ALAGAPPA UNIVERSITY

(State University Accredited with 'A+' Grade, 3.64 CGPA on 4.0 poi t scale by NAAC)

KARAIKUDI

DIRECTORATE OF DISTANCE E UCATION

PROGRAMME PROJECT REPORT

M.Sc. DEGREE in CHEMISTRY

REGULATIONS AND SYLLABUS

[For the Candidates admitted from the academic year 2018 – 2019 onwards]

Credit Based System

CONTENTS

a. Programme's Mission & Objectives:

To afford a High Quality Post Graduate Degree (M.Sc.,) Chemistry through Distance Learning mode to the graduate-aspirant in order to to educate the undergraduate students in the fascinating fields of chemistry in an effective manner. M.Sc. Chemistry is a unique kind of course dealing with all aspects of chemistry such as preparation, properties, structure elucidation, kinetics and mechanism of the reaction, techniques of analysis for different kinds of materials, which are very essential for the human society

OBJECTIVES OF THE COURSE

All the changes in life in one-way or other involve CHEMISTRY. Chemistry is central to the current revolutions in Science. No educated person today can understand the modern world without a basic knowledge of chemistry. The existence of a large number of chemical factories, mines and related industries necessitates chemistry education. The major objectives of M.Sc. Chemistry course are:

- To impart knowledge in fundamental aspects of the three branches of chemistry viz. Organic chemistry, Inorganic Chemistry and Physical Chemistry.
- To acquire deep knowledge in the study of physical, chemical, electrochemical and magnetic properties, structure elucidation using various techniques and applications of various organic and inorganic materials and
- To acquire basic knowledge in the specialized areas such as Polymer chemistry and Instrumental methods of analysis.

b. Relevance of the Programme with Alagappa University's Mission and Goals:

In order to align with the mission and goals of Alagappa University the M.Sc., Chemistry Programme is planned to deliver in Distance Learning mode which may reach the maximum number of student aspirants who are unable to thrive to spend non-elastic timings of formal conventional class room education. Such a higher education in science subject with appropriate practical experiences will enrich the human resources for the uplift of the nation to Educational, Social, Technological, Environmental and Economic Magnificence (ESTEEM).

c. Nature of Prospective Target Group of Learners:

This M.Sc., Chemistry programme through Distance Learning mode is developed by keeping in mind to give opportunity to economically and socially excluded people includes graduates of various socio-economic status viz., unemployed youths, employed with

marginalized salary due to lack of sufficient knowledge in the subject chemistry. Also, the target group of learners includes various level employees of industrial employees, research and development company worker, secondary –level school teachers, research aspirants, women taking care of family –the important unit of the community, etc.,

d. Appropriateness of programme to be conducted in Distance learning mode to acquire specific skills and competence:

M.Sc., Chemistry programme through Distance Learning mode is developed in order to give subject-specific skills including i) Apply knowledge obtained in Chemistry lecture to problem solving and critical thinking in the laboratory, ii) Engage in safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents appropriately, using general guidelines and basic knowledge about the common hazards associated with them in an organic chemistry laboratory, iii) Maintain an appropriate scientific notebook using notational and descriptive content containing information on relevant chemical reagents, experimental procedure followed, data collected, and observations made during the experimental process, iv) Assemble glassware and perform the following techniques as a part of synthetic procedures: aqueous workup, distillation, reflux, separation, isolation, and crystallization, v) Predict the outcome of several common organic reaction types through a basic understanding of starting materials, functional groups, mechanism, and typical reaction conditions, vi) Characterize prepared substances by physical and spectroscopic means, vii) Develop the skill set necessary to continue on to higher studies such as M.Phil and Ph.D. in Chemistry, viii) Can confidently attend and clear competitive examinations especially CSIR NET, ix) Become Chemistry teachers in educational institutes and scientist in research laboratories.

e. Instructional design
e. 1. Curriculum Design

Sl. No.	Course Code	Title of the Course	CIA Max.	ESE Max.	TOT Max.	Credit.
FIRST YEAR						
I Semester						
1.	34411	Inorganic Chemistry -I	25	75	100	4
2.	34412	Organic Chemistry - I	25	75	100	4
3.	34413	Physical Chemistry - I	25	75	100	4
4.	34414	Practical : Analytical Chemistry Practical	25	75	100	4
		Total	**100**	**300**	**400**	**16**
II Semester						
5.	34421	Inorganic Chemistry -II	25	75	100	4
6.	34422	Organic Chemistry - II	25	75	100	4
7.	34423	Physical Chemistry - II	25	75	100	4
8.	34424	Practical : Organic Chemistry Practical	25	75	100	4
		Total	**100**	**300**	**400**	**16**
SECOND YEAR						
III Semester						
9.	34431	Advanced Inorganic Chemistry	25	75	100	4
10.	34432	Advanced Organic Chemistry	25	75	100	4
11.	34433	Spectroscopy – Applications in Organic and Inorganic Chemistry	25	75	100	4
12.	34434	Practical : Inorganic Chemistry Practical	25	75	100	4
		Total	**100**	**300**	**400**	**16**
IV Semester						
13.	34441	Analytical Chemistry	25	75	100	4
14.	34442	Applied Chemistry	25	75	100	4
15.	34443	Advanced Physical Chemistry	25	75	100	4
16	34444	Practical : Physical Chemistry Practical	25	75	100	4
		Total	**100**	**300**	**400**	**16**
		GRAND TOTAL	**400**	**1200**	**1600**	**64**

Course Code Legend:

3	4	4	Y	Z

344- M. Sc., Chemistry Programme
Y -Semester No
Z- Serial of Course number in the semester

CIA: Continuous Internal Assessment, ESE: End Semester Examination, TOT: Total, C: Credit Points, Max.: Maximum

No. of Credits per Course (Theory) - 4

No. of Credits per Course (Practical) - 4

Total No. of Credits per Semester - 16

Total No. of Credits the Programme- 16 X 4 = 64

e. 2. Detailed Syllabi:

FIRST SEMESTER

Course Code	Title of the Course
34411	INORGANIC CHEMISTRY – I

Course Objectives: The major objectives of this course are to understand the concepts of

- ✓ Chemical periodicity, structure and bonding of atoms
- ✓ Acids and basis, solid state structures and its determination
- ✓ To distinguish isopolyacids from heteropolyacids.
- ✓ To know about various types of silicates.

Learning Outcomes: The student would be able to

- ✓ Predict the shape of atoms and chemical bonding
- ✓ The apply the Bronsted and Lewis concept of acids and bases for different explanations
- ✓ Understand the structure of solids having different ratio of atoms
- ✓ Know about the chemistry of pH and Buffer solution

Block -1: Basic concepts in inorganic chemistry

Unit –1: Chemical periodicity

Chemical periodicity – ionic radii, ionization potential, electron affinity, electro negativity, concept of hybridization - Molecular orbitals and electronic configuration of homonuclear and heteronuclear diatomic molecules - Shapes of polyatomic molecules.

Unit – 2: VSEPR theory

VSEPR theory - shapes of molecules. The concept of multi centre bonding. Structure and bonding in fluorine and oxygen compounds of xenon. Bonding in simple triatomic molecules/ions.

Unit – 3: Molecular Orbital theory of covalent bonding

Bond length, bond order, bond angle, bond energy and magnetism – ionic character in a covalent bond. MO approach to covalent bonding - symmetry and overlap of atomic orbitals -symmetry of molecular orbitals - sigma-pi-and delta-bonding - energy levels in homo- and hetero nuclear diatomic molecules.

Unit – 4: Intermolecular forces and Lattice energy

Intermolecular forces -Lattice energy and its calculations by Born-lande and Born-Meyer equations- Determination by Born-Haber cycle - Kapustinski equation. Dipolemoment.

Unit – 5: Properties of ionic compounds

Properties of ionic compounds-hardness and electrical conductivity. Energetic of dissolution of ionic compounds in polar solvents.

Block -2: Acids, and Base

Unit -6: Bronsted concept of acids and bases

Bronsted concept - relative strength in aqueous medium-levelling and differentiating solvents - periodic trends in Bronsted acidity – acid strength of oxy-acids- advantages and limitations of Bronsted concept.

Unit -7: Lewis concept of acids and bases

Lewis acids and bases – relative order of acid strength of boron halides and basic strength of hydrides. Comparison between Bronsted and Lewis acids and bases

Unit -8: HSAB

Hard and Soft Acid and Bases (HSAB) principle– applications-limitations. pH and Buffer solutions.

Block -3: Polyacids and Silicates

Unit -9: Polyacids

Isopoly and heteropoly acids, and their anions, Anderson structure. Keggin structure.

Unit -10: Silicates

Types of silicates - Ortho and meta silicates, pyrosilicates, ring silicates, chain silicates, double chain silicates, sheet silicates, three dimensional silicates.

Unit -11: Silicate with frame work structures

Feldspar, zeolites - molecular sieves - clay minerals

Block -4: Solid State Chemistry

Unit -12: Crystal structure of solids

Close packing of atoms and ions –HCP, FCC and BCC types of solids- calculation of packing voids – radius ratio rule –its influence on structures. Classification of ionic structures - AX, AX_2, AX_3 types – AX type (ZnS, NaCl, CsCl) structures only - AX_2 type (fluorite, rutile, beta-cristobolite) structure only - layer structure – CdI_2- Nickel arsenite structure.

Unit -13: Defects in crystal

Schottky and Frenkel defects -explanation and calculation of number defects per cm^3 – metal excess defect - F-centers and interstitial ions - metal deficiency defect - positive ions absent - extra interstial negative ions.

Unit -14 : Electrical properties of solids

Electrical properties of conductor, semiconductors and insulators - band theory of solids. Structure of graphite and diamond

Text books

1. **Modern aspects of Inorganic chemistry,** H.J. Emelius and Sharpe, Universal book Stall, New Delhi, 1989.

2. **Inorganic Chemistry- Principles of structure and reactivity**, J.E. Huheey, E.A. Keiter and R.L. Keiter, 4th edition, Pearson-Education, 2002.
3. **Advanced Inorganic Chemistry** - F.A. Cotton and G. Wilkinson, Wiley Eastern, 5th edition, 1998.
4. **Inorganic Solids,** D. M. Adams, John Wiley Sons, 1974.

Reference books

1. **Inorganic Chemistry**, D. F. Shriver and P. W. Atkins, Oxford U.K., 1999.
2. **Concise Co-ordination Chemistry**, R. Gopalan, 1E 2nd reprint, VPH (P) Ltd., 2009.
3. **Inorganic Chemistry,** G. S.Sodhi; Ist Edition, VB (P) Ltd, 2006.
4. **Solid state chemistry and its applications**, A.R. West, Wiley, New York, 1984.
5. **Structural methods in Inorganic Chemistry,** E.A.V. Ebsworth, D.WH. Rankine and S. Craddock, Black well Scientific Publ., 1987.

Course Code	Title of the Course
34412	ORGANIC CHEMISTRY – I

Course Objectives: The primary objective of this course is to introduce the student to the concepts of organic chemistry and to develop critical thinking skills. The objectives are

- To learn the about the nucleophilic and electrophilic substitutions reaction
- To be able to interpret the reaction pathways
- To learn the stereochemistry of organic compounds

Learning Outcomes: The students shall be able to:

- ✓ Understand and give the IUPAC name of all organic compounds, Reaction Mechanism, Aromaticity nature of the compounds.
- ✓ Efficient knowledge in the reaction mechanism of electrophilic and Nucleophilic reaction and naming reactions.
- ✓ Create a valuable understanding of the main and important concepts in this course.

Block -1: Fundamentals of organic chemistry

Unit – 1: IUPAC nomenclature of organic compounds

Bicyclic, polycyclic and Heterocyclic compounds.

Unit – 2: Electron Displacement in molecules

Inductive and field effects – mesomeric effect – steric inhibition of resonance – steric enhancement of resonance – hyperconjugation - time variable effects -hydrogen bonding – effect of structure on the dissociation constants of acids and bases.

Unit – 3: Aromaticity

Electron delocalization and resonance -Aromatic, antiaromatic, homoaromatic and non-aromatic compounds -Molecular orbital picture of Aromaticity- HMO theory

Unit – 4: Alternate and non-alternate hydrocarbons

Aromaticity on cyclopentadienyl anion, fulvene, ferrocene, azulene, tropolones, annulens and tropylium cations. Aromaticity on larger annulenes, hetero annulenes and fullerenes (C_{60}).

Block -2: Stereochemistry of Organic compounds

Unit – 5: Introduction to stereochemistry

Introduction to molecular symmetry and chirality – examples from common objects to molecules – axis, plane, center, alternating axis of symmetry. Stereoisomerism – definition based on symmetry and energy criteria – configuration and conformational stereoisomers.Center of chirality – molecules with C, N, S based chiral centers – absolute configuration - enantiomers – racemic modifications.

Unit – 6: Nomenclature

R and S nomenclature using Cahn-Ingold-Prelog rules – molecules with a chiral center and Cn – molecules with more than one center of chirality – definition of diastereoisomers – constitutionally symmetrical and unsymmetrical chiral molecules - erythro, threo nomenclature – E and Z nomenclature – out/in isomers.

Unit – 7: Stereochemistry and absolute configuration

Axial, planar and helical chirality – examples – stereochemistry and absolute configuration of allenes, biphenyls and binaphthyls, ansa and cyclophanic compounds, spiranes, exo-cyclic alkylidenecycloalkanes.

Block -3: Reaction mechanism and molecular rearrangement

Unit – 8: Kinetics of reaction mechanisms

Classification of organic reactions - Principle of microscopic reversibility - Hammond postulate - Kinetic and thermodynamic control of chemical reactions - Kinetic and non-kinetic methods for determining organic reaction mechanisms

Unit – 9: Carbocation

Structure and stability of carbocations, Classical and non-classical carbocations, Neighbouring group participation and rearrangements including Wagner-Meerwein, Pinacol-pinacolone, semi-pinacol rearrangement

Unit – 10: Molecular rearrangements

Mechanisms of Wagner – Meerwein, Demzonev, Wolff, Baeyer-Villiger, Stern, Beckmann and Favorskii rearrangements.

Block -4: Substitutions reaction

Unit – 11: Aliphatic nucleophilic substitutions

Nucleophiles and nucleofuge – S_N1, $S_N2$and S_Ni mechanisms with examples - Factors influencing the Aliphatic nucleophilic substitutions– kinetics of Aliphatic nucleophilic substitutions– stereochemistry- competition between$S_N1$and S_N2

Unit – 12:Aliphatic electrophilic substitutions

S_E1, S_E2 and S_Ei reaction and mechanism.

Unit – 13:Aromatic electrophilic substitutions

Aromatic electrophilic substitution reaction, O/P ratio, ring activator, deactivator, arenium ion mechanism, typical reaction and Mechanisms of nitration, diazonium coupling, sulphonation, halogenation, Friedel craft alkylation and acylation - Gatermann Koch formylation - VilsmierHaak reaction.

Unit – 14:Aromatic Nucleophilic substitutions

Addition-elimination reaction, elimination –addition reaction and mechanism- benzyne mechanism - Von-Richter reaction.

Text books

1. **Advanced Organic Chemistry** – **Reactions, Mechanisms and Structure,** Jerry March, IV Edn., John Wiley & Sons, 1992.
2. **A Guide Book to Mechanisms in Organic Chemistry**, P. Sykes, VI Edn., Longmans Scientifics and Technical, Essex 1986.
3. **Reaction Mechanism in Organic Chemistry**, S.M. Mukherji and S.P. Singh, III Edn. MacMillan.1984.
4. **Organic Chemistry, Vol. I & II**, I.L. Finar**,** V Edn. First Indian reprint, Pearson Education Asia Pvt. Ltd. 2000.

Reference books

1. **Advanced Organic Chemistry, Part A& B**, F.A. Carey and Sundberg, III edition, Plenum Press, 1990.
2. **Organic Chemistry,** S.H. Pine, J.B. Hendrickson, D.J. Cram and G.S. Hammond, IV Edn. McGraw-Hill Company 1980.
3. **Organic Reaction Mechanisms**, V.K. Ahluwalia and R.K. Prashar, 4th edition, Alpha Science International, UK, 2011.
4. **Organic Reactions and Mechanisms**, P.S. Kalsi, II Edn., New Age International Publishers, 2000.
5. **Fundamentals of Organic Reaction Mechanisms**- J.M. Harris and C.C. Wamser, John Wiley & Sons, Inc. 1976.
6. **Organic Reaction Mechanisms**- R.K. Bansel, Tata McGraw Hill, 1975.
7. **Organic Chemistry,** P. Mehta & M. Mehta, Prentice Hall India, New Delhi, 2005.
8. **Organic Chemistry,** StevanA.Fleming, 4th ed., W.W. Norton & Compound, London, 2010.
9. **Organic Chemistry**, R.T. Morrison and R. N. Boyd's, 6th edition, Spring, 2008.
10. **Fundamentals of Reaction Mechanisms in Organic Chemistry**, R.P. Narain, PHI Learning Private Limited, New Delhi, 2011.

Course Code	Title of the Course
34413	PHYSICAL CHEMISTRY – I

Course Objectives: To make the students:

- Familiarity with basic concepts in thermodynamics and to relate the characteristics
- This unit covers the principles of chemical kinetics, theory of kinetics
- Quantum Chemistry will be applied to understanding the basic energetics of atoms and molecules.

Course Outcomes: The students shall be able to:

- ✓ Recognize the importance of quantum chemistry and of its applications.
- ✓ Describe the fundamental chemical and physical properties that determine chemical reaction rates.
- ✓ To study the solution and gas phase kinetics and some fast reaction kinetics

Block -1: Classical thermodynamics

Unit – 1: Law of thermodynamics

First and Second law of thermodynamics – Need, Statements. Entropy - Definition, entropy changes in reversible and irreversible processes, Carnot's cycle clausius inequality, entropy changes in ideal gases, entropy of mixing, entropy changes in phase changes - Degradation of energy.

Unit – 2: Gibb's and Helmholtz free energies

Gibb's and Helmholtz free energies - Criteria for spontaneity and conditions of equilibrium Maxwell relations - Thermodynamic equations of state Free energy changes in ideal gases. Gibbs Helmholtz equation, applications.

Unit – 3: Nernst Heat theorem

Nernst Heat theorem - Third law of thermodynamics, apparent exceptions to third law - Partial molar quantities - chemical potential Gibb's Duhem equation - Duhem Margules equation - determination of partial molar quantities. Zeroth law of thermodynamics.

Unit – 4: Fugacity

Fugacity and its determination - Activity and activity co-efficient - determination of mean activity co - efficient of electrolytes - Reaction isotherm - equilibrium constant and its dependence on temperature and pressure.

Block -2: Electrochemistry

Unit – 5: Transport number

Transport number and ionic mobilities (only definition and not determination) - Debye Huckel theory of interionic attraction.

Unit – 6: Debye Huckel Onsagar equation

Debye Huckel Onsagar equation - Validity and extension of the theory - Activity of ions in solution - Debye Huckel limiting law

Unit – 7: Applications of conductivity measurements

Applications of conductivity measurements - Electrode potential and Nernst equation - types of electrodes and electrochemical cells.

Unit – 8: EMF

EMF Applications of cell EMF - Electrode Kinetics over voltage and its determination - Butler-Volmer equation and approximation of the equation.

Block -3: Quantum Chemistry

Unit – 9: Fundamental of quantum chemistry

Inadequacy of classical mechanics, Block body radiation, and photoelectric effect-wave-particle dualism - Heisenberg's uncertainty principle.

Unit – 10: Mathematical preparation for quantum chemistry

Mathematical preparation for quantum chemistry: functions, operators, matrices, vectors – Eigen value and Eigen functions.

Unit – 11: Postulates of quantum mechanics

Postulates of quantum mechanics-Schrodinger wave equation - Application of quantum chemistry to particle in one and three dimensional boxes – degeneracy.

Block -4: Chemical Kinetics

Unit – 12: Theories of reaction rates

Theories of reaction rates: Absolute reaction rate theory(ARRT) - thermodynamic and statistical treatment - comparison to simple collision theory - Application of ARRT to unimolecular (Lindemann, Hinshelwood and KRRM and Slater) bimolecular and third order reactions

Unit – 13: Isotopic effect

Potential energy surfaces, Kinetic isotopic effect (qualitative approach only) - Principles of microscopic reversibility - steady state approximation –

Unit – 14: Kinetics of complex reactions

Parallel consecutive and opposing or reversible reactions, Branched chain and explosive reactions - Fast reactions - Flow, relaxation and NMR methods.

Text Books

1. **Thermodynamics for Students of Chemistry**, J. Rajaram and J.C. Kuriacose, Lal Nagin Chand, New Delhi, 1986.
2. **Physical Chemistry,** P.W. Atkins, Oxford University Press, Oxford, 1990.

3. **Text Book of Physical Chemistry**, D.A. McQuarrie, University Science Books, Mill Valley, California, 1983.
4. **Quantum Chemistry,** Henry Eyring, John Walter, George E. Kimball, BiblioBazaar, California, 2011.
5. **Chemical Kinetics**, Farrington Daniels, BiblioBazaar, Cornell University Press LONDON, 2011.
6. **Kinetics and Mechanism of Chemical Transformations**, J. Rajaram and J.C. Kuriacose, MacMillan India Ltd. 1993.

Reference Books

1. **Molecular Quantum Mechanics**, P.W. Atkins, Oxford University Press, Oxford, 1983.
2. **Quantum Mechanics in Chemistry**, M.W. Hanna, W.A. Benjamin Inc. London 1965
3. **Thermodynamics for Chemists**, S. Glasstone, Affiliated East West Press, New Delhi 1960.
4. **Chemical Kinetics,** K.J. Laidler, **3rd ed.,** Pearson Education Inc, New Delhi, 2008.
5. **Kinetics and Mechanism**, R.G. Frost and Pearson, Wiley New York, 1961.
6. **Quantum Chemistry**, R.K. Prasad, Wiley Eastern, New Delhi, 1992.
7. **Thermodynamics,** Enrico Fermi, Create Space, Dover Publications USA, 2011.

Course Code	Title of the Course
34414	ANALYTICAL CHEMISTRY PRACTICAL

Course Objectives

- To understand the principle behind the estimation of organic compounds and get practical knowledge.
- To improve the skill in semi-micro qualitative analysis of inorganic mixtures containing two less familiar cations and two familiar cations.

Learning Outcomes: Students will get the experience in the

- ✓ Estimation of various organic compounds
- ✓ Semi-micro qualitative analysis of cations.

This will make the students to work well in the research institutes and quality control laboratories.

Block -1: Quantitative Estimation -1

Unit 1: Quantitative estimation of aniline

Estimate the amount of aniline present in the whole of the given solution.

Unit 2: Quantitative estimation of phenol

Estimate the amount of phenol present in the whole of the given solution

Unit 3: Quantitative estimation of ethylmethylketone

Estimate the amount of ethylmethylketone present in the whole of the given solution

Unit 4: Quantitative estimation of glucose

Estimate the amount of glucose present in the whole of the given solution

Block -2: Semi-micro qualitative analysis -1

: Unit 5: Semi-micro qualitative analysis of mixture -1

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Unit 6: Semi-micro qualitative analysis of mixture -2

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Unit 7: Semi-micro qualitative analysis of mixture -3

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Block -3: Semi-micro qualitative analysis -2

Unit 8: Semi-micro qualitative analysis of mixture -4

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Unit 9: Semi-micro qualitative analysis of mixture -5

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Unit 10: Semi-micro qualitative analysis of mixture -6

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Block -4: Semi-micro qualitative analysis -3

Unit 11: Semi-micro qualitative analysis of mixture -7

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Unit 12: Semi-micro qualitative analysis of mixture -8

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Unit 13: Semi-micro qualitative analysis of mixture -9

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Unit 14: Semi-micro qualitative analysis of mixture -10

Analysis of mixtures containing two less familiar cations like W, Tl, Mo, Se, Te, Ce, Zr, Th, Ti, V, U and Li and two familiar cations like Pb, Cu, Bi, Cd, Mn, Ni, Co, Zn,Ca, Ba, Sr and Mg.

Reference Books

1. **A Laboratory Manual of Inorganic Chemistry,** John Bernard Ekeley, BiblioLife, 2010.
2. **Laboratory Manual of Organic Chemistry**, Raj K. Bansal, III Edition, New Age International (P) Ltd., 1996.
3. **Vogel's qualitative Inorganic analysis**, G. Svehla, VI Edition, Orient Longman, 1987.
4. **Inorganic Semimicro Qualitative analysis,** V.V. Ramanujam, National Publishing Co., 1971.

SECOND SEMESTER

Course Code	Title of the Course
34421	INORGANIC CHEMISTRY – II

Course Objectives: The objectives are to understand the concepts of

- The Nomenclature of coordination compounds
- The formation of coordination compounds by CFT and MOT
- Nuclear structure and nuclear reactions
- Extraction of lanthanides, spectral and magnetic properties of lanthanides and actinides.

Learning outcomes: The students will have knowledge in

- ✓ The formation of coordination complexes based on the various theories
- ✓ Magnetic properties of coordination complexes
- ✓ Basic mechanism of nuclear reactions and nuclear reactor
- ✓ Uses of lanthanide and actinides

Block -1: Coordination chemistry

Unit- 1: Fundamentals of coordination chemistry

Nomenclature of coordination compounds, Geometrical and optical isomerisms in octahedral, square planar and tetrahedral complexes. Theory on coordination compounds – valence bond theory, limitation of VBT

Unit-2: Crystal field Theory in octahedral and tetrahedral complexes

CFT – Splitting in octahedral filed – CFSE - Strong field and weak field splitting-calculation of CFSE for d^n systems - splitting in tetrahedral complexes - only weak field splitting – reason, spectrochemical series.

Unit-3: Crystal field Theory in tetragonal and square planar complexes

Tetragonal symmetry - differences between tetrahedral and tetragonal symmetries - Jahn-Teller distortion - theorem - square planar symmetry - factors affecting 10Dq - Jorgensen relation - evidences for CFSE.

Unit-4: Molecular orbital theory of Coordination complexes

MOT - Octahedral, tetrahedral, square planar complexes-pi bonding and MOT ligands having empty and filled π orbitals – effect on 10Dq, comparision of VBT and CFT

Unit-5: Magnetic properties of complexes.

Para, dia, ferro, ferri, antiferro magnetisms - calculation of μ_{eff} values for complexes.

Block -2: Nuclear Chemistry

Unit -6: Basics of nuclear structure

Nuclear structure - composition of nuclei,– nuclear forces-its characteristics - meson field theory nuclear models - liquid drop, shell and collective models- Properties of nucleus.

Unit -7: Nuclear stability

Nuclear stability, factors affecting the nuclear stability; Mode of decay - alpha, beta, gamma and orbital electron capture; Q value - threshold energy- reaction cross section; isobars- nuclear isomerism

Unit -8 : Radioactive decay and detection

Radioactive decay - theories of decay processes – Laws of radioactivity, series of radioactivity. Detection and measurements of radiations –Half life period, Geiger Muller counter, Scintillation counters.

Block -3: Artificial radioactivity

Unit -9: Classification of nuclear reactions and Artificial radioactivity

Nuclear reactions - transmutation, stripping and pick up, fission, fusion, spallation and fragmentation reactions - nuclear cross-section.

Unit -10: Particle accelerators

Charged particle accelerators, Cyclotron and synchrotron, Uses of accelerator.

Unit -11: Application of nuclear Chemistry

Application C^{14} dating – agriculture - biology – neutron activation and isotopic dilution analysis.

Block -4: Lanthanides and Actinides

Unit -12: Position of Lanthanides and Actinides

Lanthanides and Actinides -position in the periodic table, electronic configuration and oxidation states

Unit -13: Lanthanides and Actinides - occurrence, extraction and separation techniques

Lanthanides - occurrence, extraction and separation techniques -fractional crystallization, precipitation, ion exchange, solvent extraction and thermal decomposition, selective reduction and oxidation

Unit -14: Properties and uses of lanthanides and Actinides

Lanthanides and Actinides contraction – Causes of Lanthanides contraction - spectral and magnetic properties - coordination compounds of lanthanides. Comparative account of lanthanides and actinides, Uses of lanthanides and Actinides and their compounds

Text books

1. **Advanced Inorganic Chemistry**, F.A. Cotton and G. Wilkinson, Wiley Eastern (P) Ltd., 1988.
2. **Essentials of nuclear chemistry**, H.J. Arniker, 2nd edition Wiley eastern Co., 1987.
3. **Concise Inorganic Chemistry,** J.D. Lee, Fifth edition Oxford, 2008.

Reference books

1. **Co-ordination Chemistry,** D. Bannerjea, Tata-McGraw Hill, 1993.
2. **Inorganic Chemistry- Principles of structure and reactivity**, J.E. Huheey, E.A. Keiter and R.L. Keiter, 4th edition, Pearson-Education, 2002.
3. **The Magneto Chemistry of Complex Compounds** in Modern Coordination Chemistry, B. N. Figgeis and J. Lewis, Ed: Lewis & Wilkins, Interscience. N.Y., 1967.
4. **Nuclear and radiochemistry,** G. Friedlander, J.W. Kennedy and J.M. Miller, Wiley, 1964.
5. **Elements of Nuclear Chemistry,** A.K. Srivatsava and P.C. Jain, S. Chand and Co., 1989.

Course Code	Title of the Course
34422	ORGANIC CHEMISTRY – II

Course Objectives: To make the students:

- To understand on the basic concepts on how an organic compound undergoes photochemical or pericyclic reactions.
- Emphasis the stereoisomerism of organic compound
- Emphasis is on the construction of organic compounds through the reactive intermediates.
- To understand the elimination and addition reaction.

Course Outcomes: The students shall be able to:

- ✓ Increase in ability of isomerism and stereochemistry of organic compounds
- ✓ Understand the importance of photochemistry and pericyclic reaction.
- ✓ Recognize the mechanism of addition and elimination reaction
- ✓ Recognize the mechanism of oxidation and reduction reactions in organic synthesis.

Block -1: Elimination and Addition reaction

Unit – 1: Elimination reactions

E_1, E_2 and E_1cB mechanisms - orientation of the double bond - effect of substrate, base, leaving group and reaction medium

Unit – 2: Rules of Elimination reactions

Hofmann and Saytzeff rules - elimination versus substitution - pyrolytic cis elimination - Bredt's rule.

Unit – 3: Addition reaction

Electrophilic, Nucleophilic and free radical additions - stereochemistry of additions - addition to conjugated systems - regioselectivity and chemoselectivity in additions

Block -2: Addition to multiple bond and Conformational analysis

Unit – 4: Addition to carbon-carbon multiple bond

Hydration of olefins – hydroboration - Michael addition - and lithium dimethyl Cuprate - Diels-Alder reaction.

Unit – 5: Addition to carbon-hetero multiple bond

Mechanisms of Aldol condensation, Perkin reaction, Knovenagal reaction, Mannich reaction, Claisen ester condensation, Dickmann condensation, Darzen reaction. Wittig reaction, Cannizzaro reaction, Benzoin condensation and Reformatsky reaction-Addition of Grignard reagents

Unit-6: Conformational analysis of acyclic and cyclic systems

Conformational analysis of acyclic and cyclic systems – substituted n-butanes – cyclohexane and its derivatives – decalins –fused and bridged bicyclic systems – conformation and reactivity some examples

Unit – 7: Topicity and NMR distinction of organic compounds

Topicity and prostereoisomerism – topicity of ligands and faces, and their nomenclature – NMR distinction of enantiotopic/diastereotopic ligands.

Block -3: Reaction intermediates

Unit – 8: Carbenes

Structure of carbenes, generation of carbenes, addition and insertion reactions, rearrangement reactions of carbenes - Wolff rearrangement.

Unit – 9: Nitrenes

Structure of nitrene, generation and reactions of nitrene and related electron deficient nitrogen intermediates, Curtius, Hoffmann, Schmidt, Beckmann rearrangement reactions.

Unit – 10: Free radical reactions

Formation, detection, stability and reactions of free radicals – radicals chain reactions - polymerization, substitution, additions and rearrangements – Barton, Gomberg, Sandmeyer, Ullmann, Pschorr and Hunsdiecker reactions.

Block -4: Photochemistry

Unit – 11: Fundamentals of Photochemistry

Principles - excited states - Energy transfers - Jablonski diagram - sensitization, quenching and quantum efficiency

Unit – 12: Photochemical reaction

Norrish type I and type II reactions – Paterno-Buchi reaction – photoreduction – photooxidation - photochemical reactions of olefins - cis-trans isomerisation - di-π methane rearrangement.

Unit – 13:Pericyclic reactions

Woodward-Hoffmann rules - Frontier molecular orbital theory -perturbation theory - electrocyclic reactions - cycloaddition reactions

Unit – 14: chemotropic reaction

Sigmatropic rearrangements. Cope and Claisen rearrangements; 1,3-dipolar additions - Diels - Alder reaction.

Text books

1. **Advanced Organic Chemistry** – **Reactions, Mechanisms and Structure,** Jerry March, IV Edn., John Wiley & Sons, 1992.
2. **A Guide Book to Mechanisms in Organic Chemistry**, P. Sykes, VI Edn., Longmans Scientifics and Technical, Essex 1986.
3. **Reaction Mechanism in Organic Chemistry**, S.M. Mukherji and S.P. Singh, III Edn. MacMillan.1984.
4. **Stereochemistry of carbon compounds**, Ernest L. Eliel, T.M.H. Edn., Tata McGraw-Hill Publishing Company, 1962.
5. **Organic Photochemistry**, J.M.Coxon and B. Halton, Cambridge University Press, 2011.
6. **Molecular Rearrangements, Vol.I, Vol. II**, Paul de Mayo, Interscience, NY, 1963.

Reference books

1. **Advanced Organic Chemistry, Part A& B**, F.A. Carey and Sundberg, III edition, Plenum Press, 1990.
2. **Organic Chemistry,** S.H. Pine, J.B. Hendrickson, D.J. Cram and G.S. Hammond, IV Edn. McGraw-Hill Company 1980.
3. **Organic Reaction Mechanisms**, V.K. Ahluwalia and R.K. Prashar, 4th edition, Alpha Science International, UK, 2011.
4. **Organic Reactions and Mechanisms**, P.S. Kalsi, II Edn., New Age International Publishers, 2000.
5. **Organic Reaction Mechanisms**- R.K. Bansel, Tata McGraw Hill, 1975.
6. **Organic Chemistry**, R.T. Morrison and R. N. Boyd's, 6th edition, Spring, 2008.
7. **Fundamentals of Reaction Mechanisms in Organic Chemistry**, R.P. Narain, PHI Learning Private Limited, New Delhi, 2011.

Course Code	Title of the Course
34423	PHYSICAL CHEMISTRY – II

Course Objectives: To make the students

- To study adsorption isotherm for adsorption on to solid surfaces and to understand heterogeneous catalysis.
- To acquire basic knowledge in area of Fundamental concepts of polymer chemistry, Polymerization reactions Polymerization techniques
- To know about photochemistry and radiation chemistry

Learning Outcomes: After completion of the course, the students shall be able to

- ✓ Get deep knowledge about various methods of polymerization and speciality polymers
- ✓ Get knowledge about nomenclature of polymer, degree, types, mechanism and kinetics of polymerization and Characterization of polymers
- ✓ To describe adsorption isotherm for adsorption on to solid surfaces and to understand heterogeneous catalysis

Block -1: Surface Chemistry

Unit – 1: Adsorption of gases

Adsorption of gases on solids - Physical and Chemical adsorption –Freundlich, Langmuir, Temkin and BET isotherms

Unit – 2: Surface area reaction

Surface area determination - Mechanisms of uni and bimolecular surface reactions - Langmuir-Hinshelwood and Langmuir-Riedal mechanisms

Unit – 3: Surface excess

Surface excess - Gibbs adsorption isotherm - spreading of a liquid on another - contact angle – surfactants - micelles and detergents.

Block -2: Photochemistry and radiation chemistry

Unit – 4: photophysical processes

Absorption of light by atoms and molecules - photophysical processes of the electronically excited states - fluorescence and phosphorescence

Unit – 5: Energy transfer mechanisms

Energy transfer mechanisms - photosensitization and Chemiluminescence - actinometers and quantum yield determination

Unit – 6: Flash photolysis

Flash photolysis. Study of photochemical reactions - Hydrogen-Halogen reaction - decomposition of carbonyl compounds

Unit – 7: Radiation chemistry

Radiation chemistry of aqueous solutions-hydrated electron - radiolysis of water – Pulsed radiolysis.

Block -3: Polymer chemistry

Unit – 8: Fundamentals of Polymer

Definition, classification of polymers- addition polymerization – type of initiators – initiator efficiency

Unit – 9: Stepwise polymerization

Stepwise polymerization – Functionality of monomers and its significance – Molar masses - Degree of polymerization

Unit – 10: Kinetics and Mechanism polymerization

Kinetics and Mechanism of free radical, cationic and anionic polymerization.

Unit – 11: Polymerization techniques

Various methods of polymerization – solution, bulk, emulsion and suspension polymerization.

Block -4: Colloids and solar energy

Unit – 12: Colloids

Definition, classification, Stability and properties of colloids.

Unit – 13: Solar energy conversion

Conducting polymers, polymer electrolyte, fire retardant, thermally stable and bio-degradable polymers. Atom radical polymerization- Basic, mechanism and applicaiton. Dendrimer.

Unit -14: Solar energy conversion

Principle, solar panel, photovoltaic cell – dye sensitized solar cell, solar water splitting, artificial photosynthesis, water oxidation and hydrogen evolution reaction.

Text Books

1. **Fundamentals of Photochemistry,** K.K. Rohatgi-Mukherjee, New Age International (P) Ltd, Publishers, New Delhi, 2008.
2. **Physical Chemistry,** P.W. Atkins, Oxford University Press, Oxford, 1990.
3. **Physical Chemistry of surfaces**, A.W.Adamson, 4th edn., Wiley - Interscience, Newyork, 1982.
4. **Text Book of Polymer Science**, F.W.Billmeyer Jr. 3rd edn., John Wiley & Sons, New York, 2003.
5. **A Textbook of Polymers**, . M.S. Bhatnagar, Vol I, S.Chand & Company Ltd., 2004.

Reference Books

1. **Physical Chemistry of Surfaces**, A.W. Anderson, Wiley-Interscience, Newyork, 1990.
2. **Physical Chemistry**, Paul Monk, John Wiley and Sons Limited, England, 2004.
3. **Polymer Science**, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, New Age International, New Delhi, 2003.
4. **Contemporary Polymer Chemistry**, H.R. Alcock and F.W. Lamber, Prentice Hall,1981.
5. **Principles of polymer chemistry**, P.J. Flory, Cornell University press, New York, 1953.

Course Code	Title of the Course
34424	ORGANIC CHEMISTRY PRACTICAL

Course Objectives

The objectives of this course are to:

- Develop practical skill with reference to organic qualitative analysis and organic preparations
- Have expertise in the chromatographic separations
- Understand how to solve the structure of organic compounds using spectroscopies
-

Learning Outcomes

The student would have through practical knowledge in the

- ✓ Separation of organic mixture and identification of organic compounds
- ✓ Chromatographic separations
- ✓ Confirmation of structure of organic compounds using spectroscopes

Block -1. Qualitative analysis: Separation and Identification of components in a two component mixture and preparation of their derivatives. Determinations of boiling point/melting point for components and melting point for their derivatives.

Unit 1: Analysis of two-component mixtures

Separation and characterization of components -1

Unit 2: Analysis of two-component mixtures

Separation and characterization of components -2

Unit 3: Analysis of two-component mixtures

Separation and characterization of components – 3

Block -2. Qualitative analysis

Unit 4: Analysis of two-component mixtures

Separation and characterization of components – 4

Unit 5: Analysis of two-component mixtures

Separation and characterization of components -5

Unit 6: Analysis of two-component mixtures

Separation and characterization of components -5

Block -3. About a dozen single stage preparation of organic compounds-1

Unit 7: single stage preparation of organic compounds

Preparations of organic compounds illustrating N-acylation

Unit 8: Single stage preparation of organic compounds
Preparations of organic compounds illustrating O-acylation

Unit 9: Single stage preparation of organic compounds
Preparations of organic compounds illustrating bromination

Unit 10: Single stage preparation of organic compounds
Preparations of organic compounds illustrating nitration

Block -4. About a dozen single stage preparation of organic compounds -2

Unit 11: Single stage preparation of organic compounds
Preparations of organic compounds illustrating benzoylation

Unit 12: Single stage preparation of organic compounds
Preparations of organic compounds illustrating diazotization

Unit 13: Single stage preparation of organic compounds
Preparations of organic compounds illustrating rearrangements

Unit 14: Single stage preparation of organic compounds
Preparations of organic compounds illustrating hydrolysis

Reference books

1. **Laboratory Manual of Organic Chemistry**, Raj K. Bansal, III Edition, New Age International (P) Ltd.1996.
2. **Elementary practical organic chemistry: Quantitative organic analysis Part-III, 2e(pb),** A.I.Vogel**,** Pearson Education Asia, 2011
3. **Elementary practical organic chemistry: Qualitative organic analysis Part-II, 2e(pb),** A.I.V ogel, Pearson Education Asia, 2011

THIRD SEMESTER

Course Code	Title of the Course
34431	ADVANCED INORGANIC CHEMISTRY

Course Objectives: To make the students:

- To know synthetic procedure of metal alkyl, alkene, alkyne, and arene complxes
- To describe the various organometallic reaction mechanisms
- To appreciate the uses of organometallic complexes
- To predict their structures and bonding found in inorganic rings
- To distinguish substitution reactions in octahedral and square planar complexes
- To understand spectral and magnetic properties of octahedral complexes
- Distribution of metal ions in bioligands
- Role of metals in medicine and their structure and properties.

Learning Outcomes: After completion of the course the student are able to:

- ✓ Predict the reaction mechanisms of organometallic complexes and catalysis They will have expertise in
- ✓ Know the electron transitions in complexes and its effect on magnetic properties
- ✓ Understand the chemistry of cages and clusters

Block -1: Coordination Chemistry

Unit-1: Stability of coordination compounds

Stability constants, stepwise and overall formation constants - pH metric, polarographic and Spectrophotometric methods of determining stability constants - chelate effect.

Unit-2: Kinetics and mechanisms of coordination compounds

Kinetics and mechanisms of reactions in solution - labile and inert complexes - ligand displacement reactions - hydrolysis, anation, aquation in octahedral complexes - substitution reactions in square planar complexes – trans effect – electron transfer reactions

Unit-3: complementary and non-complementary reactions

Inner sphere and outer sphere processes – isomerisation and racemisation - template effect and synthesis of macrocyclic ligands.

Block -2: Spectral properties of complexes, Spinels, Cages, clusters and boranes

Unit -4 : Spectral properties of complexes

Electronic spectra of coordination compounds - selection rules, band intensities and band widths; Term state for d ions in Octahedral complexes, energy level diagrams of Orgel and Tanabe - Sugano diagram.

Unit -5 : Spinels

Spinels – normal and inverse types, site preferences in spinnels.and perovskite structures.

Unit -6: Cages and metal clusters

Inorganic chains - rings – cages, Metal clusters - dinuclear clusters - trinuclear clusters - tetranuclear clusters - hexanuclear cluster.

Unit -7: Boranes

Boranes: Structure and bonding in polyhedral boranes and carboranes, styx notation; Wade's rule; electron count in polyhedral boranes; isolobal analogy.

Block -3: Organometallic chemistry

Unit-8: Definition of Organometallics

M-C – bond - Low oxidation state of metal – explanation – synthesis and structure of metal alkyls and aryls - Olefin and acetylene complexes - Dewar-Chatt approach to bonding in olefins

Unit-9: Metallocenes

Metallocenes – structure — comparison of ferrocene with other metallocenes with respect to their reactivity, stability etc – preparation of ferrocene –properties - fluxional molecules.

Unit-10: Metal carbonyl

Metal carbonyl complexes - synthesis - structure and reactions of metal carbonyls - metal carbonyl anions - metal carbonyl hydrides - metal carbonyl halides - metal carbonyl clusters - metal nitrosyls.

Unit -11: Catalysis involving organometallics

Oxidative addition and reductive elimination, hydrogenation, hydroformylation, Monsanto process, isomerisation and Ziegler-Natta polymerization.

Block -4: Bioinorganic chemistry

Unit-12: Metalloporphyrins and Metalloenzymes

Chlorophyll-hemoglobin and myoglobin structure and function of hemoglobin - cytochromes, enzyme action-inhibition and restoration. Carboxy peptidase-A, Vitamin B_{12} and B_{12} coenzymes. Copper containing oxidases

Unit-13: non-heme iron proteins

Rubridoxin – ferrodoxins – HIPIP, fixation of nitrogen - in vivo systems

Unit-14: Metal ions in biology

Alkali and alkaline earth metal ions in biology - sodium ion pump. Metal poisons and chelating agents in medicine.

Text books

1. Modern aspects of Inorganic chemistry, H.J. Emelius and Sharpe, Universal book Stall, New Delhi, 1989.
2. Inorganic Chemistry- Principles of structure and reactivity, J.E. Huheey, E.A. Keiter and R.L. Keiter, 4th edition, Pearson-Education, 2002.
3. Advanced Inorganic Chemistry - F.A. Cotton and G. Wilkinson, Wiley Eastern, 5th edition, 1998.
4. Modern aspects of Inorganic chemistry, H.J. Emelius and Sharpe, Universal book Stall, New Delhi, 1989.
5. Inorganic Chemistry- Principles of structure and reactivity, J.E. Huheey, E.A. Keiter and R.L. Keiter, 4th edition, Pearson-Education, 2002.
6. Advanced Inorganic Chemistry - F.A. Cotton and G. Wilkinson, Wiley Eastern, 5th edition, 1998.

Reference books

1. **Inorganic Chemistry**, D. F. Shriver and P. W. Atkins, Oxford U.K., 1999.
2. **Physical Methods in Inorganic Chemistry**, R. S. Drago, Van Nostrand Reinhold, 2nd Edn., 1968.
3. **Chemistry & Chemical Reactivity**, John C. Kotz, Paul M. Treichel, John Townsend, 8th ed. Cengage Learning, USA, 2012.
4. **A Text book of Quantitative Inorganic Analysis**, A. I. Vogel, ELBS, 3rd Edn, 1969.
5. **Source book of atomic Energy**, S. Glasstone, Van Nonstrand Co., 1969.
6. **Inorganic Chemistry**,. G. S.Sodhi; Ist Edition, VB (P) Ltd, 2006.

Course Code	Title of the Course
34432	ADVANCED ORGANIC CHEMISTRY

Course Objectives: To make the students:

- To learn the about the oxidizing and reducing reagents in organic synthesis
- Emphasis is on the construction of organic compounds through the reactive intermediates.
- To understand the importance and structural characterization of nucleic acid, vitamins, carbohydrate
- Able to synthesis the alkaloids and terpenes
- To understand the importance of target molecules and their synthesis.

Learning Outcomes: The students shall be able to:

- ✓ Create a valuable understanding of the main and important concepts in this course.
- ✓ Understand how systematic the advanced organic syntheses are carried out.
- ✓ Know about the importance and usefulness of protecting groups in organic synthesis.
- ✓ primarily with the principles to understand the oxidation and reduction reaction

Block -1: Oxidation and reduction

Unit-1: Oxidizing reagents in organic synthesis -1

Metal based and non-metal based oxidations of (i) alcohols to carbonyls (Cr, Mn, hypervalent iodine and TEMPO based reagents). (ii) phenols (Fremy's salt, silver carbonate) (iii) alkenes to epoxides (peroxides/per acids based), Sharpless asymmetric epoxidation,

Unit-2: Oxidizing reagents in organic synthesis -2

(i) alkenes to diols (Mn, Os based), Sharpless asymmetric dihydroxylation, Prevost reaction and Woodward modification, (ii) alkenes to carbonyls with bond cleavage (Os and Ru, ozonolysis) (iii) alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation, Se) (iv) ketones to ester/lactones (Baeyer-Villiger).

Unit-3: Reducing reagents in organic synthesis -1

Catalytic hydrogenation- Heterogeneous: Pd/Pt/Rh/Ni, Homogeneous, Wilkinson, Li/Na/Ca in liquid ammonia - Birch, Pinacol formation, McMurry, Acyloin formation, dehalgenation and deoxygenations,

Unit-4: Reducing reagents in organic synthesis -2

Hydride transfer reagents from Group III and Group IV in reductions – $LiBH_4$, $NaBH_4$, triacetoxyborohydride, L-selectride, K-selectride, Luche reduction; $LiAlH_4$, DIBAL-H; Trialkylsilanes, Meerwein-Pondorff-Verley reduction - Stereo/enantioselectiviey reductions -Chiral Boranes, Corey-Bakshi-Shibata

Block -2: Retrosynthetic Analysis and Heterocyclic compounds

Unit-5: Retrosynthetic Analysis

Basic principles and terminology of retrosynthesis, synthesis of aromatic compounds, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis, important strategies of retrosynthesis, functional group transposition, important functional group interconversions

Unit-6: Functional group protection

Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy amino groups and carbon-carbon multiple bonds; chemo- and regioselective protection and deprotection; illustration of protection and deprotection in synthesis

Unit – 7: Heterocyclic compounds

Synthesis, structure and reactivity of Indole, Oxazole, Flavone and Anthocyanin.

Block -3: Carbohydrates, Protein and Ezzymes

Unit – 8: Carbohydrates

Configuration and conformation of disaccharides - Maltose and cellobiose – Polysaccharides - starch and cellulose**.**

Unit – 9: Proteins and enzyme

Aspects of structure and classification of proteins.- Primary, secondary and tertiary structure- end group analysis -Solid phase peptide synthesis. Enzyme- coenzyme.

Unit – 10:Nucleic acids

Aspects of structure and classification DNA and RNA. DNA replication and RNA transcription and translation

Block -4: Natural products

Unit – 11: Alkaloids

Structure and synthesis of Morphine and Atropine, Biosynthesis of Alkaloids.

Unit –12: Terpenes

Structure and synthesis of □-Pinene, Camphor and Zingiberene. Biosynthesis of terpenes.

Unit – 13: Vitamins

Chemistry and physiological action of ascorbic acid, thiamin, riboflavin and pyridoxine – Elementary aspect of vitamin A, E, K and B12.

Unit – 14:Cholesterol and steroid

Structural elucidation of cholesterol– biosynthesis of Cholesterol. Structural elucidation and synthesis of Progesterone.

Text books

1. **Advanced Organic Chemistry** – **Reactions, Mechanisms and Structure,** Jerry March, IV Edn., John Wiley & Sons, 1992.
2. **A Guide Book to Mechanisms in Organic Chemistry**, P. Sykes, VI Edn., Longmans Scientifics and Technical, Essex 1986.
3. **Reaction Mechanism in Organic Chemistry**, S.M. Mukherji and S.P. Singh, III Edn. MacMillan.1984.
4. **Organic Chemistry, Vol. I & II**, I.L. Finar**,** V Edn. First Indian reprint, Pearson Education Asia Pvt. Ltd. 2000.

Reference books

1. **Organic Reaction Mechanisms**- R.K. Bansel, Tata McGraw Hill, 1975.
2. **Chemistry of Alkaloids,** S.W. Pelletier, Van Nostrand Reinhold, 1970.
3. **Chemistry of Terpenesand Terpenoids**, A.A. Newman (editor), Academic Press, London, 1972.

4. **Organic Chemistry,** P. Mehta & M. Mehta, Prentice Hall India, New Delhi, 2005.
5. **Chemistry of Terpenoids**, P. De Mayo, Interscience publishers, 1959.
6. **Biochemistry**, A.L. Lehninger, Nath publishers, 2000.
7. **Organic Chemistry,** StevanA.Fleming, 4th ed., W.W. Norton & Compound, London, 2010.
8. **Organic Chemistry**, R.T. Morrison and R. N. Boyd's, 6th edition, Spring, 2008.
9. **March's Advanced Organic Chemistry Reactions, Mechanishms and Structure**, Micheal B. Smith and Jerry March, 6th edition, John Wiley & Sons Inc., New Jersey, 2007.
10. **Fundamentals of Reaction Mechanisms in Organic Chemistry**, R.P. Narain, PHI Learning Private Limited, New Delhi, 2011.

Course Code	Title of the Course
34433	Spectroscopy – Applications in Organic and Inorganic Chemistry

Course Objectives

The primary objective of this course is to introduce the student to the advanced concepts of applications of spectroscopy in organic and inorganic chemistry. The objectives are:

- To learn the about the theory and applications of UV-VIS, and FT IR spectroscopies
- To be familiar with the principles and applications of NMR, ESR, and Mass spectroscopies
- To be able to interpret the spectra and work out conjoined problems in spectroscopies.

Learning Outcomes

Students will be able to

- ✓ Understand how different spectroscopes work and their applications in structure elucidations.
- ✓ Recognize and distinguish the different molecules by applying the spectroscopies
- ✓ Solve spectral problems
- ✓ Know about the importance and usefulness of various spectroscopies in organic and inorganic chemistry.

Block -1: UV-Visible and IR spectroscopy

Unit 1: UV-Visible spectroscopy

Basic Principles – electronic excitations-solvent effects - factors affecting position and intensity of absorption bands - instrumentation

Unit 2: Application of UV-Visible spectroscopy

Applications – Qualitative analysis - Quantitative analysis - spectra of dienes - □,□-unsaturated ketones and aromatic carbonyl compounds – Woodward –Fieser rules - charge transfer complexes.

Unit 3: IR-Spectroscopy

Basic principles-stretching vibrations - Hook's law - Bending vibrations –Overtone and combination bands - Fermi resonance – Instrumentation

Unit 4: Application of IR-Spectroscopy

Applications to organic compounds - characteristic frequencies - effects of substitution, conjugation, bond angle and hydrogen bond - vibrational frequencies.

Block -2: NMR Spectroscopy

Unit 5: ^{1}H NMR Spectroscopy

Theory of ^{1}H NMR spectroscopy – chemical shift – factors affecting chemical shift – spin –spin coupling Instrumentation - first order and non-first order spectra - shift reagents

Unit 6: ^{1}H NMR Spectral Technique

Double resonance - spin tickling - Nuclear Overhauser Effect - Deuterium exchange reactions – Applications.

Unit 7: ^{13}C NMR Spectroscopy

^{13}C NMR, Theory, instrumentation, Application

Block -3: ESR, Mass Spectroscopy and ORD and CD

Unit 8: ESR Spectroscopy

Theory – Instrumentation - Presentation of spectrum - comparison between ESR and NMR - 'g' values - applications to organic and inorganic compounds.

Unit 9: Mass Spectroscopy

Principle - parent ion - Meta stable ion - isotopic ions - Basic peak Nitrogen rule - Instrumentation – general rule of fragmentation - Mclafferty rearrangement. Structural elucidation.

Unit 10: ORD and CD

Principle – Circular birefringence and circular dichromism– Cotton effect - ORD curves

Unit 11 Application of ORD and CD

Application on cotton effect curves - □-haloketone rule - octant rule - Applications for determination of conformation and configuration.

Block -4: Thermal and Spectrometric methods of analysis

Unit 12: Thermal analysis

Thermogravimetry - Differential thermal analysis - Differential scanning calorimetry - Thermometric titrations

Unit 13: Fame photometry

Principle, instrumentation and applications of flame photometry

Unit 14: Turbidimetry and Nephelometry

Principle, instrumentation and applications of turbidimetry and Nephelometry

Text Books

1. **Instrumental Methods of Analysis**, Willard, Merit Dean and Settle CBS Publishers and Distributors, IV edition, 1986.
2. **Principles of Instrumental Analysis,** Schoog, Holler, Nieman, Thomson, Asia Pvt. Ltd., Singapore, 2004.
3. **Spectrometric identification of organic compounds**, R.M Silverstein, C.G. Bassler and Morril, VI Edition, John Wiley & Sons, New York, 2002.
4. **Text Book of Quantitative Inorganic Analysis**, A.I Vogel, ELBS III Edition, 1987.
5. **Instrumental methods of chemical analysis**, Chatwal and Anand, Himalaya publishing House New Delhi, 2000.

Reference Books

1. **Chemical Analysis: Modern Instrumentation Methods and Techniques**, F.Rouessac, A.Rouessac , 2nd Edition, Wiley & sons, USA, 2011.
2. **Analytical Chemistry,** J.G. Dick McGraw Hill Publishers, 1974.
3. **Instrumental Methods of Chemical Analysis,** G.W.Ewing McGraw Hill Pub, 1975.
4. **Instrumental methods in Electrochemistry**, R. Greef, R. Peat, L.M. Peter, D. Pletcher and J. Robinson, Ellis Horwood, Chichester, 1985.
5. **Spectroscopy of organic compounds**, P.S. Kalsi, Wiley Eastern Ltd., Madras, 1995.
6. **Fundamentals of Analytical Chemistry,** D.A. Skoog and D.M. West Holt Rinehart and Winston Publications, IV Edition, 2004.
7. **NMR in Chemistry,** W. Kemp, MacMillan Ltd, 1986.
8. **Spectroscopy in Inorganic Chemistry**, C.N.R. Rao, J.R. Ferraro, Methven Co., London, 1968.
9. **Basic Principles of Spectroscopy,** Raymond Chang, Mc Graw Hill Ltd., New York, 1993.
10. **Instrumental Analysis,** G. D. Christian and J.E.O Reilly, Allyn and Bacon Inc, II Edition, 1986.
11. **Structural methods in Inorganic Chemistry,** E.A.V. Ebsworth, D.WH. Rankine and S. Craddock, Black well Scientific Publ., 1987.
12. **Principles of Instrumental Analysis**, Schoog, Holler, Nieman, Thomson, Asia Pvt . Ltd., Singapore, 2004.
13. **Fundamentals of Analytical Chemistry**, D.A.Skoog and D.M.West, Winston Publications, IV Edition, 2004.
14. **Analytical chemistry: a modern approach to analytical science**, J.M. Mermet, M. Otto, R. Kellner, Wiley-VCH, 2004.

Course Code	Title of the Course
34434	INORGANIC CHEMISTRY PRACTICAL

Course Objectives

This course will help in developing practical skill with reference to separation, estimation by volumetric, gravimetric and complexometric method of analysis of metal ions.

Learning Outcomes

The student would have through practical knowledge in quantitave and qualitative estimation of inorganic cations. with suitable methods.

Block-1: Quantitative analysis of mixtures containing two components system-1

Unit 1: Separation and estimation of mixtures containing two components – 1

Separation and estimation of Cu^{2+} - Ni^{2+} mixtures by volumetric method and the other by gravimetric method.

Unit 2: Separation and estimation of mixtures containing two components – 2

Separation and estimation of Cu^{2+} – Ba^{2+} mixtures by volumetric method and the other by gravimetric method.

Unit 3: Separation and estimation of mixtures containing two components – 3

Separation and estimation of Cu^{2+} – Zn^{2+} mixtures by volumetric method and the other by gravimetric method

Unit 4: Separation and estimation of mixtures containing two components – 4

Separation and estimation of Fe^{2+} – Ni^{2+} mixtures by volumetric method and the other by gravimetric method

Block-2: Quantitative analysis of mixtures containing two components system-2

Unit 5: Separation and estimation of mixtures containing two components – 5

Separation and estimation of Fe^{2+} – Zn^{2+} mixtures by volumetric method and the other by gravimetric method

Unit 6: Separation and estimation of mixtures containing two components – 6

Separation and estimation of Fe^{2+} - Cu^{2+} mixtures by volumetric method and the other by gravimetric method

Unit 7: Separation and estimation of mixtures containing two components – 7

Separation and estimation of Zn^{2+} – Cu^{2+} mixtures by volumetric method and the other by gravimetric method

Block-3: Complexometric estimation of binary mixture of cations -1

Unit 8: Complexometric estimation of binary mixture of cations -1

Estimation of Bi^{2+} - pb^{2+} mixtures using EDTA as a complexing agent by adopting any one of the techniques, like precipitation, pH variation, masking and demasking.

Unit 9: Complexometric estimation of binary mixture of cations -2

Estimation of pb^{2+} – Ca^{2+} mixtures using EDTA as a complexing agent by adopting any one of the techniques, like precipitation, pH variation, masking and demasking.

Unit 10: Complexometric estimation of binary mixture of cations - 3

Estimation of Ni^{2+} – Cu^{2+} mixtures using EDTA as a complexing agent by adopting any one of the techniques, like precipitation, pH variation, masking and demasking.

Unit 11: Complexometric estimation of binary mixture of cations -4

Estimation of Fe^{2+} – Ni^{2+} mixtures using EDTA as a complexing agent by adopting any one of the techniques, like precipitation, pH variation, masking and demasking.

Block-4: Complexometric estimation of binary mixture of cations -2

Unit 12: Complexometric estimation of binary mixture of cations -5

Estimation of Zn^{2+} – Cu^{2+} mixtures using EDTA as a complexing agent by adopting any one of the techniques, like precipitation, pH variation, masking and demasking.

Unit 13: Complexometric estimation of binary mixture of cations -6

Estimation of Co^{2+} - Cu^{2+} mixtures using EDTA as a complexing agent by adopting any one of the techniques, like precipitation, pH variation, masking and demasking.

Unit 14: Complexometric estimation of binary mixture of cations -7

Estimation of Zn^{2+} - Ca^{2+} mixtures using EDTA as a complexing agent by adopting any one of the techniques, like precipitation, pH variation, masking and demasking.

Reference Books

1. **Vogel's qualitative Inorganic analysis,** G. Svehla, VI Edition, Orient Longman, 1987.
2. **Inorganic Semimicro Qualitative analysis,** V.V. Ramanujam, National Publishing Co., 1971.
3. **A Laboratory Manual of Inorganic Chemistry**, John Bernard Ekeley, BiblioLife, 2010.

FOURTH SEMESTER

Course Code	Title of the Course
34441	Analytical Chemistry

Course Objectives

The major objectives of this course are to understand the concepts of:

- ✓ Errors in chemical analysis, Statistical analysis and validation comparison of results
- ✓ Purification techniques
- ✓ Electro analytical methods
- ✓ Separation and identification of compounds by Chromatographic methods

Learning Outcomes

The student would be able to

- ✓ Predict the error
- ✓ To know about electroanalytical methods
- ✓ Understand the gas chromatography and High pressure liquid chromatography
- ✓ Know about the Purification techniques

Block-1: Error analysis

Unit 1: Errors in chemical analysis.

Errors in chemical analysis. Classification of errors- systematic and random, additive and proportional, absolute and relative.

Unit 2: Data analysis.

Accuracy and precision. Mean, median, average deviation and standard deviation. Significant figures and rules to determine significant figures. Calculations involving significant figures.

Unit 3: Comparison of results

Confidence limit, correlation coefficient and regression analysis. Comparison of methods: F-test and T-test. Rejection of data based on Q-test. Least squares method for deriving calibration graph.

Block-2: Electroanalytical methods

Unit 4: Electrodics

Ion selective electrodes - Potentiometric methods – electrogravimetry - Coulometric analysis.

Unit 5: Polarography

Principles and applications of polarography – Instrumentation, Types of cells, advantages of dropping mercury electrode. and applications.

Unit 6: Cyclic voltammetry

AC polarography – Cyclic Voltammetry, Instrumentation, advantages over polarographic techniques – test of reversibility of electron transfer reactions – Application

Unit 7: Chrono techniques

Chronopotentiometry – instrumentation, advantages over polarography – controlled potential coulometry.

Block-3: Chromatography

Unit 8: Chromatographic methods

Definition - Classification - Basic and elementary principle and practice of Paper chromatography. Thin Layer Chromatography

Unit 9: Gas Chromatography

Gas chromatographic techniques – Principle, instrumentation – injection system, column, and detector, application of GC.

Unit 10: GC-MS

Gas chromatographic –mass spectral techniques – Principle, instrumentation – interpretation and application of GC-MS

Unit 11: High Pressure Liquid Chromatography

Principle, types of HPLC, Normal and reversed phase liquid chromatography (NP- & RP LC); Instrumentation, Application

Block-4: Ion Chromatography, Purification Techniques and Ionic separation

Unit 12: Ion chromatography

Theory, application of Ion exchange and gel permission Chromatography

Unit 13 - Purification Techniques

General methods of isolation and purification of chemicals – Solvent extraction – Fractional crystallization – sublimation – distillation – vacuum distillation – purification of solvents.

Unit 14: Ionic Separations

Types of equipment employed for electrophoresis, Di-electrophoresis and electrodialysis Controlling factors, Applications.

Text Books

1. A.I Vogel, **Text Book of Quantitative organic Analysis**, ELBS III Edn, 1987.
2. Chatwal and Anand, **Instrumental methods of chemical analysis**, Himalaya publishing House New Delhi, 2000.
3. D.B.Hibbert and J.J. Gooding, **Data Analysis for chemistry**, Oxford University Press, 2006
4. Allen J.Bard and Faulkner, **Electrochemical Methods, Fundamentals and Applications**, John Wiley and Sons, New York, 1983.

Reference Books

1. Willard, Merit Dean and Settle, **Instrumental Methods of Analysis**, CBS Publishers, IV Edn., 1986.
2. Schoog, Holler, Nieman, Thomson, **Principles of Instrumental Analysis**, Asia Pvt. Ltd., Singapore, 2004.
3. D.A.Skoog and D.M.West, **Fundamentals of Analytical Chemistry**, Winston Publications, IV Edn, 2004.
4. J.M.Mermet, M.Otto, R.Kellner, **Analytical chemistry: a modern approach to analytical science**, Wiley-VCH, 2004.
5. F.Rouessac, A.Rouessac, **Chemical Analysis: Modern Instrumentation Methods and Techniques**, 2nd Edition, Wiley & sons, USA, 2011.
6. J. R. Lakowicz, **Principles of Fluorescence Spectroscopy**, 3rd Ed., Springer, New York, 2006.
7. Lacey, R.E. and S.Loaeb - **Industrial Processing with Membranes**, Wiley -Inter Science, New York, 1972.
8. King, C.J. **Separation Processes** , Tata McGraw - Hill Publishing Co., Ltd., 1982.
9. 4. Ronald W.Roussel - Handbook of Separation Process Technology, John Wiley, New York, 1987.
10. James A. Plam Beck, **Electroanalytical Chemistry – Basic Principles and Applications**, John Wiley & Sons, 1982.

Course Code	Title of the Course
34442	APPLIED CHEMISTRY

Course Objectives

- To educate on the basic terminologies of the environment
- To develop knowledge about air, water and soil
- To create awareness various pollutions and abatements
- To gain an understanding of the principles of nanotechnology; characterization of nano structured materials; and tools and equipment for producing and assembling at the nano scale.
- To acquire advanced knowledge about the equipment used in nanotechnology such as XRD, SEM, TEM, STM, AFM, XPS, AES

Learning Outcomes

- ✓ The students will acquire basic knowledge about environment
- ✓ Environmental awareness about the various types of pollution and their control.
- ✓ This multidisciplinary course provides an in-depth view of the synthesis, characterisation and application of nanostructures using chemical routes. Necessarily, it will incorporate various concepts from colloidal chemistry, supramolecular chemistry, polymer chemistry and electrochemistry.
- ✓ This course will gain knowledge in the most exciting, novel and interdisciplinary issues in nanoscale science and Technology.

Block-1: Environmental Wastewater treatment methods and **Electrochemical power sources**

Unit – 1: Environmental Chemistry

Hazardous materials and their ill effects**.** Acid rain, Ozone hole and green house effect. Types of pollution – air, water, land, pesticide, thermal and radioactive. Physicochemical and biological investigations of water - water quality.

Unit – 2: Wastewater treatment methods

Pretreatment, preliminary treatment, secondary (or biological) methods of treatment and tertiary (or advanced) methods of wastewater treatment.

Unit – 3: Electrochemical power sources

Principle of energy conversion, electrochemical energy conversion, Classification of batteries - primary and secondary systems. Basic electrochemical reactions and performance of primary and secondary systems - Fuel cells - Introduction - Types of fuel cells, Advantages - fuel cell, supercapcitors.

Block-2: Electrochemistry-I

Unit – 4: Corrosion

Basic aspects of corrosion: Importance of corrosion studies – EMF and Galvanic series – classification of corrosion – corrosion kinetics – Pourbaix diagram for Fe- H_2O system – passivity

Unit – 5: Methods of corrosion

High temperature corrosion – Forms of corrosion. Chemical and Electrochemical methods of corrosion rate measurements methods.

Unit – 6: Corrosion control methods

General classification of corrosion control methods – Designing aspects in corrosion control – corrosion inhibitors – Electrochemical methods of protection such as anodic and cathodic protection.

Block-3: Electrochemistry-II

Unit – 7: Electroplating

Principles of electroplating – Metal deposition from solutions of simple salts and complex salts – measurement of current density, throwing power and current efficiency of electroplating bath – surface preparation for electroplating. Electroplating of nickel and copper

Unit – 8: Electroforming

Principle and applications, Alloy plating of Brass, Brush plating, Cladding and Vapour deposition

Unit – 9 Electroless plating

Principles, advantages and limitations of electroless plating – Composite coating - principle, mechanism and their applications. Anodizing – principle, types of anodizing bath – colouring of anodizing aluminium.

Block-4: Nanomaterials, Characterization Techniques and Computer applications in Chemistry

Unit – 10: Nanomaterials

Brief introduction to nanoscience and technology. Preparatory synthesis - Sol-gel thermolysis, combustion method, solvothermal method and microemulsion method.

Unit – 11: Physical and chemical method of nanomaterials

Physical methods – vacuum evaporation, sputtering, pulsed laser deposition. Chemical methods - CVD, chemical solution deposition, electrochemical deposition, spray pyrolysis deposition.

Unit 12: Physical characterization techniques of nanomaterial

FT-IR, XPS and Laser Raman spectroscopy. XRD analysis. Microscopic techniques: SEM, AFM and TEM. Thermal analysis: TG/DTA and DSC.

Unit 13: Computer applications in Chemistry

Calculation of pH, solubility product, calculation of bond energy using Born-Lande equation. Standard deviation and correlation coefficient.

Unit 14: Online resources for chemistry

Introduction - Internet service providers, terms used in E-mail-search engines - chemistry databases- table of contents - source for list of journals – Online courses NPTEL, Swayam, MOOC, virtual lab..

Text books

1. **Environmental Chemistry,** Sharma & Kaur, Krishna Publishers, New Delhi, 2000.
2. **Principles and prevention of corrosion**, D.Jones, Macmillan Publications New York, 1992.
3. **The Chemistry of nanomaterials; Synthesis, properties and applications**, C.N.R. Rao, Wiley-VCH Verlag Gmbh&Co, Weinheim, 2004.
4. **Computers in Chemistry,** K.V. Raman, Tata McGraw Hill, New Delhi, 1993.

Reference Books

1. Environmental Chemistry, S.E Manahan CRC press, 2010.
2. Environmental Chemistry, S.K. Banerji, Prentice Hall of India, New Delhi, 2003.
3. Wastewater treatment, Ed. M. Henze, P. Harremoes, J.C. Jansen and E. Arvin, Springer Verlag, New York, 1995.
4. Cathodic Protection Theory and practice, J.J. Meketta, Marcel Dekker Publication, NY, 1993.
5. An introduction of corrosion and corrosion inhibition, S.N. Banerjee, Oxonian Press Ltd., New Delhi.

6. **Modern Electroplating,** K.A. Lowenheim, Second Edition, John Wiley & Sons, New York, 1963.
7. **BASIC Programming for Chemists,** P.C. Jurns, T.L. Isenhour and C.C. Wilkins, JW.& Sons 1987.
8. **Computers in Chemistry,** K.V. Raman, Tata McGraw Hill, New Delhi, 1993.
9. **Nanoscale materials in Chemsitry**, Kenneth J. Klabunde, John-Wiley & Sons, 2001.
10. **Environmental Chemistry for a Sustainable World: Remediation of Air and Water Pollution,** E. Lichtfouse, J. Schwarzbauer, D. Robert, Springer, 2011.

Course Code	Title of the Course
34443	ADVANCED PHYSICAL CHEMISTRY

Course Objectives: To make the students

- To understand the statistical thermodynamics
- To familiar with one dimensional harmonic oscillator, rigid rotator
- The basic of group theory and character table
- To study about salt effect and catalysis system.

Learning outcomes

The students will gain knowledge about

- ✓ Advanced concepts in quantum mechanics which make the students to understand the atomic orbitals and their structures.
- ✓ Recognize the importance of quantum chemistry and of its applications.
- ✓ Describe and understand the basic group theory and its applications
- ✓ Get deep knowledge about chemical kinetic of reaction in solution.

Block-1: Statistical thermodynamics

Unit – 1: Statistical thermodynamics

Maxwell - Boltzmann distribution law of molecular energies - Negative absolute temperature - Entropy and probability,

Unit – 2: Partition functions

Partition functions and thermodynamic functions, translational, rotational and vibrational partition functions entropies and energies – Equilibrium constant from partition function

Unit – 3: Statistical interpretation of third law

Statistical interpretation of third law - Bose-Einstein distribution law Application of the law to photon gas - Fermi-Dirac distribution law -Application of the law to electron gas

Unit – 4: Heat capacities of solids

Heat capacities of solids: Einstein and Debye's models - Non equilibrium thermodynamics - Elementary treatment, Onsager reciprocal relations.

Block-2: Quantum chemistry

Unit – 5: Quantum chemistry

Application of wave mechanics to simple systems - One dimensional harmonic oscillator, rigid rotor

Unit – 6: Quantum mechanical treatment

Quantum mechanical treatment for radical and angular wave function and hydrogen atom like atoms - Pauli's exclusion principle and Slater determinant – Approximation methods – variation - time independent perturbation and SCF methods

Unit – 7: HMO method

Application of variation methods to hydrogen atom - Application of perturbation method to helium - HMO method – application to butadiene.

Block-3: Group theory

Unit – 8: Assignment of point groups

Symmetry elements and symmetry operations - Rules for forming a group, group multiplication table, group classification - Point groups and systematic assignment of point groups for molecules

Unit – 9: Matrix representation theory

Matrix representation theory - matrix multiplication, inverse of a matrix, matrix diagonalization and matrix representation for symmetry operations

Unit – 10: Character table

Reducible and irreducible representations.-Character table of C_{2v} and C_{3v} point groups. The great orthogonality theorem and character table - Direct product representation –

Unit – 11: Symmetry oriented spectral methods

Application of group theory to IR and Raman spectra - H_2O and NH_3 molecules - Application of group theory to electronic spectra (HCHO and C_2H_4)

Block-4: Chemical kinetics

Unit – 12: Reactions in solution

Reactions in solution – factors which influence the reaction rates in solution. Application of ARRT to solution kinetics – Bronsted – Bjerrum equation,

Unit – 13: Salt effect

Primary salt effect, secondary salt effect - influence of internal pressure - effect of pressure and volume of activation. Effect of solvent: ion-ion and ion-dipole reactions-dielectric constant – Effect of substituents on reaction rates Hammett and Taft equations

Unit – 14: Acid base catalysis

Acid base catalysis-acidity functions – Bronsted relations - Zucker Hammett hypothesis – Enzyme catalysis – Michaelis – Menton equation- Lineweaver- Burke equation, Edie equation – Effect of pH and temperature on enzyme catalyzed reactions.

Text Books

1. **Statistical Thermodynamics**, M.C. Gupta, Wiley Eastern, New Delhi, 1990.
2. **Quantum Chemistry**, D.A. McQuarrie, University Science Books, Mill Valley, California, 1983.
3. **Group Theory**, A.K. Chandra, Discovery Publishing House, New Delhi, 2010.
4. **Kinetics and Mechanism of Chemical Transformations**, J. Rajaram and J.C. Kuriacose, MacMillan India Ltd. 1993.

Reference Books

1. **Introduction to Statistical Thermodynamics**, R.P.H. Gasser and W.G. Richards, World Scientific, Singapore, 1995.
2. **Quantum Chemistry**, R.K. Prasad, Wiley Eastern, New Delhi,1992.
3. **Quantum Mechanics in Chemistry**, M.W. Hanna, W.A. Benjamin Inc. London, 1965.
4. **Chemical Application of Group Theory**, F.A. Cotton, John Wiley and Sons Inc. New York, 1971.
5. **Group theory and its applications to Chemistry**, K.V. Raman, Tata McGraw-Hill Publishing Company, 2008.
6. **Irreversible Thermodynamics,** J. Rajaram and J.C. Kuriacose, Lal Nagin Chand, New Delhi, 1989.
7. **Chemical Kinetics**, K.J. Laidler, Harper and Row, New York,1987.
8. **Kinetics and Mechanism**, R.G. Frost and Pearson, Wiley New York, 1961
9. **Kinetics and Mechanism**, W.J. Moore and R.G. Pearson, 1981.
10. **Symmetry and spectroscopy of molecules,** K. Veera Raddy, New Age International Publishers; Second edition, 2009.
11. **Group theory in Chemistry**, V. Ramakrishnan and M.S. Gopinathan, Vishal Publications, 1988.

Course Code	Title of the Course
34444	PHYSICAL CHEMISTRY PRACTICAL

Course Objectives

- The Physical Chemistry practical course is designed such that to provide deep knowledge and hands on experimenting the more advanced physical chemistry practicals such as kinetics, distribution studies, conductometry, potentiometry, and spectrophotometric method

Learning outcomes

The students will be able to

- ✓ Carry out electrical experiments such as Conductomerty and Potentiometric Titrations
- ✓ Determine out the kinetic parameters in the ester hydrolysis
- ✓ Understand the equilibrium reactions
- ✓ Determine the concentration by spectrophotometric method

Block-1: Partition Co-efficient

Unit 1: Partition Co-efficient - 1

Determination of Partition Co-efficient of iodine in water/

Unit 2: Partition Co-efficient - 2

Determination of Equilibrium constant of KI

Unit 3: Partition Co-efficient - 3

Determination of Unknown KI

Block-2: Conductometric titration

Unit 3: Conductometric titration of Acid vs Base

Cconductometric titration of (i) strong acid vs strong base, (ii) weak acid vs strong base (iii) mixture of acids vs strong base

Unit 4: Conductometric titration of Mixed halides

Conductometric titrations of mixed halides

Unit 5: Conductometric titration of solubility product

Solubility product by conductivity measurement

Unit 6: Determine the strength of the given salt by conductometric titration

Determine the strength of the given salt solution by conductometric titration

Block-3: Potentiometric titration

Unit 7: Potentiometric titration of Acid vs Base

Potentiometric titration of strong acid vs strong base and weak acid vs strong base

Unit 8: Determine the strength of the given salt by Potentiometric titration

Determine the strength of the given salt solution by potentiometric titration (FAS vs $K_2Cr_2O_7$ and FAS vs $KMnO_4$)

Unit 9: Potentiometric titration of simple halides and Mixed halides

potentiometric titration of simple halide and mixture of halides

Block-4: Chemical Kinetics and Spectrophotometric method

Unit 10: First order and second order kinetics of hydrolysis of ester

Acid catalyzed hydrolysis of an ester, base catalyzed hydrolysis of an ester by titration method

Unit 11: Kinetics of hydrolysis of ester by conductivity method

Base catalyzed hydrolysis of an ester by conductivity method

Unit 12: Determination of metal by colorimeter

Determine the amount of manganese present in the given steel sample.

Unit 13: Determination of Iron by spectrophotometer method

Determine the amount of iron present in the given water sample by spectrophotometeric method.

Unit 14: Determination of Copepr by spectrophotometer method

Determine the amount of copper present in the given sample by spectrophotometeric method.

REFERENCE BOOKS

1. **Findlay's Practical Physical Chemistry,** Revised and edited by 'B.P.Levitt, 9th edn., Longman, London, 1985.
2. **Advanced Experimental Chemistry,** J.N.Gurtu and R. Kapoor, Vol.I, S.Chand & Co. Ltd., New Delhi (1980).
3. **Practical Physical Chemistry**, B. Viswanathan and P.S. Raghavan, ViVa Books, 2009.
4. **Systematic Experimental Physical Chemistry**, S.W. Rajbhoj and T.K.Chondhekar, Anjali Publication, Aurangabad, 2000.

e. 3. Duration of the Programme:

The programme for the degree of Master of Science in Chemistry shall consist of two academic years divided in to four semesters. Each semester consists of Three Theory Papers and One Practical Paper. Theory course carry 4 credits each and Practical course carry 4 credits. Each semester consist of 16 credits.

e. 4. Faculty and Support Staff Requirements:

The programme for the degree of Master of Science in Botany requires following faculty and supporting staff

Staff Category	Required
Faculty for Core Chemistry Subjects #	3
Faculty for Special Subject viz.,Analytical Chemistry, Applied chemistry, etc., #	2
Laboratory Assistant	1
Clerical Assistant	1

Faculty may be belongs to at least Assistant Professor level

e. 5. Instructional Delivery Mechanisms:

The instructional delivery mechanisms of the programme includes SLM – study materials, face to face contact session for both theory and practical courses of the programme, e-content of the study materials in the form of CD and virtual laboratory wherever applicable.

e. 6. Identification of Media:

The SLM – designed study materials will be provided in print media as well is in the form of CD which carries electronic version of the study material in addition to virtual laboratory courses.

e. 7. Student Support Services:

The student support services will be facilitated by the head quarter i.e., Directorate of Distance Education, Alagappa University, Karaikudi and its approved Learning Centres located at various parts of Tamil Nadu. The pre-admission student support services like councelling about the programme including curriculum design, mode of delivery, fee structure and evaluation methods will be explained by the staff at head quarter and Learning Centres. The post-admission student support services like issuance of identity card, study materials, etc. will be routed through the Learning Centres. The face to face contact sessions of the programme for both theory and practical courses will be held at the head quarter only. The conduct of end semester examinations, evaluation and issuance of certificates will be done by office of the Controller of Examinations, Alagappa University, Karaikudi.

f. Procedure for Admission, curriculum transaction and evaluation

f. 1. Procedure for Admission:

A candidate who has passed the B.Sc., degree (10 + 2+ 3 system) examination in Chemistry of the University or an Examination of any other University accepted by the Syndicate as equivalent thereto shall be eligible to appear and qualify for the M.Sc. Degree in Chemistry of this University after a course of study of two academic years.

f. 2. Curriculum Transactions:

The classroom teaching would be through chalk and talk method, use of OHP, Power Point presentations, web-based lessons, animated videos, etc. The face to face contact sessions would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill.

For practical courses exclusive study materials containing the requirements, procedure for the experiments will be issued to the learners. In the laboratory, instruction would be given for the experiments followed by demonstration and finally the students have to do the experiments individually.

The face to face contact sessions will be conducted in following durations;

Course Type	**Face to Face Contact Session per Semester (in Hours)**
Theory Courses (3 courses with 4 credits each)	48
Practical Courses (1 course with 4 credits)	120
Total	**168**

f. 3. Evaluation:

The examinations shall be conducted separately for theory and practical's to assess the knowledge acquired during the study. There shall be two systems of examinations viz., internal and external examinations. In the case of theory courses, the internal evaluation shall be conducted as Continuous Internal Assessment via. Student assignments preparation and seminar, etc. The internal assessment shall comprise of maximum 25 marks for each course. The end semester examination shall be of three hours duration to each course at the end of each semester. In the case of Practical courses, the internal will be done through continuous assessment of skill in demonstrating the experiments and record or report preparation. The external evaluation consists of an end semester practical examinations which comprise of 75 marks for each course.

f. 3.1. Question Paper Pattern:

Time: 3 Hours Max. Marks: 75

Part A- 10 x 2 Marks = 20 Marks (Answer all questions) Q. No. 1 – 10

Part B -5 x 5 Marks = 25 Marks Q. No. 11 – 15

11 a) or b)
12 a) or b)
13 a) or b)
14 a) or b)
15 a) or b)

Part C- 3 x 10 Marks = 30 Marks (Answer any three from five question s) Q. No. 16 – 20

f. 3.2. Distribution of Marks in Continuous Internal Assessments:

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade points. Evaluation for each course shall be done by internal assessment during Personal Contact Programme as well as by annual examination and will be consolidated at the end of the programme.

The components for continuous internal assessment are:

Internal Tests /Seminar/Assignment - 25 marks

Attendance need not be taken as a component for continuous assessment, although the student should put in a minimum of 75% attendance in each course.

The annual examination, which will be a written examination of at least 3 hours duration, would also form an integral component of the evaluation. The ratio of marks to be allotted to internal assessment and to end semester examination is 25:75. The evaluation of laboratory component, wherever applicable, will also be based on internal assessment and annual practical examination.

Distribution of marks for practical examinations

(Internal Assessment 25 marks + Annual Examination 75 marks)

ESE mark distribution	
Qualitative/Quantitative analysis	50 marks
Record Note	10 marks
Viva voce	15 marks
Total	75 marks

f. 3.3. Passing Minimum:

- For internal Examination, the passing minimum shall be 40% (Forty Percentage) of the maximum marks (25) prescribed for UG and PG Courses.
- For External Examination, the passing minimum shall be 40% (Forty Percentage) of the maximum marks (75) prescribed for UG and PG Courses.
- In the aggregate (External + Internal), the passing minimum shall be 40% for UG and 50% for PG courses.

f. 3.4. Marks and Grades:

The following table gives the marks, grade points, letter, grades and classification to indicate the performance of the candidate.

Range of Marks	Grade Points	Letter Grade	Description
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
00-49	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

C_i = Credits earned for the course i in any semester
G_i = Grade Point obtained for course i in any semester.
n refers to the semester in which such courses were credited

For a semester;

Grade Point Average [GPA] = $\sum_i C_i G_i / \sum_i C_i$

Grade Point Average = Sum of the multiplication of grade points by the credits of the courses

Sum of the credits of the courses in a semester

For the entire programme;

Cumulative Grade Point Average [CGPA] = $\sum_n \sum_i C_{ni} G_{ni} / \sum_n \sum_i C_{ni}$

CGPA = Sum of the multiplication of grade points by the credits of the entire programme

Sum of the credits of the courses for the entire programme

CGPA	Grad	Classification of Final Result
9.5-10.0	O+	First Class- Exemplary*
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-appear

*The candidates who have passed in the first appearance and within the prescribed semester of the PG Programme are eligible.

f. 3.5. Maximum duration for the completion of the course:

The maximum duration for completion of M.Sc., Degree in Chemistry programme shall not exceed ten semesters from their fourth semester.

f. 3.6. Commencement of this Regulation:

The Department shall form a Grievance Redressal Committee for each course with the course Teacher and the HOD as the members. This committee shall solve all grievances relating to the internal Assessment marks of the students.

f. 3.7 Transfer of credits

Students are permitted to transfer their programme credits from Directorate of Distance Education (DDE) of Alagappa University to Regular Stream and Vice-versa, if the PG degree programme is same.

f. 3.8. Revision of regulations and curriculum

The University may from time to time revise, amend and change the regulation and the curriculum, if found necessary.

f. 3.9. Commencement of this regulation

These regulations shall take effect from the academic year 2018-2019 (June session) i.e., for students who are to be admitted to the first year of the course during the academic year 2018-2019 (June session) and thereafter.

f. 4. Fee Structure:

The programme has the following Fee Structure:

Sl. No.	Fees Detail	Amount in Rs.	
		First Year	**Second Year**
1	Admission Processing Fees	300.00	-
2	Course Fee	20000.00	20000.00
3	ICT Fees	150.00	150.00
	TOTAL	20450.00	20150.00

The above mentioned fee structure is exclusive of Exam fees.

***g.* Requirement of the laboratory support and Library Resources:**

A well-equipped Chemistry Laboratory exclusive for Distance Education Programme was established at the Department of Industrial Chemistry, Alagappa University, Karaikudi with all the necessary equipments for conducting face to face contact sessions for Practical courses of M. Sc., Chemistry programme. The students who have enrolled themselves in M. Sc Chemistry Programme shall attend the face to face contact session for Practical Courses **only** at Chemistry Laboratory, Directorate of Distance Education, Located at Alagappa University, **Karaikudi**.

Directorate of Distance Education, Alagappa University, Karaikudi housing an exclusive Library facility with adequate number of copies of books in relevant titles for M. Sc., Chemistry programme. The Central Library of Alagappa University also having good source of reference books. The books available at both the libraries are only for reference purpose and not for lending services.

***h.* Cost estimate of the programme and the provisions:**

The cost estimate of the programme and provisions for the fund to meetout the expenditure to be incurred in connection with M. Sc., Chemistry Programme as follows:

S.No.	Expenditure Heads	Approx. Amount in Rs.
1	Programme Development	20,00,000/-
2	Programme Delivery	24,00,000/-
3	Programme Maintenance	5,00,000/-

***i.* Quality assurance mechanism and expected programme outcomes:**

University's Moto:

'Excellence in Action'

University's Vision Statement:

Achieving Excellence in all spheres of Education, with particular emphasis on "PEARL"- Pedagogy, Extension, Administration, Research and Learning.

University's Objectives

1. Providing for Instructions and Training in such Branches of Learning as the University may determine.
2. Fostering Research for the Advancement and Dissemination of Knowledge

University's Quality Policy

Attaining Benchmark Quality in every domain of 'PEARL' to assure Stakeholder Delight through Professionalism exhibited in terms of strong purpose, sincere efforts, steadfast direction and skillful execution.

University's Quality Quote

Quality Unleashes Opportunities Towards Excellence (QUOTE)

Programme's Review Mechanism

The quality of the programme depends on scientific construction of the curriculum, strong-enough syllabi, sincere efforts leading to skilful execution of the course of the study. The ultimate achievement of M. Sc., Chemistry programme of study may reflect the gaining of knowledge and skill in the subject chemistry. And all these gaining of knowledge may in Chemistry may helps the students to get new job opportunities, upgrading in their position not only in employment but also in the society, make students feel thirsty to achieve in research in the fields associated with the discipline- Chemistry, achieving in competitive examinations on the subject- Chemistry, etc.

The benchmark qualities of the programme may be reviewed based on the performance of students in their end semester examinations. Apart from the end semester examination-based review feedback from the alumni, students, parents and employers will be received and analyzed for the further improvement of the quality of the M. Sc., Chemistry Programme.

Minutes of the Meeting of the Board of Studies in Chemistry for M. Sc., Chemistry Directorate of Distance Education (DDE), Alagappa University, Karaikudi held on 16.05.2017 at 10.30 A.M of Department of Industrial Chemistry, Alagappa University Karaikudi.

Members Present

1. **Dr. P. Manisankar** - **Chairman**
   Prof. and Head, Department of Industrial Chemistry
   Alagappa University, Karaikudi
2. **Dr. A. Ramu** - **Member**
   Prof and Head, Department of Inorganic Chemistry
   Madurai Kamaraj University, Madurai – 625 021
3. **Dr. E. Murugan** - **Member**
   Professor, Department of Physical Chemistry
   University of Madras, Guindy Campus, Chennai -25
4. **Dr. M. Anbukulandainathan** - **Member**
   Principal Scientist, CECRI, Karaikudi
5. **Dr. N. Sengottuvelan** - **Member**
   Assistant Professor, (DDE)
   Department of Industrial Chemistry, Alagappa University, Karaikudi,
6. **Dr. P. Muthu Mareeswaran** - **Special Invitee**
   DST INSPIRE Faculty, Dept of Industrial Chemistry,

Dr. G. Paruthimal Kalaignan has gone to USA on personal work and he will be back only on 22.06.2017. Dr. M. Sundharavadivelu has informed his inability to attend the meeting.

The Chairman of the Board Dr. P. Manisankar, welcomed the members.

The committee had detailed discussion on the draft syllabus prepared by the Chairman and Faculty Members of Department of Industrial Chemistry.
After detailed discussion the board has passed the following resolution :

1. Resolved to approve the regulation, course structure and Syllabi of DDE M. Sc., Chemistry

2. Resolved to introduce the the internal mark system (25 marks internal and 75 external).

3. Resolved to authorize the Chairman of the committee, submit the regulation, course structure and syllabi of DDE M. Sc., Chemistry, both Soft and hard copies.

Prof. P. Manisankar P. Manisankar 16/05/17

Prof. A. Ramu

Prof. E. Murugan 16/05/2017

Dr. M. Anbukulandainathan 16/05/2017

Dr. N. Sengottuvelan

Dr. P. Muthu Mareeswaran P. Muthu 16/05/2017.