under near equilibrium.
CO4	Develop the non-equilibrium conditions, exchange current density.
CO5	Calculate the types of statistics: Maxwell-Boltzmann. Bose-Einstein and Fermi-Dirac statistics. Idea of microstates and macrostates.
CO6	Illustrate the evaluation of translational, rotational and vibrational partition functions for monatomic.

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 principles, techniques and applications of thermometric titration methods.

Detailed Syllabus

Unit-1: Polarography: Origin of polargraphy, Current-voltage relationship, Theory of polarographicwaves (DC and sampled DC (tast) polarograms), Instrumentation, Ilkovič equation, Qualitative and quantitative applications.
Unit-2: Atomic Spectroscopy: Theory, Instrumentation and applications of X-rays (emission,absorption, diffraction and fluorescence methods), Atomic absorption Spectroscopy, Atomic fluorescence spectrometry, Atomic emission spectrometry.
Unit-3: Molecular Spectroscopy: UV-visible molecular absorption spectrometry (instrumentation andapplication), Molecular luminescence spectroscopy (fluorescence, phosphorescence, chemilumi-nascence), Mass spectroscopy.
Unit-4: Separation Methods: Principle of chromatography, Classifications of chromatography,Techniques of planar and column chromatography, Gas chromatography, High-performance liquid chromatography. HP-TLC and Z-D chromatography, reverse phase HPLC.
Unit-5: Thermal Analysis: Theory, methodology and applications of thermogravimetric analysis(TGA), Differential Thermal Analysis (DTA), and Differential scanning calorimetry (DSC). Principles, techniques and applications of thermometric titration methods.

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	Describe the origin of polargraphy.
CO2	Understand the current-voltage relationship, Theory of polarographic waves (DC and sampled DC (tast) polarograms),
CO3	Explain the gas chromatography, High-performance liquid chromatography
CO4	Develop the applications of thermogravimetric analysis(TGA).
CO5	Calculate the techniques and applications of thermometric titration methods.
CO6	Illustrate the differential Thermal Analysis (DTA).

MCH252: 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+} (volumetrically).
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)

MCH253: 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.

MCH254: 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

Prerequisite: 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). 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.