Session 2020-21

Programme and Course Outcome

M.Sc. Chemistry

Multani Mal Modi College, Patiala

Program Specific Outcomes

PO1: Student will gain complete knowledge about all fundamental aspects of chemistry.

PO2: Students will develop critical thinking, will be able to put forward new ideas, explain observations and draw logical inference form scientific studies in field of chemistry.

PO3: Student will learn basic analytical and technical skills to work effectively in the various fields of chemistry

PO4: Student will be able to solve complex chemical problems, e.g., analysis of data, synthetic logic, spectroscopy, structure and modeling, team-based problem solving, etc. which are essential skills to succeed in field of research or in industry.

PO5: Student will be able to handle standard laboratory equipment, modern scientific instruments, planning and performing in laboratory experiments.,

Course Outcomes (COs)

CLASS - M.Sc. CHEMISTRY 1st Year

COURSE NAME	COURSE OUTCOME
COURSE-101 INORGANIC CHEMISTRY	CO-1. Student will able to understand different types of chemical bonds present in inorganic compounds. CO-2. Understand the nature of pi acid ligands and their bonding in metal-ligand complexes. CO-3. Learn Structural aspects and Thermodynamic Consequences of Partly Filled-shells. CO-4. Learn about spectral properties of inorganic complexes such as selection rules and types of spectra. CO-5. Understand the the biochemistry of Iron and other metals such as zinc, copper, cobalt, molybdenum and tungsten.
COURSE-102 ORGANIC CHEMISTRY	CO-1. Learn everything about reaction intermediates involved in organic reactions. CO-2. Understand the nature of bonding involved in organic compounds. CO-3. Learn about aromatic, non-aromatic and anti-aromatic compounds. CO-4. Learn about different techniques used or determination of reaction mechanism. CO-5. Understand the types and mechanisms of elimination reactions in organic chemistry. CO-6. Learn in detail about molecular orbital symmetry and pericyclic reactions.
SUBJECT CODE: 103 PHYSICAL CHEMISTRY	CO-1. Understanding of laws of **thermodynamics** and the theoretical concepts of generalized forces and coordinates, work, and thermodynamic potentials. CO-2.Understanding of the meaning and the role of thermodynamic description of systems. CO-3.Command of methods of **statistical thermodynamics**, understanding of concepts of phase space and phase integral, temperature, and chemical potential.

	CO-4. Investigating various phenomenon involving Ion-solvent interactions, Ion - ion interactions: **Debye - Huckel theory of ion - ion interactions**. CO-5. Probing and grasping understanding regarding various phenomenon viz. **Electrokinetic** phenomenon, **Electrocatalysis**, Electrochemical Energy Conversion and Electricity storage
SUBJECT CODE–105 PRACTICAL INORGANIC CHEMISTRY	CO-1 Learn systematic analysis of cations and anions CO-2 Can eliminate the interfering anions from the given mixture. CO-3 Prepare alums and complexes Co-4 Preparation and estimations .
SUBJECT CODE: 106 ANALYTICAL CHEMISTRY PRACTICALS	CO-1. Develops analytical skills and problem solving skills requiring application of chemical principles CO-2. Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries. CO-3. Prepare standard solutions CO-4. Conduct acid base titrations, complexometric titrations and redox titrations like permanganometry, dichrometry and iodometric-iodimetric titrations. CO-5. Different indicators used in titrations
COURSE-201 INORGANIC CHEMISTRY	CO-1. Understand the various kinds of organometallic compounds and their structural study by NMR. CO-2. Understand the types of bonding involved in Nitrogen, Oxygen, sulphur and halogens. CO-3 Learn the chemistry of xenon, krypton and radon. CO-4. Learn the concepts of group theory and its uses in octaheral, tetrahedral, sq. planar and trigonal bipyramidal symmetry. CO-5. Understand the applications of group theory in inorganic systems.
COURSE-202	CO-1. Learn basics of stereochemistry such as types of representation of 3-D

ORGANIC CHEMISTRY	structures, enantiomers, diastereoisomers, racemic mixtures, resolution and how to carry out asymmetric synthesis. CO-2. Understand conformational isomers and their effect on physical and chemical properties of various systems. CO-3. Learn the stereochemistry of six member rings and fused ring systems. CO-4. Understand geometrical isomerism and its effect on physical properties. CO-5. Learn about addition reactions to C-C and Carbon-hetero multiple bonds. CO-6. Learn about mechanism of reduction and condensation reactions.
SUBJECT CODE: 203 PHYSICAL CHEMISTRY	CO-1 Understanding Fundamental concepts of quantum mechanics. CO-2 Understanding operators and postulates of quantum mechanics CO-3 Application of Schrodinger equation to various model systems. CO-4 **Understanding Approximate Methods** The variation principle, perturbation theory. CO-5 Probing **Electronic Structure of Atom**: Electronic states of complex atoms CO-6 To understand the effect of temperature on reaction rates. CO-7 To understand the different theories of chemical kinetics. CO-8 Understand the concept of reaction rates and be able to use the coefficients of a balanced chemical equation to express the rate of reaction in terms of the change in concentration of a reactant or product over time.
COURSE–205 : ORGANIC CHEMISTRY PRACTICALS	CO-1. Learn essential laboratory skills required for organic synthesis by performing synthesis of important organic compounds. CO-2. Learn to characterize synthesized products using different spectral methods. CO-3. Learn to separate solid-solid/ solid-liquid/ liquid-liquid mixture of two organic compounds. CO.3- Learn identification of functional groups by using different qualitative lab techniques. CO.4. Learn identification of compounds by different conformation tests and by preparation of derivatives. CO.5. Learn separation of organic mixture by prep. TLC. CO.6. Learn IR and PMR studies to confirm identification of compounds.

PAPER–206 : PHYSICAL CHEMISTRY PRACTICALS	CO-1 Determine the viscosity of various liquids using Ostwald's viscometer CO-2 Determine cryoscopic constant (Kf) of solid solvent and molecular mass of the solute using cooling curve method . CO-3 Determine transition temperature CO-4 prepare the solution of the desired concentration and the desired volume CO-5 Know the principle and handling of pH meter, Potentiometer, conductivitymeter, colorimeter, viscometer,etc. CO-6 Plot accurate graphs of the desired scale for the calculations CO-7 Maintain laboratory ethics, safety and cleanliness CO-8 Understand waste management of the laboratory

M.Sc. (Chemistry) 3rd Semester

Analytical Chemistry **Subject Code– 301**

Learning Objectives

- Introduction to analytical chemistry
- Methods of quantitative analysis
- Sampling in analysis
- criterion of a good sampling plan
- Errors in chemical analysis
- Classification of errors
- Minimization of errors
- Accuracy and precision.
- Improving accuracy of analysis
- Correlation and Regression, linear regression and analysis of variance.
- Basic Principles of Polarography
- Chronoptentiometry
- Thermo Analytical Methods
- Spectrophotometry and Colorimetry
- Ion exchange chromatography.
- Applications in analytical chemistry

Learning Outcomes

After studying this paper, students will be able to:

- Understand the fundamentals of analytical chemistry and steps of a characteristic analysis.
- Compare qualitative and quantitative analysis methods.
- Express the quantitative analysis methods.
- Express the qualitative analysis methods.
- Evaluate the analytical data in terms of statistics.
- Estimate the types of errors in chemical analysis.

- Express the terms such as mean, median, precision, accuracy, absolute error and relative error.
- Express the systematical errors and the error sources.
- Interpret the statistical tests.
- To interpret the sources of random errors and effects of random errors on analytical results.
- Express the terms such as standard deviation, variance, relative standard deviation and coefficient of variance.

- Express the significant figures and rounding off the data.
- Employ the volumetric calculations.
- Define the confidence limit and confidence level.
- Compare of the experimental mean with a true value and two experimental means.
- Identify the detection limit.
- Express the titrimetric analysis methods.

Inorganic Chemistry
Reaction mechanism of transition metal complexes Subject Code– 312

Learning Objectives

1. To provide a broad learning about the different types of reaction mechanism involved in a variety of metal ligand complexes.
2. To acquire the role of stability constants in reaction mechanism of metal complexes.
3. To study the stereochemical aspects of various metal ligand complexes.
4. To learn oxidative addition and migration reaction of different kinds of metal atom complexes.

Learning Outcomes

After studying this paper, students will be able to understand:

1. Theories and types of mechanism of the substitution reactions in octahedral, square planar and metal carbonyl complexes.
2. Factors effecting mechanism of nucleophilic substitution reaction and the reaction intermediates involve in the course of reaction.
3. Oxidative addition and reductive elimination of some specific molecules and acid base behaviour of metal atom in complexes.

4. Factors affecting the stability constants of metal complexes.
5. Make the students able to work in the metallurgical industry.

Inorganic Chemistry
Inorganic spectroscopy-I **Subject Code– 313**

Learning Objectives

1. Aims to provide students a deep understanding of different kinds of spectroscopic techniques to carry out scientific experiments and interpretation of the data.
2. To attain sufficient knowledge about the applications of a variety of spectroscopic techniques.
3. To understands the spectra of transition metal complexes.
4. Aims to determine the inorganic structures by using spectroscopic techniques.

Learning Outcomes

After studying this paper, students will be able to understand:

1. Analyze the data obtained from sophisticated instruments (like FTIR, NMR, GCMS, UV-Vis, Fluorescence, and TGA) for the structure determination and chemical analysis.
2. Have sound knowledge about the inorganic spectroscopy fundamentals and applications in different fields.
3. Selection rules and intensities of transition in the spectra of transition metal complexes.
4. Operate the variety of instruments and can interpret the data from the spectrum.

Organic Chemistry

Chemistry of Natural Products **Subject Code–322**

Learning Objectives

1. To understand the general methods and basic techniques used in structure determination.
2. Structure elucidation and synthesis of some natural products based on chemical and spectroscopic studies.
3. To understand the degradation of Carbon Skeleton.
4. To understand the direct and indirect oxidation methods.
5. To understand the biogenetic approach of the acetate pathways.

Learning Outcomes

To enable the students:

1. To study the general methods and basic techniques used in structure determination of natural products

2. To develop proper aptitude towards the spectroscopic studies of natural products in the structure determination.

3. To learn the chemistry of terpenes, alkaloids and steroids.

4. To understand and study mechanism and transformations in different natural products.

5. To understand the structure elucidation of alkaloids, steroids and antibiotics.

Physical Chemistry **Subject Code: 331**
Fundamentals of Spectroscopy

Learning Objectives

The course content has the following objectives:

- To learn some properties of a simple microwave reflection spectrometer.
- To measure the g factor, nuclear spin, and hyperfine coupling constant of various ESR active nuclei.
- Know how nuclear spins are affected by a magnetic field, and be able to explain what happens when radiofrequency radiation is absorbed. .
- To predict the number of proton and carbon NMR signals expected from a compound given its structure.
- To predict the splitting pattern in the proton NMR spectrum of a compound given its structure.
- To assign peaks in an NMR spectrum to specific protons in a compound with the aid of a chart of chemical shifts from ^{1}H and ^{13}C NMR, to
- To interpret integration of NMR spectra.
- To calculate coupling constants from 1H NMR spectra, and utilize the coupling constants for determining compound structure.
- Students learn the principles of different molecular spectroscopic methods.

Learning Outcomes

After completing this unit the student will be able to:

- Describe the selection rule for infrared-active transitions.
- Determine the vibrations for a triatomic molecule and identify whether they are infrared-active.
- Draw the design of a non-dispersive infrared spectrophotometer and describe how it functions. 4. Describe the difference between time and frequency domain spectra.
- Explain how a Michelson Interferometer can be used to obtain a time domain spectrum.
- Explain the advantages of Fourier Transform infrared spectroscopy over conventional infrared spectroscopy
- Determine whether the molecular vibrations of a triatomic molecule are Raman active.
- Explain the difference between Stokes and anti-Stokes lines in a Raman spectrum.
- Justify the difference in intensity between Stokes and anti-Stokes lines.
- Draw the Stokes and anti-Stokes lines in a Raman spectrum of a compound when given the energies of the different transitions
- Magnetic properties of atomic nucleus and resonance.
- Nuclear relaxation mechanisms.
- NMR spectrometers.
- Spin-spin interactions and chemical shift.
- ^{1}H and ^{13}C NMR spectroscopy.
- 2D NMR techniques.
- Interpretation of NMR spectra.

Physical Chemistry **Subject Code: 332**
Statistical Thermodynamics

Learning Objectives

The course content has the following objectives:

- Recapitulation of classical statistics and partition function
- Comparison between Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics
- Understanding concept of thermodynamic probability
- Description of statistics of monatomic ideal gas
- Understanding Principle of equipartition of energy
- Application and interpretation of Barometric equation
- Application of statistical approach to Theory of paramagnetism
- Statistics of photon and electron gases
- Formulation of Velocity, speed and energy distribution functions
- Evaluation of Thermionic emission.

- Classical treatment of specific heat of solids
- Differentiation among Einstein and Debye theories of specific heats
- Debye's T^3 law, entropy of solids, equation of state of solids, order and disorder and the melting point.
- Description of Law of mass action, chemical equilibrium, dissociation
- Computation of equilibrium constants
- Means distribution, mean square deviation, fluctuations in energy in a canonical ensemble, density fluctuation in a gas.. Theory of Brownian motion and Brownian motion of galvanometer.
- Entropy production, coupled phenomena, transport parameters
- Thermoelectric phenomena, The Seebeck effect, Peltier effect and Thomson effect.

Learning Outcomes

After completing this course the student will be able to:

- Learn about Boltzmann equation relating bulk and microscopic behavior.
- Learn about most probable distribution.
- Learn about Microscopic and Macroscopic Systems
- Distinguish between Classical and Statistical Thermodynamics.
- Distinguish between Classical and Quantum Approaches
- Infer applications of Statistical Thermodynamics

Physical Chemistry **Subject Code: 333**
Fundamental and Atmospheric Photochemistry

Learning Objectives

The course content has the following objectives:

- To study Photochemical Reactions
- To study Photochemistry of Atoms
- To study Photochemistry of Simple Molecules
- To study Photochemistry of Polyatomic Molecules
- To study Electronically Excited Singlet and Triplet States
- To study Photochemical Oxidation and Reductions
- To study Industrial Applications of Photochemistry
- To study structure of the atmosphere, structure in terms of temperature, diffusion and ionization, characteristics and chemical composition.
- To study Chemistry of the upper atmosphere, features of odd oxygen and singlet oxygen, NO_2 and HO_2 species and other species like N_2O, NH_3, HNO_3 etc., in the atmosphere.
- To understand meaning of Pollutant, different ways to express concentration of Pollutants
- Description of concept regarding Photochemical smog and production of smog.

Learning Outcomes

After completing this course the student will be able to:

- Explain the structure of the atmosphere.
- Define important chemical processes in the stratosphere and troposphere.
- Discuss the role of greenhouse gases on global warming.
- Demonstrate an increased knowledge and understanding of chemical science
- Use investigative skills, critical thought and the ability to evaluate information and to analyze experimental data.

Learning Objectives & Outcomes
M.Sc. (Chemistry) 4th Semester

Organic Chemistry

Modern Synthetic Reactions & Rearrangements **Subject Code– 423**

Learning Objectives

- To understand the various organic reactions and reagents used in them as tools applied in the art of organic synthesis.
- To understand the behavior of non -activated carbon in organic synthesis.
- To understand the rearrangements in three membered and four membered systems.

Course Outcomes

To enable the students:

- To study the use of various reagents in organic synthesis
- To develop aptitude towards the study of reaction mechanism at the un-activated C-H bonds and their applications to steroid nucleus.
- To learn the chemistry of C-C bond formation by using Organ metallic reagents.
- To understand acid catalyzed and base catalyzed rearrangements in small ring compounds.
- To study the use of phase transfer reagents and use of compounds of Thallium (III), Palladium and Ruthenium oxide in organicsynthesis.
- Carbocation Rearrangement in Bridged Bicyclic Systems and steroid systems.

Physical Chemistry **Subject Code: 431**

X-Ray Diffractions and other Techniques

Learning Objectives

- Structures of Ionic Solids (crystal chemistry), Metals and Alloys,
- Band Theory in Solids (Metals, Semiconductors, Inorganic Solids)
- Crystal defects, non-stoichiometric compounds, solid solutions, dislocations and stacking faults.
- Unit Cell, Crystal Systems, Asymmetric Unit, Crystal lattices (2D)
- Bravais Lattices (3D), Miller planes (crystallographic directions and multiplicities) d-spacing formula
- Scattering by an Atom and Crystal, Bragg's Law, Reciprocal Lattice, Reflecting and Limiting sphere of reflection, systematically absent reflections
- Mossbauer spectroscopy: Physical concepts, spectral line shape, isomer shift, quadrupole splitting, magnetic hyperfine interaction.
- Interpretation of Mossbauer parameters of ^{57}Fe and ^{119}Sn.
- Applications to Solid-state reactions, thermal decomposition, ligand exchange, electron transfer and isomerism
- Theory of polarized light, optical activity and optically active molecules
- Cotton effects, CD and ORD, Octant Rule
- Experimental Techniques, applications: quantitative analysis, determination of absolute configuration, conformational studies and equilibrium studies.

Learning Outcomes

After completing this unit the student will be able to:

- Basics of Crystallography
- Basic theoretical and experimental aspects of the discussed X-ray diffraction methods
- basic data analysis on materials
- The student will acquire qualitative and quantitative knowledge of the fundamental concepts of various spectroscopic methods of Mossbauer spectroscopy
- Apply applications of MB to characterize different molecules and crystals.
- The learners should be able to distinguish between various spectroscopic transitions and interpret data for molecular characterization

Physical Chemistry **Subject Code: 432**

Biophysical Chemistry and Advanced Spectroscopy

Learning Objectives

- The structure of biological macromolecules.
- Membrane proteins and membrane transport. Spectroscopic methods: UV-Vis and fluorescence related to biochemistry
- Physical methods for studies of the interaction between biological macromolecules.
- Thermodynamics of protein folding/stability by fluorescence, CD and calorimetric techniques
- Be able to predict the fragmentation patterns expected to arise in the mass spectrum of various organic compounds.
- Description of what happens to a compound in a mass spectrometer
- Description of Basic instrumentation: electron bombardment and photo ionization sources, magnetic, electrostatic and time of flight analyzers, ion detectors
- Introduction to LASER and its characteristics.
- Applications of LASER for Chemistry.
- Basic principles of Photoelectron spectroscopy. (PES)
- Experimental techniques of Photoelectron spectroscopy

Learning Outcomes

After completing this unit the student will be able to:

- Account for the different interactions that are important for the formation of structures in biological systems and for how thermodynamic parameters can be measured.
- Account for structures and functions of biological membranes, as well as model systems and relevant methods for the study of these structures and functions.
- Account for and apply spectroscopic methods for the study of structures and functions in biological systems
- Be able to use the mass spectrum of a compound to find the molecular mass, and to help identify the structure of a compound.
- Be able to use PES as a tool to characterize the given material.

Physical Chemistry **Subject Code: 433**

Polymers and Surface Chemistry

Learning Objectives

- Introduction: Classification and nomenclature of polymers
- Composition and polymerization mechanism.
- Radical chain polymerization
- Co-polymerization and emulsion polymerization

- Molecular weight average and viscosity average molecular weight, molecular weight determination by osmotic method, light scattering method, sedimentation method, diffusion constant, sedimentation equilibrium, viscosity method.
- Adsorption and Kinetics of heterogeneous reaction at solid surfaces
- Catalysis : Catalysts and Criteria of catalysis and initiation of a reaction
- Spectroscopic methods like PES, AES, LEED applicable to Polymers

Learning Outcomes

After completing this unit the student will be able to:

- Classify the different Polymers
- Assign nomenclature to different class of polymers
- To apply various statistical techniques to polymers for determination of its properties.
- To apply isotherms to the various phenomenon involving adsorption
- To apply kinetics to various reactions occurring on solid surfaces
- Apply various spectroscopic techniques to determine surface properties.