DEPARTMENT OF CHEMISTRY

III SEMESTER

COURSE TITLE: CHEMISTRY – III **COURSE CODE: 21CH301**

CREDITS: 4

COURSE OUTCOMES:

After the completion of this course, the student would be able to:

CO1: Understand the importance of fundamental law and validation parameters in chemical analysis Know how different analytes in different matrices (water and real samples) can be determined by spectrophotometric nephelometric and turbid metric methods.

CO2: Suggest the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory

CO3: To understand the concept of mechanism for a given reaction and also to know the importance of reaction intermediates.

Unit-I Quantitative analysis-Instrumental methods **14hrs**

Electromagnetic spectrum, absorption of electromagnetic radiation. Beer's law, Beer-Lambert law derivation, deviations from Beer's law, limitations, construction of calibration graph (Plot of absorbance versus concentration), Evaluation Procedures- standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, dynamic/linearity range. Instrumentation: Single beam and Double beam spectrophotometers, quantitative applications of colorimetry (determination of Fe, Mo, Cu, Ti and $PO4^{3-}$) and numerical problems on application of Beer's law.

10hrs

Nephelometry and Turbidometry: Introduction, Principle, Instrumentations of Nephelometry and Turbidometry; effects of concentration, particle size and wavelength on scattering; choice between Nephelometry and Turbidometry, applications of nephelometry and turbidimetry (determination of $S04^{2-}$and $PO4^{3-}$). **4hrs**

Unit-II Structure and Bonding-I **14 hrs**

Structure and Bonding-I

The ionic bond II: Structures of ionic solids, Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number 6 (octahedral) close packing. **4hrs**

Classification of ionic structures:

Ionic compounds of the type AX (ZnS, NaCl, CsCl), Ionic compounds of the type AX2: Calcium fluoride (fluorite) and Rutile structure, Layer structures- CdI2 (Cadmium iodide). Limitations of radius ratio concept, Kapustinskii equation, solvation energy and solubility of ionic solids, Numerical problems. **5hrs**

Covalent bond II: The Lewis theory, Octet rule, exceptions to the octet rule, Sidgwick- Powell theory. Review of Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF_3 and BF_4^-, NH_3

and $NH4^+$, ClF3, SF4, $I3^-$ and $I3^+$, SF6 and IF7. Limitations of VSEPR. **5hrs**

Unit III Mechanism of Organic Reactions II **14hrs**

Carbon-carbon pi bonds: Formation of alkenes and alkynes by elimination reaction. Mechanism of E1, E2, E1cB reaction. Saytzeff and Hofmann eliminations. Addition of HBr to propene (Markownikov's), Free radical addition mechanism of HBr to propene (Anti-Markownikov's). Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereo-specificity of halogen addition. Ozonolysis mechanism-ozonolysis of propene.Diel–Alder reaction and Mechanism of Allylic and benzylic bromination and mechanism in propene,1-butene,1-toluene and ethyl benzene.

7 hrs

Leophilic substitution at saturated carbon: Mechanism of SN_1 (t-butyl bromide) and SN_2 reactions (Methyl bromide). Energy profile diagrams, Stereochemistry and factors effecting SN_1 and SN_2 reactions. Aromatic Electrophilic substitution reactions**:** Mechanisms: σ and π complexes formation, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, Ortho-para ratio. Aromatic nucleophilic substitution reaction: SN_{Ar} and Benzyne mechanism with suitable examples. **7 hrs**

UNIT IV Thermodynamics and surface chemistry **14hrs**

First Law of Thermodynamics

Thermodynamic Processes, Reversible and Irreversible Processes, First Law of Thermodynamics, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule-Thomson Effect, Joule-Thomson coefficient of an ideal gas.

Second law of Thermodynamics

Statements of Second Law of Thermodynamics, Concept of entropy. Entropy change in isothermal reversible expansion of an ideal gas. Free Energy: Variation of free energy with temperature and pressure. Numerical problems. Gibbs-Helmholtz equation.

Third Law of Thermodynamics

Statement of third law, calculation of absolute entropy of molecules. **9Hrs**

Surface Chemistry

Adsorption: Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

Catalysis: Types of Catalysis; Homogeneous and Heterogeneous catalysis. Theories with examples (intermediate compound theory and adsorption theory), Enzyme catalysis-Michaelis-Menten equation-derivation. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements. **5Hrs**

DEPARTMENT OF CHEMISTRY
III SEMESTER
PRACTICALS

COURSE TITLE: CHEMISTRY PRACTICAL III **COURSE CODE: 21CH302**
CREDITS : 2

COURSE OUTCOMES:

After the completion of this course, the student would be able to:

CO1: Understand the importance of instrumental methods for quantitative applications. Apply colorimetric methods for accurate determination of metal ions and anions in water or real samples

CO2: Able to evaluate acid- base titrations and generates the titration curves for strong acid and bases and also explain the reference and indicator electrodes.

CO3: Understand how functional groups in a compound is responsible for its characteristic property

CO4: Learn the importance of qualitative tests in identifying functional groups.

PART-A

Colorimetric determination of copper using ammonia solution

Colorimetric determination of iron using thiocyanate solution

Determination of the enthalpy of neutralization of a strong acid with strong base.

Determination of velocity constant for acid catalysed hydrolysis of methylacetate.

PART-B

Qualitative analysis of Organic compounds such as

1) Salicylic acid, p-Nitrobenzoic acid, Antranilicacid, p-Chloro benzoic acid
2) o-Cresol, p-Cresol, Resorcinol, o-Nitrophenol, p-nitophenol
3) o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p-Bromoaniline,
4) Ethyl Salicylate, Salicylaldehyde, Acetophenone, p-Dichlorobenzene, p-Nitrotoluene, Benzamide etc. (At least 6-8compounds to be analysed in a semester)

DEPARTMENT OF CHEMISTRY
III SEMESTER
OPEN ELECTIVE SUBJECT

COURSE TITLE: FUEL CHEMISTRY AND ENVIRONMENTAL CHEMISTRY
COURSE CODE: 21CH311 **CREDITS: 03**
COURSE OUTCOMES:
After the completion of this course, the student would be able to:
CO1: Understand the concept of fuels, and their classifications.
CO2: Learn the different types of fuels and their applications.
CO3: Know the different types of pollution and their prevention.

UNIT-I: FUEL CHEMISTRY: **14hrs**
Classification of fuels and their calorific value. Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal and requisites of a good metallurgical coke. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, different types of petroleum products and their applications

UNIT-II: PETROCHEMICALS **14 hrs**
Fractional Distillation (Principle and process), Cracking (Catalytic cracking), Octane number and Cetane number, Reforming of petrol and non-petroleum fuels (LPG and bio-gas), Knocking of IC engine, Catalytic converter.
Lubricants: Classification of lubricants- lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

UNIT-III ENVIRONMENTAL CHEMISTRY **14 hrs**
Energy and Environment: Sources of energy: coal, petrol and natural gas. Nuclear fusion/ fission, solar energy, hydrogen and geo-thermal energy. **3 hrs**
Air pollutants: types, sources, particle size and chemical nature. Control measures of air pollution. Photochemical smog: its constituents and photochemistry. Greenhouse effect, global warming and ozone depletion.
4hrs
Water pollution, water quality standards: Water pollutants and their sources. Industrial effluents and their treatment (primary and secondary treatment). Sludge disposal. Water quality parameters for waste water, industrial water and domestic water.
Nuclear pollution: Disposal of nuclear waste, nuclear disaster and its management. **7hrs**

DEPARTMENT OF CHEMISTRY

SEMESTER-IV

COURSE TITLE: CHEMISTRY IV **COURSE CODE: 21CH401**

CREDITS : 4

COURSE OUTCOMES:

After the completion of this course, the student would be able to:

CO1: Able to define chromatography and also know the steps involved in a chromatography investigation.

CO 2: Predict the nature of the bond formed between different elements. Identify the possible type of arrangements of ions in ionic compounds. Write Born-Haber cycle for different ionic compounds Relate different energy parameters like, lattice energy, entropy, enthalpy and solvation energy in the dissolution of ionic solids.

CO 3: To understand the concept of mechanism for a given reaction and also to know the importance of reaction intermediates,

CO 4: Understand the concept of rate of a chemical reaction, integrated rate equations, energy of activation and determination of order of a reaction based on experimental data and to know the different types of electrolytes, usefulness of conductance and ionic mobility measurements. Determine the transport numbers

Unit-I Separation methods **14 hrs**

Fundamentals of Chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase, nature of adsorbents. Principles of paper, thin layer, column chromatography. Column efficiency, factors affecting the column efficiency, Van Deemter's equation and its modern version. **5 hrs**

Paper chromatography: Theory and applications. Thin layer chromatography (TLC): Mechanism, Rfvalue, efficiency of TLC plates, development, spray reagents, identification and detection, qualitative applications. **2 hrs**

Solvent Extraction: Types-batch, continuous, efficiency, selectivity, distribution coefficient, factors affecting the partition, relationship between % extraction and volume fraction, Numerical problems on solvent extraction. Solvent extraction of iron and copper. **4hrs**

Ion exchange Chromatography

Resins, types with examples-cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion -exchange chromatography (softening of hard water and separation of lanthanides). **3hrs**

Unit-II Structure and Bonding-II **14hrs**

Structure and Bonding-II

Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp^2, sp^3,dsp^2,dsp^3, d^2sp^3 and sp^3d^2 with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory. **4hrs**

Molecular Orbital theory-II:

Calculation of bond order, relationship between bond order, bond energy and bond length. Magnetic properties based on MOT. Examples of molecular orbital treatment for homonulcear diatomic molecules: He_2, Li_2, Be_2, B_2, C_2, N_2, N_2^+, and O_2^{2-} **5hrs**

Metallic Bonding:

General properties of metals: Conductivity, Lustre, Malleability and cohesive force, Crystal structures of metals and Bond lengths. Theories of bonding in metals: Free electron theory, Valence bond theory, Molecular orbital or band theory of solids. Prediction of conducting properties of conductors, insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory. **5hrs**

Unit III Reaction Intermediates and methods of identification **14hrs**

Reaction Intermediates: Generation, Stability and Reactions of,

i) Carbocations: Dienone-phenol; and Pinacol-Pinacolone Rearrangement (Mechanism).
ii) Carbanions: Perkin Reaction, Aldol condensation (Mechanism).
iii) Free Radicals: Sandmeyer Reaction
iv) Carbenes and Nitrenes: Singlet and Triplet states, their relative stability and reactions
v) Arynes: Formation and detection **9hrs**

Methods for Identifying Reaction Mechanism:

Product analysis, Isolation and identification of intermediates, stereo chemical evidences, crossover experiments, isotopic studies, kinetic studies. **5 hrs**

UNIT IV: Kinetics and Electrochemistry **14hrs**

Chemical Kinetics-II

Temperature dependence of reaction rates; Temperature co-efficient of reaction. Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates-Lindemann's mechanism- uni-molecular reaction rate. Self study- Experimental determination of kinetics of (i) Saponification of Ethyl acetate (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

6Hrs

Electrochemistry–I

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation (No derivation). Ionic mobility and its determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf's method.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts and (iv) conductometric titrations (acid base titrations only). Numerical problems. **8hrs**

DEPARTMENT OF CHEMISTRY
IV SEMESTER PRACTICALS

COURSE TITLE: CHEMISTRY PRACTICAL IV **COURSE CODE: 21CH402**

CREDITS : 2

COURSE OUTCOMES:

After the completion of this course, the student would be able to:

CO1: Understand the chemical reactions involved in the detection of cations and anions.

CO2: Explain basic principles involved in classification of ions into groups in semi-micro qualitative analysis of salt mixture Carry out the separation of cations into groups and understand the concept of common ion effect.

CO 1: understand the use of instruments like conductivity meter to obtain various physicochemical parameters and also know the theory about chemical kinetics and determine the velocity constants of various reactions.

CO 3: Learn to fit experimental data with theoretical models and interpret the data

Part A- Inorganic Chemistry Practicals

Qualitative semi-microanalysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of different reactions.

The following cations and anions are suggested.

Cations: NH_4^+, Pb^{2+},Bi^{3+},Cu^{2+},Al^{3+},Fe^{3+},Co^{2+},Cr^{3+},Ni^{2+},Zn^{2+},Mn^{2+},Ba^{2+},Ca^{2+}, Sr^{2+}, Mg^{2+},Na^+, K^+.

Anions: CO_3^{2-}, Cl^-,Br^-,I^-,NO_3^-,,SO_4^{2-}, S^{-2}(Sulphide)

Spot tests and flame tests to be carried out wherever possible.

Part B- Physical Chemistry Practicals

Determination of $R_f$values of two or three component systems by TLC /Paper Chromatography

Separation of different metal ions by paper chromatography/ Solvent extraction of iron using oxine solution **(demonstration)**

Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.

Determination of dissociation constant of weak acid by conductivity method.

Conductometric titration of strong acid and strong base.

Conductometric titration of weak acid and strong base.