LJ University
University with a Difference

M.Sc. Semester I - Chemistry

PAPER: CHEM 401: INORGANIC CHEMISTRY – I

Total Credits: 04 **Total Hours: 60**

Course Objectives:

- Explore the properties of elements in the periodic table and predict their chemical behavior based on structure and bonding.
- Analyze atomic structure, bonding theories, and periodic trends to understand chemical reactivity.
- Examine coordination compounds, metal-ligand bonding theories, and the chemistry of transition and inner transition elements.
- Learn fundamental principles of quantum mechanics and apply them to atomic structure and spectroscopy.

Course Outcomes:

- Describe and predict the chemical behaviour of elements based on their position in the periodic table, structure, and bonding characteristics.
- Analyze and apply knowledge of atomic structure, bonding theories, and periodic trends to understand chemical reactivity and properties.
- Examine and explain the chemistry of transition and inner transition elements, metal-ligand bonding, and factors influencing their structure, color, and stability.
- Apply fundamental principles of quantum mechanics to understand atomic structure and spectroscopy, including solving Schrödinger's equation and using quantum theory to describe atomic and molecular systems.

Unit-1: Atomic Structure and Chemical Periodicity

Atomic Model. Atomic structure and spectroscopy: Term symbols
Fundamental Trends, First and Second Row - Anomalies, The use of p orbitals in Pi Bonding, The use (or no use) of d Orbitals by Non-metals, Reactivity and d Orbital Participation, Periodic Anomalies of the Non-metals and Post transition Metals.

Unit 2: Structure and Bonding

Lewis structures: Octet rule, Resonance, VSEPR model.
Valence bond theory: hydrogen molecule, homo-nuclear diatomic molecules, polyatomic molecules.
Molecular orbital theory: An introduction to the theory, homo-nuclear diatomic molecules, hetero-nuclear diatomic molecules, Bond properties, polyatomic molecules,

molecular shape in terms of molecular orbitals. Structure and bond properties: bond length, bond strength, electronegativity, bond enthalpy and oxidation states.

Unit-3: Transition elements and Coordination compounds

Introduction to coordination compounds, IUPAC nomenclature of coordination compounds, theories for metal-ligand bonding in complexes, structure and isomerism in coordination compounds, colour and electronic spectra, magnetism, stability of complexes and reaction mechanisms. Inner Transition Elements:
Occurrence and recovery, Physical properties and applications, General Trends, Electronic and Magnetic Properties, Binary ionic compounds, Ternary and complex oxides, coordination compounds, organometallic compounds.

Unit-4: Basic principle and methods of Quantum mechanics

The Schrödinger Equation, Postulates, Operators, The Particle in a Box, Harmonic Oscillator, Angular Momentum, Hydrogen Atom, Theorems of Quantum Mechanics, Many-Electron Atoms. Atomic structure and spectroscopy: many-electron systems and anti-symmetry principle.
The Variation Method, Perturbation Theory up to second order in energy, Applications

References:

1. Inorganic Chemistry Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Mehdhi Fourth edition published by Pearson 2017.
2. Inorganic Chemistry by Shriver & Atkins' Fifth addition Published by Oxford University Pres, 2010.
3. Coordination Chemistry by Ajai kumar 6 th edition published by Aaryush Educations January, 2020.
4. Concise Inorganic Chemistry by J.D. Lee, Fifth Edition Published by Oxford University Press, 2008. 5. Chemistry of the Elements by N. N. Greenwood and A. Earnshaw Second Edition Published by Elsevier, 2012.
5. Quantum Chemistry by Ira N. Levine Published by Pearson, seventh Edition 2014.
6. Fundamentals of Quantum Chemistry Molecular Spectroscopy and Modern Electronic Structure Computations by Michael Mueller Published by Kluwer Academic Publishers 2001.
7. Inorganic Chemistry by Gary L. Miessler and Donald A.Tarr Third Edition Pearson Education International 2008

M.Sc. Semester I - Chemistry
PAPER: CHEM 402: ORGANIC CHEMISTRY - I

Total Credits – 4 **Total Hours – 60**

Course Objectives:

- Students will understand the structure, synthesis, and reactivity of alkanes, alkenes, and alkynes and will be proficient in IUPAC nomenclature.
- Students will understand the concept of aromaticity, aromatic stabilization, and apply this knowledge to predict the reactivity of aromatic and heterocyclic compounds.
- Students will be able to independently analyze and describe stereoisomers, optical activity, and conformational analysis, using concepts such as R/S nomenclature and Cram's Rule for stereoisomer determination.
- Students will be able to identify and analyze various reactive intermediates and reaction mechanisms, including substitution and elimination reactions, and apply this understanding to name reactions and rearrangements.

Course Outcomes:

- Understand Organic Chemistry Fundamentals: Understand IUPAC nomenclature, structure, synthesis, and reactivity of alkanes, alkenes, and alkynes.
- Conceptualize Aromaticity: Study aromatic stabilization, aromaticity rules, and the reactivity of aromatic and heterocyclic compounds.
- Master Stereochemistry: Learn about stereoisomers, optical activity, and conformational analysis of organic molecules.
- Understand Reaction Mechanisms: Analyze reactive intermediates and mechanisms in organic reactions, including important name reactions and rearrangements

Unit-1: General Organic Chemistry:

IUPAC nomenclature of organic molecule including region and stereoisomers.
Structure, synthesis and reactions of Alkane, alkene and alkynes
Electronic effect: Inductive effect, hyperconjugation, resonance, mesomeric effect.
Concept of electronegativity in terms of property of organic compounds.
Concept of Acidity and Basicity of Organic compounds;

Unit-2: Concept of Aromaticity

Huckel's rule, Craig's rule, Aromatic, Anti-aromatic, Non-aromatic systems. Aromaticity of Benzenoid and non-benzenoid compounds, Annulenes, Azulene, Aromaticity in charged ring, Homoaromaticity, Fused ring systems, Heterocyclic rings. Synthesis and reactivity of some common heterocyclic compounds containing one or two hetero atoms (O, N, S).

Unit-3: Stereochemistry and Conformational Analysis

Concept of Optical activity; R/S nomenclature; Topicity, Prostereoisomerism, Fischer, Sawhorse and Newmann projections. Cram's Rule for diastero selectivity.
Types of Stereoisomers; Homomer Enantiomer, Diasteromer. Numericals related to optical activity
Stability and conformational analysis of cyclic and acyclic compounds: (Ethane, n-butane, cyclohexane and decalene).

Unit 4: Reactive Intermediates and Mechanisms in Organic Reactions

Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
Organic reaction mechanisms Organic reaction mechanisms involving addition, Syn and anti-addition, Elimination reactions: aliphatic and aromatic substitution reactions, SN1, SN2, SNi mechanism, Substitution reactions: E1, E2, E1CB, with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
Some important name reactions and rearrangements – applications in organic synthesis. Hiyama Coupling, Suzuki Coupling, Negishi Reaction, Sonogashira Reaction, Mitsunobu Reaction, Buchwald Hartwig, Stork-Enamine Reaction, Wittig Reaction, Robinson Annulation.
Rearrangement: C – C migration, C – N migration.
Reagents in Organic Chemistry:
Oxidising agents: OsO_4, SeO_2, MnO_2, DDQ, PCC, $KMnO_4$
Reducing agents: $LiAlH_4$, $NaBHH_4$, Na/NH_3 (l), Lindlar catalyst, Catalytic reduction

References:

1. Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd and Saibal Kanti Bhattacharjee, Seventh Edition Published by Pearson Education, Inc., 2014.
2. Advanced Organic Chemistry Part-A Structures and Mechanisms by Francis A. Carey and Richard J. Sundberg, Fifth Edition Published by Springer; 2008.
3. Stereo Chemistry Conformation and Mechanism by P S Kalsi, Ninth Edition Published by New Age International Publishers 2017.
4. Organic Chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren, Second Edition Published by Oxford University press 2018.
5. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 7ed Michael B Smith; Published by Wiley–Blackwell, 2015

M.Sc. Semester I - Chemistry
PAPER: CHEM 403: PHYSICAL CHEMISTRY – I

Total Credits – 4 **Total Hours – 60**

Course Objectives:

- Students will understand and apply the principles of thermodynamics to analyze phase transitions, reaction equilibria, and solve problems related to ideal and non-ideal gases and solutions.
- Students will explore the principles of nuclear chemistry, including radioactivity, nuclear fission, and fusion, and understand the applications and separation of isotopes.
- Students will examine crystal lattices, types of solids, and properties such as defects and band theory, and apply this knowledge to understand material properties.
- Students will learn about different types of polymers, their solutions, and polymerization kinetics, applying this knowledge to analyze and synthesize polymeric materials.

Course Outcomes:

- Understand the principles of thermodynamics, including phase transitions, reaction equilibria, and statistical thermodynamics.
- Explore nuclear reactions, radioactivity, and the applications of isotopes in chemistry.
- Examine crystal structures, defects, and properties of different types of solids.
- Learn about polymer types, solutions, and polymerization kinetics.

Unit-1: Chemical Thermodynamics

Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.

Statistical Thermodynamics Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.

Unit-2: Nuclear Chemistry

Nuclear binding energy, Radioactivity, Artificial isotopes, nuclear fission, Syntheses of transuranium elements, the separation of radioactive Isotopes, Nuclear fusion, Applications of isotopes, Sources of 2H and 13C, radio-analytical techniques and activation analysis

Unit-3: Solid State

Crystal lattices: Lattices and unit cells, identification of lattice planes, investigation of structure, Neutron and electron diffraction, Bragg's law, Crystal structure: Metallic solids, Ionic solids, Molecular solids and covalent networks, Properties of solids, Defects in solid state lattices, Band theory, Semiconductors.

Unit-4: Polymer Chemistry

Introduction, Types of macromolecules, Polymer solutions, Thermodynamics of polymer solutions, Molar masses and molar mass distributions, Methods of measuring molar masses, kinetics of polymerization

References:

1. Physical Chemistry by Peter Atkins and Julio de Paula, Ninth Edition Published by Oxford University Press, 2010.
2. Modern Nuclear Chemistry, Second Edition. Walter D. Loveland, David J. Morrissey, and Glenn T. Seaborg, Published by John Wiley & Sons, Inc. 2017.
3. Principle of Physical Chemistry by Puri, Sharma, Pathania, 47th Edition Published by Vishal Publishing Co. 2018.
4. Textbook of physical chemistry 2nd Edition by Samuel Glasstone Published by Macmillan, 1948.
5. Physical Chemistry by Gilbert W. Castellan Third Edition published by Addison-Wesley Publishing Company, Inc.1983.
6. Inorganic Chemistry by Catherine E. Housecroft and Alan G. Sharpe 5th Ed, Published by Pearson Education Limited 2018.
7. A Textbook Of Polymer Chemistry, 1st edition; S. Chand Publications, 2004.

M.Sc. Semester I - Chemistry
PAPER: CHEM 404: ANALYTICAL CHEMISTRY – I

Total Credits – 4 **Total Hours – 60**

Course Outcomes:

- Students will gain expertise in various chromatographic methods (GC, HPLC) and apply these techniques for effective separation and analysis of compounds.
- Students will understand the principles of UV-Visible spectroscopy and apply this knowledge to determine the structure and concentration of organic compounds.
- Students will be able to interpret spectra from IR, NMR, and mass spectrometry to elucidate the structure of organic molecules and understand their chemical properties.
- Students will apply statistical methods to analyze experimental data, including error analysis, significance testing, and data presentation, to ensure accuracy and reliability in chemical analysis.

Course Objectives:

- Understand various chromatographic methods and their applications in separation and analysis.
- Explore the principles and applications of UV-Visible spectroscopy for structure determination.
- Interpret spectra from IR, NMR, and mass spectrometry to elucidate the structure of organic compounds.
- Apply statistical methods to analyze experimental data, including error analysis and significance testing.

Unit-1: Chromatographic Techniques:

Chromatography: Gas Chromatography, High-Performance Liquid Chromatography, Capillary Electro chromatography, Ion-Exchange Chromatography, Ion Chromatography, Molecular Exclusion Chromatography, Affinity Chromatography, Hydrophobic Interaction Chromatography.

Unit-2: UV-Visible Spectroscopy

UV-Visible Spectroscopy: The Nature of Electronic Excitations, Lambert - Beer's Law

Origin of UV Band Structure, Principles of Absorption Spectroscopy, Presentation of Spectra, Aromatic Compounds, Visible Spectra. Problems based on structure determination using combined spectroscopy

Unit-3: Spectroscopy of Organic Compounds

Infrared Spectroscopy (IR): Interpretations of Spectra, Characteristic Group Absorption of Organic Molecules.
1H NMR: Magnetic Properties, Excitation, Relaxation, Chemical Shift, Spin Coupling, Exchangeable Protons, Coupling of Protons, Chemical Shift Equivalence, Magnetic Equivalence, Coupling Constant.
13C NMR: Chemical Shift Scale and Range, Interpretation of Spectra.
Mass Spectroscopy: Ionisation Methods, Mass Analyzers, Interpretation of EI Mass Spectra, Mass Spectra of Organic Compounds.

Unit-4: Data Handling and Statistical Analysis:

Measurement of uncertainty, Accuracy and Precision. Mean and standard deviation; absolute and relative errors; Test of significance, rejection of results – Q-test, F-test and Grubb's test. linear regression; covariance and correlation coefficient.

References:

1. Quantitative Chemical Analysis by Daniel C. Harris Eighth Edition published by W. H. Freeman and Company 2014.
2. A Textbook of Physical Chemistry (Volume-3) by K.L. Kapoor Third Edition published by Macmillan Publishers India Ltd.2013.
3. Physical Chemistry by Gilbert W. Castellan Third Edition published by Addison-Wesley Publishing Company, Inc.1983.
4. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug Seventh Edition Published by John Wiley & Sons, Inc. 2014.
5. Principles of Instrumental Analysis by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch Sixth Edition Published by Cengage Learning, 2016.

M.Sc. Semester I - Chemistry

PR- CHEM - 401: Analysis of Environmental Pollutants - Air, Soil And Waste Water (Pr)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

- To impart awareness on the criticality of environment pollution and its impact
- To teach analytical methods for determining parameters to assess pollutants.
- To familiarise students with the Regulatory framework of the Gujarat and India and permissible limits for various parameters.
- Facilitate assessing environmental risk and Identify pollution mitigation strategies
- Induce awareness on the sustainable practices in environment management

Course Outcomes:

At the end of this course, the student will:

- Gain in-depth understanding of the critical environmental pollution issues, its sources, and impact on ecosystems and human health.
- Test environmental parameters in compliance with prevalent regulatory standards with clarity and analyse the data.
- Have knowledge of Regulatory guidelines for permissible limits and compliance.
- Assess environmental risks and develop mitigation strategies through technical and policy based solutions. Gain awareness of sustainable environmental management practices.

List of Practicals:

I Introduction of Environmental Pollutants

II **Analysis of Waste Water Parameters**

1. Determination of Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD)
2. Determination of Total Solids(TS)/Total Dissolved Solids (TDS) / Total Suspended Solids (TSS)
3. Determination of Oil and Greece
4. Determination of Chemical Oxygen Demand (COD)
5. Determination of Phosphate by Spectrophotometer
6. Determination of Sulphate by Spectrophotometer
7. Determination of Nitrate by Spectrophotometer

III Analysis of Soil Parameters

1. Determination of Organic Carbon by Titrimetric method
2. Determination of Total Nitrogen by Kjeldahl method
3. Determination of Total Phosphorous by Spectrophotometry
4. Determination of Organic Matter by Gravimetric method
5. Determination of Sodium and Potassium by Flame Photometry

IV Analysis of Air Parameters

1. Determination of Suspended Particulate Matter – PM 10 and PM 2.5
2. Determination of Oxides of Nitrogen by Spectrophotometry
3. Determination of Oxides of Sulphur by Spectrophotometry 4. Determination of Ammonia by Spectrophotometry

References

1. Indian Standard Methods, Bureau of Indian Standards,2006, Ministry of Consumer Affairs, Food & Public Distribution, Government of India
2. Standard methods for examination of water and wastewater. 22nd Edition. APHA (2005)., Washington D.C
3. Hand Book of Methods in Environmental Studies (Vol. 1 & 2), 2017, S. K. Maiti, Oxford Book Company.

M.Sc. Semester I - Chemistry

PR- CHEM - 402: ORGANIC SYNTHESIS OF SELCETIVE DRUGS, DYES AND INTERMEDIATES (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of this course, students will be able to:

- Design synthetic strategies incorporating green chemistry principles and identify methods for regioselective and stereoselective synthesis.
- Equipped to develop processes for optimised efficiency and yield for organic synthesis of various dyes, drugs and intermediates.
- Apply advanced laboratory technological techniques in synthetic process and characterisation of molecules.

Course Outcomes:

- To explain the principles and mechanisms involved in the organic synthesis of complex molecules, like drugs, dyes, and intermediates.
- To teach selective synthetic strategies with a focus on regioselectivity and stereoselectivity.
- To explore the mechanisms of key organic reactions and lab – level advanced methodologies.
- To make students understand the utilisation of green principles in organic synthesis, increase efficiency and optimising reaction conditions and overcoming synthetic bottlenecks.

List of Practicals:

1) To synthesize Dibenzal Acetone from Benzaldehyde and Acetone (Claisen – Schmidt reaction)
2) To synthesize Aspirin from Salicylic Acid.
3) To synthesize 2-Hydroxy-4-Methylquinoline from Acetoacetanilide. (Knorr Quinoline synthesis)
4) To synthesize Phenytoin from Benzil and Urea.
5) To synthesize Fluorescein from Resorcinol and Phthalic anhydride.
6) To synthesize 7-Hydroxy-4-Methyl Coumarins from Resorcinol and Ethyl Aceto Acetate. (Pechmann reaction)

7) To synthesize Acid Dye from 7-Hydroxy-4-Methyl Coumarin & Anthranilic acid.
8) To synthesize p-Chloro Nitrobenzene from p-Nitro Aniline (Sandmeyer reaction)
9) To synthesize Chalcone from Benzaldehyde and Acetophenone
10) To synthesize p – Iodo Nitro Benzene from p – Nitro Aniline

References

1 Vogel's Textbook of Practical Organic Chemistry, 5th Edition, 2005 Pearson Publication.
2 Practical Organic Chemistry by Mann and Saunders, 4th Edition, 2009, Pearson Publication.
3 Comprehensive Practical Organic Chemistry: Preparations and Quantitative Analysis by V.K. Ahluwalia, S. Dhingra ,2004, Universities Press (India) Private Limited.

M.Sc. Semester I - Chemistry

PR- CHEM - 403: CHEMICAL ANALYSIS AND DETECTION OF ADULTERANTS IN MILK AND MILK PRODUCTS (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course, the student will:

- Have a thorough understanding of the processes of milk in milk industry – right from procurement, to analysis and storage.
- Will be familiar with advanced techniques of milk analysis and specific requirements for milk quality.
- Develop proficiency in milk composition analysis and detection of adulterants in milk in line with the Food safety regulation.

Course Outcomes:

- To impart knowledge about the milk industry and methods of collection, identification of milk
- Teach the platform tests at milk collection and explain the importance and advantage of classical method and Instrumental methods of milk analysis.
- Make the students aware of the latest techniques used in the dairy industry for milk analysis, the permissible standards and storage techniques.
- Explain the methods of protein, fat lactose solid-not fat content analysis of milk and detect the presence of adulterants in milk and milk products in accordance with the regulatory requirements.

List of Practicals:

1. **PLATFORM TESTS**
   1) Organoleptic test
   2) Clot-on boiling test (COB)
   3) Alcohol test
   4) Alcohol- alizarin test

2. **LABORATORY TESTS – (CLASSICAL METHOD)**
   1) Determination of density (specific gravity) by lactometer
   2) To determine total acidity (titratable acidity) of milk
   3) Determination of Fat in Milk by Gerber method.
   4) Determination of solids-non-fat content (SNF) in milk by lactometer

3. MILK ANALYSIS – (INSTRUMENTAL METHOD BY MILK ANALYSER)

1) Protein Determination in milk samples
2) Fat determination in milk samples
3) Determination of Solids-Not-Fat Content (SNF) in Milk
4) Lactose Determination in milk samples
5) Added Water Determination in milk samples
6) Freezing Point of milk samples
7) Density of milk samples
8) Corrected lactometer reading (CLR) of milk samples
9) Determination of % salt

4. DETECTION OF VARIOUS ADULTERANTS IN MILK SAMPLES

1) To detect the adulteration of Urea by formation of DMAB (p-Dimethyl Amino Benzaldehyde) complex.
2) To detect the adulteration of starch by formation of starch-iodo complex.
3) To detect the adulteration of cane sugar by Seliwanoff's test.
4) To detect the adulteration of soap by neutralization reactions.
5) To detect the adulteration of ammonium sulphate by formation of monochloramine complex.

REFERENCES

1. FSSAI Manual of methods of analysis of Foods-Milk And Milk Products, Revised 25-05-2016,Under Section 16 (2) (f) of the FSS Act, 2006

M.Sc. Semester I - Chemistry

PR- CHEM - 404: CHARACTERIZATION AND DETECTION OF ADULTERANTS IN EDIBLE OIL (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of this course, the student will be able:

- Develop clear understanding of the properties, nutritional aspects of various edible oils.
- Aware of the health risks associated with adulterated oils and the importance of ensuring safety and quality in oil products.
- Gain the skills to analysis oil and oil products in accordance with regulatory standards.

Course Outcomes:

- Provide students with understanding of physical and nutritional properties of edible oils
- Equip them with skills to characterise various oils and inform them of the quality control standards and permissible limits for additives and contaminants.
- Develop hands on laboratory skills in quality assessment and utilisation of green principles in adulterant analysis.
- Raise awareness of the risks associated with adulterated edible and importance quality and safety in oil products.

List of Practicals:

1. Quantitative estimation of saponification value for fats/oils
2. Determination of acid number of oil sample
3. Determination of ester value
4. Quantitative estimation of iodine value for fats/oils by Wij's method
5. Determination of peroxide value of fat/oil sample
6. Determination of Reichert-Meisel Value

7. Determination of Polenske Value
8. To detect the presence of Sesame Oil as an adulterant (Baudouin Test)
9. To detect the presence of Cottonseed Oil as an adulterant (Halphen's Test)

REFERENCES

1. FSSAI manual of methods of analysis of Foods–Oils and Fats, Revised oil and Fats_22-06-2021. Under Section 16 (2) (f) of the FSS Act, 2006.
2. A.O.A.C. 17th edn, 2000, Official method 920. 159 – Iodine absorption number of oils and fats / I.S.I. Handbook of Food Analysis (Part XIII) – 1984.
3. ISO-Standard 3960 third edition 2001 AOCS CD 8b-90 European Pharmacopeia Leatherhead Food RA, second edition.
4. I.S.I. Handbook of Food Analysis (Part XIII) – 1984) /A.O.A.C 17th edn, 2000. Official method 925.41 Acids in oils and fats.

M.Sc. Semester II - Chemistry
PAPER: CHEM – 501: INORGANIC CHEMISTRY – II

Total Credits: 04 **Total Hours: 60**

Course Objectives:

- Understanding, synthesis, structure, bonding of halogens and noble gas and main group compounds, Ring and cage compounds and their industrial importance.
- Exploring metalloporphyrins, their reactions in respiration and photosynthesis. Studying enzymes like carbonic anhydrase, xanthine oxidase, and nitrogen fixation. Biochemistry of iron and the role of biomaterials and medicinal chemistry,
- Understanding organometallic compounds - metal carbonyls and cluster compounds and their reactions.
- Understanding symmetry elements, operations, and point groups their properties and representations and application in molecular orbital & ligand field theory.
- Studying the principles of catalysis, energetics, types and industrial application of catalysis.

Course Outcomes:

- To understand the relationship between the structures and chemical bonds as well as to elucidate mechanisms in catalysis.
- To understand uniqueness of the electronic configurations as well as similarities and differences between lanthanides and actinides.
- To understand the proton transfer reaction, electron pair transfer reaction and identifications of donor and acceptor.
- To understand the electronic structure of the elements and to evaluate the physical and chemical properties.

Unit 1: Main Group Elements and Their Compounds

Allotropy, Synthesis, Structure and bonding, Industrial importance of the compounds; Inorganic Chain, Rings and Cages, Boron Cage Compounds, Halogens and Nobel Gas Chemistry.

Unit 2: (A) Bioinorganic Chemistry

Energy source for life, Metalloporphyrins and respiration cytochromes, Dioxygen binding, transport and utilization, Electron transfer, respiration and photosynthesis, Enzymes, carbonic anhydrase, xanthine oxidase, aldehyde oxidase, nitrogen fixation, biochemistry of iron, transport of iron, storage of iron: Ferritin, Biomaterials, medicinal chemistry, antibiotics and related compounds, anticancer drug – cisplatin.

(B) Organometallic Compounds

An introduction to organometallic compounds, Metal Carbonyls, Cluster Compounds, Reaction of organometallic compounds, Alkyl, Carbene, Carbyne, Alkene, Alkyne, Allyl and Buta-1,3- diene Complexes, Cyclic Polyene Complexes, Catalysis, Coupling Reactions.

Unit 3: Symmetry and group theory

Symmetry Elements and Operations, Point Groups; Groups of Low and High Symmetry, Properties and Representations of Groups; Matrices, Representation of Point Groups. Applications of Symmetry; Molecular Orbital Theory in Organic Chemistry, Inorganic and Organometallic Compounds, Ligand Field Theory, Molecular Vibrations, Crystallographic Symmetry.

Unit 4: Catalysis

Catalysis, General principles: Energetics, catalytic efficiency and life time. Selectivity, Homogeneous catalysis: Wacker's oxidation of alkene, Asymmetric oxidation, Hydro formylation. Heterogeneous catalysis: hydrogenation, catalytic cracking, sulphur dioxide oxidation. Electro catalysis and photo catalysis, new direction in heterogeneous catalysis.

References:

1) Organometallic and Bioinorganic Chemistry by Ajai kumar 3rd Edition, Published by Aaryush Education 2016.
2) Inorganic Chemistry by Shriver & Atkins' Fifth Edition published by Oxford University Press 2010.
3) Inorganic Chemistry by Gary L. Miessler and Donald A.Tarr Third Edition Pearson Education International2008.
4) Inorganic Chemistry Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Mehdhi Fourth edition published by Pearson 2017.
5) Concise Inorganic Chemistry by J.D. Lee, Fifth Edition Published by Oxford University Press, 2008.
6) Chemistry of the Elements by N. N. Greenwood and A. Earnshaw Second Edition Published by Elsevier, 2012.
7) Chemical Applications of Group Theory by F. Albert Cotton Third Edition
8) Published by a Wiley- Interscience Publication 1990.
9) Group Theory and Symmetry in Chemistry by L. H. Hall, Published by McGraw-Hill, 1984.
10) Inorganic chemistry by Weller, Overton, Rourke, Armstrong 6th Edition published by oxford publication 2015.

M.Sc. Semester II - Chemistry
PAPER: CHEM – 502: ORGANIC CHEMISTRY – II

Total Credits: 04 **Total Hours: 60**

Course Objectives:

- To understand the application of reactive intermediates in organic synthesis
- To apply the concept of cycloaddition, sigmatropic reactions in organic reactions
- To identify the different types of natural products and their function in living organisms.
- To gain insight about the structure, configuration, biosynthesis and properties of natural products and apply the principles of oxidation, degradation and synthesis for structure elucidation of natural products.
- To obtain structural simplification and for discovering different synthetic routes and comparing them in a logical and straightforward fashion.
- To obtain stereoisomeric compounds for pharmaceutical applications because different enantiomers of molecules are known to have different biological activities.

Course Outcomes:

- To obtain structural simplification and for discovering different synthetic routes and comparing them in a logical and straightforward fashion.
- To obtain stereoisomeric compounds for pharmaceutical applications because different enantiomers of molecules are known to have different biological activities.
- Understand the chemistry of heterocyclic compounds used as pharmaceuticals, agrochemical and veterinary products as well as play a vital role in the metabolism of all living things.
- Gain expertise in techniques of retrosynthesis and Asymmetric synthesis

Unit-1:

(A) Retrosynthetic analysis

Synthesis backwards, Disconnections, Synthons, Multiple step synthesis, Functional group interconversion, c-c disconnections, Available starting material, Donor and acceptor synthons, Two group c-c disconnections, 1,5- related functional groups, Natural reactivity and umpolung.

(B) Asymmetric synthesis

Chiral pool, Enantiomeric and Diastereomeric excess, Chiral auxiliaries, Alkylation of enolates, Chiral reagents, Asymmetric catalysis, Asymmetric epoxidation, Asymmetric formation of carbon-carbon bonds, Asymmetric aldol reaction, Enzymes as catalysts.

Unit-2:

(A) Chemistry of Natural Products – I

Carbohydrates: Introduction and classification, determination of configuration of Monosaccharides (Glucose, Fructose), Disaccharides (Cellobiose, Lactose, Sucrose) Oligosaccharides (Cyclodextrin) and Polysaccharides (Starch, Cellulose).
Proteins and Peptides: Structure of Amino acids, isoelectric point, Configuration of natural amino acids, preparation and reaction of amino acids, Geometry of peptides linkage, determination of structure of peptide, synthesis of peptides, classification and structure of proteins, conjugated proteins and coenzymes.
Nucleic acids: Nucleotide, nucleosides, polynucleotides, genetic code and control of protein biosynthesis, laboratory synthesis of oligonucleotides, polymerase chain reaction, DNA fingerprinting.
Fatty acids: Lipids, occurrence and composition of fats, hydrolysis of fats, soaps, micelles, detergents, phosphoglyceride, phospholipids, biosynthesis of fatty acids.

(B) Chemistry of Natural Products – II

Alkaloids: Extraction, general properties, methods of determination of structures, classification of alkaloids, structure of common alkaloids (conine, nicotine), biosynthesis of alkaloids.
Terpenes: Occurrence, isolation and classification, isoprene rule, general methods of structure determination, structure of citral, α- pinene, camphor, biosynthesis of Terpenoids.

Unit-3: Organic Transformations and Reagents

Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.

Unit-4: Pericyclic Reactions and Photo Chemistry

Introduction, Cycloaddition Reactions, Diels-Alder Reaction, 1, 3-Dipolar Cycloaddition Reactions, [2+2] Cycloaddition Reactions, Electrocyclic Reactions, Sigmatropic Rearrangements, Application of DFT Concepts to Reactivity and Regiochemistry of Cycloaddition Reactions, Principles and applications of photochemical reactions in organic chemistry

References:

1) Organic Chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren Second Edition Published by Oxford University press 2018.
2) March′s Advanced Organic Chemistry: Reactions, Mechanisms, and Structure by Michael B. Smith and Jerry March, Sixth Edition Published by Wiley–Blackwell, 2007.
3) Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd and Saibal Kanti Bhattacharjee Seventh Edition Published by Pearson Education, Inc., 2014.
4) Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd and Saibal Kanti Bhattacharjee Seventh Edition Published by Pearson Education, Inc., 2014.
5) Organic chemistry volume 2 stereochemistry and the chemistry natural products by I.L. Finar Fifth Edition published by Pearson, 2017.
6) Inorganic Chemistry Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Mehdhi Fourth edition published by Pearson 2017.
7) Name Reactions: A Collection of Detailed Mechanisms and Synthetic Applications by Jie Jack Li, Fourth E xpanded Edition Published by Springer-Verlag Berlin Heidelberg, 2009.
8) Advance Organic Chemistry Part-A Structures and Mechanisms by Francis A. Carey and Richard J. Sundberg Fourth Edition Published by Kluwer academic / Plenum publishers, 2000.
9) Modern methods of Organic synthesis by William Carruthers and Iain Coldham Fourth Edition, Published by Cambridge University Press, 2004.
10) Photochemistry and Pericyclic Reactions by Jagdamba Singh and Jaya Singh Fourth Edition Published by New Age International Publishers, 2019.

M.Sc. Semester II - Chemistry

PAPER: CHEM – 503 PHYSICAL CHEMISTRY – II

Total Credits: 04 **Total Hours: 60**

Course Objectives:

- Students will be able to understand the concepts of reaction rates, determine reaction order, activation energy, enzyme kinetics, and analyze photochemical reactions.
- Grasp the basic principles of surface thermodynamics and calculate the effects of surface tension, contact angles, and wetting behavior.
- Understand spontaneous and non-spontaneous redox reactions involving direct electron transfer between molecules and atoms.
- Gain a comprehensive understanding of acid-base concepts. Analyze the mechanisms of colloidal behavior and catalytic activity in heterogeneous systems.

Course Outcomes:

- To understand the concept of reaction rates, and determine the order of reaction, activation energy, enzyme kinetics and photochemical reactions.
- To understand the basic principles of surface thermodynamics and calculate the effect of surface tension, contact angles, wetting behaviour and related phenomena
- To understand the reaction mechanisms and the kinetics in polymer synthesis as well as basic concepts of polymer chain architecture, structure and morphology.
- To understand the atomic and electronic structure, fundamental of specific heat, electric conductivity (semiconductor and insulator), optical property and magnetism of solids.

Unit-1: Chemical Kinetics

Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.

Unit-2: Electrochemistry

Introduction, Electrolytic cell, Reversible and Irreversible cells, Electromotive force (EMF) and its measurement, Electrical and electrochemical potential, Different types of half-cells and their reduction potential, Nernst equation, EMF of cell and cell reaction, Standard potential, Ionic activity, Cell reaction and its relation with cell potential, Debye Huckel limiting law, Kohlrausch's law, Applications of Electrochemical cell, Potentiometric Titrations, Concentration cell, Concentration cell without liquid junction potential and with LJP, Commercial cells.

Unit-3: Concepts of Acid-Base

Major Acid-Base Concepts: Arrhenius, Bronsted-Lowry, Lewis, Hydrogen Bonding and Electronic Spectra. Theory of Hard and Soft Acids and Bases. Solvent System, Non aqueous Solvents and Acid - Base Strength.

Unit-4: Colloids and Surfaces

Growth and structure of solid surfaces, Extent of adsorption, Physisorption and chemisorption, Adsorption isotherms, rates of surface processes, Heterogeneous catalysis, Mechanisms of heterogeneous catalysis, Catalytic activity at surfaces, Colloids, Stability and properties of colloids, Micelles and biological membranes.

References:

1) A Textbook of Physical Chemistry (Volume-3) by K.L. Kapoor Third Edition published by Macmillan Publishers India Ltd.2013.
2) Physical Chemistry by Gilbert W. Castellan Third Edition published by Addison-Wesley Publishing Company, Inc.1983.
3) Inorganic Chemistry by Shriver & Atkins' Fifth Edition published by Oxford University Press 2010.
4) Inorganic Chemistry by Gary L. Miessler and Donald A.Tarr Third Edition Pearson Education International2008.

M.Sc. Semester II - Chemistry

PAPER: CHEM – 504 ANALYTICAL CHEMISTRY – II

Total Credits: 04 **Total Hours: 60**

Course Objectives:

- To understand the spontaneous and non-spontaneous chemical reactions where electrons are transferred directly between molecules and/or atoms
- To understand the interaction of electromagnetic radiation with matter and the resulting spectra, rotational and vibrational energy levels and interpretation of spectra based on selection rules.
- To interpret the molecular spectra and assign the structure based on the absorption frequencies.
- To understand the Mossbauer Effect and concept of hyperfine interaction and measure the Mossbauer spectrum to analyse structure of Inorganic compounds.
- To be conversant with pollution, its effects and environment quality parameters in order to analyse, control and treat industrial effluent

Course Outcomes:

- To understand the interaction of electromagnetic radiation with matter and the resulting spectra. To understand the rotational and vibrational energy levels and interpretation of spectra based on selection rules.
- To interpret the molecular spectra and assign the structure based on the absorption frequencies. To determine structure and chemical properties of compounds from the values of absorption of energy and fragmentation pattern in molecules.
- Structure interpretation from Spectroscopic data using IR, NMR, Mass and UV-Visible spectroscopy.
- Characterisation of inorganic compounds using the principles of Mossbauer Effect and concept of hyperfine interaction and measure the Mossbauer spectrum

Unit – 1: Molecular Spectroscopy

Rotational Spectroscopy: The Rotational Energy Levels of Molecules, Forbidden and Allowed Rotational States, Populations at Thermal Equilibrium, Rotational Transitions; Microwave Spectroscopy, Line widths, Rotational Raman Spectra.
Vibrational Spectroscopy: The Vibrations of Molecules, Vibrational Transitions, Anharmonicity, Vibrational Raman Spectra of Diatomic Molecules, the Vibrations of Polyatomic Molecules, Vibration-Rotation Spectra, Vibrational Raman Spectra of Polyatomic Molecules.

Unit – 2: Electro-Analytical techniques

Fundamentals of Electrolysis, Electrogravimetric Analysis, Coulometry, Amperometry, Voltammetry, Polarography, Electric Double Layer, Karl Fischer Titration of H_2O.

Unit – 3: Environmental Chemistry

Environmental pollutants: Introduction, Aquatic pollution – inorganic, organic, pesticide, agriculture, industrial and sewage, detergents, oil spills and oil pollutions.
Water quality parameters – dissolved oxygen, biochemical oxygen demand. Analytical methods for measuring DO, BOD and COD. Purification and treatment of water.
Air analysis: Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect. Analytical methods for measuring air pollutants.
Effluent treatment: Industrial pollution of sugar, distillery, drug, pulp & paper and polymer industries and their analysis. Effluent treatment plants of above industries.

Unit-4: Characterisation of Inorganic compounds

EPR: Introduction, Nuclear Hyperfine Splitting, Anisotropic Effects.
Mössbauer: Interpretation of Isomer Shifts, Quadrupole Interactions, Paramagnetic Mössbauer Spectra, Mossbauer Emission Spectroscopy, Applications.
NQR: Introduction, Energies of the Quadrupole Transitions, Effect of a Magnetic Field on the Spectra, Relationship between Electric Field Gradient and Molecular Structure, Applications, Double Resonance Techniques.

References:

1) Elements of Physical Chemistry by Peter Atkins and Julio de Paula 6th edition Published by Oxford University Press 2013
2) Spectroscopy in Inorganic Chemistry V1 by C.N.R. Rao, Academic Press, 2012
3) Inorganic chemistry by Weller, Overton, Rourke, Armstrong 6th Edition published by oxford publication 2015.
4) Spectrometric Identification of Organic Compounds 7th edition by Robert M. Silverstein, Francis x. Webster and David J. Kiemle 2005.
5) Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, George A. Kriz and James R. Vyvyan Fifth edition 2015.

M.Sc. Semester II - Chemistry

PR- CHEM – 501: SYNTHESIS AND ANALYSIS OF SELECTED INORGANIC COMPLEXES AND POLYMERS (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course the student will be able to:

- Apply the principle and concept of coordination chemistry in developing new metal complexes of industrial importance. Students will also be able to independently characterise the complexes formed using basic and advanced techniques
- Gain practical skills in synthesizing metal complexes and perform their characterization using various techniques, including UV-Vis spectroscopy, IR spectroscopy, NMR, and X-ray crystallography.
- Design innovative synthesis schemes for metal complexes and polymers, incorporating principles of environmental sustainability, green chemistry, and material recycling.

Course Outcomes:

- To explain the concept and principles of coordination chemistry and associated theories for metal complexes.
- To provide hands on experience in the synthesis of some metal complexes, their characterisation and estimation using different techniques.
- To synthesise polymers of industrial importance and characterise them using wet lab methods and analytical techniques.
- To enable students to design novel schemes in the synthesis of metal complexes and polymers with a focus on environmental sustainability, application of green chemistry principles, and material recycling

List of Practicals:

1) Preparation of Tetramine Cupric Sulphate
2) Preparation of Tri (Thiourea) Cuprous Sulphate
3) Preparation of Hexamine (II) Chloride
4) Preparation of Hexa (Thiourea) Plumbus Nitrate
5) Preparation of Ni – DMG complex
6) Preparation of Sodium Thiosulphate
7) Preparation of Potassium Tris(Oxalato) Chromate (III)
8) Preparation of Phenol – Formaldehyde Resin : Novolak

9) Preparation of Phenol – Formaldehyde Resin : Resol
10) Preparation of Urea – Formaldehyde Resin
11) To determine % of free Formaldehyde in a given Phenolic resin. (Novolak or Resol)

REFERENCES

1) Advanced Practical Inorganic Chemistry by Gurdeep Raj, Goel Publishing House, 2001.
2) Experiments in Polymer Science by D.G.Hundiwale , New Age International Publishers,2008.

M.Sc. Semester II - Chemistry

PR- CHEM – 502: ANALYSIS OF CHEMICALS BASED IN COMPLIANCE WITH BUREAU OF INDIAN STANDARDS (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course the student will be able to:

- Apply the understanding of BIS framework, guidelines, and regulations related to the analysis and quality control of chemicals in various industries.
- Gain proficiency in performing analytical methods in compliance with these specifications.
- Gain the ability to accurately perform chemical analyses, interpret analytical data, and prepare standardized reports that meet BIS guidelines and requirements.
- Students will develop critical problem-solving skills to address compliance issues, ensuring that chemicals meet the necessary BIS standards for safe and effective use in industry and commerce.

Course Outcomes:

- To familiarise the student with the BIS framework, guidelines, and regulations concerning the analysis and quality control of chemicals
- To learn the BIS specifications for a wide range of chemicals of industrial importance, and perform analytical methods in compliance with BIS specifications.
- To enable students to perform analysis, interpret analytical data and prepare accurate, standardized reports as per BIS guidelines.
- Develop problem solving skills to ensure that chemicals meet the necessary BIS standards for safe and effective use.

List of Practicals:

A) Caustic Soda

a) To determine the % Purity of Carbonates from Caustic Soda by double indicator method.
b) To determine the amount of Chloride from Caustic Soda.
c) Estimation of Sulphate from Caustic Soda.
d) To determine the amount of Iron from Caustic Soda.
e) To determine the amount of Copper from Caustic Soda.

B) Soda Ash

a) Determination of Bulk Density of Soda Ash.
b) Estimation of Volatile Matter Content of Soda Ash by Gravimetry method.
c) To determine the total alkalinity of Soda Ash.
d) Determination of Matter Insoluble in Water of Soda Ash.
e) Estimation of Sulphate from Soda Ash by Turbidimetric Method.
f) To determine the amount of Chloride from Soda Ash.

C) Sodium Bicarbonate

a) Determination of total alkalinity of Sodium bicarbonate.
b) To determine the pH value of Sodium bicarbonate by Electrometric Method.
c) Estimation of Chloride from Sodium bicarbonate by Volumetric Method.
d) Estimation of Matter Insoluble in Water of Sodium bicarbonate.
e) To determine the amount of Sulphate from Soda Ash by Turbidimetric Method.
f) Estimation of Calcium and Magnesium from Sodium Carbonate by Complexometric titration method.
g) To determine the amount of Potassium from Sodium Carbonate by Flame photometer.

D) Sodium Carbonate

a) Determination of total alkalinity of Sodium Carbonate.
b) Estimation of Matter Insoluble in Water of Sodium Carbonate.
c) To determine the amount of Sulphate from Sodium Carbonate.
d) Estimation of Chloride from Sodium Carbonate by Turbidimetric Method.
e) etermination of Iron from Sodium Carbonate.
f) Estimation of Calcium and Magnesium from Sodium Carbonate by Complexometric titration method.
g) To determine the amount of Potassium from Sodium Carbonate by Flame photometer.

E) Sodium Chloride (Analytical Reagent)

a) **S** To determine the % Purity of Sodium Chloride by Gravimetric Method.
b) Estimation of Calcium and Magnesium from Sodium Chloride by Complexometric titration method.
c) To determine the amount of Potassium from Sodium Chloride by Flame photometer.Test For: Sulphate, Nitrate, Insoluble Matter, Iron, Barium, heavy metal.

F) Calcium Chloride

a) Estimation of Matter Insoluble in Water of Calcium Chloride.
b) To determine the % Purity of Calcium Chloride.
c) Determination of total alkalinity of Calcium Chloride.
d) Determination of alkali chlorides of Calcium Chloride.

e) Test for: Magnesium and alkali salt in Calcium Chloride by Qualitative Analysis.

G) Copper Sulphate

a) Determination of Soluble Iron and Aluminium Compounds (as Fe) in Copper Sulphate.

H) Sodium Thiosulphate (Photographic Grade)

a) To determine the % Purity of Sodium Thiosulphate from sample.
b) To determine the pH value of Sodium Thiosulphate by Electrometric Method.
c) Test For: Sulphide, Insoluble Matter and Matter Precipitated as Oxalates, Phosphates and Hydroxides, Iron, heavy metal.

REFERENCES:

- BUREAU OF INDIAN STANDARDS (BIS)

M.Sc. Semester II - Chemistry

PR- CHEM – 503: PREPARATION AND ANALYSIS OF SOME PHARMACEUTICAL FORMULATIONS (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course the student will be able to:

- Acquire hands-on experience in the preparation of various pharmaceutical formulations such as tablets, capsules, suspensions, and emulsions in a laboratory setting.
- Apply a range of analytical techniques, including titration, chromatography, and UV-Vis spectroscopy, to assess the quality and consistency of pharmaceutical formulations.
- Develop the ability to design, optimize, and troubleshoot pharmaceutical formulation processes to achieve the desired dosage form.
- gain basic skills in documenting and reporting data related to pharmaceutical formulation.

Course Outcomes:

- To provide an understanding of the basic principles and methods involved in pharmaceutical formulation including dosage form design. To provide hands-on experience in the preparation of various pharmaceutical formulations such as tablets, capsules, suspensions, and emulsions in a laboratory setting.
- To learn to apply a range of analytical techniques, including titration, chromatography, UV-Vis spectroscopy, to evaluate the quality of pharmaceutical formulations.
- To enable students to design, optimize, and troubleshoot formulation processes to meet the desired dosage form.
- Gain skills in basic documenting, and reporting data related to pharmaceutical formulation preparation and analysis.

List of Practicals:

1) To formulate Paediatric Paracetamol Elixir. (Anti-Pyretic ; Pain reliever in post immunization pyrexia)
2) Formulation of Calamine Lotion. (Skin protective lotion and Astringent)

3) Formulation of Non-staining Iodine Ointment with Methyl Salicylate BPC (Local Analgesic and Anti-Inflammatory)
4) To formulate Diclofenac Sodium Gel using Carbopol 934P (Analgesic and Anti-Inflammatory.)
5) Formulation of Chlorhexidin Mouthwash (Oral Hygiene)
6) Formulation of Oral Rehydration Salt (ORS) powder (WHO 2005) Oral Rehydration Solution)
7) To formulate Zinc Oxide - Salicylic Acid Dusting Powder. (Astringent and Local Antiseptic)
8) Preparation and analysis of Paracetamol tablets by wet granulation method.(Anti Pyretic & Analgesic drug)
9) Preparation and analysis of Aspirin tablets by direct compression method. (Analgesic, Anti-Inflammatory & Anti Pyretic drug)

REFERENCES

1 Pharmaceutical Formulations by A. H. Nathani, Career Publication, 2013.
2 Pharmaceutics Basic Principles and Formulation by D. K. Tripathi B.S.P. Books Publishers, 2019.
3 Text Book of Pharmacy Practice by Prof. S Balasubramanium, B.S.P. Books Publishers, 2020.

M.Sc. Semester II - Chemistry

PR- CHEM – 504: GOOD LABORATORY PRACTICES FOR QUALITY ASSURANCE IN INDUSTRIES (PR)

Total Credits: 03 **Total Hours: 45**

Course Objectives:

At the end of the course the student will be able to:

- Conduct laboratory operations in compliance with GLP guidelines,
- Perform experiments with higher efficiency and precision resulting in the production of accurate and reliable data
- Prepare documentation a per regulatory requirements so that it can be used to support regulatory submissions, product development, and decision-making in various industries.

Course Outcomes:

- To familiarize participants with the principles and requirements of GLP in laboratory settings. To develop skills for the implementation of GLP guidelines in laboratory operations.
- To train participants in the appropriate use of equipment and procedures to ensure accurate and reliable results.
- To enhance the understanding of the importance of record-keeping, documentation, and reporting requirements under GLP.
- To provide participants with the knowledge and skills required to ensure that laboratory practices and procedures are safe, reliable, and scientifically valid.

List of Practicals:

UNIT-1: Calibration of Instruments:

a) pH meter
b) Conductometer
c) Potentiometer
d) UV-Vis Spectrophotometer
e) BOD-Incubator
f) COD-Incubator
g) FT – IR
h) H P L C

UNIT-2: Calibration of Glassware:

a) Measuring Cylinder
b) Burette
c) Pipette
d) Volumetric Flask
e) Beaker

UNIT-3: SOP (Standard Operating Procedure) of Instruments:

• pH meter	• Gerber Tube
• Conductometer	• Desiccator
• Potentiometer	• Flame Photometer
• Colourimeter	• Centrifuge
• UV-Vis Spectrophotometer	• Cooling Centrifuge
• Muffle Furnace	• Water bath
• Hot Air Oven	• UV-Chamber
• Incubator	• M.P. Apparatus
• BOD- Incubator	• Turbidimeter
• COD-Incubator	• HVAS (High Volume air sampler)
• Ice Maker	• Magnetic Stirrer
• Kjeldahl Apparatus	• Weighing Balance

UNIT-4: GLP & GMP (Good Laboratory Practice & Good Manufacturing Practice)

REFERENCES:

1) GLP Essentials : A Concise Guide to Good Laboratory Practice, Second Edition , By Milton A. Anderson
2) OECD : Principles of GLP (As Revised)
3) HOW TO PRACTICE GMPs ,4th Edition ,Vandana Publication by P P Sharma (2004)

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M.Sc. Semester 3 – Chemistry
CHEM – 601: ADVANCED ORGANIC CHEMISTRY - I

Total Credits: 04 **Total Hours: 60**

Course Objectives:

- Students will gain the ability to apply the understanding of important organic name reactions to synthesis problems.
- Gain insight into the mechanism of heterocyclic reactions of importance and apply the various effects and principles for the synthesis of medicinal organic compounds containing heterocylic moiety.
- Understand the principles of separation of organic compounds based on their physical behaviour.
- Apply the understanding of organic functional groups for identification.

Course Outcomes:

- Understanding the basic concepts about how the organic reactions are carried out.
- To make the students understand the principle, mechanisms, applications of different organic common name reactions
- Understand the qualitative analysis of ternary mixtures, the functions of various reagents and reaction mechanisms.
- Imparting knowledge in the theory and practical of various name reactions which are very important in almost every industry for different fields of Chemistry.

Unit I: Principle, Mechanism and Synthetic Applications of Some important Name Reactions.

(Prerequisites or topics for Self-Study: Basic terms and fundamental aspects related to Name reactions)

Overview of name reactions in organic chemistry. Historical significance of key name reaction and their mechanisms: Transition states, intermediates, and reaction kinetics. Application of reactions to synthesis of drug, dyes, and chemicals of importance.

1) Sandmeyer reaction
2) Pechmann reaction
3) Riemer-Tiemann reaction
4) Kolbe-smith reaction

5) Hoffman reaction
6) Diels-alder reaction
7) Cannizaro's Reaction
8) Schotten – Baumann's Reaction

Unit II: Principles, Reaction Mechanism and Synthetic Applications of Some Heterocyclic Name Reactions

(Prerequisites or topics for Self-Study: Basic terms and fundamental aspects related to Name reactions)
Concept and mechanism of name reactions involved in the synthesis of heterocyclic compounds. Effect of hetero atom on the formation of product of interest.

1. Fischer – Indole synthesis
2. Biginelli Reaction
3. Skraup Synthesis
4. Earlein – Mayer Azlactone Synthesis

Unit III: Ternary Organic Mixture Separation and Analysis

Fundamentals concept of solubility and factors affecting solubility. Principle governing the separation of organic mixtures. Separation of ternary organic mixtures into individual components and identification of each compound based on their characteristic reactions.

1) Ternary mixture of (S + S + S) or (L + L + L) Substances
2) Type determination.
3) Separation by physical and chemical methods.
4) Identification of all substances

References:

1) March′s Advanced Organic Chemistry: Reactions, Mechanisms, and Structure by Michael B. Smith and Jerry March, Sixth Edition Published by Wiley–Blackwell, 2007.
2) Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd and Saibal Kanti Bhattacharjee Seventh Edition Published by Pearson Education, Inc., 2014.
3) Vogel's Textbook of Quantitative Analysis, G.H. Jeffery, j. Basset, J. Mendham, R.C. Denny, Longman Scientific 5th Ed, 1989.
4) Vogel's Textbook of Practical organic Chemistry, Brian Furniss, Antony J Hennaford, Peter W.G. Smith, Austin R Tatchell, Pearson, 5th Ed. 2003.
5) Organic Chemistry Volume 2 Stereochemistry and the Chemistry Natural Products by I.L. Finar Fifth Ed, Pearson, 2017.

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M.Sc. Semester 3 – Chemistry
CHEM – 602: ADVANCED ORGANIC CHEMISTRY - II

Total Credits: 04 **Total Hours: 60**

Course Objectives:

- Understanding the basic concepts about how the organic reactions are carried out and also to make the students understand the principle, mechanisms, and applications of different organic common name reactions.
- Understand the qualitative analysis of drug molecules, different chromatographic techniques and isolation of natural products.
- Imparting knowledge in the theory and practical of various name reactions, multiple steps synthesis, extraction technique, chromatographic techniques which are very important in almost every industry for different fields of Chemistry.

Course Outcomes:

- Explore the importance of reaction sequences in the synthesis of complex molecules.
- To understand how each step influences the overall reaction outcome.
- Evaluate reaction pathways, balancing efficiency, selectivity, and yield in multistep syntheses.
- Carry out in-process characterisation by TLC, purification and characterisation of product.

Unit I: Principles, Mechanism and Synthetic Applications of some multistep reactions:

Theory of synthesis of some important multi step chemical reactions in organic chemistry and their mechanism. Stoichiometric calculations, blocking methods for functional groups in organic synthesis. Analysis of intermediates and final product and study of completion of reaction by various methods.

a) Preparation of 2-phenyl Indole from phenyl hydrazine (2 step)
b) 2,5-dihydroxy Acetophenone from Hydroquinone (2-step)
c) 6–methyl Uracil from ethylacetoacetate (2-steps)
d) Antipyrine from Pheylhydrazine (2-steps)
e) Benzilic acid from Benzoin (2-step)
f) Acridone from anthranilic acid (3-step)
g) Benzocaine from p-nitro benzoic acid (2-steps)

Unit II: Drug Assay Determination:

Quantitative determination, of some common pharmaceutical molecules.

1. Assay of Aspirin
2. Assay of Ibuprofen
3. Assay of Analgin
4. Assay of Ascorbic acid

Unit III: Chromatographic techniques in Organic synthesis

Introduction to Chromatographic techniques in qualitative and quantitative analysis of organic compounds during synthesis. Principle, technique and interpretation of chromatographic data.

1. Paper Chromatography
2. Preparative chromatography
3. Thin layer chromatography
4. Column chromatography

Unit IV: Principles and Methods in Distillation and Extraction/Isolation of Natural Products

1. Distillation of Aniline by steam distillation method
2. Extraction of Piperine from Black Pepper
3. Extraction of Caffeine from Tea leaves
4. Extraction of Lycopene from Tomatoes

References:

1) Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd and Saibal Kanti Bhattacharjee Seventh Edition Published by Pearson Eduction, Inc., 2014.
2) Advance Organic Chemistry Part-A Structures and Mechanisms by Francis A. Carey and Richard
3) J. Sundberg Fourth Edition Published by Kluwer academic / Plenum publishers 2000.
4) Stereo chemistry Conformation and Mechanism by P S Kalsi Ninth Edition Published by New Age International Publishers 2017.
5) Organic Chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren Second Edition Published by Oxford University press 2018.

M.Sc. Semester 3 – Chemistry
CHEM - 603: CONCEPTS OF ADVANCED ANALYTICAL TECHNIQUES

Total Credits: 04 **Total Hours: 60**

Course Objectives:

- To provide knowledge and understanding of the principle and theory of spectroscopy and spectrophotometric methods of chemical analysis.
- To make the students understand the principle, theory and working of various Analytical techniques for interpretation of chemical structure, purity and quantitative evaluation.
- To train the students in handling the IR, UV-visible spectrophotometer and HPLC independently and analyse the data output.
- To provide basic understanding of calibration, working, of the instruments and apply the knowledge in interpretation of the information to unknown samples.

Course Outcomes:

- Equip student with the skills to operate a UV-Visible spectrophotometer, preparing solutions and Record absorbance spectra and construct calibration curves for quantitative analysis.
- Use UV-visible spectroscopy for monitoring chemical reactions, determining concentration, and studying the electronic properties of molecules.
- Impart training of handling IR spectrophotometer, sampling, analysis and interpretation of IR spectra.
- Develop hand-on skills in HPLC operation, perform sampling and understand integration techniques. To explain how to integrate HPLC, IR and uv-visible spectral data for analysis of unknown compounds.

Unit I: UV-Visible Spectroscopy and its Applications:

The electronic spectrum and principle of electronic absorption. Theory of chromophore and factors affecting absorption. Electronic transitions and calculation of λmax. Concept of chromophore, Auxochrome, and factors affecting electronic transition like conjugation, solvent effect, steric effect, effect of functional groups, etc.
Woodward Fieser and Scott rules for calculation of absorption maxima for different organic molecules like dienes, enones, aromatic ketones, aldehydes and esters using empirical values.
Problems based on interpretation of absorption data to identify molecular structure.

Unit II: IR Spectroscopy

The IR spectrum, regions of the IR spectrum. Principle and instrumentation and sampling techniques for IR spectroscopy. Fundamental modes of vibration and types of vibrations for different type of molecules. Types of bonds, absorption of different functional groups. Hooke's law and its applications, selection rule. Absorption frequencies for different functional groups and factors affecting them – H-bond, mass effect, bond multiplicity, ring size, electronic effects, Resonance, Inductive effect, Tautomerism, etc. FTIR spectroscopic technique.
Interpretation of IR spectra for different molecules and difference between IR and Raman spectroscopy. Problems based on IR spectral data to identify the structure of organic compounds.

Unit III: High Performance Liquid Chromatography and its applications

Introduction to separation techniques in chemical analysis. Principle and theory of chromatography. Types of chromatographic techniques. Principle, Instrumentation and working of High Performance Liquid Chromatography. Theory and important factors involving the efficiency of separation in HPLC.
Theory and practice of HPLC in chemical analysis. Types of HPLC techniques, and detectors used in HPLC methods. Analysis of various chemical, pharmaceutical and biological samples by HPLC. Interpretation of HPLC chromatograms.

Unit IV: Interpretation of Spectroscopic data for structural identification.

Interpretation of IR, UV and HPLC chromatographic spectral data for qualitative and quantitative analysis of different chemical, pharmaceutical and biological samples.

References:

1) Quantitative Chemical Analysis by Daniel C. Harris Eighth Edition published by W. H. Freeman and Company 2014.
2) Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug Seventh Edition Published by John Wiley & Sons, Inc. 2014.
3) Principles of Instrumental Analysis by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch Sixth Edition Published by Cengage Learning, 2016.
4) High Performance Liquid Chromatography, Fundamental Principles and Practice. Ed. W.J. Lough & I. W. Wainer, CRC Press, 1995.

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M.Sc. Semester 3 – Chemistry

CHEM - 601: ADVANCED ORGANIC CHEMISTRY - I (PR)

Credits: 04 **Hours: 60**

Course Objectives:

- Students will gain practical skills in conducting two-step synthesis; one pot synthesis and application of principles of green chemistry in organic synthesis.
- Gain expertise in process chemistry design and characterisation of compounds, using physical parameters.
- Apply the understanding of important organic name reactions to synthesis problems.
- Understand the principles of separation of organic compounds based on their physical behaviour and identification of the mixture components.
- Understand the principle and technique of steam distillation and gain insight into the qualitative and quantitative analysis of organic compounds by Chromatographic methods like TLC, paper and HPLC

Course Outcomes:

- To enable students to carry out multi-step organic synthesis along with checking the completion of reaction using TLC. Purifying and characterising the product formed.
- To understand the significance of region-selectivity and stereo-selectivity in synthesising organic compounds of industrial importance.
- Understand the qualitative analysis of ternary mixtures, the functions of various reagents and reaction mechanisms.
- Imparting knowledge in the theory and practical of various name reactions which are very important in almost every industry for different fields of Chemistry.

List of Practicals:

Name Reactions

1) Sandmeyer reaction
2) Pechmann reaction
3) Riemer-Tiemann reaction
4) Kolbe-smith reaction
5) Hoffman reaction
6) Diels-alder reaction
7) Cannizaro's Reaction
8) Schotten – Baumann's Reaction

Synthesis of heterocyclic compounds:

1) Fischer – Indole synthesis
2) Biginelli Reaction
3) Skraup Synthesis
4) Earlein – Mayer Azlactone Synthesis

Separation and analysis of Organic Ternary Mixture:

1) Ternary mixture of (S + S + S) or (L + L + L) Substances
2) Type determination.
3) Separation by physical and chemical methods.
4) Identification of all substances

References

1) Vogel's Textbook of Practical Organic Chemistry, 5th Ed. A. Vogel, et al., ed., Prentice Hall, 1996, 1552 pp.
2) Practical Organic Chemistry: A student handbook of techniques, Chapman & Hall, 1989.
3) Practical Organic Chemistry, FE Mann. BC Saunders, 4th Ed., Pearson Education India, 2009.

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M.Sc. Semester 3 – Chemistry

CHEM - 602: ADVANCED ORGANIC CHEMISTRY - II (PR)

Credits: 04 **Hours: 60**

Course Objectives:

Upon completing this course, students will be able to:

- Understand and analyze reaction sequences in the synthesis of complex molecules.
- Evaluate and optimize reaction pathways, in terms of efficiency, selectivity, and yield.
- Apply principles of organic synthesis to design and optimize multistep reaction strategies for complex molecule synthesis.
- Perform In-Process monitoring and characterisation of reactions using thin-layer chromatography (TLC).

Course Outcomes:

- Explore the importance of reaction sequences in the synthesis of complex molecules.
- To understand how each step influences the overall reaction outcome.
- Evaluate reaction pathways, balancing efficiency, selectivity, and yield in multistep syntheses.
- Carry out in-process characterisation by TLC, purification and characterisation of product.

List of Practicals:

2- Step Synthesis:

a) Preparation of 2-phenyl Indole from phenyl hydrazine (2 step)
b) 2,5-dihydroxy Acetophenone from Hydroquinone (2-step)
c) 6–methyl Uracil from ethylacetoacetate (2-steps)
d) Antipyrine from Pheylhydrazine (2-steps)
e) Benzilic acid from Benzoin (2-step)
f) Acridone from anthranilic acid (3-step)
g) Benzocaine from p-nitro benzoic acid (2-steps)

Drug Assay:

1. Assay of Aspirin
2. Assay of Ibuprofen
3. Assay of Analgin
4. Assay of Ascorbic acid

Chromatographic techniques:

1. Paper Chromatography
2. Preparative chromatography
3. Thin layer chromatography
4. Column chromatography

Isolation and Extraction of organic compounds from natural products

1. Distillation of Aniline by steam distillation method
2. Extraction of Piperine from Black Pepper
3. Extraction of Caffeine from Tea leaves
4. Extraction of Lycopene from Tomatoes

References

4) Vogel's Textbook of Practical Organic Chemistry, 5th Ed. A. Vogel, et al., ed., Prentice Hall, 1996, 1552 pp.
5) Practical Organic Chemistry: A student handbook of techniques, Chapman & Hall, 1989.
6) Practical Organic Chemistry, FE Mann. BC Saunders, 4th Ed., Pearson Education India, 2009.

M.Sc. Semester 3 – Chemistry

CHEM - 603: APPLICATIONS OF ADVANCED ANALYTICAL TECHNIQUES (PR)

Credits: 4 **Hours: 60**

Course Objectives:

At the end of this course, the student will be equipped with:

- Skills to operate a UV-Visible spectrophotometer, sampling, recording absorbance spectra, and construct calibration curves for quantitative analysis.
- Ability to handle IR spectrophotometer, including sampling, analysis, and interpretation of IR spectra.
- Develop hands-on skills in HPLC operation, performing sample preparation, and understanding data integration techniques.
- Integrate the use of HPLC, IR, and UV-Visible spectroscopy for comprehensive characterization and quantitative estimation of organic compounds.

Course Outcomes:

- Equip student with the skills to operate a UV-Visible spectrophotometer, preparing solutions and Record absorbance spectra and construct calibration curves for quantitative analysis.
- Use UV-visible spectroscopy for monitoring chemical reactions, determining concentration, and studying the electronic properties of molecules.
- Impart training of handling IR spectrophotometer, sampling, analysis and interpretation of IR spectra.
- Develop hand-on skills in HPLC operation, perform sampling and understand integration techniques.
- To explain how to integrate HPLC, IR and uv-visible spectral data for analysis of unknown compounds.

List of Practicals:

IR Spectroscopy:

1) Sample preparation and analysis of standard organic compounds
2) Analysis of IR spectra for Caffeine
3) Analysis of IR spectra for paracetamol
4) Analysis of IR spectra for Metformin

UV – visible spectrophotometry

1) Determination of λmax for some standard samples
2) Preparation of Calibration curve of standard samples
3) Calibration and Analysis of Caffeine
4) Assay determination of Metformin
5) Assay determination and Analysis of Paracetamol

HPLC Analysis:

1) Identification and purity analysis of Caffeine
2) Identification and purity analysis of Paracetamol
3) Identification and purity analysis of Metformin

REFERENCES:

1) Organic Spectroscopy, William Kemp,1991 by Red Globe Press
2) Spectroscopy of Organic Compounds, P.S. Kalsi, 1995 John Wiley & Sons (Asia)
3) Principles of Instrumental Analysis, Douglas Skoog, F. Holler, Stanley Crouch.
4) High Performance Liquid Chromatography: Fundamental Principles and Practice W.J. Lough, I.W. Wainer, CRC Press, 1995.

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M.Sc. Semester IV

CHEM-PRJ/INT – 701 PROJECT/INTERNSHIP

Credits: 16

Course Objectives:

- Students will gain practical experience in a professional setting, applying theoretical knowledge and skills to real-world situations in industry, research
- Build professional networks within the research comm,unity and industry facilitating career development.
- Independently identify Research problems, write proposals, and learn best methods of conducting research.
- Students will learn to identify specific research goals that contribute to the scientific community and address societal challenges.
- Students will acquire skills to communicate scientific research findings through the preparation of a comprehensive project report.

Course Outcomes:

- To allow student to gain hands-on experience in a professional setting, to apply theoretical knowledge to real-world situations in industry, research, or pathology.
- To enhance practical skills relevant to field of study, including laboratory techniques, data analysis, and problem-solving in a professional context.
- To facilitate opportunities for students to build professional relationships and networks within the industry or research community, promoting career development.
- To identify specific goals in research to contribute to the scientific community and society at large. To conceptualize a research project, conduct literature study and perform research as per guidelines. Teach student to communicate scientific research data into a project report.

Students in semester IV will be assessed based on their performance in Industry Internship/Dissertation.

The student may choose to undertake an Internship in the industry/Research Institute/pathology laboratory as per his area of interest and subject of specialization. The student needs to complete a minimum period of 5-6 months of Internship/training under the supervision of the company supervisor.
Alternately, students may choose to take up a Research project/dissertation in the institute under the mentorship of their subject faculty.

Evaluation will be based on the following parameters:

1. Continuous Evaluation Component –
   - Continuous evaluation by mentor/supervisor
   - Internal presentation
2. External Presentation on the project or Internship topic
3. Viva – voce examination