LEARNING OUTCOMES
SUBJECT: CHEMISTRY
STREAM: NEP 2020

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

STREAM: CHEMISTRY MAJOR

SEMESTER: I

Course Code: CHEM1011

Course Title: *Basic Chemistry-I*

Course Objective:

Topic: Atomic structure

Upon completion of this topic, learners should be able to:

- Outline the historical developments of atomic theory.
- Describe the structure of the atom.
- Write the postulates of different atomic theory.
- Derive the Rydberg equation using Bohr's atomic model.
- Determine the wavelength and frequency of radiation of emission spectrum.
- Draw s, p, d and f orbitals.
- Write Pauli's exclusion principle, Hund's rules of maximum multiplicity, Aufbau principle.
- Write the electronic configuration of atoms.
- Learn about the Ground state Term symbols of atoms.

Topic: Periodic properties

Upon completion of this topic, learners should be able to:

- Outline the historical developments of Periodic table.
- Describe the position of s-, p-, d- and f-block elements in the periodic table.
- Write the general characteristics of s-, p-, d- and f-block elements.
- Define different periodic properties viz. atomic and ionic size, ionization energy, electron affinity, electronegativity.
- Write the variation of periodic properties along the group and along the period in the periodic table.
- Describe the position of hydrogen and noble gases in the periodic table.
- Learn about the relativistic Effect, inert pair effect.

Topic: ***Acids and bases***

Upon completion of this topic, learners should be able to:

- Gain concepts about Arrhenius concept, Brönsted–Lowry concept, Lewis acid- base concept.
- Classify Lewis acids and bases.

- Describe conjugate acids and bases and relative strengths of acids and bases.
- Understand Lux-Flood concept and solvent system concept.
- Discuss about thermodynamic acidity parameters, Drago-Wayland equation, superacids, gas phase acidity, proton affinity.
- Elucidate HSAB concept and its applications.
- Learn about different buffer, acid-base neutralisation curves, indicator.
- Gain concept of different organic acids and bases.
- Discuss about proton sponge, gas-phase acidity and basicity.

Topic: Fundamentals in Organic chemistry

Upon completion of this topic, learners should be able to:

- Get knowledge about various electronic displacement phenomena *e.g.* inductive effect, field effect, mesomeric effect, electromeric effect, steric effect, steric inhibition of resonance (SIR).
- Differentiate between homolytic and heterolytic cleavage of bonds.
- Identify nucleophiles, electrophiles.
- Calculate formal charges and degree of unsaturation (DBE or IHD) in organic compounds.

- Draw orbital diagram of different types of bonding in organic compounds.
- Get idea about reactive intermediates e.g. carbocations, carbanions and free radicals radicals, carbenes, benzynes and nitrenes.
- Conceptualize melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular and intramolecular forces.
- Explain relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation.
- Understand the concept of aromaticity and Hückel's rules.
- Differentiate among aromatic, antiaromatic, non-aromatic and homoaromatic organic compounds.
- Draw Frost diagram of cyclic aromatic compounds.
- Get elementary idea about α and β and calculate delocalization energies in terms of β.

Topic: Properties of Gases

Upon completion of this topic, learners should be able to:

- Know about the behaviors and different law of ideal gases.

- Describe the deviation of gases from ideal behavior and derive van der Waals equation.;
- Derive compressibility factor; Boyle temperature and explain real gas behavior.
- Represent Andrew's and Amagat's plots and explain real gas behavior.
- Know about critical state, critical constants in terms of van der Waals constants.
- Describe the van der Waals equation expressed in virial form and significance of second virial coefficient.
- Know about intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea).

Topic: Chemical Kinetics-I

Upon completion of this topic, learners should be able to:

- Discuss the factors that affect the rate of chemical reactions.
- Differentiate between order and molecularity of a chemical reaction.
- Describe the general form of a (differential) rate law and how the rate of a chemical reaction depends on the concentrations of species that appear in the rate law.
- Determine the "overall reaction order" for a chemical reaction using the

(differential) rate law.

- Derive a general expression for the unit of rate constant and to find the unit of rate constant for zero, 1^{st}, 2^{nd},n^{th} order reaction.
- Explain why reactant molecules must have a certain minimum amount of kinetic energy when they collide in order for a chemical reaction to occur.
- Describe "activation energy" and how it can be experimentally determined.
- Determination of order of a reaction by half-life and differential method, opposing reactions, consecutive reactions and parallel reactions.
- Exemplify ‘kinetically controlled and thermodynamically controlled’ product.
- Discuss Temperature dependence of rate constant’.
- Describe "activation energy" and how it can be experimentally determined.
- Discuss Arrhenius equation, rate-determining step and steady-state approximation – explanation with suitable examples.

Topic: Thermodynamics-I

Upon completion of this topic, learners should be able to:

- Explain with suitable examples that laws of thermodynamics are based on the experiences gathered from natural phenomena.
- Justify the necessity of the knowledge of calculus in dealing with the laws of thermodynamics and their application.
- Exemplify the idea of system, surrounding and boundary. Mention salient features of different thermodynamic processes.
- Classify different properties as extensive and intensive; also make a correlation among the two.
- Explain that a thermodynamic function is called a state function only if it is a perfect differential.
- Write a brief review on internal energy.
- Explain why dq and dw are not state function but their sum is a state function.
- Interpret 1^{st} law of thermodynamics while applying to different processes.
- State the outcomes of Joule's experiment.
- Derive expression for work involved with different processes.
- Derive expression of work involved with different thermodynamic processes for ideal and real gases.

- Compare between works involved with different thermodynamic processes.
- Represent the concept of specific heat and explain how these have been used in thermodynamic derivations.
- State the reason for the change in enthalpy during chemical reactions and physical processes.
- Define with examples various types of enthalpy change associated with chemical reactions and physical changes. Also comment on their temperature dependence.
- Learn about different laws of thermo-chemistry, bond energy, bond dissociation energy and resonance energy from thermo-chemical data
- Establish Kirchhoff's equations and its effect of pressure on enthalpy of reactions.
- Discuss adiabatic flame temperature, explosion temperature.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

STREAM: CHEMISTRY MINOR

SEMESTER: I

Course Code: CHEM1021

Course Title: *General Chemistry-I*

Course Objective:

Topic: *Atomic Structure*

Upon completion of this topic, learners should be able to:

- Outline the historical developments of atomic theory.
- Describe the structure of the atom.
- Write the postulates of different atomic theory.
- Determine the wavelength and frequency of radiation of emission spectrum.
- Draw s, p, d and f orbitals.
- Write Pauli's exclusion principle, Hund's rules of maximum multiplicity, Aufbau principle.
- Write the electronic configuration of atoms.

Topic: Periodic properties

Upon completion of this topic, learners should be able to:

- Outline the historical developments of Periodic table.
- Describe the position of s-, p-, d- and f-block elements in the periodic table.
- Write the general characteristics of s-, p-, d- and f-block elements.
- Define different periodic properties viz. atomic and ionic size, ionization energy, electron affinity, electronegativity.
- Write the variation of periodic properties along the group and along the period in the periodic table.

Topic: *Acids and bases*

Upon completion of this topic, learners should be able to:

- Differentiate the following concepts Brönsted–Lowry concept, Lewis acid- base concept.
- Classify Lewis acids and bases.
- Describe conjugate acids and bases and relative strengths of acids and bases.
- Understand Lux-Flood concept and solvent system concept.
- Elucidate HSAB concept and its applications.

Topic: Aliphatic hydrocarbons

Upon completion of this topic, learners should be able to:

- Learn inductive effect, resonance and hyperconjugation.
- Differentiate between homolytic and heterolytic cleavage of bonds.
- Predict the structure of organic molecules on the basis of VBT.
- Draw orbital diagram of different types of bonding in organic compounds.
- Identify nucleophiles, electrophiles, nucleofuges and electrofuges.
- Get idea about reactive intermediates e.g. carbocations, carbanions and free radicals.
- Get idea about different types of aliphatic hydrocarbons.
- Prepare alkanes using catalytic hydrogenation, Wurtz reaction, Kolbe's electrolysis, Grignard reagent and organocopper reagents.
- Functionalize alkanes and carry out substitution reactions of alkanes via free radical mechanism such as halogenations reactions.
- Synthesize alkenes via elimination reactions e.g. dehydration of alcohols, dehydrohalogenation of alkyl halides, partial catalytic hydrogenation of alkynes and Birch reduction of alkynes.
- Prepare diol on reaction with Baeyer's reagent, OsO_4 with alkenes.

- Prepare vicinal dibromides, halohydrins, epoxides with reasonable mechanisms.
- Add unsymmetrical addendum of HX type according to Markownikoff's and anti-Markownikoff's addition with unsymmetrical alkenes.
- Carry out hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reactions on alkenes.
- Synthesize alkynes from metal carbides, by dehalogenation of tetra halides and dehydrohalogenation of vicinal & geminal dihalides.
- Convert terminal alkynes into non-terminal alkynes and vice-versa.
- Carry out addition, ozonolysis and oxidation reactions of alkynes.
- Exploit the acidity of acetylenic protons to form various metal acetylides.

Topic: Properties of Gases

Upon completion of this topic, learners should be able to:

- Know about the behaviors and different law of ideal gases.
- Describe the deviation of gases from ideal behavior and derive van der Waals equation.;
- Derive compressibility factor; Boyle temperature and explain real gas behavior.
- Represent Andrew's and Amagat's plots and explain real gas behavior.
- Know about critical state, critical constants in terms of van der Waals constants.

- Describe the van der Waals equation expressed in virial form and significance of second virial coefficient.
- Describe Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Topic: Thermodynamics-I

Upon completion of this topic, learners should be able to:

- Explain with suitable examples that laws of thermodynamics are based on the experiences gathered from natural phenomena.
- Exemplify the idea of system, surrounding and boundary. Mention salient features of different thermodynamic processes.
- Classify different properties as extensive and intensive; also make a correlation among the two.
- Explain that a thermodynamic function is called a state function only if it is a perfect differential.
- Write a brief review on internal energy.
- Explain why dq and dw are not state function but their sum is a state function.
- Interpret 1^{st} law of thermodynamics while applying to different processes.
- State the outcomes of Joule's experiment.
- Derive expression for work involved with different processes.

- Derive expression of work involved with different thermodynamic processes for ideal and real gases.
- Compare between work involved with different thermodynamic processes.
- Represent the concept of specific heatand explain how these have been used in thermodynamic derivations.
- State the reason for the change in enthalpy during chemical reactions and physical processes.
- Define with examples various types of enthalpy change associated with chemical reactions and physical changes. Also comment on their temperature dependence.
- Learn about different laws of thermochemistry, bond energy, bond dissociation energy and resonance energy from thermochemical data
- Establish Kirchhoff's equations and its effect of pressure on enthalpy of reactions.
- Discuss adiabatic flame temperature, explosion temperature.

Topic: Chemical Kinetics-I

Upon completion of this topic, learners should be able to:

- Discuss the factors that affect the rate of chemical reactions.
- Differentiate between order and molecularity of a chemical reaction.

- Determine the "overall reaction order" for a chemical reaction using the (differential) rate law.
- Derive a general expression for the unit of rate constant and to find the unit of rate constant for zero, 1^{st}, 2^{nd} , n^{th} order reaction.
- determination of order of a reaction by half-life and differential method, opposing reactions, consecutive reactions and parallel reactions.
- Discuss Temperature dependence of rate constant'.
- Describe "activation energy" and how it can be experimentally determined.
- Discuss Arrhenius equation, rate-determining step and steady-state approximation – explanation with suitable examples.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

STREAM: CHEMISTRY MAJOR

SEMESTER: 2

Course Code: CHEM2011

Course Title: ***Basic Chemistry-II***

Course Objective:

- Several basic topics from inorganic, organic and physical chemistry have been chosen for the development of the general chemistry knowledge of the students.
- This will help to grow the foundation for studying the several aspects of applied chemistry in future.

Course outcome:

- The topics will grow the foundation of the students for the subject chemistry for learning any further advanced topics.

Topic: ***Stereochemistry-I***

Upon completion of this topic, learners should be able to:

- Gain concept of asymmetry in carbon compounds.
- Can draw different projection formulae and interconvert them.
- Be familiar with symmetry elements and point groups.
- Know difference between asymmetric and dissymmetric molecules.
- Gain concepts about stereoisomerism, stereogenicity, chirotopicity etc.
- Get knowledge about Relative and absolute configuration.

- Get detailed idea about optical rotation, specific rotation and molar rotation.
- Know the process of racemization and resolution techniques of optically active acids, bases and alcohols.
- Calculate optical purity and enantiomeric excess.

Topic: ***General Treatment of Reaction Mechanism***

Upon completion of this topic, learners should be able to:

- Draw potential energy diagrams of elementary and complex organic reactions.
- Get idea about catalyzed reactions and classification of catalysis.
- Draw energy profile diagrams for a catalyzed and uncatalyzed reaction and explain the role of a catalyst in a chemical reaction.
- Explain electrophilic and nucleophilic catalysis with proper examples.
- Make out kinetic control and thermodynamic control of reactions.
- Elaborate both primary and secondary kinetic isotopic effect with evidences.
- Describe principle of microscopic reversibility.
- Gather information about tautomerism, specially keto-enol tautomerism and factors affecting tautomeric equilibria.
- Illustrate different types of tautomerism including prototropy, anionotropy, ring-chain tautomerism and valence tautomerism.
- Prove the presence of both keto and enol forms in solution.

Topic: ***Substitution and Elimination Reactions***

Upon completion of this topic, learners should be able to:

- Learn nucleophilic substitution reactions at sp3 centre with mechanism.

- Explain the effects of solvent, substrate structure, leaving group and nucleophiles on substitution reactions.
- Explain the involvement of NGP in the treatment of cancer.
- Describe the role of crown ethers and phase transfer catalysts in nucleophilic substitution reactions.
- Perform synthesis of alkenes and alkynes involving different kinds of elimination reaction with mechanism.
- Explain the conditions leading to the formation of Saytzeff & Hofmann elimination products.
- Compare between substitution and elimination reactions.
- Compare between nucleophilicity and basicity.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

STREAM: CHEMISTRY MINOR

SEMESTER: 2

Course Code: CHEM2011

Course Title: *General Chemistry-II*

Course Objective:

- Several basic aspects from inorganic, organic and physical chemistry have been discussed
- Generation of idea for studying physical and biological sciences in future.

Course outcome:

- The idea created from this course may help to understand students for further studying physical, biological and material sciences.

Topic: ***Fundamentals of Organic Chemistry***

Upon completion of this topic, learners should be able to:

- Learn inductive effect, resonance and hyperconjugation.
- Differentiate between homolytic and heterolytic cleavage of bonds.
- Predict the structure of organic molecules on the basis of VBT.
- Draw orbital diagram of different types of bonding in organic compounds.
- Identify nucleophiles, electrophiles, nucleofuges and electrofuges.
- Get idea about reactive intermediates e.g. carbocations, carbanions and free radicals.

Topic: ***Stereochemistry***

Upon completion of this topic, learners should be able to:

- Represent the molecule in different projection formulae (*e.g.* Fischer and Newman).
- Illustrate the asymmetric and dissymmetric molecules; enantiomers and diastereomer.
- Describe absolute and relative configuration: D/L, R/S and E/Z, threo and erythro, *cis*- and *trans*- nomenclature.

Topic: ***Nucleophilic Substitution and Elimination Reactions***

Upon completion of this topic, learners should be able to:

- Learn elementary mechanistic aspects of nucleophilic substitution reactions (S_N1 & S_N2) and elimination reactions (E1 & E2).
- Get familiar with S_Ni reaction.
- Predict Saytzeff and Hofmann elimination products
- Recognize substitution-elimination dichotomy in case of base catalyzed reactions.

- Understand elimination *vs.* substitution products.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

STREAM: CHEMISTRY MINOR

SEMESTER: 2

Course Code: CHEM2031

Course Title: *Multidisciplinary*

Course Objective:

- Introduction of idea of every day products of chemical industries

Course Outcome:

- Development of idea of several molecules and materials related to dye and cosmetics industry

Topic: *Chemistry of Dyes, Pigments*

Upon completion of this topic, learners should be able to:

- Learn elementary mechanistic aspects of nucleophilic substitution reactions (S_N1 & S_N2) and elimination reactions (E1 & E2).
- Define and classify dyes and pigments.
- Draw structures of dyes and pigments.
- Understand theories of coloration of dyes and pigments.
- Prepare dyes like phenolphthalein, methyl orange, malachite green, alizarin and indigo.
- Get elementary idea on different types of pigments like chlorophyll, carotenoids, anthocyanins, flavonoids.

Topic: ***Chemistry of Cosmetics***

Upon completion of this topic, learners should be able to:

- Document the constituents, their function and toxic effects, if any, in the following cosmetics:-

  Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.

- Outline the analysis of deodorants and anti-perspirants.

Topic: ***Chemistry of Perfumes***

Upon completion of this topic, learners should be able to:

- Learn elementary idea about essential oils.
- Their importance to the cosmetic industries with the given oils; e.g. eugenol, geraniol, sandalwood oil, eucalyptus, rose-oil, 2-phenyl ethyl alcohol, jasmone, civetone, muscone.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

STREAM: CHEMISTRY SEC

SEMESTER: I

Course Code: CHEM1051

Course Title: *Drugs and pharmaceuticals*

Course Objective:

Topic: Drugs and pharmaceuticals

Upon completion of this topic, learners should be able to:

- Learn about drug discovery, design and development.
- Synthesize aspirin, paracetamol, ilbuprofen, penicillin, chloramphenicol, sulphonamides, sulphanethoxazol, sulphacetamide, trimethoprim, acyclovir, phenobarbital, diazepam, glyceryl trinitrate, glyceryl trinitrate and zidovudine.
- Understand the mechanism of action of drugs and their uses.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

STREAM: CHEMISTRY Multi

SEMESTER: I

Course Code: CHEM1031

Course Title: *Chemistry for Household Importance*

Course Objective:

Topic: Food chemistry

Upon completion of this topic, learners should be able to:

- Gather knowledge about Food additive, food flavor, adulterant, preservative, artificial sweeteners.

Topic: Drugs and pharmaceuticals

Upon completion of this topic, learners should be able to:

- Learn about Structure and function of antipyretic and analgesic drugs – aspirin, paracetamol, and ibuprofen.

Topic: Vitamins

Upon completion of this topic, learners should be able to:

- Gain concepts about vitamin C and B_{12}

Topic: Antibiotics

Upon completion of this topic, learners should be able to:

- Get idea about penicillin, sulphaguanidine and chloramphenicol

Topic: Glass and ceramics

Upon completion of this topic, learners should be able to:

- Define glasses and describe the manufacturing process of optical and color glasses.

Topic: Surface chemistry

Upon completion of this topic, learners should be able to:

- Get idea about soaps and detergents.

Topic: Chemistry of fuels

Upon completion of this topic, learners should be able to:

- Explain conventional and non-conventional energy sources.
- Classify fuels and know calorific values of fuels like kerosene, coal, coal gas, petrol, liquefied petroleum gas, octane number, and biogas.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

Paper title: CHEM2051

STREAM: Basic Analytical Chemistry

SEMESTER: 2

Course objective:

- Development of skill for analyzing several natural and synthetic samples to find out their purity, composition, etc Development of skill for advanced separation techniques for natural and synthetic¬ samples

Course outcome:

- This course will develop the analysis as well as separation skills of the students which may help them to motivate for joining research and/or have employment.

Upon completion of this topic, learners should be able to:

- Get an introduction on the interdisciplinary nature of analytical chemistry.
- Compare accuracy and precision.
- Calculate mean, median, standard deviation, relative standard deviation, variance, range, etc. from a given set of data.
- Identify significant figures.
- Round off results of numerical calculations up to correct number of significant figures.
- Calculate standard deviations of calculations.

Topic: ***Analysis of Soil***

Upon completion of this topic, learners should be able to:

- Gather knowledge about composition, texture, water content, pH of various types of soil.
- Understand the importance of soil pH and its determination.
- Know about the ways to control soil pH.
- Justify the use of EDTA as the complexone in the complexometric titration.
- Classify complexometric titrations.
- Point out the requirements of a chelometric indicator.
- State the importance of pH in complexometric titrations.
- Enumerate pM [negative logarithm of metal ion concentration] at different stages of complexometric titration.
- Determine the hardness of water sample by complexometric titration.
- Exemplify masking and demasking agents and their use in determination of more than one metal ion in a mixture.

Topic: ***Analysis of Water***

Upon completion of this topic, learners should be able to:

- Gather the knowledge about the contaminants/impurities and health issues resulted from these.
- Explain the importance of DO, BOD and COD.
- State the principle of the methods of determination of DO, BOD and COD.
- Describe the process of water purification.
- Narrate water sampling methods.

Topic: ***Analysis of Food Products***

Upon completion of this topic, learners should be able to:

- Discuss about the nutritional value of foods.
- Have the idea of food processing.
- Name different food preservatives, their function and adverse effects, if any, on the health of consumers.
- Name different food adulterants with examples.
- Mention the adverse effects of food adulteration.

Topic: ***Chromatography***

Upon completion of this topic, learners should be able to:

- Define chromatography.
- State the stationary and mobile phases employed in different types of chromatographic techniques.
- Classify chromatographic techniques in different categories.
- Expound the importance of retention factor (R_f) in chromatography.
- Write basic principles of adsorption and partition chromatography.
- Narrate the difference in basic principles of ion-exchange chromatography, thin layer chromatography and paper chromatography.
- Differentiate among different types of chromatographic techniques.

Topic: ***Ion-Exchange***

Upon completion of this topic, learners should be able to:

- Comment on the types of ion-exchange resins.
- Put down relevant chemical equations regarding the functioning of cation and anion exchangers.
- Elaborate the method of determination of exchange capacity of both cation and anion exchangers.
- Arrange cations/anions in the order of their elution by ion-exchange chromatographic technique.

Topic: ***Analysis of Cosmetics***

Upon completion of this topic, learners should be able to:

- Document the constituents, their function and toxic effects, if any, in the following cosmetics:-

  Nail polish, lipstick, eye liner, hair gel, shampoo, conditioner, nail polish remover, pedicure, manicure, face powder, sun screen lotion, cleansing lotion, cold cream, vaseline, lip gloss, fairness cream, vanishing cream, non-sticky hair oil, deodorant, anti-perspirant.

- Outline the analysis of deodorants and anti-perspirants.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

Paper title: CHEM3011

STREAM: Inorganic Chemistry (Th)

SEMESTER: III

Course objective:

Chapters	Syllabus	Course outcome *Upon completion of the topic, learners should be able to:*
1. Chemical Bonding-II	Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach): sigma and pi-bonds and delta interaction, multiple bonding. Orbital designations: gerade, ungerade, HOMO, LUMO. Orbital mixing, MO diagrams of H_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO^+, CN^- , HF, BeH_2, CO_2 and H_2O. Bond properties: bond orders, bond lengths. Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids – stoichiometric and non-stoichiometric. Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Intermolecular forces: Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points.	➢ Illustrate MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals. ➢ Define sigma, pi-bonds, delta interaction and multiple bonding. ➢ Identify the orbital designations: gerade and ungerade. ➢ Define HOMO and LUMO in MO diagrams. ➢ Describe the criteria of orbital mixing. ➢ Draw and explain the MO diagram of homodiatomic molecules (H_2, Li_2, Be_2, B_2, C_2, N_2, O_2 and F_2) and bonding properties and magnetic behavior. ➢ Draw and explain the MO diagrams of heterodiatomic molecules (CO, NO, NO^+, CN^-, HF, BeH_2, CO_2 and H_2O) and bond properties and magnetic behavior. ➢ Understand the importance and application of weak chemical forces(inter-molecular and intramolecular) and their effect on melting points, boiling points, solubility and energetics of dissolution.
2. Coordination Chemistry-I	Double and complex salts. Werner's theory of coordination complexes, Classification of ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination	➢ Present a brief history of the emergence of coordination chemistry. ➢ Differentiate between double and complex salts. ➢ Untangle Werner's theory of

	compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.	coordination complexes. ➢ Classify ligands into different categories. ➢ Define and furnish examples of various kinds of ligands. ➢ Explicate classical and non-classical binding modes of ligands and correlate denticity and hapticity. ➢ Show different binding modes of a ligand. ➢ Justify the binding of ambidentate ligands with the aid of SHAB principle, symbiotic effect and competitive pi-bonding. ➢ Rationalize synergic bonding and synergic effect. ➢ Compare and contrast between pi-acid ligands and pi-complexing ligands. ➢ Explain chelate effect and compare with the macrocyclic effect. ➢ Write a note on inner-metallic complexes. ➢ Name coordination complexes obeying the rules set by IUPAC. ➢ Expound different types of isomerism in square planar and octahedral complexes.
3. Chemistry of s and p-block elements	Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides. Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur. Sulphur-nitrogen compounds, Basic properties of halides and polyhalides, interhalogen compounds, pseudohalides, fluorocarbons and chlorofluorocarbons. Noble Gases Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation, structures (VSEPR theory) and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2 and XeF4).	➢ Outline the relative stabilities of different oxidation states of representative elements. ➢ Point out the anomalous behaviour of first member of each group. ➢ Describe allotropy and catenation properties of elements. ➢ Describe the structure, bonding, preparation, properties and uses of beryllium hydrides, beryllium halides, boric acid, borates, boron nitrides, borohydrides (diborane) and graphitic compounds. ➢ List the oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. ➢ Describe the structure and properties of sulphur-nitrogen compounds. ➢ Enumerate the basic properties of halides. ➢ Write the preparation, structure and properties of polyhalides, interhalogen compounds, polyhalides, pseudohalides. ➢ Write the properties and use of fluorocarbons and chlorofluorocarbons and their adverse effect on ozone layer.

	Xenon-oxygen compounds.	**Topic: *Noble Gases*** ➢ Describe the occurrence, uses and interest of nobel gases. ➢ Define and explain clathrate compounds of nobel gases and their application. ➢ Discuss the preparation, structure, nature of bonding and properties of XeF_2, XeF_4 and XeF_6. Know about xenon-oxygen compounds and their application.

LEARNING OUTCOMES

SUBJECT: CHEMISTRY

Paper title: CHEM3031

STREAM: Chemistry of Soil and Fertilizer

SEMESTER: III

Course objective:

Chapters	Syllabus	Course outcome *Upon completion of the topic, learners should be able to:*
1. Soil	Composition, texture, micro & macro nutrients, soil health, soil conditioner, growth factor, NPK and their determination, soil productivity and effect of pH	➢ Know fundamental chemistry nd chemical composition of soil including the role of organic matter and how to analyze soil pH and salinity ➢ Manage soil fertility and productivity ➢ Identify soil defects and how to use biofertilizers and other organic inputs
2. Fertilizer	Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.	➢ Explain the roles of essential plant nutrients like nitrogen, phosphorus, potassium, and their impact on plant growth. ➢ Describe the chemical processes involved in manufacturing common fertilizers like urea, DAP, and potash, including raw materials and production steps. ➢ Understand methods for testing fertilizer quality and ensuring compliance with regulatory standards.
3. Fungicide, pesticide, herbicide	Fungicide, pesticide, herbicide with examples, advantage and disadvantage.	➢ Know about different pesticides, herbicides and fungicides and their and their effect on soil and also on

		atmosphere. ➢ Learn about the harmful impact of pesticide residue on human life.
4. Soap & Detergents	Different types of soap and detergents with example, surface active and surface inactive substances	➢ Understand raw materials and soap making process. ➢ Understand different types of soaps and their uses. ➢ Understand and learn the detergent making process.