Chemistry – Course Learning Outcome (CLO)

Semester I:

1) BSEDCHEM-101: Physical and Inorganic Chemistry

Course Learning Outcome:

Theory:

At the end of the course students will be able to

- Define the terms, state the laws and principles involved in chemical kinetics, gaseous state
- Calculate the slopes, maxima and minima of the various functions involved in Mathematical Concept.
- Describe the theories of reaction rates and different methods of determination of Order of reaction
- Derive and use the equations involved in Chemical kinetics and Gaseous state to solve numericals.
- Interpret structure of atom based on Thomson's, Rutherford's and Bohr's theory.
- Generalise bonding in Covalent molecules based on Valence bond theory, VSEPR theory and Molecular Orbital Theory.
- Calculate dipole moment and % ionic character.
- To draw molecular orbital diagrams and calculate bond order and magnetic properties.

Practical:

At the end of the course students will be able to

- Develop an understanding of role of catalyst in hydrolysis of methyl acetate, degree of hydrolysis of urea hydrochloride.
- Demonstrate the use of Ostwald's viscometer and to determine viscosity
- Demonstrate calibration of apparatus
- Analyse the given salt for its components (cations and anions)
- Apply the concepts of molarity, normality to prepare the solutions.

2) BSEDCHEM-103: Organic and Inorganic Chemistry

Course Learning Outcome:

Theory:

At the end of the course students will be able to

- Explain the concepts of hybridization, C-C bond lengths, bond angles, bond energy, localized and delocalized chemical bonds,
- Define the various terms like Van der Waals interactions, resonance, hyperconjugation, inductive and field effects, intramolecular and intermolecular hydrogen bonding.
- Identify and use the curved arrow notations in organic reaction.
- Draw the energy profile diagrams for exothermic and endothermic reactions.
- Explain the types of Organic reactions with examples.
- Explain reactive intermediates and methods of determination of reaction mechanism.
- Explain the concept of acids and bases.
- Give the general methods of formation and explain Baeyer strain and strainless rings theory.
- Give the general methods of formation and Chemical reactions of alkanes, alkenes and alkynes with mechanism.
- Classify dienes and write the nomenclature of dienes, alkanes and alkenes.

- Predict the structure and stereochemistry of allenes.
- Write the chemical reactions of dienes.
- Define the terms involved in the chapter Periodic Properties, derive the equations for the various periodic properties and follow the trends within groups and periods of the various periodic properties • Define and understand various acid-base theories with various examples
- Understand the behavior of non- aqueous solvents like liquid ammonia and liquid Sulphur dioxide with the help of the distinct reactions taking place in these solvents.

Practical:

- The students will be able to get hands on experience for the systematic qualitative analysis of the organic compounds and the purification and separation techniques for organic compounds.
- Will be able to calibrate burettes and pipettes.
- Will be able to prepare dilutions in molarity and ppm using KMnO4 and K2Cr2O7
- Will be able to qualitatively analyse different cations and anions using the method of semi-micro analysis

Semester II:

1) BSEDCHEM-102: Physical and Inorganic Chemistry

Theory:

At the end of the course students will be able to

- Define the terms, state the laws and principle used in thermodynamics, Solutions and liquid state.
- Explain the concept of standard states in thermodynamics, activity and activity coefficient in solutions and structural differences between solids, liquids and gases.
- Derive the equations of thermodynamics, thermochemistry, colligative properties, surface tension and viscosity and to solve numericals.
- Discuss the experimental methods based on colligative properties.
- The students will be able to define the terms hydration energy, polarization, inert pair effect, allotropy, catenation.
- They will be able to state the electronic configuration of group I, II, 13 and 14.
- They will be able to draw the structure of chlorophyll and sodium potassium ion pumping system, structure of diamond, graphite, borazine, silicates
- They will be able to generalize the Characteristics of group I &II .
- Explain the diagonal relationship of elements involving group I and II elements.
- Discuss the biological significance of Sodium/Potassium , Calcium and Magnesium.

Practical:

At the end of the course students will be able to

- Develop an understanding of concept order of the reaction.
- Demonstrate the use of stalagmometer and to determine surface tension of the liquid
- Apply the concepts of morality, normality, ppm, mole fraction to prepare the solutions. And also prepare the further dilutions of the same.
- Perform standardization (volumetric titration)using double burette method. 14
- Estimate ions (volumetric titration) using single burette method.
- Carry out quantitative estimation of mixtures by gravimetric method of analysis.

2) BSEDCHEM-104: Organic and Inorganic Chemistry

Theory:

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

- Draw Newman, Sawhorse, Fischer and flying Wedge representations and the conformations with respect to ethane, n-butane, cyclohexane and mono-substituted cyclohexane derivatives.
- Discuss the concept of isomerism, stereoisomerism, configuration, chirality, optical isomerism, resolution of enantiomers, inversion, retention and racemization.
- Distinguish between conformation and configuration.
- Give the nomenclature and assign configuration to configurational isomers.
- Give the nomenclature of benzene derivatives, alkyl halides and classify alkyl halides.
- Explain the structure of benzene and the concept of aromaticity.
- Explain the mechanism of various aromatic electrophilic substitution reactions of arenes along with the influence of activating and deactivating substituents.
- Give the general methods of formation and chemical reactions of alkyl benzenes and alkyl halides.
- Explain the mechanism and stereochemistry of nucleophilic substitution reactions of alkyl halides

and the addition – elimination and the elimination – addition mechanisms of nucleophilic aromatic substitution reactions. 18

- Explain the relative reactivities of alkyl halides vs. Allyl, vinyl and aryl halides.
- Describe the general properties of group 15,16 and 17 elements and the general properties of xenon.
- Explain the diagonal relationship of elements involving group 15,16 and 17 elements.
- Explain the general properties and structure and bonding of special compounds of elements of groups 15,16,17 and of xenon compounds.

Practicals:

The students will be able to:

- Conduct double burette and single burette methods.
- To gravimetrically estimate composition of double salt mixtures by weight loss method.
- Get hands on experience for the systematic qualitative analysis of the organic compounds which include alkyl and aryl halides, nitrohydrocarbons, bases, alcohols, esters, anilides and carbohydrates.

Semester III:

1) BSEDCHEM-201: Physical and Inorganic Chemistry

Theory:

At the end of the course students will be able to

- Define the terms involved in Thermodynamics, Chemical equilibrium and Phase equilibrium.
- State the laws, principles of Thermodynamics, Chemical equilibrium and Phase equilibrium.
- Draw the schematic diagrams, phase diagrams and the graphs involved.
- Distinguish between types of systems, types of liquid-liquid mixtures.
- Explain the terms involved in Thermodynamics, Chemical equilibrium and Phase equilibrium with suitable examples, interpret the phase diagrams.
- Explain classification of liquid mixtures, one component and two component systems; working of Carnot cycle and its efficiency.
- Derive and use the equations to solve the numericals in Thermodynamics, Chemical equilibrium and Phase equilibrium.
- Interpret the reaction isotherm and reaction isochore, study the concept of entropy with respect to variables.
- Apply IUPAC rules for naming co-ordination compounds.
- Interpret Werner's co-ordination theory for co-ordination compounds.
- Classify ligands on basis of Chelation.
- Generalise and explain the different characteristics of 3d metals.

Practical:

At the end of the course students will be able to

- Understand the concepts of phase equilibrium, partition coefficient and conductometry.
- Develop skills of working with a mixture of immiscible liquids and separating them.
- Solve numericals based on conductance values and verify the Nernst distribution law

2) BSEDCHEM-203: Organic and Inorganic Chemistry

Theory:

At the end of the course students will be able to

- Define and explain giving examples the terms involved, the laws, the rules and the principles in UV -Visible Spectroscopy and Infra Red (IR) absorption spectroscopy.
- Explain various electronic transitions in UV -Visible Spectroscopy
- Apply Woodward-Fieser rules for calculation of λmax for Conjugated dienes and enones.
- Explain the various factors which effects the intensity and position of IR and UV bands.
- Explain the use of Finger print region to establish the identity of unknown compound in Infra Red (IR) absorption spectroscopy.
- Give applications of UV -Visible Spectroscopy and Infra Red (IR) absorption spectroscopy.
- Interpret the IR and UV spectra of simple organic compounds.
- Elucidate the structure of simple organic compound using UV and IR spectroscopy.
- Classify, name and draw the structures of monohydric alcohols, dihydric alcohols, ethers, aldehydes and ketones.

- Describe the methods of preparations of monohydric alcohols, dihydric alcohols, ethers, epoxides, aldehydes and ketones.
- Explain hydrogen bonding and acidity of alcohols.
- Give physical properties of ethers, aldehydes and ketones.
- Describe the reactions of alcohols, ethers, epoxides, aldehydes and ketones mentioned in the syllabus including mechanism and application.
- Define the concepts of oxidation and reduction anddraw Frost, Latimer and Pourbaix diagrams and apply them for various reactions
- Define lanthanides and understand their position, occurrence compounds and the oxidation states exhibited by them.
- Understand the effects of lanthanide contractions on the elements of the periodic table and the technique of lanthanide separation.

Practicals:

- Will be able to quantitatively estimate the desired organic compounds
- Will be able to prepare desired Organic derivatives
- Will be able to quantitatively estimate the desired metal ions by gravimetry

Semester IV:

1) BSEDCHEM-202: Physical and Inorganic Chemistry

Theory:

At the end of the course students will be able to

- Define the terms involved in Electrochemistry, Solid state and Colloidal state.
- Draw the schematic diagrams, diagrams of Hittorf method and moving boundary method.
- Describe the electrical transport –conduction in metals and in electrolyte solutions.
- Explain the terms involved giving examples, classify the types of sols, colloids and emulsions.
- Derive and use the equations to solve the numericals in electrochemistry, solid state.
- Interpret the laws of crystallography. Interpret crystal structures, determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).
- To generalize the characteristics of transition metals of second and third series.

Practical:

At the end of the course students will be able to

- Understand the concepts of conductance measurement and solubility product.
- Develop skills of working and set up of electrochemical cells and electrodes.
- Solve numericals based on conductance, volumetric estimation and verify the graph of conductivity measurements and chemical kinetics.

2) BSEDCHEM-204: Organic and Inorganic Chemistry

Theory:

At the end of the course students will be able to

- Give nomenclature and draw structures of Organic compounds mentioned in the syllabus.
- Give the properties of various organic compounds mentioned in the syllabus.
- Explain structure and bonding in organic compounds mentioned in the syllabus.
- Compare acidic characters, physical properties and acid strength of alcohols and phenols.
- Explain preparations/synthesis methods and reactions mentioned in the syllabus with mechanism of various organic compounds.
- Explain properties and preparation of picric acid.
- Explain structural features affecting basicity of amines.
- Explain Stereochemistry of amines and separation of mixtures of primary, secondary and tertiary amines.
- Give the use of amines as phase-transfer catalyst.
- Define actinides and understand their position in the periodic table.
- Separate the individual actinides like Np, Pu, Am and U from their ores.
- Define ionic solids and know the properties of ionic solids.
- Derive the values of lattice energies of various ionic crystals.
- Understand defects in stoichiometric and non-stoichiometric solids and apply this knowledge for finding out defects in various ionic solids.

Practicals:

- Will be able to develop skills of identification and analysis of desired organic compounds
- Will be able to develop skills of binary mixture separation.
- Will be able to quantitatively estimate the metal ions calcium and nickel by volumetric techniques.

Semester V:

Theory

1) CHE-501: Physical Chemistry

At the end of the course students will be able to

- Define the terms involved in Quantum chemistry, electrochemistry, molecular structure and nuclear chemistry.
- State the laws, principles of quantum chemistry, electrochemistry, molecular structure and nuclear chemistry. postulates of quantum mechanics
- Draw the schematic diagrams, diagrams of instruments, wavefunctions, orbital diagrams and the graphs involved.
- Distinguish between types of nuclear forces, types of polarisations.
- Explain the terms involved in quantum chemistry, electrochemistry, molecular structure and nuclear chemistry with suitable examples, interpret the graph of binding energy, neutron energy.
- Explain classification of electrochemical cells, nuclear models, working of counters used in measurement of radioactivity, electrodes used in electrochemical cells.
- Derive and use the equations to solve the numerical in quantum chemistry,electrochemistry, molecular structure and nuclear chemistry.
- Interpret the wavefuction, compare the various methods involved in measurement of dipole moment.

2) CHE-502: Inorganic Chemistry

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

- Generalise the drawbacks of valence bond theory, postulates of Crystal field theory for complexes.
- Interpret the magnetic properties, structure and spin behaviour of complexes based on Crystal field theory
- Define the terms Organometallic compounds, mononuclear, polynuclear metal carbonyls.
- State and calculate the Effective atomic number rule, 18 electron rule for metal carbonyls and organometallic compounds.
- State the names of metal carbonyls and organometallic as per the IUPAC system.
- Discuss methods of preparation, structure and bonding in metal carbonyls and ferrocene.
- Prepare alkyls and aryls of Li ,Al ,Hg and Ti by various methods and Know the physical and chemical properties of alkyls and aryls of Li ,Al ,Hg and Ti
- Understand the use of model systems in studying macromolecular biological molecules.
- Define the roles of metalloenzymesin biological systems.
- Explain general methods of preparations of organometallic compounds
- Explain preparation method and structures of polynuclear metal carbonyl like Mn2(CO)10 , Fe2(CO)9 and Fe3(CO)12
- Define and differentiate different types of defects.

Practical

1) CHE-503: Experiments in Physical and Inorganic Chemistry

At the end of the course students will be able to

- Understand the concepts of phase equilibrium, adsorption isotherms and activation energy solubility

- Develop skills of working and set up of electrochemical cells.
- Solve numericals on and verify the graph of adsorption isotherms.
- Understand the methods to quantitatively estimate with precision the desired amount of the precipitate by using gravimetry.
- Understand various methods to estimate inorganic complexes of various ionsand calculate the percentage yield.
- Discuss the theory behind experiments.

Semester VI:

Theory

1) CHE-601: Organic Chemistry

At the end of the course students will be able to

- Explain important concepts in NMR and Mass spectroscopic methods.
- Solve the problems pertaining to structure elucidation of simple organic molecules using spectroscopictechniques (UV, IR, PMR, CMR and MS).
- Explain the structure elucidation and give synthesis of nicotine, atropine, papaverine, vitamin A, C, thyroxine and adrenaline.
- Explain the mechanism and stereochemistry of addition of halogens and halogen acids to open chain alkenes, substitution reactions and elimination reactions.
- Explain the molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine.
- Give the methods of synthesis and chemical reactions of pyrrole, furan, thiophene and pyridine with particular emphasis on the mechanism of electrophilic substitution and indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and bischler-Napieralski synthesis.
- Explain the mechanism of, nucleophilic substitution reactions in pyridine derivatives and electrophilic substitution reactions of indole, quinoline and isoquinoline.
- Compare basicity of pyridine, piperidine and pyrrole.
- Give examples of condensed 5 and 6 membered heterocycles.
- Discuss the importance of vitamins and hormones.
- Classify vitamins, amino acids and proteins.
- Explain the structure of amino acids, peptides and proteins.
- Give the preparation methods and reactions of α-amino acids.
- Explain the concept of isoelectric point, electrophoresis, protein denaturation/renaturation, nucleic acids and double helical structure of DNA.
- Give reactions for peptide synthesis, hydrolysis of peptides, nucleic acids and methods for peptide structure determination

2) CHE-602: Analytical Chemistry

At the end of the course students will be able to

- To define the terms involved in analytical chemistry
- To explain scope and importance of analytical chemistry
- To interpret steps involved in chemical analysis
- To describe the basic components of instruments for analysis
- To define the terms involved in sampling techniques.
- To classify and explain different types of sampling.
- To explain the terms involved giving examples.
- To explain sampling of liquid, solid and gases.
- To define the terms involved in data handling
- To classify different types of errors giving examples.
- To explain and to solve numericals.

- To derive and use the equations of linear least squares and method of averages and to solve numericals.
- To state the laws and principles involved in Solvent extraction.
- To explain the different types of extraction.
- To derive and use the equations to solve numericals.
- To define the terms involved in different electrolytic methods, state laws and principles.
- To draw the schematic diagrams, diagrams of instruments and describe its working.
- To differentiate between various methods and explain them.
- To discuss the merits and limitations of the methods.
- To describe the application of each method giving examples.
- To state the terms used.
- To explain the principle of potentiometric titrations, location of equivalence point and types of potentiometric titrations.
- To draw schematic diagrams

Practical

1) CHE-603: Experiments in Organic and Analytical Chemistry

- Understand stoichiometric requirements during organic synthesis.
- Develop skills of common laboratory techniques including reflux, recrystallisation, recording of melting point, distillation, titration and chemical analysis.
- Perform calculations for quantitative analysis.
- Determine concentration of iron amd magnesium by using colorimeter.
- Use ion exchangers to separate mixtures of Mg and Zn. Estimate Pb by conductometry,vit c by iodometry and calcium by volumetry.

Semester VII:

Theory

1) CHE-701: Physical Chemistry

At the end of the course students will be able to

- Define the terms involved in Quantum chemistry, electrochemistry, photochemistry, spectroscopy and nuclear chemistry.
- Draw the schematic diagrams, diagrams of reactors, energy sources, molecular orbital diagrams and the graphs involved.
- Describe the working of reactors, electrochemical cells and energy sources.
- Explain the terms involved giving examples, classify the types of nuclear reactors, energy sources and corrosion types.
- Derive and use the equations to solve the numerical in electrochemistry, spectroscopy, photochemistry
- Interpret the physical picture of bonding and antibonding wavefuction, Interpret Jablonski diagram, distinguish between various photochemical processes.

2) CHE-702: Inorganic Chemistry

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

- Know the types of electronic transitions and understand the selection rules to determine whether the different electronic transitions are allowed or not.
- Apply the knowledge of allowed transitions to determine ligand field strength, color of complexes, Cis-trans isomerism and Geometry of complexes.
- Discuss the manufacture of coal gas, producer gas and Water gas.
- Discuss the different factors affecting the synthesis of ammonia by Haber's method and Nitric acid by Ostwald's method.
- Explain Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rotation – reflection axis and Identity and apply to different molecules
- Define the terms magneticmoment, hysteresis, curie temperature, neel temperature.
- Generalise the different types of magnetic behaviour and evaluate the temperature dependence of magnetic susceptibility.
- Generalise the properties and applications of nanomaterials with examples.
- To discuss properties structure and applications of Zeolites.
- Discuss superconductivity and different types of superconductors
- Define and know the properties of inorganic polymers.
- Classify condensation, addition and coordination Polymers
- Discusspreparation, structure & bonding and applications of silicones
- Define stability constants of reactions in terms of thermodynamic and kinetic stability.
- Know the various factors affecting the stability constants of complexes.
- Know the types of substitution reaction mechanisms of octahedral complexes
- Understand the trans effect and to apply it to square planar complexes.

Practical

1) CHE-703: Experiments in Physical and Inorganic Chemistry

At the end of the course students will be able to

- Understand the concepts of conductance adsorption isotherms and activation energy solubility product.
- Develop skills of working and set up of electrochemical cells and electrodes
- Solve numericals on and verify the graph of adsorption isotherms.
- Understand the volumetric method to quantitatively estimate with precision the desired amount of the metal ions.
- Understand the volumetric methods for determination of some physicochemical parameters in sea and mineral water.

Semester VIII:

Theory

1) CHE-801: Organic Chemistry

At the end of the course students will be able to

- Define/Explainvarious terms involved in the syllabus.
- Classify carbohydrates, terpenes, polymerization, dyes and drugs
- Illustrate general reactions and discuss configuration of Monosaccharides with reference to glucose. • Draw cyclic structure of D(+)- glucose, discuss interconversion of glucose and determine ring size of Monosaccharides with reference to glucose.
- Describe mechanism of mutarotation, formation of glycerides, ethers, esters and structure elucidation of sucrose.
- Explain the general methods of structure elucidation of terpenes.
- Describe the chemistry of α-terpineol, camphor, citral, α-pinene, zingiberene and describe the synthesis of α-terpineol, camphor, citral and its conversion to ionones.
- Explain the acidity of α-hydrogens, alkylation of diethyl malonate, ethyl acetoacetate, 1,3-dithianes, enamines and acylation of enamines.
- Explain the keto-enol tautomerism and synthesis of ethyl acetoacetate by Claisen condensation.
- Define and explain the terms saponification value, iodine value and acid value of oils.
- Explain the chemistry of following- Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, soaps, synthetic detergents, alkyl and aryl sulphonates and hydrogenation of unsaturated oils.
- Describe the chemistry and preparations of various polymers, dyes and drugs mentioned in the syllabus.
- Name and draw structure of one compound from all classes of pharmacodynamic agents and chemotherapeutic agents and give their applications.
- Name and describe the structural features of Organosulphur and Organophosphorus compounds.
- Describe the various methods of preparations and reactions of thiols, thioethers, sulphonic acids, phosphines and phosphonium salts.
- Draw Jablonskii diagram and explain various processes, electronic transitions, 62 transition states and photochemical reactions.

2) CHE-802: Analytical Chemistry

At the end of the course students will be able

- To define the terms, principle involved in Chromatographic Techniques.
- To classify and explain different types of Chromatographic Techniques.
- To explain the terms involved giving examples.
- To draw the schematic diagrams of instruments and describe its working.
- To derive the equations involved in gas chromatography and to solve the numericals
- To discuss the applications of each technique
- To define the terms involved in basic electronics.
- To draw the schematic diagrams, notation of various components, circuit diagrams and graphs involved.
- To describe the working of various components and circuits.

- To explain the terms involved giving examples, interpret the graphs, classify the types of components.
- To solve the numerical based on binary arithmatics.
- To define the terms involved in molecular thermal methods.
- To draw the schematic diagrams of the instruments, and thermograms.
- To explain the the instruments, and thermograms.
- To differentiate between different thermal methods and apply them for chemical analysis.
- To define the terms and state the laws, principle involved in Fluorimetry
- To draw the schematic diagrams and explain different types of instruments of Fluorimetry
- To differentiate between Flame photometry, Atomic absorption spectroscopy.
- To discuss the merits and limitations of the methods.
- To describe the application of each method giving examples.
- To define the terms involved in Radiochemical methods
- To describe isotope dilution method and neutron activation analysis.
- To solve numerical based on isotope dilution method and neutron activation analysis
- To define the terms involved in water, soil and air analysis.
- To detect the different parameters involved in analysis

Practical

1) CHE-803: Experiments in Organic and Analytical Chemistry

Develop skills of separation of binary mixture and the analysis of separated compounds at the scale of 1 gm of mixture in case of solids and 3 to 4 ml in case of liquids.