(University of Delhi)
Shyam Lal College

Programme Specific Outcomes and Course Outcomes

B.Sc. (H) Chemistry

Shyam Lal College (University of Delhi)

Department of Chemistry

Programme Outcomes and Course Outcomes

Programme Outcomes

Programme	Programme Outcomes
B.Sc. (H) Chemistry	**PO-1:** The students acquire in-depth knowledge of the various concepts and theoretical principles and are aware of their manifestations. **PO-2:** The students are expected to be thoroughly conversant with all basic analytical, qualitative and quantitative laboratory techniques and demonstrate meticulousness in operation. **PO-3:** Students are aware of the importance of working with safety and consciousness in laboratory and actively seeks information about health and environmental safety of chemicals that are used in the laboratories and follows protocols for their safe disposal. **PO-4:** Students assimilate technical information about chemistry from various sources and convey it to intended audience, both orally and in writing in an intelligible manner. **PO-5:** Critical thinking as an attribute enables a student to analyze a problem, assess it, reconstruct it and solve it. **PO-6:** An integral part of chemistry curriculum is problem solving. The student will be equipped to solve problems of numerical, synthetic and analytical nature that are best approached with critical thinking. **PO-7:** The student will be able to draw logical conclusions based on a group of observations, facts and rules. **PO-8:** The student is inquisitive about processes and phenomena happening during experiments in laboratories and seeks answers through the research path.

Course Outcomes

Core Subjects- Semester 1

Course Name	Course Outcomes	Methodology to Achieve the Specific Outcomes
Atomic Structure & Chemical Bonding	**CO-1**: Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization enthalpy and electron affinity of elements. **CO-2**: Draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules). **CO-3**: Understand the concept of lattice energy using Born-Lande and Kapustinskii equation. **CO-4**: Calibrate the apparatus used in titrimetric analysis and prepare standard solutions for titration. **CO-5**: Understand the theory and application of various acid-base and redox titrations. **CO-6**: Comprehend the theory of acid-base indicators.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Hands on methods in laboratory to learn quantitative techniques so that students can join the industrial labs. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.
Gaseous and Liquid State	**CO-1:** Derive mathematical expressions for different properties of gas and liquid and understand their physical significance.	1. Students will learn the skills to handle the viscometer and stalgmometer and measure the viscosity and surface tension of

	CO-2: Apply the concepts of gas equations and liquids while studying other chemistry courses and every-day life. **CO-3:** Handle stalagmometer and Ostwald viscometer properly. **CO-4:** Determine the density of aqueous solutions. **CO-5:** Dilute the given solutions as per required concentrations. **CO-6:** Data reduction using numerical and graphical methods.	different liquids. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Training to handling basic chemical laboratory instruments and their use in analytical and biochemical determinations. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Basic Concepts and Aliphatic Hydrocarbons	**CO-1:** Understand and explain the electronic displacements and reactive intermediates and their applications in basic concepts. **CO-2:** Formulate the mechanistic route of organic reactions by recalling and correlating the fundamental concepts. **CO-3:** Identify and comprehend mechanism for free radical substitution, electrophilic addition, nucleophilic substitution and elimination reactions. **CO-4:** Understand the fundamental concepts of stereochemistry. **CO-5:** Understand and suitably use the chemistry of hydrocarbons.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Hands on methods in laboratory to learn quantitative techniques so that students can join the industrial labs. 3. Video lectures from SWAYAM and NPTEL 4. Use of Virtual Labs 5. Correlation of concepts with demonstration and experiments in Laboratory 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Core Subjects - Semester 2

Course Name	Course Outcomes	Methodology to Achieve the Specific Outcomes
Haloalkanes, Arenes, Haloarenes, Alcohols, Phenols, Ethers and Epoxides	**CO-1:** Understand reactions of arenes, haloarenes and some oxygen containing functional groups. **CO-2:** Understand the concept of protection and deprotection**.** **CO3:** Use the synthetic chemistry learnt in this course to do functional group transformations. **CO4:** Propose plausible mechanisms for the reactions under study.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. The students will learn the techniques to synthesize the new chemical molecules in the lab. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs 5. Correlation of concepts with demonstration and experiments in Laboratory 6. Demonstration of chromatography techniques in lab. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Chemical Thermodynamics and its Applications	**CO-1:** Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties. **CO-2:** Derive the expressions of ΔU, ΔH, ΔS, ΔG, ΔA for ideal gases under differentconditions. **CO-3:** Explain the concept of partial molar properties.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Chemistry of s and p-Block Elements	**CO-1:** Learn the fundamental principles of metallurgy and understand the importance of recovery of by-products during extraction. **CO-2:** Applications of thermodynamic concepts like that of Gibbs energy and entropy to the principles of extraction of metals. **CO-3:** Learn about the characteristics of s- and p- block elements as well as the synthesis, structure, bonding and uses of their compounds. **CO-4:** Understand the concept and use of internal and external redox indicators **CO-5:** Comprehend the theory and application of iodometric and iodimetric titrimetric analysis.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Hands on methods in laboratory to learn quantitative techniques so that students can join the industrial labs. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Core Subjects - Semester 3

Course Name	Course Outcomes	Methodology to Achieve the Specific Outcomes
s- and p-Block Elements	**CO-1:** Learn the fundamental principles of metallurgy and understand the importance of recovery of byproducts during extraction. **CO-2:** Understand the basic and practical applications in various fields of metals and alloy behavior and their manufacturing processes. **CO-3:** Apply the thermodynamic concepts likethat of Gibbs energy andentropy to the principles of extraction of metals. **CO-4:** Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table. **CO-5:** Understand oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides. **CO-6:** Understand vital role of sodium, potassium, calcium and magnesium ions in biological systems and the use of cesiumin devising photoelectric cells.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Halogenated Hydrocarbons and Oxygen Containing Functional Groups	**CO-1:** Understand preparation, properties and reactions of haloalkanes, haloarenes and oxygen containing functional groups. **CO-2:** Use the synthetic chemistry learnt in this courseto do functional group transformations. **CO-3:** To propose plausible mechanisms for any relevant reaction.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Phase Equilibria and Electrochemical Cells	**CO-1:** Understand phase equilibrium, criteria, CST, Gibbs-Duhem-Margules equation. **CO-2:** Learn the working of electrochemical cells, galvanic cell.	1. Demonstration of working of electrochemical cells in the lab. 2. Handling skills for potentiometer. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Core Subjects - Semester 4

Course Name	Course Outcomes	Methodology to Achieve the Specific Outcomes
Coordination Chemistry	**CO-1:** Understand the terms, ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds. **CO-2:** Discuss the various types of isomerism possible in such compounds and understand the types of isomerism possible in a metal complex. **CO-3:** Use Valence Bond Theory to predict the structure and magnetic behavior of metal complexes and understand the terms inner and outer orbital complexes. **CO-4:** Explain the meaning of the terms Δo., Δt, pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy. **CO-5:** Explain magnetic properties and colour of complexes on basis of Crystal Field Theory **CO-6:** Understand the important properties of transition metalslike variable oxidation states, colour, magnetic and catalytic properties and use Latimer diagrams to predict and identifyspecies which are reducing, oxidizing and tend to disproportionate and calculate skip step potentials. **CO-7:** Understand reaction mechanisms of coordination	1. Demonstration of UV-Vis spectrophotometer working. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Demonstration and performing the experiments to synthesize the new inorganic molecules inthe lab. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

	compounds and differentiate between kinetic and thermodynamic stability.	

Nitrogen containing functional groups,Polynuclear Hydrocarbons,Heterocyclic Chemistry,Alkaloids and Terpenes	**CO-1:** Gain theoretical understanding of chemistry of compounds having nitrogen containing functional groups, heterocyclic, polynuclear hydrocarbons, alkaloids and terpenes which includes various methods for synthesis through application of the synthetic organic chemistry concepts learnt so far. **CO-2:** Become familiar with theirparticular properties, chemical reactions, criterion of aromaticity with reference to polynuclear hydrocarbons and heterocyclic compounds, trendsin basicity of amines and heterocyclic compounds and their behavior at different pH. **CO-3:** Learn practical approach to structural elucidation of organic compounds with specific examples of terpenes and alkaloids. **CO-4:** Predict the carbonskeleton of amines and heterocyclic compounds via useof Hoffmann's exhaustive methylation and Emde'smodification methods. **CO-5:** Understand the applications of thesecompounds including their medicinal applications throughtheir reaction chemistry.	1. Practicals related to structural elucidation of organic compounds with specific examples of terpenes and alkaloids. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Experiment to predict the carbon skeleton of amines and heterocyclic compounds via use of Hoffmann's exhaustive methylation and Emde's modification methods. 7. Experiment to isolate caffeine from tea leaves

Conductance & Chemical Kinetics	**CO-1:** Explain the chemistry of conductance and its variation with dilution, migration of ions in solutions. **CO-2:** Learn the applications of conductance measurements. **CO-3:** Have understanding of rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic. **CO-4:** Have knowledge of the laws of absorption of light energy by molecules and the subsequent photochemicalreactions.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Core Subjects - Semester 5

Course Name	Course outcomes	Methodology to Achieve the Specific Outcomes
Biomolecules	**CO-1:** Understand and demonstrate how structure of biomolecules determines their reactivity and biological functions. **CO-2:** Gain insight into concepts of heredity through the study of genetic code, replication, transcription and translation. **CO-3:** Demonstrate understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes.	1. Techniques for Isolation and estimation of DNA using cauliflower/onion. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and vivavoce.

Quantum Chemistry & Spectroscopy	**CO-1:** Learn about limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecularsystems. **CO-2:** Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy. **CO-3:** Interpret various types of spectra and know about their application in structure elucidation.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Students will learn the techniques to handle colorimeter and spectrophotometer by hands on experience in the lab. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination.

Core Subjects - Semester 6

Course Name	Course Outcomes	Methodology to Achieve the Specific Outcomes
Organometallic Chemistry & Bio-inorganic Chemistry	**CO-1:** Understand and explain the basic principles of qualitative inorganic analysis **CO-2:** Apply 18-electron rule to rationalize the stability of metal carbonyls and related species **CO-3:** Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls. **CO-4:** Identify important structural features of the metal alkyls tetrameric methyl lithium and dimeric trialkyl aluminium and explain the concept of multicenter bonding in these compounds **CO-5:** Diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting it and understand and describe the active sites and action cycles of the metalloenzymes carbonic anhydrase and carboxypeptidase **CO-6:** Explain the sources and consequences of excess and deficiency of trace metals and learn about the toxicity of certain metal ions, the reasons for toxicity and antidotes **CO-7:** Explain the use of chelating agents in medicineand, specifically, the role of cisplatin in cancer therapy and explain the applications of iron in biological systems withparticular reference tohemoglobin, myoglobin, ferritin	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In practicals, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

	and transferring **CO-8:** Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process.	

Spectroscopy and Applied Organic Chemistry	**CO-1:** Gain insight into thebasic principles of UV, IR and NMR spectroscopic techniques. **CO-2:** Use spectroscopic techniques to determine structure and stereochemistry ofknown and unknowncompounds. **CO-3:** Develop a sound understanding of the structureof Pharmaceutical Compounds. They will also understand the importance of different classes of drugs and their applications for treatment of various diseases. **CO-4:** Learn about the chemistry of natural andsynthetic polymers including fabrics and rubbers. **CO-5:** Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles. **CO-6:** Learn about the theory of colour and constitution as well as the chemistry of dyeing. **CO-7:** Know applications of various types of dyes including those in foods and textiles.	1. Techniques to Identify simple organic compounds by IR and NMR spectroscopy. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

DSE Semester 5/6

Course Name	Course Outcomes	Methodology to Achieve the Specific Outcomes
DSE-1: Novel Inorganic Solids	**CO-1:** Understand the mechanism of solid-state synthesis. **CO-2:** Explain about the different characterization techniques and their principle. **CO-3:** Understand the concept of nanomaterials, their synthesis and properties. **CO-4:** Explain the mechanism of growth of self-assembled nanostructures. **CO-5:** Appreciate theexistence of bioinorganic nanomaterials. **CO-6:** Explain the importance of composites, conducting polymers and their applications. **CO-7:**Understand the usageof solid materials in various instruments, batteries, etc. which would help them to appreciate the real life importance of these materials.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

DSE-2: Inorganic Materials of Industrial Importance	**CO-1:** Learn the composition and applications of the differentkinds of glass. **CO-2:** Understand glazing of ceramics and the factors affecting their porosity. **CO-3:** Give the composition of cement and discuss the mechanism of setting of cement. **CO-4:** Explain the suitability of fertilizers for different kinds of crops and soil. **CO-5:** Explain the process of formulation of paints and the basic principle behind the protection offered by thesurface coatings. **CO-6:** Explain the principle, working and applications of different batteries. **CO-7:** List and explain the properties of engineering materials for mechanical construction used in day to day life. **CO-8:** Explain the synthesis and properties of Nano-dimensional materials, various semiconductor and superconductor oxides.	1. Use of 3D models to visualize the organic molecules in a three dimensional space. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and blackboard method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and vivavoce.

Skill Enhancement Course

Course Name	Course Outcomes	Methodology to Achieve the Specific Outcomes
Green Methods in Chemistry	**CO-1:** Get idea of toxicology, environmental law, energy and the environment. **CO-2:** Think to design and develop materials and processes that reduce the use and generation of hazardous substances in industry. **CO-3:** Think of chemicalmethods for recovering metals from used electronics materials. **CO-4:** Get ideas of innovativeapproaches to environmental and societal challenges. **CO-5:** Know how chemicals can have an adverse/potentially damaging effect on human and vegetation. **CO-6:** Critically analyze the existing traditional chemical pathways and processes and creatively think about bringing environmentally benign reformations in these protocols. **CO-7:** Convert biomass into valuable chemicals through green technologies.	1. Some motivating short movies in green chemistry especially in bio mimicry. 2. Blended mode of teaching with flip classroom approach along with traditional chalk and black board method. 3. Video lectures from SWAYAM and NPTEL. 4. Use of Virtual Labs. 5. Correlation of concepts with demonstration and experiments in Laboratory. 6. Assessment based upon continuous evaluation including quizzes, assignments projects, presentations, and class test. 7. In Practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce. 7. Visits to a green chemistry lab.