List of Courses for B.Sc. Chemistry Program w.e.f 2015-2016

	Course Name
	A. Chemistry Courses – Code: CH
1	Semester I: CH-101: Physical and Inorganic Chemistry CH-103: Organic and Inorganic Chemistry
2	Semester II: CH-102: Physical and Inorganic Chemistry CH-104: Organic and Inorganic Chemistry
3	Semester III: CH-201: Physical and Inorganic Chemistry CH-203: Organic and Inorganic Chemistry
4	Semester IV: CH-202: Physical and Inorganic Chemistry CH-204: Organic and Inorganic Chemistry
5	Semester V: Theory CH-311: Physical Chemistry CH-321: Inorganic Chemistry CH-331: Organic Chemistry CH-341: Analytical Chemistry
	Practical CH-301: Experiments in Physical and Analytical Chemistry CH-303: Experiments in Inorganic and Organic Chemistry
6	Semester VI: Theory CH-312: Physical Chemistry CH-322: Inorganic Chemistry CH-332: Organic Chemistry CH-342: Analytical Chemistry
	Practical CH-302: Experiments in Physical and Analytical Chemistry CH-304: Experiments in Inorganic and Organic Chemistry

Year	Semester	Chemistry Courses (CH)
First Year	I	CH-101: Physical and Inorganic Chemistry CH-103: Organic and Inorganic Chemistry
	II	CH-102: Physical and Inorganic Chemistry CH-104: Organic and Inorganic Chemistry
Second Year	III	CH-201: Physical and Inorganic Chemistry CH-203: Organic and Inorganic Chemistry
	IV	CH-202: Physical and Inorganic Chemistry CH-204: Organic and Inorganic Chemistry
Third Year	V	Theory CH-311: Physical Chemistry CH-321: Inorganic Chemistry CH-331: Organic Chemistry CH-341: Analytical Chemistry
		Practical CH-301: Experiments in Physical and Analytical Chemistry CH-303: Experiments in Inorganic and Organic Chemistry
	VI	Theory CH-312: Physical Chemistry CH-322: Inorganic Chemistry CH-332: Organic Chemistry CH-342: Analytical Chemistry
		Practical CH-302: Experiments in Physical and Analytical Chemistry CH-304: Experiments in Inorganic and Organic Chemistry

PROGRAMME SPECIFIC OUTCOME (PSO)
• Students will be able to acquire core knowledge in Chemistry in the key areas, develop written & oral communication skills in communicating chemistry-related topics. • Design & conduct an experiment, demonstrate their understanding of the scientific methods & processes. • Develop proficiency in acquiring data using a variety of instruments, analyze & interpret the data, learn applications of numerical techniques. • Realize & develop an understanding of the impact of Chemistry & science on society.

CH-101	Physical Chemistry & Inorganic Chemistry (SEMESTER I)	Number of Lectures: 45

COURSE OBJECTIVES:

Theory:

- To define terms involved in chemical kinetics, gaseous state .
- To state the Postulates of Kinetic Theory of Gases.
- To calculate the slopes, maxima and minima of the various functions.
- To distinguish between ideal and real gases.
- To describe the theories of reaction rates, methods of determination of Order of reaction .
- To derive the expressions and solve numerical based on Gaseous State and chemical kinetics.
- To generalize the Thomson's Model , Rutherford's Model and Bohr's theory for understanding atomic structure.
- To state quantum numbers, rules for electronic configuration of elements.
- To discuss Valence bond theory for evaluating structures of Covalent compounds.
- To interpret distortion in Covalent molecules based on VSEPR theory.
- To evaluate dipole moment and interpret % ionic character of polar molecules.
- To state bond strength and bond energy.
- To generalize Molecular Orbital theory and draw molecular orbital diagrams for homo and hetero di atomic molecules.

Practical:

- To understand process of scientific investigation and develop a broad understanding of scientific concepts.
- Engage students in helping them develop important skills.

SYLLABUS

Theory

Section - I (Physical Chemistry) I Mathematical Concepts Logarithmic relations, curve sketching, linear graphs and calculations of slopes differentiation of functions like Kx, ex , x n , sin x, log x, maxima & minima, partial, differentiation & reciprocity relations. Integration of some useful/relevant	**06 L**
II Gaseous State Postulates of kinetic theory of gases and deviation from ideal behaviour, Van der Waal's equation of state. Critical phenomena; PV isotherms of real gases, continuity of states , the isotherms of van der Waal's equation, relationship between critical constants and van der Waal's constants , the law of	**10 L**

corresponding states, reduced equation of state. Molecular Velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter, liquifacation of gases (based on Joule – Thomson effect) III Chemical Kinetics Rate of reaction, factors influencing the rate of a reaction concentration, temperature, pressure, solvent, light, catalyst Concentration dependence of rates mathematical characteristics of simple chemical reaction. Zero order, first order, second order, pseudo order, half life& mean life. Determination of order of reaction: Differential method Integration method, Method of half life period & Isolation method. Radioactive decay as a first order phenomenon. Theories of Chemical Kinetics. Effect of temperature on the rate of reaction, Arrhenius equation and concept of activation energy. Simple collision theory based on hard sphere model. Transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant & thermodynamic aspects. Section – II (Inorganic Chemistry) I. Atomic Structure Evidence for the electrical nature of matter; discharge tube experiments; Thomson's atomic model; Rutherford model; Bohr's model of hydrogen atom; probability picture of electron; quantum numbers; Shapes of s, p, d, orbitals; Aufbau and Pauli exclusion principles, Hund's rule of maximum multiplicity; Electronic configurations of the elements; effective nuclear charge. II. Chemical Bonding (A) Covalent bond – Valence Bond Theory (VBT) and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion Theory (VSEPR Theory) to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O. Molecular Orbital Theory, homonuclear and heteronuclear diatomic molecules(CO and NO), multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference	**14 L** **06 L** **09 L**
Practical	
PHYSICAL CHEMISTRY Chemical Kinetics : 1. Hydrolysis of Methyl Acetate using two different initial concentrations in presence of mineral acid (HCl) as catalyst. 2. Relative strength of two acids i.e. HCl& H_2SO_4. 3. Degree of hydrolysis of urea hydrochloride. 4. Measurements of viscosity of a given liquid using Ostwald's viscometer (minimum three liquids) **INORGANIC CHEMISTRY** Calibrations and dilutions: 1. Calibration of Burette and Pipettes. 2. To prepare 100 mL of standard 0.1 M $K_2Cr_2O_7$ solution and carry out dilution to 0.05, 0.01, 0.005, and 0.001 M in 100 mL standard flasks. 3. To prepare 100 ppm of Manganese solution using $KMnO_4$ and carry out dilution	

of 5, 10, 15, 20 and 25 mL in 100 mL standard flasks.
4. Semi-micro qualitative analysis:
To analyse 4 - 6 inorganic mixtures containing four ions only.(Two cations and two anions). Mixtures containing the following ions may be prepared

Cations :

Pb^{2+} , Bi^{3+} ,Cu^{2+} , Cd^{2+}, Sn^{2+} , Sb^{3+} ,Fe^{2+} , Fe^{3+}, Al^{3+} ,Cr^{3+} ,Zn^{2+} , Mn^{2+} , Ni^{2+} , Co^{2+} , Ba^{2+} , Sr^{2+} ,Ca^{2+} , Mg^{2+} , $(NH_4)^{+}$, K^{+}

Anions:

Cl^{-}, Br^{-}, I^{-}, NO_2^{-}, NO_3^{-}, SO_3^{2-}, CO_3^{2-}, SO_4^{2-}, CrO_4^{2-}, PO_4^{3-}.

LEARNING OUTCOMES:

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 cayalyst 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.

REFERENCES:

Physical Chemistry

1. Puri, Sharma, Pathania,Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press
2. G. K. Vemulapalli, Physical chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry
4. G. L. Agarwal, Basic Chemical Kinetics, Tata McGraw-Hill Publication

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao,University General Chemistry , McMillan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS publications.New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, ,Pergamon, Oxford,1984.

CH -103	Organic and Inorganic Chemistry (Semester I)	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I- Organic Chemistry

- To understand the concepts of hybridization, C-C bond lengths, bond angles, bond energy, localized and delocalized chemical bonds.
- To define the various terms like Van der Waals interactions, resonance, hyperconjugation, inductive and field effects, intramolecular and intermolecular hydrogen bonding.
- To understand the curved arrow notations.
- To understand various types of Organic reactions with examples.
- To learn Energy profile diagrams for exothermic and endothermic reactions
- To study the reactive intermediates and methods of determination of reaction mechanisms.
- To know the concept of acids and bases.
- To understand the nomenclature of alkanes, cycloalkanes and alkenes.
- To understand the general methods of formationand Baeyer strain and strainless rings theory.
- To understand the general methods of formation and Chemical reactions of alkenes and alkynes with mechanism.
- To classify dienes and write the nomenclature.
- To understand structure and stereochemistry of allenes.
- To learn the chemical reactions of dienes.

Section II -Inorganic Chemistry

- To define the various periodic properties like atomic and ionic radii, electron affinity and electronegativity and determine the trends of the periodic properties in the groups and the periods of the periodic table
- To define various acid -base theories.
- To know the several types of solvents and their typical characteristics.
- To explain the distinct types of reactions occurring in liquid ammonia and liquid Sulphur dioxide solvents.

Practical:

- To get hands on experience for the systematic qualitative analysis of the organic compounds.
- To learn the purification and separation techniques.
- To carry out calibration of burettes and pipettes
- To carry out dilutions in molarity and ppm using KMnO4 and K2Cr2O7
- To carry out qualitative analysis of different cations and anions using the method of semi-micro analysis.

SYLLABUS

Theory:

Section I **I. Structure and Bonding:**	

Hybridization, C-C bond lengths and bond angles, bond energy, localized and delocalized chemical bonds, Definition and examples of Van der Waals interactions, resonance, hyperconjugation, inductive and field effects, intramolecular and intermolecular hydrogen bonding.	**04 L**
II. Fundamentals of Organic Chemistry: Curved arrow notation, drawing electron movement with arrows, half and double headed arrows, homolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles with examples. Types of Organic Reactions: Addition, Elimination, Substitution, Oxidation, Reduction and Rearrangement-one example of each. Energy profile diagrams for exothermic and endothermic reactions, single step and two step reactions. Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes; examples, shape and ways of formation. Assigning formal charges on intermediates and other ionic species. Methods of determination of reaction mechanisms (one example each of product analysis, intermediates, isotope effects, kinetic and stereochemical studies). Theory of acids and bases: Lewis concept; Bronsted and Lowry concept.	**08 L**
III. Alkanes and cycloalkanes IUPAC nomenclature of alkanes. General methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction & decarboxylation of carboxylic acids). Physical properties and chemical reactions of alkanes: halogenation, combustion and pyrolysis. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity with propane as an example. Cycloalkanes – nomenclature, general methods of formation, Baeyer strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring: banana bonds.	**06 L**
IV. Alkenes, dienes and alkynes IUPAC nomenclature of alkenes, general methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hoffmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes – Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$. Mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction. Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethene and propene. Nomenclature and classification of dienes, isolated, conjugated and cumulated dienes. Structure and stereochemistry of allenes, methods of formation of butadiene, polymerization. Chemical reactions – 1,2- and 1,4-additions, Diels-Alder reaction. Nomenclature, structure and bonding in alkynes. General methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, metal-ammonia reduction and polymerization.	**12 L**

Section II **I. Periodic Properties** Atomic and ionic radii, ionization energy, electron affinity and electronegativity, definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.	**05 L**
II. Acids, Bases and Non-Aqueous Solvents Arrhenius Concept and Bronsted Theory. The Lux – Flood Solvent Systems. Lewis Concept of Acids and Bases. Physical Properties of a solvent. Types of Solvents and their general Characteristics. Reactions in non-aqueous solvents with respect to liquid NH_3 and liquid SO_2.	**10 L**
Practicals **ORGANIC CHEMISTRY** I. **Crystallization:** - a) Benzoic acid from hot water. b) m-dinitrobenzene from ethanol II. **Sublimations:** - a) Naphthalene and b) Anthracene III.Distillation: - a) Separation of acetone and ethyl acetate using water condenser. b) Separation of toluene and nitrobenzene using air condenser. IV. Qualitative Analysis: List of compounds Acids: Benzoic, Acetylsalicylic, Salicylic, Phthalic. Phenols: Phenol, α-Naphthol, β-Naphthol. Bases: p-Toluidine, Diphenylamine, o-, m- and p-Nitroanilines, Aniline. Hydrocarbons: Naphthalene, Anthracene. Amides: Benzamide, Urea. Carbonyl compounds: Benzaldehyde, Acetone, Butanone. **INORGANIC CHEMISTRY** Calibrations and dilutions: 1. Calibration of Burette and Pipettes. 2. To prepare 100 mL of standard 0.1 M K2Cr2O7 solution and carry out dilution to 0.05, 0.01, 0.005, and 0.001 M in 100 mL standard flasks. 3. To prepare 100 ppm of Manganese solution using KMnO4 and carry out dilution of 5, 10, 15, 20 and 25 mL in 100 mL standard flasks. 4. Semi-micro qualitative analysis: To analyse 4 - 6 inorganic mixtures containing four ions only.(Two cations and two anions). Mixtures containing the following ions may be prepared **Cations :** Pb2+ , Bi3+ ,Cu2+ , Cd2+, Sn2+ , Sb3+ ,Fe2+ , Fe3+, Al3+ ,Cr3+ ,Zn2+ , Mn2+ , Ni2+ , Co2+ , Ba2+ , Sr2+ ,Ca2+ , Mg2+ , (NH4) + , K+ **Anions:** Cl^-, Br^-, I^-, $NO2^-$, $NO3^-$, $SO32^-$, $CO32^-$, $SO42^-$, $CrO42^-$, $PO43^-$.	
LEARNING OUTCOMES:	

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,
- Definethe 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.
- Classifydienes 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.

Practicals:

- The students will be able to get hands on experience for the systematic qualitative analysis of the organiccompounds 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.

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry;; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS publications, 4th edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India
2. Paula YurkanisBruice, Organic Chemistry; 3rd Edition, Pearson Education Asia
3. Jerry March, Advanced Organic Chemistry; 4rd Edition, John Wiley

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry Vallabh Publications, First Edition

2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao,University General Chemistry , McMillan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS publications.New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984

Books suggested for laboratory course

1.Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient L:ongman.
2. Vogel's textbook of Quantitative Inorganic analysis (revised) J. Basset, R.C.
3. Mann and Saunders , Practical Organic Chemistry
4. N.K. Vishnoi, Practical Organic Chemistry
5. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd., First Edition, 2006.

CH-102	Physical and Inorganic Chemistry SEMESTER II	Number of lectures:45

COURSE OBJECTIVES:

Theory:

Section I: Physical Chemistry- I

- To define the terms, state laws and principlesinvolved in thermodynamics and thermochemistry.
- To explain the concept of standard state, enthalpies of solution, integral and differential enthalpies of solution and dilution.
- To derive the equations involved in thermodynamic, thermochemistry and to solve the numericals.
- To define ,explain , derive the equations , discuss the terms, principles, laws involved in solutions, concept of activity,activity coefficients and types of solutions, colligative properties and to solve numerical, experimental methods for determining colligative properties.
- To define the term involved in Liquid State and explain the structural differences between solids, liquids and gases.
- To discuss the types of liquid crystals, seven segment cell & derive the equations and to solve the numericals of surface tension and viscosity.

Section II: Inorganic Chemistry

- To define the terms, alkali metals, alkaline earth metals, hydration energy hydration polarisation.
- Describe the occurrence of group I & II elements and state the electronic configurations of s block elements of group I & II.
- To draw the structure of chlorophyll and sodium potassium ion pumping system.
- To discuss the general characteristics of group I & II elements, diagonal relationship of Li with Mg and Be with Al, anomalous behavior of Lithium and Beryllium, biological significance of Magnesium in chlorophyll, sodium and potassium.
- To classify the elements based on their solvation and polarization tendencies.
- To define the terms, inert pair effect, promotion energy, catenation , allotropy.
- To describe the occurrence of group I3 & I4 elements.
- To draw the structure of diamond, graphite, borazine, silicates.
- To discuss the general characteristics of group I3 & I4 elements, diagonal relationship of Boron with Silicon and Carbon with Phosphorus, anomalous behavior of Boron and Carbon, inert pair effect and its variation in group I3 & I4 elements, oxidation states exhibited, catenation property of carbon family elements. compounds formed by Boron and Carbon namely borazine , diborane, tetraborane, fluorocarbons, carbides, silicates.

Practical:

- To understand process of scientific investigation and develop a broad understanding of scientific concepts.
- Engage students in helping them develop important skills.

SYLLABUS

Theory:

Section - I (Physical Chemistry) **I Thermodynamics** Thermodynamic terms:System, surrounding, types of systems, intensive & extensive properties. State & path functions & their differentials. Thermodynamic process. Concept of work & heat First law of thermodynamics : statements and definitions of internal energy & enthalpy. Heat capacities at constant volume & pressure & their relationship. Joule's law, Joule-Thomson coefficient & inversion temperature . Calculation of w, q, dU, dH, for the expansion of ideal gases under isothermal & adiabatic conditions for reversible processes. Thermochemistry : standard state, standard enthalpy of formation . Hess's law of heat summation & its applications. Heat of reaction at constant pressure & at constant volume . Enthalpy of neutralization, bond dissociation energy & its calculation from thermochemical data. Temperature dependence of enthalpy. Kirchoff's equation.	**10 L**
II Solutions, Dilute Solutions and Colligative Properties Ideal & non ideal solutions, methods of expressing concentrations of solutions, activity & activity coefficients. Dilute solutions, colligatve properties, Roult's law , relative lowering of vapour pressure molecular weight determination. Osmosis: osmotic pressure & its measurement, depression of freezing point, thermodynamic derivation of relation between molecular weight and depression of freezing point. Elevation in boiling point thermodynamic derivation of relation between molecular weight and elevation in boiling point. Experimental methods for determining various colligative properties.	**10 L**
III Liquid State and Applications Intermolecular forces, structure of liquids (Qualitative description) Structural differences between solids, liquids and gases. Liquid crystal : Difference between liquid crystals ,solid and liquid. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell. Surface between a liquid and vapour .Surface tension by capillary rise method, stalagmometer method .Viscosity of liquids, Poiseuille equation, use of Ostwald's Viscometer.	**10 L**
Section – II (Inorganic Chemistry) I.s – block elements Comparative study including diagonal relationship of groups, salient features of Hydrides, solvation and complexation tendencies including their function in biosystems. An introduction to alkyls and aryls.	**06 L**
II. p - block elements (A) Comparative study including diagonal relationship of groups 13 and 14. Group 13--- Hydrides of Boron, diborane, and higher boranes, borazine, borohydrides. Group 14 ---Fullerenes, carbides, fluorocarbons, silicates (structural principle)	**09 L**
Practical	
PHYSICAL CHEMISTRY 1. Measurements of surface tension of a given liquid using stalagmometer (minimum three	

liquids)
2. Preparation of standard solutions based on normality,molarity, molality. Also further dilutions from a standard solution are expected (e.g. $KMnO_4$, NaOH etc.)
3. Preparation of standard solutions based on ppm and mole fraction. Also further dilutions from a standard ppm solution are expected(e.g. Oxalic acid, $CuSO_4$)
4. To investigate the order of the reaction between $K_2S_2O_8$ + KI (a = b)

INORGANIC CHEMISTRY
Volumetry: (Double Burette*)
1. To prepare 0.1 N Na_2CO_3/ Borax solution and standardize the given ≈ 0.1 N HCl solution.
2. To prepare 0.1 N Succinic acid/KHP solution and standardize the given ≈ 0.1 N NaOH solution.

Volumetry: (Single Burette)
1. To prepare 0.05 N $Na_2C_2O_4$ solution and standardize the given $KMnO_4$ solution.
2. To prepare 0.005 M EDTA solution and estimate the amount of Zn^{2+} and Mg^{2+} from $ZnSO_4.7H_2O$ and $MgSO_4.6H_2O$ solutions respectively.

Gravimetric analysis:
1. NH_4Cl + $BaSO_4$
2. ZnO + $ZnCO_3$

LEARNING OUTCOMES:

Theory:

At the end of the course students will be able to

- Define the terms, state the lawsand 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.

- Estimate ions (volumetric titration) using single burette method.
- Carry out quantitative estimation of mixtures by gravimetic method of analysis.

REFERENCES:

Text Books :

1. P.W. Atkins et al., Physical Chemistry, 7th edition
2. J.D. Lee, Concise Inorganic Chemistry, ELBS publications, 4th edition

Reference Books

Physical Chemistry

1. Puri, Sharma, Pathania,Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press
2. G. K. Vemulapalli, Physical chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry
4. G. L. Agarwal, Basic Chemical Kinetics, Tata McGraw-Hill Publication

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao,University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS publications.New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984

CH -104	Organic and Inorganic Chemistry Semester II	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I

- To draw Newman, Sawhorse, Fischer and flying Wedgerepresentations and the conformations with respect to ethane, *n*-butane, cyclohexane and mono-substituted cyclohexane derivatives.
- To understand the concept of isomerism, stereoisomerism, configuration, chirality, optical isomerism, resolution of enantiomers, inversion, retention and racemization.
- To understand the difference between conformation and configuration.
- To understand rules for nomenclature and assigning configuration to configurational isomers.
- To study the nomenclature of benzene derivatives, alkyl halides and classes of alkyl halides.
- To understand the structure of benzene and the concept of aromaticity.
- To understand the mechanism of various aromatic electrophilic substitution reactions of arenes along with the influence of activating and deactivating substituents.
- To learn the general methods of formation and chemical reactions of alkyl benzenes and alkyl halides.
- To understand 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.
- To study the relative reactivities of alkyl halides vs. allyl, vinyl and aryl halides.

Section II

- To describe the various elements present and their general characteristics in groups 15,16 and 17 of the periodic table and to understand the diagonal relationship between the various elements of groups 15,16 and 17 of the periodic table.
- To describe the special compounds of group 15,16 and 17 with respect to occurrence, preparation methods, physical and chemical properties structure and bonding and applications.
- To describe the occurrence and general properties of inert gas xenon.
- To describe the structure and bonding in various xenon compounds

Practical:

- To carry out double burette and single burette titration methods
- To carry out gravimetric estimations of double salt mixtures by weight loss method.
- To carry out systematic qualitative analysis of the organic compounds which include alkyl and aryl halides,nitrohydrocarbons, bases, alcohols, esters, anilides and carbohydrates.

SYLLABUS

Theory:

Section I 1. **Stereochemistry of organic compounds** Newman and saw horse formulae, Fischer and flying wedge formulae. Concept of isomerism. Types of isomerism. Conformational isomerism – Conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono-substituted cyclohexane derivatives. Optical isomerism – elements of symmetry, molecular chirality, definition and examples of enantiomers, stereogeniccentre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Specification of configuration at chiral centers: Sequence rules and R:S system of nomenclature. Geometric Isomerism - Determination of configuration of geometric isomers. E and Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Difference between configuration and conformation.	14 L
2. **Arenes and Aromaticity** Nomenclature of benzene derivatives. Structure of benzene: molecular formula and Kekule structure. Stability and C–C bond lengths of benzene, resonance structure, MO picture. Aromaticity: The Huckel's rule, aromatic ions, anti-aromaticity. Aromatic electrophilic substitution – general pattern of the mechanism role of σ- and π- complexes. Mechanism of nitration, halogenation, sulphonation and Friedel-Crafts reaction. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. General methods of formation and chemical reactions of alkyl benzenes – reduction, oxidation, ring and side chain substitution.	9 L
3. **Alkyl and aryl halides:** Nomenclature and classes of alkyl halides, general methods of formation, chemical reactions. Mechanism and stereochemistry of nucleophilic substitution reactions of alkyl halides, SN_2 and SN_1 reactions with energy profile diagrams, solvent effect. The addition – elimination (bimolecular displacement) and the elimination – addition (benzyne) mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs. allyl, vinyl and aryl halides.	7 L
Section II **1. p - block elements (B)** Comparative study including diagonal relationship of groups 15, 16 and 17. group 15- phosphazenes, group 16—tetra sulfur tetranitride, group 17—basic properties of halogens, interhalogens and polyhalides	**12 L**
2. Chemistry of Noble Gases Chemical properties of Noble Gases, Chemistry of Xenon, structure and bonding in Xenon compounds,	**03 L**

Practicals

INORGANIC CHEMISTRY

Volumetry: (Double Burette*)

1. To prepare 0.1 N Na_2CO_3/ Borax solution and standardize the given $\approx$ 0.1 N HCl solution.
2. To prepare 0.1 N Succinic acid/KHP solution and standardize the given $\approx$ 0.1 N NaOH solution.

Volumetry: (Single Burette)

1. To prepare 0.05 N $Na_2C_2O_4$ solution and standardize the given $KMnO_4$ solution.
2. To prepare 0.005 M EDTA solution and estimate the amount of Zn^{2+} and Mg^{2+} from $ZnSO_4.7H_2O$ and $MgSO_4.6H_2O$ solutions respectively.

Gravimetric analysis:

1. $NH_4Cl + BaSO_4$
2. $ZnO + ZnCO_3$

ORGANIC CHEMISTRY

1. Qualitative Analysis

   List of compounds

   Alkyl and aryl halides: Chloroform, Carbon tetrachloride, Chlorobenzene, Bromobenzene, p-dichlorobenzene.

   Nitrohydrocarbons: Nitrobenzene, m-dinitrobenzene, p-nitrotoluene.

   Bases: α-Naphthylamine, Diphenylamine, o-, m- and p-Nitroanilines, N-methylaniline, N,N-dimethylaniline.

   Alcohols: Methanol, Ethanol, 2-propanol, Cyclohexanol.

   Esters: Methyl acetate, Ethyl acetate, Ethyl benzoate, Methyl salicylate.

   Anilides: Acetanilide, Benzanilide

   Carbohydrates: Glucose, Fructose, Mannose

   Note: 7 compounds of the following type to be analyzed in 5 practicals: Carbohydrate – 1; Anilide – 1; Ester – 1; Alcohol – 1; Nitrohydrocarbon - 1; Alkyl or aryl halide – 1; Base – 1

LEARNING OUTCOMES:

Theory:

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

- Draw Newman, Sawhorse, Fischer and flying Wedgerepresentations 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.

- 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.

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry;; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS publications, 4th edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India.
2. Paula YurkanisBruice, Organic Chemistry; 3rd Edition, Pearson Education Asia.
3. Jerry March, Advanced Organic Chemistry; 3rd Edition, John Wiley.

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry
Vallabh Publications, First Edition 9.
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry,
Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao, University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS publications.New edition

Books suggested for laboratory course

1. Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient L:ongman.
2. Mann and Saunders , Practical Organic Chemistry
3. N.K. Vishnoi, Practical Organic Chemistry
4. Vogel's textbook of Quantitative Inorganic analysis (revised) J. Basset, R.C.
5. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd.,
First Edition, 2006

CH - 201	Physical and Inorganic Chemistry (SEMESTER III)	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Physical Chemistry)

- To define the principles, laws, theorems in Thermodynamics, Chemical equilibrium and Phase equilibrium.
- To draw the phase diagrams, schematic diagrams and the graphs involved.
- To explain and interpret the Nernst distribution law.
- To distinguish between liquid-liquid and ideal liquid mixtures, different types of systems.
- To solve the numerical with respect to Gibbs free energy, to derive Clapeyron equation and Clausius-Clapeyron equation and its applications.
- To study concept of residual entropy, evaluation of absolute entropy from heat capacity data and thermodynamic quantities.
- To classify different component systems, types of mixtures.
- To study equilibrium constant and free energy, reaction isotherm and reaction isochore.
- To study entropy as a state function and its change in ideal gas and mixing of gases.

Section II (Inorganic Chemistry)

- To generalise the IUPAC nomenclature rules for co-ordination compounds.
- To discuss Werner's co-ordination theory for co-ordination compounds.
- To classify ligands based as monodentate and polydentate citing different examples.
- To study the general characteristics of 3d metals of first transistion series.
- To discuss the variable oxidation states, magnetic properties, complexation tendencies, catalytic behavior and spectral properties of 3d metals.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory (conductometry, partition coefficient, volumetric estimation, gravimetric estimation).

SYLLABUS

Theory:

Section I 1. Thermodynamics Second law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Concept of entropy :entropy as a state function ,entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality ,entropy as a criteria of spontaneity and equilibrium .Entropy change in ideal gases and mixing of gases. Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantages over entropy change. Variation of G and A with P, V & T.	14 L
2. Chemical Equilibrium Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle. Reaction isotherm and reaction isochore – Clapeyron equation and Clausius – Clapeyron equation, applications.	05 L
3. Phase Equilibrium Statement and meaning of the terms–phase , component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system–water, CO_2 and S systems. Phase equilibria of two component system – solid –liquid equilibria, simple eutectic –Bi-Cd, Pb-Ag systems, desilverisation of lead. Solid solutions –compound formation with congruent melting point (Mg-Zn) and incongruent melting point, ($NaCl$-H_2O), ($FeCl_3$-H_2O) and ($CuSO_4$-H_2O) system. Freezing mixtures, acetone –dry ice. Liquids –liquid mixtures – ideal liquid mixtures, Raoult's and Henry's law. Non –ideal system –azeotropes- HCl-H_2O and ethanol – water systems Partially miscible liquids –phenol –water, trimethylamine –water, nicotine – water systems. Lower and upper consolute temperature. Effect of impurity on consolute temperature. Immiscible liquids, steam distillation. Nernst distribution law – thermodynamic derivation, applications.	11 L
Section II 1. Chemistry of the Elements of the First Transition Series.	

General characteristics, comparative treatment with their 3d analogues in respect of Ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry. 2. Co-ordination compounds Werner's co-ordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of co-ordination compounds.	10 L 05 L

Practical

Physical Chemistry

1. To determine the partition coefficient of I_2 between $C_2H_4Cl_2$ and H_2O.
2. To determine molecular condition of the given acid in benzene/toluene by the partition coefficient method.
3. To determine the amount of strong acid (HCl) present in the given solution by conductometric titration using standard NaOH solution.
4. To determine the amount of weak acid (CH_3COOH) present in the given solution by conductometric titration using standard NaOH solution.
5. To study the solubility of benzoic acid at room temperature and below room temperature by volumetric method.

Inorganic Chemistry

Gravimetric estimations:

1 Ba as $BaSO_4$
2 Fe as Fe_2O_3

LEARNING OUTCOMES:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th edition.

Reference Books

Physical Chemistry

1. Puri, Sharma, Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Oxford University Press
2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry

Inorganic Chemistry

1. B.R. Puri, L.R. Sharma, K.C. Kale, Principles of Inorganic Chemistry, Vallabh Publications, First Edition
2. F.A. Cotton and G. Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao, University General Chemistry, Mc Millan, 1993.
4. Sharpe and Emilus, Inorganic Chemistry, ELBS Publications. New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, Pergamon, Oxford,1984

CH -203	Organic and Inorganic Chemistry Semester III	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Organic Chemistry)

- To learn the terms involved, the laws, the rules and the principles in UV –Visible Spectroscopy and Infra Red (IR) absorption spectroscopy.
- To understand various electronic transitions in UV –Visible Spectroscopy.
- To know Woodward - Fieser rules for calculation of λmax for Conjugated dienes and enones.
- To understand the various factors which effects the intensity and position of IR bands to know the characteristic absorptions of various functional groups.
- To know the use of Finger print region to establish the identity of unknown compound in Infra Red (IR) absorption spectroscopy.
- To know the applications of UV –Visible Spectroscopy and Infra Red (IR) absorption spectroscopy.
- To learn the interpretation of the IR and UV spectra of simple organic compounds.
- To know the classification and nomenclature of monohydric alcohols and dihydric alcohols.
- To learn the methods of preparations and reactions of alcohols
- To understand the concept of hydrogen bonding and acidity of alcohols.
- To know the nomenclature of ethers
- To learn the preparation, physical properties and chemical reactions of ethers.
- To study the synthesis and reactions of epoxides
- To know the nomenclature of aldehydes and ketones.
- To study the synthesis, physical properties and reactions of aldehydes and ketones with mechanism

Section II(Inorganic Chemistry)

- To define the basic concepts of oxidation and reduction and the study of electrochemical series.
- To define and draw Frost, latimer and Pourbaix diagrams for various types of reactions and to study the principles involved in extraction of elements
- To define lanthanides, their occurrence and position in the periodic table, their electronic structure and the oxidation states exhibited by them
- To study lanthanide contraction and its effects on the elements of the periodic table.
- To understand the technique of isolation of individual lanthanides from its ores by complex formation method

Practical:

- To understand and quantitatively estimate the desired organic compounds.
- To learn the preparation of desired Organic derivatives.
- To understand and systematically estimate quantitatively the desired metal ions by gravimetry.

SYLLABUS

Theory:

Section I (Organic Chemistry)	

I. Electromagnetic Spectrum: Absorption Spectra Ultraviolet (UV) absorption spectroscopy – Absorption laws (Beer-Lambert law), Molar absorptivity, presentation and analysis of UV spectra, Types of electronic transitions, effect of conjugation. Concept of chromophore and auxochromes, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones, Woodward-Fieser rules for calculation of UV maxima of the above two systems. Numerical problems on above. Infra Red (IR) absorption spectroscopy – Molecular vibrations, Hooke's law, selection rules, Intensity and position of IR bands, measurement of IR spectrum, Finger print region and its use to establish identity, Applications to determine purity, to study progress of chemical reactions and hydrogen bonding. Characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Simple problems in structure elucidation using UV and IR spectroscopy.	**12 L**
II. Alcohols Classification and nomenclature. Monohydric alcohols – Methods of preparations by reduction of carbonyl compounds, carboxylic acids, and esters, using Grignard reaction. Hydrogen bonding, acidic nature. Reactions of alcohols – esterification, oxidation and dehydration. Dihydric alcohols – Nomenclature, methods of preparation by hydroxylation of alkenes and acid catalyzed opening of epoxides. Reactions of vicinal glycols – pinacol-pinacolone rearrangement with mechanism.	**05 L**
III. Ethers and Epoxides Nomenclature of ethers and methods of preparation by Williamson synthesis, from alcohols by use of diazomethane and by use of H_2SO_4. Physical properties. Chemical reactions: cleavage with HI. Synthesis of epoxides by reaction of alkenes with peracids and by elimination from vicinal halohydrins. Acid and base catalyzed ring opening of epoxides, orientation of ring opening, reactions of Grignard and organolithium reagents with epoxides.	**04 L**
II. Aldehydes and Ketones Nomenclature and structure of the carbonyl group. Synthesis of aldehydes by oxidation of alcohols and reduction of acid chlorides, synthesis of ketones by oxidation of alcohols, from nitriles by Grignard reaction and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knovenagel condensations, reaction with ammonia and its derivatives, Wittig reaction and Mannich reaction. Halogenation of enolizable ketones. Mechanisms and one application each of the above reactions.	**09 L**
<u>Section II</u> (Inorganic Chemistry) **I. Oxidation and Reduction** Use of redox potential data-analysis of redox cycle, redox stability in water – frost, Latimer and pourbaix diagrams. Principles involved in the extraction of the elements.	**08 L**

II. Chemistry of the Lanthanide Elements Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds. **Practicals** **Organic Chemistry**: Organic Estimations: Estimations of Acetamide, Aniline and Glucose. Organic Derivatives: Benzoyl Derivative of β-naphthol and aniline. Bromo Derivative of phenol and aniline. Note: 1] The Organic Derivatives to be completed in 2 practicals. 2] Organic Estimations / Organic Derivatives to be given for examination. **Inorganic Chemistry**: Gravimetric Estimations 1. Mn as Mn-pyrophosphate 2. Ni as Ni-DMG 3. Al as Al2O3 from aluminium sulphate	**07 L**

LEARNING OUTCOMES:

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 ?max 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

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th Edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India
2. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia
3. Jerry March, Advanced Organic Chemistry; 3rd Edition, John Wiley
4. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry
Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry,
Wiley Eastern Ltd, 2nd Edition,1993
3. C N R Rao, University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS Publications.New Edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984

Books suggested for laboratory course

1. Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Basset, R.C.
3. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd.,
First Edition, 2006.

CH - 202	Physical and Inorganic Chemistry (SEMESTER IV)	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Physical Chemistry)

- To study conductometric titrations and the graphs involved.
- To interpret the crystal structure of NaCl, KCl and CsCl.
- To define terms involved in electrochemistry, conductance, specific conductance, equivalent conductance.
- To study the applications of conductivity measurements.
- To describe the preparation and properties of colloids.
- To derive and solve numericals on Bragg's equation.
- To study transport number, its determination by Hittorf method and moving boundary method.
- To classify colloids, sols and emulsions.
- To discuss the stability of colloids, protective action, Hardy- Schulze law, gold number.
- To define the terms and laws involved in Electrochemistry, Solid state and Colloidal state.
- To draw and interpret graphs of conductometric titrations.
- To study X-ray diffraction by crystals with examples.

Section II (Inorganic Chemistry)

- To discuss different types of Isomerism in co-ordination compounds with .
- To study the general characteristics of metals of second and third transistion series.
- To discuss the variable oxidation states, complexation tendencies, catalytic behavior and spectral properties and binary compounds of the metals of second and third transition series.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory.(Chemical kinetics, conductometry).
- To understand the principles involved in volumetric estimations by acid-base, redox and precipitation methods.

SYLLABUS

Theory:

Section I (Physical Chemistry)

1. Electrochemistry

Electrical transport –conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law its uses and limitations. Debye –Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method. Applications of conductivity measurements :determination of degree of dissociation , determination of Ka of acids , determination of solubility product of a sparingly soluble salt, conductometric titrations . **12 L**

2. Solid State

Definition of space lattice, unit cell. **11 L**

Laws of crystallography –(i) law of constancy of interfacial angels (ii) law of rationality of indices (iii) law of symmetry elements in crystals. X-ray diffraction by crystals .derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).

3. Colloidal State

Definition of colloids, classification of colloids .

Solids in liquids (sols): properties –kinetic, optical and electrical; stability of colloids, protective action, Hardy- Schulze law gold number. **07 L**

Liquids in liquids (emulsions): types of emulsions, preparation .Emulsifier

Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids

Section II (Inorganic Chemistry)

1. Chemistry of the elements of the second and third transition series **10 L**

Characteristic properties of the d-Block elements. Properties of the elements of the second and third transition series, their binary compounds, and complexes illustrating relative stability of their oxidation states, co-ordination number and geometry.

2. Co-ordination Compounds

Isomerism in co-ordination compounds, valence bond theory of transition metal complexes. **05 L**

Practical

Physical Chemistry

1. To determine the amount of chloride ion present in given solution by conductometric method.
2. To determine the solubility and solubility product of sparingly soluble salts ($BaSO_4$, $PbSO_4$, $CaSO_4$, $SrSO_4$) by conductometric method.
3. To study the kinetics of inversion of cane sugar in the presence of HCl solution
4. To investigate reaction between H_2O_2 and HI.
5. To investigate reaction between $HBrO_3$ and HI.

Note: Polarimeter experiment is to be performed by each student and is not a demonstration experiment.

Inorganic Chemistry

Volumetric analysis

1. Estimation of Cu by EDTA method.
2. Estimation of Fe^{2+} using internal indicator by potassium dichromate method.
3. Determination of alkali content in antacid tablet using Standard HCl solution.

LEARNING OUTCOMES:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th edition

Reference Books

Physical Chemistry

1. Puri, Sharma, Pathania, Principles of Physical Chemistry, Vishal Publishing Company,
   Oxford University Press
2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry

Inorganic Chemistry

1. B.R. Puri, L.R. Sharma, K.C. Kale, Principles of Inorganic Chemistry, Vallabh Publications, First Edition
2. F.A. Cotton and G. Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao, University General Chemistry, Mc Millan, 1993.
4. Sharpe and Emilus, Inorganic Chemistry, ELBS Publications. New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, Pergamon, Oxford,1984

CH -204	Organic and Inorganic Chemistry Semester IV	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Organic Chemistry)

- To know the nomenclature of Phenols, Carboxylic acids, derivatives of carboxylic acids and amines.
- To learn the methods of preparation and reactions of Phenols, Carboxylic acids, derivatives of carboxylic acids, nitroalkanes and nitroarenes and amines.
- To study the physical properties, acidic character and acid strength of alcohols and phenols.
- To study oxidation and reduction reactions of aldehydes.
- To understand the mechanism and know application of each reaction mentioned in the syllabus.
- To study the physical properties, acidity and effect of substituents on acid strength.
- To understand the mechanism of nucleophilic substitution in nitroarenes.
- To learn the preparation and properties of picric acid.
- To study physical properties, stereochemistry of amines and separation of mixtures of primary, secondary and tertiary amines.
- To understand the structural features affecting basicity of amines
- To study the use of amines as phase-transfer catalyst.

Section II (Inorganic Chemistry)

- To define actinides, their position and occurrence in the periodic table.
- To know the method of separation of individual actinides like Np, Pu, Am and U from their ores.
- To define ionic solids and know their properties.
- To understand close packing of spheres and to determine the types of interstitial sites like trigonal, tetrahedral, octahedral and cubic.
- To define lattice energy and to derive the values of lattice energies in various ionic crystals.
- To understand defects in stoichiometric and non-stoichiometric solids.

Practical:

- To gain knowledge and get hands on experience of analysing organic compounds.
- To understand and get hands on experience in performing binary mixture separation
- To understand the volumetric techniques to quantitatively estimate the metal ions calcium and nickel using three different salts of each ion.

SYLLABUS

Theory:

Section I (Organic Chemistry) **I. Phenols** Nomenclature, structure and bonding. Preparation of phenols by alkali fusion of aromatic sulphonic acids, Dow's process from chlorobenzene and from Cumene throughhydroperoxide rearrangement with mechanism. Physical properties and acidic character. Comparative acid strengths of alcohols and phenols, resonance stabilization of the phenoxide ion. Reaction of phenols – Electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement,	**04 L**

Claisen rearrangement, Gattermann synthesis and Riemer-Tiemann reaction. **II. Oxidation and Reduction reactions of carbonyl compounds** Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, Meerwein-Pondorf-Verley, Clemmensen, Wolff-Kischner, $LiAlH_4$ and $NaBH_4$ reduction. Mechanisms and one application each of the above reactions	**04 L**
III. Carboxylic Acids Nomenclature, structure and bonding. Physical properties, acidity and effects of substituents on acid strength. Preparation of carboxylic acids by oxidation of carbonyl compounds, carbonation of Grignard reagent, hydrolysis of cyanides, preparation of aromatic acids by oxidation of alkyl benzenes. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction, synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Dicarboxylic acids: Methods of preparation and effect of heat and dehydrating agents with reference to malonic acid only.	**05 L**
IV. Carboxylic Acids Derivatives Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides. Physical properties. Methods of preparation from carboxylic acids and interconversion of acid derivatives by nucleophilic acyl substitution. Mechanisms of esterification and acidic and basic hydrolysis of esters with evidences.	**04 L**
V. Organic Compounds of Nitrogen Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid – preparation and properties. Structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amine. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines by reduction of nitro compounds and nitriles, reductive amination of carbonyl compounds, Gabriel phthalimide reaction and Hofmann bromamide reaction.	**12 L**
<u>Section II</u> (Inorganic Chemistry) **I. Chemistry of Actinides** General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between later actinides and later lanthanides.	**04 L**
II. Ionic Solids Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, salvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule, metallic bond - free electron, valence bond and band theories	**11 L**

Practicals

Organic Chemistry:

Qualitative Analysis: - At least 5 compounds to be analyzed from the following compounds.

List of compounds

Acids: Cinnamic, o-Chlorobenzoic, Salicylic, Succinic, Oxalic, p-nitrobenzoic, p-hydroxybenzoic, Sulphanic acid.

Phenols: o- and m- Nitrophenols, Resorcinol.

Bases: p-Toluidine, Diphenylamine, o-, m- and p-nitroanilines, N-methylaniline, N,N-dimethylaniline

Hydrocarbons: Naphthalene, Anthracene, Toluene.

Amides: Benzamide, Urea, Thiourea

Carbonyl compounds: Salicylaldehyde, Furfural, Butanone, Acetophenone, Benzophenone, Camphor.

Alkyl and aryl halides: Chloroform, Chlorobenzene, Bromobenzene, p-Dichlorobenzene

Nitrohydrocarbons: m-Dinitrobenzene, p-Nitrotoluene,

Alcohols: 2-Propanol, Cyclohexanol

Esters: Ethyl benzoate, Methyl salicylate

Anilides: Acetanilide, Benzanilide

Note: 5 compounds of the following type to be analyzed in 3 Practical : Acid – 1 , Phenol – 1,Amides – 1 , Hydro carbon – 1 , Anilide – 1; Ester – 1; Alcohol – 1; Nitrohydrocarbons -1; Alkyl or aryl halides – 1; Bases – 1.

Tests to be performed are i. Preliminary tests; ii. Solubility and Chemical type; iii. Elements; iv. Groups and v. Physical constants.

Qualitative analysis is to be performed at a micro scale level using not more than 1g. solid and 1 ml. liquid.

Finding the organic mixture type: Solid-solid-Water Insoluble type.

Acid-Base 2) Acid-Neutral 3) Acid-Phenol 4) Phenol-Base 5) Phenol-Neutral 6) Base-Neutral

Note: 5 mixtures to given for chemical type determination in 2 practicals (not to be given for examination)

Inorganic Chemistry:

Volumetric analysis:

1. Estimation of Ca by EDTA (3 solutions of different salts of Ca).
2. Estimation of Ni by EDTA (3 solutions of different salts of Ni).

LEARNING OUTCOMES:

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 compoundsmentioned 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.

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th Edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India
2. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia
3. Jerry March, Advanced Organic Chemistry; 3rd Edition, John Wiley
4. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry
Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry,
Wiley Eastern Ltd, 2nd Edition,1993
3. C N R Rao, University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS Publications.New Edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984.

Books suggested for laboratory course

1. Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Basset, R.C.
3. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd.,
First Edition, 2006.

CH - 311	Physical Chemistry (SEMESTER V)	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To define the principles, hypothesis, postulates of quantum mechanics in Quantum chemistry.
- To draw the wave functions, orbital diagrams and the graphs involved.
- To solve the numerical, explain and interpret the wave functions.
- To distinguish between reversible and irreversible cells, Different types of reversible cells
- To solve the numerical wrt Nernst equation, to study electrochemical series and applications
- To study optical activity, polarization, dipole moment and methods of determination of dipole moments
- and structure of molecules
- To classify different nuclides. Binding energy and nuclear forces. To study nuclear models, radioactivity.
- To study emf and its measurements. To study concentration cell, its measurements, applications,
- To study decomposition potential, overvoltage and factors affecting them.

Section II

- Molecular structure and molecular spectra:
- To study the electromagnetic spectrum, terms, principles involved. To study Rotational spectra of diatomic molecules, determination of bond lengths and qualitative description
- To study counters used in measurement of radioactivity

SYLLABUS

Theory:

Section I 1. Quantum Chemistry: De Broglie hypothesis, the Heisenberg's uncertainty principle, sinusoidal wave equation, Hamiltonian operator, Schrödinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in one dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave function, radial wave functions, angular wave functions.	12 L
2. Electrochemistry:- I Electrolytic and galvanic cells; reversible and irreversible cells, conventional representation of electrochemical cells; types of reversible electrodes; gas – metal ion, metal-metal ion, metal in soluble salt-anion and redox electrodes, electrode reaction; Nernst equation; derivation of cell E.M.F. and single electrode potential, reference electrodes, standard hydrogen electrode; calomel electrodes ;standard electrodes potential, sign convention, electrochemical series and its applications.	07 L
3. Molecular Structure Optical activity and molecular structure; polarization (Mosotti-Clausius equation), orientation of dipoles in an electric field, dipole moment, induced	05 L

dipole moment, measurement of dipole moment; temperature method and refractivity method, dipole moment and structure of molecules. 4. Nuclear Chemistry: - I Composition of the nucleus. Nuclear binding forces, binding energy, stability, nucleon-nucleon forces and their equality, characteristics and theory of nuclear forces. Nuclear models, the shell model, liquid drop model and its merits. Theory of radioactive disintegration, rate of disintegration half, average life of radio element, units of radioactivity, definition and characteristics of artificial radioactivity.	06 L
Section II 5. Electrochemistry :-II EMF of a cell and its measurements; Concentration cells (both electrodes and electrolytes) with and without transport; liquid junction potential and its measurement; Application of concentration cell; determination of ionic product of water; transport number of ions; solubility and solubility product. Polarization; elimination of polarization; decomposition potential, measurement of decomposition potential ; factor affecting decomposition potential over voltage and types of over voltage; measurement of over voltage ; factor affecting over voltage	13 L
6. Molecular structure and molecular spectra: Introduction to electromagnetic radiation; regions of the spectrum; statement of the BornOppenheimer approximation; degrees of freedom. Rotational Spectrum: Diatomic molecules, energy level of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (MaxewllBoltzmann distribution); determination of bond length, qualitative description of non-rigid rotor, isotope effect.	08 L
7. Nuclear Chemistry:-II Determination and measurements of radioactivity: Ionisation current measurements; saturation collection; multiplicative ion collection; the Geiger-Muller Counter, characteristics of an ideal Geiger-Muller Counter, proportional counter. methods based on photon collection, Scintillation counter, characteristics of a suitable Scintillator.	09 L

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2 U.N.Dash, Nuclear Chemistry, by Sultan Chand & Sons, New Delhi.

Reference Books

1. Puri, Sharma, Pathania, Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press

2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,

3. Donald McQuarrie, Physical Chemistry

CH- 321	Inorganic Chemistry (SEMESTER V)	Number of lectures:60

COURSE OBJECTIVES:

Theory:

Section I

- To discuss the drawbacks of Valence bond theory for co-ordination compounds.
- To generalise the postulates of Crystal field theory
- To define the terms Crystal field splitting, Crystal field splitting energy, Crystal field stabilization energy.
- To draw the crystal field splitting diagram for octahedral, tetrahedral and square planar complexes.
- To evaluate the magnetic properties of transition metal complexes.
- To calculate the magnetic moments for different transition metal complexes having octahedral, tetrahedral and square planar geometry.
- Toknow the classification of elements as essential or trace and their uses in biological processes.
- To study the roles of myoglobin and hemoglobin with respect to the transfer and storage of oxygen in biological systems and the process of respiration.
- To introduce basic synthesis concepts of solid-state chemistryand provide introductory knowledge on concept of band gap and classification of materials based on it.

Section II

- To define the terms Organometallic compounds, mononuclear, polynuclear metal carbonyls.
- To state the Effective atomic number rule, 18 electron rule for metal carbonyls and organometallic compounds.
- To state the names of metal carboyls and organometallic as per the IUPAC system.
- To generalise the methods of preparation, properties and bonding in $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$, $Mn_2(CO)_{10}$,$Fe_2(CO)_9$,$Fe_3(CO)_{12}$ and ferrocene.
- To classify the ligands based on hapticity,.
- To prepare by various methods alkyls and aryls of Li ,Al ,Hg and Ti and to study their physical and chemicals properties.
- To learn general methods of preparationsof organometallic compounds
- To understand the model systems prepared to study macromolecular biological molecules.
- To know the types of alkali and alkaline earth metals and their roles in biological systems.
- To define metalloenzymes and to study their roles in biological systems.
- To introduce concept of defects in solids and define Schottky and Frenkel defects, Color center, extended defects and Non-stoichiometry

SYLLABUS	
Theory:	
Section I **1)Metal-Ligand Bonding in Transition Metal Complexes:** Limitations of Valence bond theory, Crystal field theory (CFT) splitting of d-orbitals in octahedral, tetrahedral and square planar complexes. Crystal Field Stabilization Energy (CFSE), Measurement of 10 Dq for $[Ti(H_2O)_6]^{3+}$ complex, Factors affecting 10 Dq, Spectrochemical series, Effect of crystal field splitting on properties of Octahedral complexes: Magnetic, Spectral.	**20L**
2)Bio-inorganic Chemistry (I) Overview, essential and trace elements in biological processes, Metalloporphyrin special reference to hemoglobin and myoglobin.	**05L**
3)Inorganic solid-state chemistry (I) Introduction, Preparation of Nonmolecular solids, Band gaps, Metals, Insulators and Semi-conductors.	**05L**
Section II **4)Organometallic chemistry** **A)** Definition, nomenclature and classification of organometallic compounds, EAN rule, 18 electron rules. General methods of preparations and properties. Structure and bonding in mononuclear metal carbonyls: $Ni(CO)_4$, $Fe(CO)_5$ and $Cr(CO)_6$ (Orbital diagram not expected) B) Polynuclear metal carbonyl: preparation and structures of $Mn_2(CO)_{10}$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$ (Orbital diagram not expected) C) Sandwich compounds like Ferrocene: preparation, properties, reactions, structure and bonding. D) Preparation and properties of alkyl and aryls of Li, Al, Hg and Ti.	**20L**
5) **Bio-inorganic Chemistry (II)** The role of Model systems, The alkali and alkaline earth metals,Metalloenzymes, Nitrogen fixation cycle.	**05L**
6) **Inorganic solid-state chemistry (II)** Defects in Solids Point defects: Schottky and Frenkel, Color center, extended defects, Non-stoichiometry.	**05 L**

LEARNING OUTCOMES:

Theory:

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 carboyls 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.

  .

REFERENCES

Text- Books:

1. Concise Inorganic Chemistry. 5th edition, J. D. Lee
2. Basic Inorganic Chemistry, 5th edition, F.A. Cotton, G. Wilkinson.

Reference books:

3. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit 18th revised edition, Himalaya Publishing House.
4. Principles of Inorganic Chemistry, B.R Puri, L. R. Sharma, Milestone Publishers.
5. Inorganic Chemistry, (Principles of Structure and Reactivity). James E. Huheey, Ellen A. Keiter, Richard L. Keiter
6. Inorganic Chemistry D. E. Shriver, P.W. Atkins and C.H. Langford, Oxford.
7. Advance Inorganic Chemistry, 6th edition, F.A. Cotton and G. Wilkinson
8. Comprehensive Inorganic Chemistry, B.S. Bahl and Sharma
9. Group theory and its Chemical applications, P. K. Bhattacharya, Himalaya Publication.
10. Environmental Chemistry, A. K. De.

CH-331	Organic Chemistry Semester V	Number of lectures:60

COURSE OBJECTIVES:

Theory:60 L

Section I

- To understand important concepts in NMR and Mass spectroscopic methods.
- To learn the structure elucidation of simple organic molecules using spectroscopictechniques (UV, IR, PMR, CMR and MS).
- To study the Structure elucidation and synthesis of Nicotine, Atropine and Papaverine.
- To understand the mechanism and stereochemistry of addition of halogens and halogen acids to open chain alkenes, substitution reactions and elimination reactions.

Section II

- To understand the molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine.
- To learn 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 andBischler-Napieralski synthesis.
- To understand the mechanism of, nucleophilic substitution reactions in pyridine derivatives and electrophilic substitution reactions of indole, quinoline and isoquinoline.
- To compare basicity of pyridine, piperidine and pyrrole.
- To study condensed 5 and 6 membered heterocycles.
- To learn the importance of vitamins, hormones and the classification of vitamins.
- To study the structure elucidation and synthesis of vitamin A, C, thyroxine and adrenaline.
- To study the structure of amino acids, peptides and proteins.
- To learn the preparation and reactions of α-amino acids.
- To understand the concept of isoelectric point, electrophoresis, protein denaturation/renaturation, nucleic acids and double helical structure of DNA.
- To learn the reactions for peptide synthesis, hydrolysis of peptides, nucleic acids and methods for peptide structure determination.

SYLLABUS

Section I

1. Spectroscopy Proton Magnetic Resonance (^{1}H NMR) spectroscopy, theory, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, intensity of peaks, interpretation of PMR spectra of simple organic molecules. ^{13}C Magnetic Resonance: Number of signals, splitting of signals – proton coupled and decoupled spectra, off resonance decoupled spectra. ^{13}CMR chemical shifts – identification of hybridization of carbons and nature of functionalization. Mass Spectrometry: Simple idea of instrumentation, Definitions of parent or molecular ion peak and base peak. Isotope effect with respect to alkyl halides, Fragmentation of ketones – α cleavage and Mc Lafferty rearrangement. Problems pertaining to the structure elucidation of simple organic molecules using spectroscopic techniques (UV, IR, PMR, CMR and MS). Types of problems to be	18 L

specified. UV and IR to be used as supporting data. Types of CMR and Mass spectroscopy problems to be specified. 2. Alkaloids Structure elucidation and synthesis of Nicotine, Atropine and Papaverine. 3. Stereochemistry of Reactions: Mechanism and stereochemistry of (i) Addition of halogens and halogen acids to open chain alkenes. Markownikoff's and anti- Markownikoff's addition. (ii) SN_1, SN_2, SN_i , substitutions and (iii) E_1, E_2 and E_{1cb} elimination reactions.	05L 07 L
Section II 4. **Heterocyclic Compounds** Introduction, Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed 5 and 6 membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis andBischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline. 5. **Vitamins and Hormones** Vitamins: Importance and classification. Structure elucidation and synthesis of Vitamins A and C. Hormones: Important hormones and their uses. Structure elucidation and synthesis of Thyroxine and Adrenaline. 6. **Amino acids, Peptides, Proteins and Nucleic Acids** Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical methods of peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structures. Protein denaturation/renaturation. Nucleic acids: Introduction. Hydrolysis of nucleic acids. Ribonucleosides and ribonucleotides. General idea of the double helical structure of DNA.	12L 08 L 10 L
LEARNING OUTCOMES:	
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.

REFERENCES:

Reference Books

1. I.L.Finar, Organic Chemistry Vols I and II, Orient Longman
2. Morrison and Boyd, Organic Chemistry; 6th Edn. Prentice Hall India
3. Francis Carey, Organic Chemistry
4. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edn. Pearson Education Asia
5. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds.

CH - 341	ANALYTICAL CHEMISTRY SEMESTER V	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

- Define the terms involved in sampling techniques, data handling and solvent extraction, electrolytic methods, potentiometric titrations.
- State the laws and principles involved in solvent extraction, electrolytic methods, potentiometric titrations.
- Explain scope and importance of analytical chemistry, sampling of liquid,solid and gases, different types of tests related to data handling, the different types of extraction.
- Differentiate between various electrolytic methods, state and explain limits and merits of the various methods.
- Draw theamperometric titration curves, schematic diagram of instruments and explain its working.
- Classify and explain different types of errors, sampling techniques and types of extraction.
- Derive and use the equations of linear least squares and method of averages and solvent extraction to solve numerical.
- Interpret steps involved in chemical analysis.
- Explain the principle of potentiometric titrations, location of equivalence point and types of potentiometric titrations.

SYLLABUS

Theory:

Section I **1. Introduction** Scope and importance of analytical chemistry Chemical analysis and analytical chemistry Analytical process (steps involved in chemical analysis): defining the problem, sampling,separation of desired components, actual analysis, presentation and interpretation of results. Basic components of instruments for analysis Signal generators, detectors (input transducers) Signal processors, read out devices, circuits & electrical devices in instruments. References:1,2,3	**4 L**
2. Sampling Techniques Terms encountered in sampling: the population or the universe, Sample, Sampling unit, increment, the gross sample, the sub sample, Analysis sample, Bulk ratio, Size to weight ratio, Random sampling, Systematic sampling, Multistage sampling, Sequential sampling. Sampling of Gases, Liquids and Solids Preservation, storage and preparation of sample solution (References: 1,2,3)	**4 L**
3. Data handling Significant figures and rounding off. Accuracy and precision Errors : determinate and indeterminate error, Constant and proportionate errors ,	**11 L**

Minimization of errors Standard deviation. Histogram and Frequency polygon Measures of central tendency and dispersion.Gaussian distribution curve Confidence limit. Test of significance: F test, Students T Rejection of the results: Q test, 2.5d & 4d rule. Linear least squares/ Method of averages (Numerical problems are expected to be solved) Reference:1,35	
4. Solvent Extraction Basic principle, percentage extraction, role of complexing agents in solvent extraction, separation factor, Types of extraction (continuous, batch). (Numerical problems are to be solved) References: 1,2,3	**3L**
Section II	
5. Electrolytic methods Introduction: principles involved in Electrogravimetric analysis, Instrumentation, Electrolysis at constant current principle, apparatus, determination of copper by constant current electrolysis. Coulometry: Introduction, constant Current measuring device, Hydrogen-Oxygen coulometer, Silver coulometer. General characteristics of coulometric method, Coulometric titrationsApplications of coulometric titrations (References: 1,3,) Polarography:Introduction, Basic principles of instrumentation of polarography, Deposition potential, Dissolution potential, Polarisation of electrode, Polarographic wave, Ilkovic equation, Half wave equation (derivation not expected) Supporting electrolytes, Interference of oxygen, Applications of polarography – inorganic and organic. (Refences: 1,3,5) Amperometric titrations: Introduction, Instrumentation, Titration Curves, advantages of amperometric titrations.(Reference:1,3)	**12 L**
6. Potentiometric Titrations Principles of potentiometric titrations, Location of equivalent point, Different types of potentiometric titrations. (References :1,2,3)	**5 L**
7. **Atomic spectrometric methods:** Flame Photometry:Introduction, Principle, Instrumentation, applications, Limitations. Atomic absorption Spectroscopy: Introduction, Principle, Instrumentation, applications, limitations.	**6 L**

Differences between flame photometry and atomic absorption spectroscopy. Inducted coupled plasma. (References: 1,2,3)	

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Book

B.K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut

Reference Books

1. G. D.Christan Analytical Chemistry by, 5th edition Wiley publications.
2. G. Chatwal and S. Anand, Instrumental Methods of Chemical Analysis 5th edition (reprint 2003), Himalaya publication.
3. B. S. Baliga and A.Zaveri, College Analytical Chemistry, 15th edition, Himalaya Publishing House, 2004
4. Vogels Textbook of Quantitative Inorganic Analysis 4th edition ELBS.
5. Willard, Meritt and Dean. Instrumental Methods of Analysis
6. Skoog and Leary, Principles of Analytical Chemistry 4th International edition.

7. P.R.Trivedi and Gurdeep Raj, Environmental Water and Soil Analysis, Akashdeep Publishing House, New Delhi.
8. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.

CH – 301	Experiments in Physical and Analytical Chemistry SEMESTER V	Number of hours: 45

COURSE OBJECTIVES:

Practical:

- To understand and develop the problem solving skills and hands on experience with refrence to concepts studied in theory(potentiometry , pH metry, partition coefficient, Chemical kinetics)
- To understand and develop the problem solving skills and hands on experience with refrence to instrumentation and techniques studied in theory.(spectrophotometry,chromatography and conductometry)

SYLLABUS

Practical

Physical

Conductometry

1. To determine the percent composition of acid mixture (strong and weak acid) by titrating against standard 0.1 N NaOH solution.
2. To verify Ostwald's dilution law using CH3COOH Potentiometry
3. To determine the formal redox potential of Fe2+/Fe3+ system using standard 0.1N K2Cr2O7 solution.
4. To determine the solubility product of AgCl/AgBr.

pH metry

5. To determine the dissociation constant of weak monobasic acid (CH3COOH) by titrating against standard 0.1N NaOH solution

General

6. Partition Coefficient: To determine the equilibrium constant for the reaction KI +I2 === KI3
7. Adsorption: To study the adsorption of acetic acid from aqueous solution by activated charcoal and verify Freundlich adsorption isotherm.
8. Chemical Kinetics: To study the acid hydrolysis of methyl acetate at two different temperature and determine the energy of activation.

Analytical

A] Spectrophotometry.

1. Determination of Mn2+ in steel or Mn2+ ion concentration periodate method.
2. Determination of iron by salicylic acid method.

B] Chromatography

3. Separation of metal ions by paper chromatography.(demonstration)
4. Separation of organic compounds by TLC.(demonstration)
5. Zn2+ /Mg2+ separation by an anion exchanger & their volumetric estimation of with standard EDTA.

C] Conductometry

6. Estimate the amount of Pb present in a solution of Pb(NO3)2 by conductometric titration with Na2SO4

D] Other Experiments

7. Determination of ascorbic acid in Vitamin C tablets by iodometry
8. Estimation of Ca in milk powder using EDTA method (volumetry) and also by precipitation as oxalate followed by titration with KMnO4 (not for examination)

LEARNING OUTCOMES:

Practical:

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.
- 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.

REFERENCES:

1.Basic Principles of Analytical Chemistry. To be used as text book.
K. Raghuraman, D.V.Prabhu, C.S. Prabhu and P.A.Sathe
3rd, 4th and 5th edition, Sheth Publishers.
2.Analytical Chemistry.
Gary Christian, 4th Edition, International Edition.
3.Principles of Analytical Chemistry.
Skoog and Leary, 4th International Edition.

CH-:303	Experiments in Inorganic and Organic Chemistry (Semester V)	Number of hours: 60

COURSE OBJECTIVES:

Practical:

- To understand and systematically estimate quantitatively the desired metal ions by gravimetry in presence of interfering ions and also quantitatively estimate inorganic complexes of different metal ions.
- To understand theoretical concepts required for experiments and develop hands on experience with reference to basic laboratory techniques required for organic estimations, synthesis and finding the organic mixture type.

SYLLABUS

Practical:

Inorganic Chemistry

Gravimetric Estimations .

1. To estimate the amount of Fe as Fe_2O_3 in the given solution of ferric chloride containing barium chloride and free HCl.
2. To estimate the amount of nickel as Ni-DMG in the solution of nickel chloride containing copper chloride and free HCl.
3. To estimate the amount of barium as $BaCrO_4$ in the solution of barium chloridecontaining ferric chloride and free HCl.
4. To estimate the amount of Zinc as $Zn_2P_2O_7$ in the given solution of zinc sulphate containing copper sulphate and free H_2SO_4.

Inorganic Preparations

1. Preparation of Sodium trioxalatoferrate(III); $Na_3[Fe(C_2O_4)_3]$ complex.
2. Preparation of Tristhioureacopper (I) sulphate.
3. Preparation of Trisethylenediaminenickel(II) complex.
4. Preparation of Chrome Red.

Organic Chemistry

1. Organic Estimations:
   a) Mixture of acid and ester
   b) Mixture of acid and amide
   c) Saponification value of oil
2. Organic synthesis: Nitration of nitrobenzene and acetanilide, p-bromoacetanilide from acetanilide, m-nitroaniline from m-dinitrobenzene, synthesis of osazone of glucose and oxime of cyclohexanone
3. Finding the organic mixture type: Solid-solid-Water Soluble- Insoluble type.
   1)Acid-Acid 2) Acid-Neutral 3) Neutral-Neutral
   Liquid-liquid mixture type as well as the separation.
   Note: 1) 6 Organic Synthesis to be completed in 3 practicals.
   2) At least 5-6 mixture type determination to be given (not to be given for examination)

LEARNING OUTCOMES:

Practical:

At the end of the course students will be able to

- 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.
- 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.

REFERENCES:

Inorganic Chemistry:

Books for Practicals:

1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham ELBS.
3. Standard Methods of Chemical Analysis W.W. Scott, Technical Press.
4. Experimental Inorganic Chemistry W.G. Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol. I and II Brauer, Academic Press.
6. Inorganic Synthesis, Mc Graw Hill.

Organic Chemistry:

1. Vogel's Qualitative Organic Analysis, Orient Longman.
2. Textbook of Practical Organic Chemistry, N.K.Vishnoi.

CH - 312	Physical Chemistry (Semester VI)	Number of lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To study the molecular orbital theory diagrams and the graphs involved.
- To interpret the physical picture of bonding and antibonding wavefuction.
- To define terms involved in electrochemistry, pH, poH, pKa, pKb. Buffer solution, buffer capacity. Measurement of pH using different electrodes by potentiometric methods.
- To describe the mechanism of buffer action.
- To derive and solve numerical on Henderson's equation.
- To study energy released in nuclear fission, fission products.
- To classify various nuclear reactors. To describe the working of reactors and its parts.
- To know nuclear reactors in India.
- To define the terms and laws involved in photochemistry.
- To draw and interpret Jablonski diagrams
- To study photochemical and photosensitized reactions with examples

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Section II

- To describe types of theories in corrosion
- To explain the types of energy sources
- To study vibrational spectroscopy, ir, harmonic and anharmonic oscillator, Raman spectroscopy,
- Define terms , force constants, bond energy, polarizability.
- To study stokes and antistock lines, Raman shift and selection rules involved.
- Chain reactions, terms involved and units of radioactivity, applications of radioactive isotopes Biological effects of radiations.

SYLLABUS

Theory:

Section I 1. Quantum Chemistry: Molecular orbital theory, basic ideas-criteria for forming M.O from A.O, construction of M.O's by LCAO-H2+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions.	06 L
2. Applied Electrochemistry - I Definition of pH, pOH pKa,and pKb; introduction to potentiometer; determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric method; Buffer solution, types, buffer action, buffer capacity ,mechanics of buffer action, Henderson-Hazelbulch equation.	08 L
3. Nuclear Chemistry - I Nuclear fission, energy released in fission and fission products, neutron emission in fission, nuclear energy, classification of reactors, the breeder reactor, nuclear reactors in India.	06 L

4. Photochemistry: Interaction of radiation with matter, differences between thermal and photochemical processes, laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagram; depicting various processes occurring in the excited state, quantum yield and its measurements qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, inter system crossing), photosensitized reactions-energy transfer processes (simple examples).	10 L
Section II 5. Applied Electrochemistry:- II Corrosion-Types, theories - electrochemical and chemical. Energy sources: Acid and alkaline battery. Ni-Cd cell fuel cells, solar cells. Secondary batteries.	08 L
6. Spectroscopy: Vibrational Spectrum: Infrared spectrum: energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of an- harmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. Raman spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.	16 L
7. Nuclear Chemistry: - II Chain reaction and conditions for its control ; reprocessing of spent fuels; units of radiation energy ;applications of radioactive isotopes; radioisotopes as tracers; biological effects of radiation.	06 L

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2 U.N.Dash, Nuclear Chemistry, by Sultan Chand & Sons, New Delhi.

Reference Books

1. Puri, Sharma, Pathania, Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press

2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,

3. Donald McQuarrie, Physical Chemistry

CH- 322	Inorganic Chemistry SEMESTER VI	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To study types of electronic transitions and selection rules for transitions to take place
- To study the applications to determine ligand field strength, color of complexes, Cis-trans isomerism and Geometry of complexes.
- To define the terms fuel gases, calorific value, benzol.
- To state the composition ,draw the flow sheet and equipment for manufacture of of coal gas, producer gas and water gas
- To explain the advantages of fuel gases over liquid and solid fuels.
- To discuss the physicochemical principles involved in the synthesis of ammonia by Haber's process and Nitric acid by Ostwald's method.
- Todefine pollutant, primary and secondary pollutant, air pollution
- To discuss sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur.
- To understand Photochemical smog.
- To discuss the phenomenon of acid rain, greenhouse effect.
- To introduce concept of Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rotation – reflection axis and Identity and apply to different molecules

Section II

- To define the terms Magnetic susceptibility, magnetic moment, diamagnetism, paramagnetism.
- To explain the different types of magnetic behaviour- diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, measurement of susceptibility by Gouy's method.
- To draw the graph of susceptibility v/s temperature for paramagnetic, ferromagnetic and antiferromagnetic substances.
- To calculate magnetic moment by spin formula for different transition metal complexes.
- To interpret the magnetic behaviour of different transition metal complexes based on observed and calculated magnetic moments.
- To introduce Nanochemistry and explain nano particles, their properties and applications.
- To introduce zeolites, their structure and applications.
- To define the terms Meissner effect,critical temperature.
- To explain the mechanism of superconductivity.
- To discuss the different types of superconductors.
- To define and study the properties of inorganic polymers.
- To classify condensation, addition and coordination Polymers
- To introduce preparation, structure & bonding and applications of silicones.
- To study stability constants of reactions in terms of thermodynamic and kinetic stability and the various factors affecting the stability constants of complexes.
- To study the substitution reaction mechanisms of octahedral complexes and the trans effect observed in square planar complexes.

SYLLABUS

Theory:

Section I

1.Electronic spectra of Transition Metal Complexes:
Introduction, Types of electronic transitions: The d-d transitions (d^1/d^9 and d^2/d^8), Charge transfer transitions and Ligand-ligand transitions, Selection rules (Laporte Orbital and Spin), Applications (Ligand field strength, Colour of complexes, Cis-trans isomerism and Geometry of complexes). **10L**
Ref: 3,7

2.Industrial fuels and chemicals.
(A) Industrial fuels like coal gas, producer gas and water gas.
(B) Physico chemical principles involved in the manufacture of HNO_3 (Ostwald's method) and NH_3 (Haber's method). **8L**
Ref: 8

3.Air Pollution:
Introduction, classification of pollutants, sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur, Photochemical smog, acid rain and House effect. **7L**
Ref: 10

4.Symmetry and Term symbols:
(A) Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rota reflection axis, Identity (Trans dichloroethylene, H_2O and BCl_3) **5L**
Ref: 9

Section II

5. Magnetic properties of transition metal complexes:
Types of magnetic behaviour, Methods of determining magnetic susceptibility (Gouy's method), spin only formula, application of magneticmoment data for 3d – metal complexes. **5L**
Ref: 1, 4

6.Selected topics: **(A) Nano chemistry:** Introduction to Nano particles, their properties and applications. **(B) Solid acids:** Introduction to zeolites, structure and applications. **(C)Superconductors:** Discovery, critical temperature, Meissner effect, Conventional and High Temperature superconductors. **Ref:** 3, 5	**10L**
7.Inorganic Polymers: Definition, Properties, Glass transition temperature, Classification (Condensation, addition and coordination Polymers) **Silicones:** Preparation, structure & bonding and applications. **Ref:** 3, 4	**6L**
8.Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamicstability of metal complexes and factors affecting the stability, substitution reactions of Octahedral complexes. Trans effect with respect to square planar complexes. **Ref:** 5	**9 L**

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text- Books:

1. Concise Inorganic Chemistry. 5th edition, J. D. Lee
2. Basic Inorganic Chemistry, 5th edition, F.A. Cotton, G. Wilkinson.

Reference books:

3. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit 18th revised edition, Himalaya Publishing House.
4. Principles of Inorganic Chemistry, B.R Puri, L. R. Sharma, Milestone Publishers.
5. Inorganic Chemistry, (Principles of Structure and Reactivity). James E. Huheey, Ellen A. Keiter, Richard L. Keiter
6. Inorganic Chemistry D. E. Shriver, P.W. Atkins and C.H. Langford, Oxford.
7. Advance Inorganic Chemistry, 6th edition, F.A. Cotton and G. Wilkinson
8. Comprehensive Inorganic Chemistry, B.S. Bahl and Sharma
9. Group theory and its Chemical applications, P. K. Bhattacharya, Himalaya Publication.
10. Environmental Chemistry, A. K. De.

CH-332:	Organic Chemistry (Semester VI)	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To know nomenclature of different carbohydrates.
- To know classification of carbohydrates and terpenes.
- To study general reactions of Monosaccharides.
- To study the determination of configuration and ring size of monosaccharides with reference to glucose, interconversion of glucose.
- To know cyclic structure of D(+)- glucose and study mutarotation, formation of glycerides, ethers, esters and structure elucidation of sucrose.
- To learn the general methods of structure elucidation of terpenes.
- To learn the synthesis of α-terpineol, camphor, citral. ethyl acetoacetate by Claisen condensation.
- To study the chemistry of α-terpineol, camphor, citral. α-pinene and zingiberene.
- To understand the acidity of α-hydrogens, keto-enol tautomerism in ethyl acetoacetate, hydrogenation of unsaturated oils,
- To study the alkylation of diethyl malonate, ethyl acetoacetate, 1,3-dithianes, enamines and acylation of enamines.
- To study the chemistry of following- Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, soaps, synthetic detergents, alkyl and aryl sulphonates.
- To learn the various terms such as saponification value, iodine value and acid value of oils.

Section II

- To learn the definition of the terms involved.
- To know the classification of dyes, synthetic drugs, polymers and types of polymerization.
- To learn the preparations of various polymers mentioned in the syllabus.
- To understand the difference between natural and synthetic rubber with examples.
- To learn the vulcanization of rubber.
- To understand the effect of constitution on colour of different organic compounds based on electronic concept.
- To study the chemistry and the synthesis of various dyes mentioned in syllabus.
- To learn nomenclature and structure of one compound from all classes of pharmacodynamic agents and chemotherapeutic agents.
- To learn synthesis and application of various synthetic drugs.
- To know the nomenclature and structural features of Organosulphur and Organophosphorus compounds.
- To learn the methods of preparations and reactions of thiols, thioethers, sulphonic acids, phosphines and phosphonium salts including Wittig reaction and its applications.
- To understand the chemistry of ylides and Organophosphorus compounds.
- To understand chemistry of photochemical reactions, Jablonskii diagram, Norrish type I and Norrish type II cleavage of ketones
- To understand electronic transitions and transition states.

SYLLABUS	
Section I 1. **Carbohydrates** Classification and nomenclature. Monosaccharides: General reactions, chain lengthening by Killiani-Fischer synthesis and chain shortening by Ruff degradation of aldoses, mechanism of osazone formation. Configuration of monosaccharides with reference to glucose. d(+)/l(-) and D/L systems of nomenclature. Interconversion of glucose to fructose and glucose to mannose. Determination of ring size of monosaccharides with reference to glucose. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. Formation of glycosides, ethers and esters. Structure elucidation of sucrose.	10L
2. Terpenes Classification. General methods of structure elucidation. Chemistry and synthesis of citral and its conversion to ionones. Chemistry and synthesis of α-terpineol, camphor. Chemistry of α-pinene. Chemistry of zingiberene.	10L
3. **Organic synthesis via Enolates**: Acidity of α-hydrogens, Synthesis of ethyl acetoacetate by Claisen condensation, keto-enol tautomerism in ethyl acetoacetate. Alkylation of diethyl malonate and ethyl acetoacetate. Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.	08L
4. **Fats, Oils and Detergents:** Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides. Hydrogenation of unsaturated oils. Saponification value, iodine value and acid value of oils. Soaps, synthetic detergents, alkyl and aryl sulphonates.	02L
Section II **5. Synthetic Polymers:** Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Zeigler-Natta polymerization and vinyl polymers. Condensation or step-growth polymerization. Polyesters, polyamides, phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.	05L
6. **Synthetic Dyes**: Color and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of methyl orange, Congo Red, Malachite Green, Crystal Violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.	08L

7. Synthetic Drugs: Classification according to use. One compound with name and structure from all classes of pharmacodynamic agents and chemotherapeutic agents. Synthesis and uses of the following drugs: Phenobarbital, Chlorpheniramine, Atenolol, Ibuprofen, Naproxen, Methyldopa, Chloramphenical, Metronidazole and Ethambutol.	06L
8. Organosulphur and Organophosphorus Compounds: Nomenclature, structural features. Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids. General reactions only. Introduction to organophosphorus compounds. General methods of preparation of phosphines and phosphonium salts. Wittig reaction and its applications.	08L
9. Photochemistry: General idea of photochemical reactions. Electronic transitions and transition states. Jablonskii diagram. Norrish type I and Norrish type II cleavage of ketones.	03L

LEARNING OUTCOMES:

Theory:

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,

transition states and photochemical reactions.

REFERENCES:

1. I.L.Finar, Organic Chemistry Vols I and II, Orient Longman
2. Morrison and Boyd, Organic Chemistry; 6th Edn. Prentice Hall India
3. Francis Carey, Organic Chemistry
4. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edn. Pearson Education Asia
5. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds;

CH - 342	*Analytical Chemistry* **(SEMISTER VI)**	**Number of hours: 45**

COURSE OBJECTIVES:

Theory:

SECTION I & II

- Define the terms involved in basic electronics and thermal methods, radiochemical methods, UV Visible Spectroscopy, Chromatographic methods, Fluorimetry
- State the principles in thermal methods of chemical analysis and basic electronics, UV Visible Spectroscopy and Fluorimetry, principles of isotope dilution method and neutron activation analysis.
- Draw the schematic diagrams, diagrams of instruments, circuit diagrams and the graphs involved.
- Describe the working of instruments, electronic components and circuits.
- Explain the terms involved giving examples, interpret the graphsin UV Visible Spectroscopy , chromatographic methods and fluorimetry.
- Classify and explain the different types of chromatographic technique.
- Derive and use the equations of Beer Lamberts law, Gas chromatography to solve numericals.
- Discuss applications of UV Visible Spectroscopy , chromatographic technique and fluorimetry.
- Analyse different parameters of water,air and soil analysis.

SYLLABUS

Theory:

Section I **1. UV-Visible Spectroscopy** Interaction of electromagnetic radiation with matter, Quantitative calculations- Beer's and Lambert's law. Deviations from Beer's law Principles of instrumentation: Sources, monochromators, cells. Types of instruments. Photoelectric colorimeters: Single & Double beam photoelectric colorimeters; comparison between colorimeter and spectrophotometer ; applications of colorimetry and/or spectrophotometry ; quantative analysis; identification of structural groups in a molcule ; study of co-ordination compound, photometric titrations, cis-trans isomerism; chemical kinetics & others limitations. *(Reference: 1,3)(numerical problems are expected to be solved)*	**09 L**
2. Chromatographic Methods Principles. Classification of chromatographic techniques Techniques of column chromatography Paper and thin layer chromatography: Principles, techniques and applications of paper and thin layer chromatography.Theory of chromatographic separation :DistributionEquilibria, Rate of travel, Retention time,Retention volume and relative retention.Ion exchange chromatography: Principles, classification of ion exchange materials, Nature of exchanging ions, Ion exchange capacity, applications in analytical chemistry.VGas chromatography and HPLC : Gas chromatography: Basic principles, Graphic diagram of apparatus, Explanation	**14 L**

of factors affecting separation, Thermal conductivity and Flame ionization detectors, Identification and estimation of sample components, Applications GC-MS and HPLC in detail. HPLC: principles equipment for HPLC , applications. *(Numerical problems are to be solved.References: 1, 2,3)* **Section II** **3. Basic Electronics** Introduction to diodes, rectifiers, zener diodes, regulated power supply, SCR's, triac and control circuits, Transistors, FET, Linear Integrated circuits and operational amplifiers.Binary arithmetic. *(Reference : 6)* **4. Thermal Methods** Thermogravimetric Methods (TG):Instrumentation, applications with respect to CaC2O4.H2O and CuSO4.5H2O Differential Thermal Analysis (DTA): General principles and applications. Differential Scanning Calorimetry (DSC): Applications. *References:2,4,5* **5. Fluorimetry** Principles of Fluorescence, chemical structure and Fluorescence. Relationship between concentration & fluorescence intensity Instrumentation & applications.*(numerical problems are expected to be solved)* *References:2,3* **6. Radiochemical methods** Isotope dilution Analysis: Principles and applications. Neutron activation analysis: principle, calibration curve method, advantages and limitations of neutron activation analysis. *(Reference : 6)* **7. Environmental Chemistry: Air, Water and Soil Analysis** Water analysis: Dissolved oxygen, free carbon dioxide, B.O.D., C.O.D. and total carbohydrates. Soil/ sediment analysis: Bulk density, Specific gravity, moisture content, water holding capacity, pH, electrical conductivity, alkalinity, detection of sulphate (By colorimeter or turbidimeter), nitrogen, nitrate, total phosphorus, phosphate, calcium, magnesium, sodium, potassium, iron and organic matter. Air analysis: SO2, H2S, NO-NO2, CO-CO2, O3 and NH3 *References: 8,9,*	**07 L** **04 L** **03 L** **03 L** **05 L**
LEARNING OUTCOMES:	
Theory:	

- 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 chemicalanalysis.
- 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

REFERENCES:

Text Book

B.K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut

Reference Books

1. G. D.Christan Analytical Chemistry by, 5th edition Wiley publications.
2. G. Chatwal and S. Anand, Instrumental Methods of Chemical Analysis 5th edition (reprint2003), Himalaya publication.
3. B. S. Baliga and A.Zaveri, College Analytical Chemistry, 15th edition, Himalaya PublishingHouse, 2004
4.Vogels Textbook of Quantitative Inorganic Analysis 4th edition ELBS.
5. Willard, Meritt and Dean. Instrumental Methods of Analysis
6.Skoog and Leary, Principles of Analytical Chemistry 4th International edition.
7. P.R.Trivedi and Gurdeep Raj, Environmental Water and Soil Analysis, Akashdeep Publishing
House, New Delhi.
8. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.

CH-302	Experiments in Physical and Analytical Chemistry SEMESTER VI	Number of hours: 45

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory(potentiometry , pH metry, partition coefficient, Chemical kinetics)
- To understand and develop the problem solving skills and hands on experience with refrence to instrumentation and techniques studied in theory.(spectrophotometry,chromatography and conductometry)

SYLLABUS

Practical

PHYSICAL CHEMISTRY

Conductometry

1. To determine the strength of mixture containing weak acid (CH3COOH) and weak base (NH4OH) by titrating against standard 0.1N NaOH solution.
2. To determine the degree of hydrolysis and hydrolysis constant of
a) CH3COONa b) NH4Cl c) C6H5NH2.HCl at room temperature.

Potentiometry:

3. To determine the standard oxidation potential of Zn/Zn2+ and Cu/Cu2+ at three different concentrations.
4. To determine the percent composition and amount of halide ions from their mixture (any two halides) using standard 0.1N AgNO3 solution.
5. To determine the dissociation constant of weak dibasic acid(H2C2O4) by titrating against standard 0.1N NaOH solution.
6. To investigate the influence of ionic strength on the rate constant between potassium per sulphate and potassium iodide.
7. To study the kinetics of ethyl acetate by NaOH at two different temperatures and hence the energy of activation.
8. To determine the formula of the complex formed between cupric ion and ammonia by distribution method.

ANALYTICAL CHEMISTRY

A] Spectrophotometry

1. Determination of nitrite in water
2. Estimation of Cr and Mn from a mixture
3. Comparison of spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10 – phenanthroline by three methods: continuous variations, mole ratio and slope ratio (not for examination)

B] Chromatography

4. Estimation of Na+ from NaCl using cation exchange resin in H – form using standard NaOH.

C] Conductometry

5. Estimation of boric acid by conductometric titration

D] Other Experiments

6. Determination of hardness of water by EDTA i.e estimate Ca asCaCO3 and report analysis in ppm. (the candidate should record more than 5 observations and carry out statistical analysis to find out mean, median, range, standard deviation, absolute error, relative error and possibly Q test.(not for examination)
7. Determination of Mg in antacid drugs

8. Estimation of aspirin	
LEARNING OUTCOMES:	
Practical:	
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.	
REFERENCES:	
1.Basic Principles of Analytical Chemistry. To be used as text book. K. Raghuraman, D.V.Prabhu, C.S. Prabhu and P.A.Sathe 3rd, 4th and 5th edition, Sheth Publishers. 2.Analytical Chemistry. Gary Christian, 4th Edition, International Edition. 3.Principles of Analytical Chemistry. Skoog and Leary, 4th International Edition.	

CH-304:	Experiments in Inorganic and Organic Chemistry (Semester VI)	Number of hours: 60

COURSE OBJECTIVES:

Practical:

- To study the volumetric methods to quantitatively estimate with precision the desired amount of the metal ions.
- To study the volumetric methods for determination of some physicochemical parameters in sea and mineral water.
- To get hands on experience for the binary mixture separation and the analysis of separated compounds.

SYLLABUS

Practical:

Inorganic Chemistry

1. Estimation of Iron(II) by dichromate method from the given solution of ferric alum byusing SnCl2.
2. Estimation of Nitrite using Ceric ammonium sulphate from the given sample of Water.
3. Estimation of Copper(II) by thiosulphate method from the solution of copper sulphate.
4. Estimation of Calcium in the given sample using KMnO4.
5. Preparation of Tetraamine Copper (II) sulphate complex.
6. Estimation of Copper from Tetraamine Copper (II) sulphate complex by iodometry.
7. Determination of dissolved oxygen from sea and mineral water using Winkler's method.
8. Determination of alkalinity of sea and mineral water using phenolphthalein and methylorange indicator.

Organic Chemistry

1. Organic mixture separation and analysis. At least 08 mixtures of compounds out of which 4 should be solid-solid, 2 liquid-liquid, and 2 solid-liquid from the following list, to be analyzed on small scale using 1 gm of mixture in case of solids and 3 to 4 ml. in case of liquids. (Existing list of mixtures to be continued)

LEARNING OUTCOMES:

Practical:

At the end of the course students will be able to

- 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.

- 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.

REFERENCES:

Inorganic Chemistry:
1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham ELBS.
3. Standard Methods of Chemical Analysis W.W. Scott, Technical Press.
4. Experimental Inorganic Chemistry W.G. Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol. I and II Brauer, Academic Press.
6. Inorganic Synthesis, Mc Graw Hill.

Organic Chemistry:
1. Vogel's Qualitative Organic Analysis, Orient Longman
2. Textbook of Practical Organic Chemistry, N.K.Vishnoi

List of Courses for B.Sc. Chemistry Program w.e.f 2016-2017

	Course Name
	A. Chemistry Courses – Code: CH
1	Semester I: CH-101: Physical and Inorganic Chemistry CH-103: Organic and Inorganic Chemistry
2	Semester II: CH-102: Physical and Inorganic Chemistry CH-104: Organic and Inorganic Chemistry
3	Semester III: CH-201: Physical and Inorganic Chemistry CH-203: Organic and Inorganic Chemistry
4	Semester IV: CH-202: Physical and Inorganic Chemistry CH-204: Organic and Inorganic Chemistry
5	Semester V: Theory CH-311: Physical Chemistry CH-321: Inorganic Chemistry CH-331: Organic Chemistry CH-341: Analytical Chemistry
	Practical CH-301: Experiments in Physical and Analytical Chemistry CH-303: Experiments in Inorganic and Organic Chemistry
6	Semester VI: Theory CH-312: Physical Chemistry CH-322: Inorganic Chemistry CH-332: Organic Chemistry CH-342: Analytical Chemistry
	Practical CH-302: Experiments in Physical and Analytical Chemistry CH-304: Experiments in Inorganic and Organic Chemistry

Year	Semester	Chemistry Courses (CH)
First Year	I	CH-101: Physical and Inorganic Chemistry CH-103: Organic and Inorganic Chemistry
	II	CH-102: Physical and Inorganic Chemistry CH-104: Organic and Inorganic Chemistry
Second Year	III	CH-201: Physical and Inorganic Chemistry CH-203: Organic and Inorganic Chemistry
	IV	CH-202: Physical and Inorganic Chemistry CH-204: Organic and Inorganic Chemistry
Third Year	V	Theory CH-311: Physical Chemistry CH-321: Inorganic Chemistry CH-331: Organic Chemistry CH-341: Analytical Chemistry
		Practical CH-301: Experiments in Physical and Analytical Chemistry CH-303: Experiments in Inorganic and Organic Chemistry
	VI	Theory CH-312: Physical Chemistry CH-322: Inorganic Chemistry CH-332: Organic Chemistry CH-342: Analytical Chemistry
		Practical CH-302: Experiments in Physical and Analytical Chemistry CH-304: Experiments in Inorganic and Organic Chemistry

PROGRAMME SPECIFIC OUTCOME (PSO)
• Students will be able to acquire core knowledge in Chemistry in the key areas, develop written & oral communication skills in communicating chemistry-related topics. • Design & conduct an experiment, demonstrate their understanding of the scientific methods & processes. • Develop proficiency in acquiring data using a variety of instruments, analyze & interpret the data, learn applications of numerical techniques. • Realize & develop an understanding of the impact of Chemistry & science on society.

CH-101	Physical Chemistry & Inorganic Chemistry (SEMESTER I)	Number of Lectures: 45

COURSE OBJECTIVES:

Theory:

- To define terms involved in chemical kinetics, gaseous state .
- To state the Postulates of Kinetic Theory of Gases.
- To calculate the slopes, maxima and minima of the various functions.
- To distinguish between ideal and real gases.
- To describe the theories of reaction rates, methods of determination of Order of reaction .
- To derive the expressions and solve numerical based on Gaseous State and chemical kinetics.
- To generalize the Thomson's Model , Rutherford's Model and Bohr's theory for understanding atomic structure.
- To state quantum numbers, rules for electronic configuration of elements.
- To discuss Valence bond theory for evaluating structures of Covalent compounds.
- To interpret distortion in Covalent molecules based on VSEPR theory.
- To evaluate dipole moment and interpret % ionic character of polar molecules.
- To state bond strength and bond energy.
- To generalize Molecular Orbital theory and draw molecular orbital diagrams for homo and hetero di atomic molecules.

Practical:

- To understand process of scientific investigation and develop a broad understanding of scientific concepts.
- Engage students in helping them develop important skills.

SYLLABUS

Theory

Section - I (Physical Chemistry) I Mathematical Concepts Logarithmic relations, curve sketching, linear graphs and calculations of slopes differentiation of functions like Kx, ex , x n , sin x, log x, maxima & minima, partial, differentiation & reciprocity relations. Integration of some useful/relevant	**06 L**
II Gaseous State Postulates of kinetic theory of gases and deviation from ideal behaviour, Van der Waal's equation of state. Critical phenomena; PV isotherms of real gases, continuity of states , the isotherms of van der Waal's equation, relationship between critical constants and van der Waal's constants , the law of	**10 L**

corresponding states, reduced equation of state. Molecular Velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter, liquifacation of gases (based on Joule – Thomson effect) III Chemical Kinetics Rate of reaction, factors influencing the rate of a reaction concentration, temperature, pressure, solvent, light, catalyst Concentration dependence of rates mathematical characteristics of simple chemical reaction. Zero order, first order, second order, pseudo order, half life& mean life. Determination of order of reaction: Differential method Integration method, Method of half life period & Isolation method. Radioactive decay as a first order phenomenon. Theories of Chemical Kinetics. Effect of temperature on the rate of reaction, Arrhenius equation and concept of activation energy. Simple collision theory based on hard sphere model. Transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant & thermodynamic aspects. Section – II (Inorganic Chemistry) I. Atomic Structure Evidence for the electrical nature of matter; discharge tube experiments; Thomson's atomic model; Rutherford model; Bohr's model of hydrogen atom; probability picture of electron; quantum numbers; Shapes of s, p, d, orbitals; Aufbau and Pauli exclusion principles, Hund's rule of maximum multiplicity; Electronic configurations of the elements; effective nuclear charge. II. Chemical Bonding (A) Covalent bond – Valence Bond Theory (VBT) and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion Theory (VSEPR Theory) to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O. Molecular Orbital Theory, homonuclear and heteronuclear diatomic molecules(CO and NO), multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference	**14 L** **06 L** **09 L**
Practical	
PHYSICAL CHEMISTRY Chemical Kinetics : 1. Hydrolysis of Methyl Acetate using two different initial concentrations in presence of mineral acid (HCl) as catalyst. 2. Relative strength of two acids i.e. HCl& H_2SO_4. 3. Degree of hydrolysis of urea hydrochloride. 4. Measurements of viscosity of a given liquid using Ostwald's viscometer (minimum three liquids) **INORGANIC CHEMISTRY** Calibrations and dilutions: 1. Calibration of Burette and Pipettes. 2. To prepare 100 mL of standard 0.1 M $K_2Cr_2O_7$ solution and carry out dilution to 0.05, 0.01, 0.005, and 0.001 M in 100 mL standard flasks. 3. To prepare 100 ppm of Manganese solution using $KMnO_4$ and carry out dilution	

of 5, 10, 15, 20 and 25 mL in 100 mL standard flasks.
4. Semi-micro qualitative analysis:
To analyse 4 - 6 inorganic mixtures containing four ions only.(Two cations and two anions). Mixtures containing the following ions may be prepared

Cations :

Pb^{2+} , Bi^{3+} ,Cu^{2+} , Cd^{2+}, Sn^{2+} , Sb^{3+} ,Fe^{2+} , Fe^{3+}, Al^{3+} ,Cr^{3+} ,Zn^{2+} , Mn^{2+} , Ni^{2+} , Co^{2+} , Ba^{2+} , Sr^{2+} ,Ca^{2+} , Mg^{2+} , $(NH_4)^{+}$, K^{+}

Anions:

Cl^{-}, Br^{-}, I^{-}, NO_2^{-}, NO_3^{-}, SO_3^{2-}, CO_3^{2-}, SO_4^{2-}, CrO_4^{2-}, PO_4^{3-}.

LEARNING OUTCOMES:

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 cayalyst 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.

REFERENCES:

Physical Chemistry

1. Puri, Sharma, Pathania,Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press
2. G. K. Vemulapalli, Physical chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry
4. G. L. Agarwal, Basic Chemical Kinetics, Tata McGraw-Hill Publication

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao,University General Chemistry , McMillan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS publications.New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, ,Pergamon, Oxford,1984.

CH -103	Organic and Inorganic Chemistry (Semester I)	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I- Organic Chemistry

- To understand the concepts of hybridization, C-C bond lengths, bond angles, bond energy, localized and delocalized chemical bonds.
- To define the various terms like Van der Waals interactions, resonance, hyperconjugation, inductive and field effects, intramolecular and intermolecular hydrogen bonding.
- To understand the curved arrow notations.
- To understand various types of Organic reactions with examples.
- To learn Energy profile diagrams for exothermic and endothermic reactions
- To study the reactive intermediates and methods of determination of reaction mechanisms.
- To know the concept of acids and bases.
- To understand the nomenclature of alkanes, cycloalkanes and alkenes.
- To understand the general methods of formationand Baeyer strain and strainless rings theory.
- To understand the general methods of formation and Chemical reactions of alkenes and alkynes with mechanism.
- To classify dienes and write the nomenclature.
- To understand structure and stereochemistry of allenes.
- To learn the chemical reactions of dienes.

Section II -Inorganic Chemistry

- To define the various periodic properties like atomic and ionic radii, electron affinity and electronegativity and determine the trends of the periodic properties in the groups and the periods of the periodic table
- To define various acid -base theories.
- To know the several types of solvents and their typical characteristics.
- To explain the distinct types of reactions occurring in liquid ammonia and liquid Sulphur dioxide solvents.

Practical:

- To get hands on experience for the systematic qualitative analysis of the organic compounds.
- To learn the purification and separation techniques.
- To carry out calibration of burettes and pipettes
- To carry out dilutions in molarity and ppm using KMnO4 and K2Cr2O7
- To carry out qualitative analysis of different cations and anions using the method of semi-micro analysis.

SYLLABUS

Theory:

Section I **I. Structure and Bonding:**	

Hybridization, C-C bond lengths and bond angles, bond energy, localized and delocalized chemical bonds, Definition and examples of Van der Waals interactions, resonance, hyperconjugation, inductive and field effects, intramolecular and intermolecular hydrogen bonding.	**04 L**
II. Fundamentals of Organic Chemistry: Curved arrow notation, drawing electron movement with arrows, half and double headed arrows, homolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles with examples. Types of Organic Reactions: Addition, Elimination, Substitution, Oxidation, Reduction and Rearrangement-one example of each. Energy profile diagrams for exothermic and endothermic reactions, single step and two step reactions. Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes; examples, shape and ways of formation. Assigning formal charges on intermediates and other ionic species. Methods of determination of reaction mechanisms (one example each of product analysis, intermediates, isotope effects, kinetic and stereochemical studies). Theory of acids and bases: Lewis concept; Bronsted and Lowry concept.	**08 L**
III. Alkanes and cycloalkanes IUPAC nomenclature of alkanes. General methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction & decarboxylation of carboxylic acids). Physical properties and chemical reactions of alkanes: halogenation, combustion and pyrolysis. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity with propane as an example. Cycloalkanes – nomenclature, general methods of formation, Baeyer strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring: banana bonds.	**06 L**
IV. Alkenes, dienes and alkynes IUPAC nomenclature of alkenes, general methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hoffmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes – Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$. Mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction. Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethene and propene. Nomenclature and classification of dienes, isolated, conjugated and cumulated dienes. Structure and stereochemistry of allenes, methods of formation of butadiene, polymerization. Chemical reactions – 1,2- and 1,4-additions, Diels-Alder reaction. Nomenclature, structure and bonding in alkynes. General methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, metal-ammonia reduction and polymerization.	**12 L**

Section II **I. Periodic Properties** Atomic and ionic radii, ionization energy, electron affinity and electronegativity, definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.	**05 L**
II. Acids, Bases and Non-Aqueous Solvents Arrhenius Concept and Bronsted Theory. The Lux – Flood Solvent Systems. Lewis Concept of Acids and Bases. Physical Properties of a solvent. Types of Solvents and their general Characteristics. Reactions in non-aqueous solvents with respect to liquid NH_3 and liquid SO_2.	**10 L**
Practicals **ORGANIC CHEMISTRY** I. **Crystallization:** - a) Benzoic acid from hot water. b) m-dinitrobenzene from ethanol II. **Sublimations:** - a) Naphthalene and b) Anthracene III.Distillation: - a) Separation of acetone and ethyl acetate using water condenser. b) Separation of toluene and nitrobenzene using air condenser. IV. Qualitative Analysis: List of compounds Acids: Benzoic, Acetylsalicylic, Salicylic, Phthalic. Phenols: Phenol, α-Naphthol, β-Naphthol. Bases: p-Toluidine, Diphenylamine, o-, m- and p-Nitroanilines, Aniline. Hydrocarbons: Naphthalene, Anthracene. Amides: Benzamide, Urea. Carbonyl compounds: Benzaldehyde, Acetone, Butanone. **INORGANIC CHEMISTRY** Calibrations and dilutions: 1. Calibration of Burette and Pipettes. 2. To prepare 100 mL of standard 0.1 M K2Cr2O7 solution and carry out dilution to 0.05, 0.01, 0.005, and 0.001 M in 100 mL standard flasks. 3. To prepare 100 ppm of Manganese solution using KMnO4 and carry out dilution of 5, 10, 15, 20 and 25 mL in 100 mL standard flasks. 4. Semi-micro qualitative analysis: To analyse 4 - 6 inorganic mixtures containing four ions only.(Two cations and two anions). Mixtures containing the following ions may be prepared **Cations :** Pb2+ , Bi3+ ,Cu2+ , Cd2+, Sn2+ , Sb3+ ,Fe2+ , Fe3+, Al3+ ,Cr3+ ,Zn2+ , Mn2+ , Ni2+ , Co2+ , Ba2+ , Sr2+ ,Ca2+ , Mg2+ , (NH4) + , K+ **Anions:** Cl^-, Br^-, I^-, $NO2^-$, $NO3^-$, $SO32^-$, $CO32^-$, $SO42^-$, $CrO42^-$, $PO43^-$.	
LEARNING OUTCOMES:	

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,
- Definethe 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.
- Classifydienes 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.

Practicals:

- The students will be able to get hands on experience for the systematic qualitative analysis of the organiccompounds 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.

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry;; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS publications, 4th edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India
2. Paula YurkanisBruice, Organic Chemistry; 3rd Edition, Pearson Education Asia
3. Jerry March, Advanced Organic Chemistry; 4rd Edition, John Wiley

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry Vallabh Publications, First Edition

2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao,University General Chemistry , McMillan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS publications.New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984

Books suggested for laboratory course

1.Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient L:ongman.
2. Vogel's textbook of Quantitative Inorganic analysis (revised) J. Basset, R.C.
3. Mann and Saunders , Practical Organic Chemistry
4. N.K. Vishnoi, Practical Organic Chemistry
5. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd., First Edition, 2006.

CH-102	Physical and Inorganic Chemistry SEMESTER II	Number of lectures:45

COURSE OBJECTIVES:

Theory:

Section I: Physical Chemistry- I

- To define the terms, state laws and principlesinvolved in thermodynamics and thermochemistry.
- To explain the concept of standard state, enthalpies of solution, integral and differential enthalpies of solution and dilution.
- To derive the equations involved in thermodynamic, thermochemistry and to solve the numericals.
- To define ,explain , derive the equations , discuss the terms, principles, laws involved in solutions, concept of activity,activity coefficients and types of solutions, colligative properties and to solve numerical, experimental methods for determining colligative properties.
- To define the term involved in Liquid State and explain the structural differences between solids, liquids and gases.
- To discuss the types of liquid crystals, seven segment cell & derive the equations and to solve the numericals of surface tension and viscosity.

Section II: Inorganic Chemistry

- To define the terms, alkali metals, alkaline earth metals, hydration energy hydration polarisation.
- Describe the occurrence of group I & II elements and state the electronic configurations of s block elements of group I & II.
- To draw the structure of chlorophyll and sodium potassium ion pumping system.
- To discuss the general characteristics of group I & II elements, diagonal relationship of Li with Mg and Be with Al, anomalous behavior of Lithium and Beryllium, biological significance of Magnesium in chlorophyll, sodium and potassium.
- To classify the elements based on their solvation and polarization tendencies.
- To define the terms, inert pair effect, promotion energy, catenation , allotropy.
- To describe the occurrence of group I3 & I4 elements.
- To draw the structure of diamond, graphite, borazine, silicates.
- To discuss the general characteristics of group I3 & I4 elements, diagonal relationship of Boron with Silicon and Carbon with Phosphorus, anomalous behavior of Boron and Carbon, inert pair effect and its variation in group I3 & I4 elements, oxidation states exhibited, catenation property of carbon family elements. compounds formed by Boron and Carbon namely borazine , diborane, tetraborane, fluorocarbons, carbides, silicates.

Practical:

- To understand process of scientific investigation and develop a broad understanding of scientific concepts.
- Engage students in helping them develop important skills.

SYLLABUS

Theory:

Section - I (Physical Chemistry) **I Thermodynamics** Thermodynamic terms:System, surrounding, types of systems, intensive & extensive properties. State & path functions & their differentials. Thermodynamic process. Concept of work & heat First law of thermodynamics : statements and definitions of internal energy & enthalpy. Heat capacities at constant volume & pressure & their relationship. Joule's law, Joule-Thomson coefficient & inversion temperature . Calculation of w, q, dU, dH, for the expansion of ideal gases under isothermal & adiabatic conditions for reversible processes. Thermochemistry : standard state, standard enthalpy of formation . Hess's law of heat summation & its applications. Heat of reaction at constant pressure & at constant volume . Enthalpy of neutralization, bond dissociation energy & its calculation from thermochemical data. Temperature dependence of enthalpy. Kirchoff's equation.	**10 L**
II Solutions, Dilute Solutions and Colligative Properties Ideal & non ideal solutions, methods of expressing concentrations of solutions, activity & activity coefficients. Dilute solutions, colligatve properties, Roult's law , relative lowering of vapour pressure molecular weight determination. Osmosis: osmotic pressure & its measurement, depression of freezing point, thermodynamic derivation of relation between molecular weight and depression of freezing point. Elevation in boiling point thermodynamic derivation of relation between molecular weight and elevation in boiling point. Experimental methods for determining various colligative properties.	**10 L**
III Liquid State and Applications Intermolecular forces, structure of liquids (Qualitative description) Structural differences between solids, liquids and gases. Liquid crystal : Difference between liquid crystals ,solid and liquid. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell. Surface between a liquid and vapour .Surface tension by capillary rise method, stalagmometer method .Viscosity of liquids, Poiseuille equation, use of Ostwald's Viscometer.	**10 L**
Section – II (Inorganic Chemistry) I.s – block elements Comparative study including diagonal relationship of groups, salient features of Hydrides, solvation and complexation tendencies including their function in biosystems. An introduction to alkyls and aryls.	**06 L**
II. p - block elements (A) Comparative study including diagonal relationship of groups 13 and 14. Group 13--- Hydrides of Boron, diborane, and higher boranes, borazine, borohydrides. Group 14 ---Fullerenes, carbides, fluorocarbons, silicates (structural principle)	**09 L**
Practical	
PHYSICAL CHEMISTRY 1. Measurements of surface tension of a given liquid using stalagmometer (minimum three	

liquids)
2. Preparation of standard solutions based on normality,molarity, molality. Also further dilutions from a standard solution are expected (e.g. $KMnO_4$, NaOH etc.)
3. Preparation of standard solutions based on ppm and mole fraction. Also further dilutions from a standard ppm solution are expected(e.g. Oxalic acid, $CuSO_4$)
4. To investigate the order of the reaction between $K_2S_2O_8$ + KI (a = b)

INORGANIC CHEMISTRY
Volumetry: (Double Burette*)
1. To prepare 0.1 N Na_2CO_3/ Borax solution and standardize the given ≈ 0.1 N HCl solution.
2. To prepare 0.1 N Succinic acid/KHP solution and standardize the given ≈ 0.1 N NaOH solution.

Volumetry: (Single Burette)
1. To prepare 0.05 N $Na_2C_2O_4$ solution and standardize the given $KMnO_4$ solution.
2. To prepare 0.005 M EDTA solution and estimate the amount of Zn^{2+} and Mg^{2+} from $ZnSO_4.7H_2O$ and $MgSO_4.6H_2O$ solutions respectively.

Gravimetric analysis:
1. NH_4Cl + $BaSO_4$
2. ZnO + $ZnCO_3$

LEARNING OUTCOMES:

Theory:

At the end of the course students will be able to

- Define the terms, state the lawsand 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.

- Estimate ions (volumetric titration) using single burette method.
- Carry out quantitative estimation of mixtures by gravimetic method of analysis.

REFERENCES:

Text Books :

1. P.W. Atkins et al., Physical Chemistry, 7th edition
2. J.D. Lee, Concise Inorganic Chemistry, ELBS publications, 4th edition

Reference Books

Physical Chemistry

1. Puri, Sharma, Pathania,Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press
2. G. K. Vemulapalli, Physical chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry
4. G. L. Agarwal, Basic Chemical Kinetics, Tata McGraw-Hill Publication

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao,University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS publications.New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984

CH -104	Organic and Inorganic Chemistry Semester II	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I

- To draw Newman, Sawhorse, Fischer and flying Wedgerepresentations and the conformations with respect to ethane, *n*-butane, cyclohexane and mono-substituted cyclohexane derivatives.
- To understand the concept of isomerism, stereoisomerism, configuration, chirality, optical isomerism, resolution of enantiomers, inversion, retention and racemization.
- To understand the difference between conformation and configuration.
- To understand rules for nomenclature and assigning configuration to configurational isomers.
- To study the nomenclature of benzene derivatives, alkyl halides and classes of alkyl halides.
- To understand the structure of benzene and the concept of aromaticity.
- To understand the mechanism of various aromatic electrophilic substitution reactions of arenes along with the influence of activating and deactivating substituents.
- To learn the general methods of formation and chemical reactions of alkyl benzenes and alkyl halides.
- To understand 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.
- To study the relative reactivities of alkyl halides vs. allyl, vinyl and aryl halides.

Section II

- To describe the various elements present and their general characteristics in groups 15,16 and 17 of the periodic table and to understand the diagonal relationship between the various elements of groups 15,16 and 17 of the periodic table.
- To describe the special compounds of group 15,16 and 17 with respect to occurrence, preparation methods, physical and chemical properties structure and bonding and applications.
- To describe the occurrence and general properties of inert gas xenon.
- To describe the structure and bonding in various xenon compounds

Practical:

- To carry out double burette and single burette titration methods
- To carry out gravimetric estimations of double salt mixtures by weight loss method.
- To carry out systematic qualitative analysis of the organic compounds which include alkyl and aryl halides,nitrohydrocarbons, bases, alcohols, esters, anilides and carbohydrates.

SYLLABUS

Theory:

Section I 1. **Stereochemistry of organic compounds** Newman and saw horse formulae, Fischer and flying wedge formulae. Concept of isomerism. Types of isomerism. Conformational isomerism – Conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono-substituted cyclohexane derivatives. Optical isomerism – elements of symmetry, molecular chirality, definition and examples of enantiomers, stereogeniccentre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Specification of configuration at chiral centers: Sequence rules and R:S system of nomenclature. Geometric Isomerism - Determination of configuration of geometric isomers. E and Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Difference between configuration and conformation.	14 L
2. **Arenes and Aromaticity** Nomenclature of benzene derivatives. Structure of benzene: molecular formula and Kekule structure. Stability and C–C bond lengths of benzene, resonance structure, MO picture. Aromaticity: The Huckel's rule, aromatic ions, anti-aromaticity. Aromatic electrophilic substitution – general pattern of the mechanism role of σ- and π- complexes. Mechanism of nitration, halogenation, sulphonation and Friedel-Crafts reaction. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. General methods of formation and chemical reactions of alkyl benzenes – reduction, oxidation, ring and side chain substitution.	9 L
3. **Alkyl and aryl halides:** Nomenclature and classes of alkyl halides, general methods of formation, chemical reactions. Mechanism and stereochemistry of nucleophilic substitution reactions of alkyl halides, SN_2 and SN_1 reactions with energy profile diagrams, solvent effect. The addition – elimination (bimolecular displacement) and the elimination – addition (benzyne) mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs. allyl, vinyl and aryl halides.	7 L
Section II **1. p - block elements (B)** Comparative study including diagonal relationship of groups 15, 16 and 17. group 15- phosphazenes, group 16—tetra sulfur tetranitride, group 17—basic properties of halogens, interhalogens and polyhalides	**12 L**
2. Chemistry of Noble Gases Chemical properties of Noble Gases, Chemistry of Xenon, structure and bonding in Xenon compounds,	**03 L**

Practicals

INORGANIC CHEMISTRY

Volumetry: (Double Burette*)

1. To prepare 0.1 N Na_2CO_3/ Borax solution and standardize the given $\approx$ 0.1 N HCl solution.
2. To prepare 0.1 N Succinic acid/KHP solution and standardize the given $\approx$ 0.1 N NaOH solution.

Volumetry: (Single Burette)

1. To prepare 0.05 N $Na_2C_2O_4$ solution and standardize the given $KMnO_4$ solution.
2. To prepare 0.005 M EDTA solution and estimate the amount of Zn^{2+} and Mg^{2+} from $ZnSO_4.7H_2O$ and $MgSO_4.6H_2O$ solutions respectively.

Gravimetric analysis:

1. $NH_4Cl + BaSO_4$
2. $ZnO + ZnCO_3$

ORGANIC CHEMISTRY

1. Qualitative Analysis

   List of compounds

   Alkyl and aryl halides: Chloroform, Carbon tetrachloride, Chlorobenzene, Bromobenzene, p-dichlorobenzene.

   Nitrohydrocarbons: Nitrobenzene, m-dinitrobenzene, p-nitrotoluene.

   Bases: α-Naphthylamine, Diphenylamine, o-, m- and p-Nitroanilines, N-methylaniline, N,N-dimethylaniline.

   Alcohols: Methanol, Ethanol, 2-propanol, Cyclohexanol.

   Esters: Methyl acetate, Ethyl acetate, Ethyl benzoate, Methyl salicylate.

   Anilides: Acetanilide, Benzanilide

   Carbohydrates: Glucose, Fructose, Mannose

   Note: 7 compounds of the following type to be analyzed in 5 practicals: Carbohydrate – 1; Anilide – 1; Ester – 1; Alcohol – 1; Nitrohydrocarbon - 1; Alkyl or aryl halide – 1; Base – 1

LEARNING OUTCOMES:

Theory:

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

- Draw Newman, Sawhorse, Fischer and flying Wedgerepresentations 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.

- 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.

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry;; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS publications, 4th edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India.
2. Paula YurkanisBruice, Organic Chemistry; 3rd Edition, Pearson Education Asia.
3. Jerry March, Advanced Organic Chemistry; 3rd Edition, John Wiley.

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry
Vallabh Publications, First Edition 9.
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry,
Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao, University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS publications.New edition

Books suggested for laboratory course

1. Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient L:ongman.
2. Mann and Saunders , Practical Organic Chemistry
3. N.K. Vishnoi, Practical Organic Chemistry
4. Vogel's textbook of Quantitative Inorganic analysis (revised) J. Basset, R.C.
5. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd.,
First Edition, 2006

CH - 201	Physical and Inorganic Chemistry (SEMESTER III)	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Physical Chemistry)

- To define the principles, laws, theorems in Thermodynamics, Chemical equilibrium and Phase equilibrium.
- To draw the phase diagrams, schematic diagrams and the graphs involved.
- To explain and interpret the Nernst distribution law.
- To distinguish between liquid-liquid and ideal liquid mixtures, different types of systems.
- To solve the numerical with respect to Gibbs free energy, to derive Clapeyron equation and Clausius-Clapeyron equation and its applications.
- To study concept of residual entropy, evaluation of absolute entropy from heat capacity data and thermodynamic quantities.
- To classify different component systems, types of mixtures.
- To study equilibrium constant and free energy, reaction isotherm and reaction isochore.
- To study entropy as a state function and its change in ideal gas and mixing of gases.

Section II (Inorganic Chemistry)

- To generalise the IUPAC nomenclature rules for co-ordination compounds.
- To discuss Werner's co-ordination theory for co-ordination compounds.
- To classify ligands based as monodentate and polydentate citing different examples.
- To study the general characteristics of 3d metals of first transistion series.
- To discuss the variable oxidation states, magnetic properties, complexation tendencies, catalytic behavior and spectral properties of 3d metals.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory (conductometry, partition coefficient, volumetric estimation, gravimetric estimation).

SYLLABUS

Theory:

Section I 1. Thermodynamics Second law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Concept of entropy :entropy as a state function ,entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality ,entropy as a criteria of spontaneity and equilibrium .Entropy change in ideal gases and mixing of gases. Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantages over entropy change. Variation of G and A with P, V & T.	14 L
2. Chemical Equilibrium Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle. Reaction isotherm and reaction isochore – Clapeyron equation and Clausius – Clapeyron equation, applications.	05 L
3. Phase Equilibrium Statement and meaning of the terms–phase , component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system–water, CO_2 and S systems. Phase equilibria of two component system – solid –liquid equilibria, simple eutectic –Bi-Cd, Pb-Ag systems, desilverisation of lead. Solid solutions –compound formation with congruent melting point (Mg-Zn) and incongruent melting point, ($NaCl$-H_2O), ($FeCl_3$-H_2O) and ($CuSO_4$-H_2O) system. Freezing mixtures, acetone –dry ice. Liquids –liquid mixtures – ideal liquid mixtures, Raoult's and Henry's law. Non –ideal system –azeotropes- HCl-H_2O and ethanol – water systems Partially miscible liquids –phenol –water, trimethylamine –water, nicotine – water systems. Lower and upper consolute temperature. Effect of impurity on consolute temperature. Immiscible liquids, steam distillation. Nernst distribution law – thermodynamic derivation, applications.	11 L
Section II 1. Chemistry of the Elements of the First Transition Series.	

General characteristics, comparative treatment with their 3d analogues in respect of Ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry. 2. Co-ordination compounds Werner's co-ordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of co-ordination compounds.	10 L 05 L

Practical

Physical Chemistry

1. To determine the partition coefficient of I_2 between $C_2H_4Cl_2$ and H_2O.
2. To determine molecular condition of the given acid in benzene/toluene by the partition coefficient method.
3. To determine the amount of strong acid (HCl) present in the given solution by conductometric titration using standard NaOH solution.
4. To determine the amount of weak acid (CH_3COOH) present in the given solution by conductometric titration using standard NaOH solution.
5. To study the solubility of benzoic acid at room temperature and below room temperature by volumetric method.

Inorganic Chemistry

Gravimetric estimations:

1 Ba as $BaSO_4$
2 Fe as Fe_2O_3

LEARNING OUTCOMES:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th edition.

Reference Books

Physical Chemistry

1. Puri, Sharma, Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Oxford University Press
2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry

Inorganic Chemistry

1. B.R. Puri, L.R. Sharma, K.C. Kale, Principles of Inorganic Chemistry, Vallabh Publications, First Edition
2. F.A. Cotton and G. Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao, University General Chemistry, Mc Millan, 1993.
4. Sharpe and Emilus, Inorganic Chemistry, ELBS Publications. New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, Pergamon, Oxford,1984

CH -203	Organic and Inorganic Chemistry Semester III	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Organic Chemistry)

- To learn the terms involved, the laws, the rules and the principles in UV –Visible Spectroscopy and Infra Red (IR) absorption spectroscopy.
- To understand various electronic transitions in UV –Visible Spectroscopy.
- To know Woodward - Fieser rules for calculation of λmax for Conjugated dienes and enones.
- To understand the various factors which effects the intensity and position of IR bands to know the characteristic absorptions of various functional groups.
- To know the use of Finger print region to establish the identity of unknown compound in Infra Red (IR) absorption spectroscopy.
- To know the applications of UV –Visible Spectroscopy and Infra Red (IR) absorption spectroscopy.
- To learn the interpretation of the IR and UV spectra of simple organic compounds.
- To know the classification and nomenclature of monohydric alcohols and dihydric alcohols.
- To learn the methods of preparations and reactions of alcohols
- To understand the concept of hydrogen bonding and acidity of alcohols.
- To know the nomenclature of ethers
- To learn the preparation, physical properties and chemical reactions of ethers.
- To study the synthesis and reactions of epoxides
- To know the nomenclature of aldehydes and ketones.
- To study the synthesis, physical properties and reactions of aldehydes and ketones with mechanism

Section II(Inorganic Chemistry)

- To define the basic concepts of oxidation and reduction and the study of electrochemical series.
- To define and draw Frost, latimer and Pourbaix diagrams for various types of reactions and to study the principles involved in extraction of elements
- To define lanthanides, their occurrence and position in the periodic table, their electronic structure and the oxidation states exhibited by them
- To study lanthanide contraction and its effects on the elements of the periodic table.
- To understand the technique of isolation of individual lanthanides from its ores by complex formation method

Practical:

- To understand and quantitatively estimate the desired organic compounds.
- To learn the preparation of desired Organic derivatives.
- To understand and systematically estimate quantitatively the desired metal ions by gravimetry.

SYLLABUS

Theory:

Section I (Organic Chemistry)	

I. Electromagnetic Spectrum: Absorption Spectra Ultraviolet (UV) absorption spectroscopy – Absorption laws (Beer-Lambert law), Molar absorptivity, presentation and analysis of UV spectra, Types of electronic transitions, effect of conjugation. Concept of chromophore and auxochromes, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones, Woodward-Fieser rules for calculation of UV maxima of the above two systems. Numerical problems on above. Infra Red (IR) absorption spectroscopy – Molecular vibrations, Hooke's law, selection rules, Intensity and position of IR bands, measurement of IR spectrum, Finger print region and its use to establish identity, Applications to determine purity, to study progress of chemical reactions and hydrogen bonding. Characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Simple problems in structure elucidation using UV and IR spectroscopy.	**12 L**
II. Alcohols Classification and nomenclature. Monohydric alcohols – Methods of preparations by reduction of carbonyl compounds, carboxylic acids, and esters, using Grignard reaction. Hydrogen bonding, acidic nature. Reactions of alcohols – esterification, oxidation and dehydration. Dihydric alcohols – Nomenclature, methods of preparation by hydroxylation of alkenes and acid catalyzed opening of epoxides. Reactions of vicinal glycols – pinacol-pinacolone rearrangement with mechanism.	**05 L**
III. Ethers and Epoxides Nomenclature of ethers and methods of preparation by Williamson synthesis, from alcohols by use of diazomethane and by use of H_2SO_4. Physical properties. Chemical reactions: cleavage with HI. Synthesis of epoxides by reaction of alkenes with peracids and by elimination from vicinal halohydrins. Acid and base catalyzed ring opening of epoxides, orientation of ring opening, reactions of Grignard and organolithium reagents with epoxides.	**04 L**
II. Aldehydes and Ketones Nomenclature and structure of the carbonyl group. Synthesis of aldehydes by oxidation of alcohols and reduction of acid chlorides, synthesis of ketones by oxidation of alcohols, from nitriles by Grignard reaction and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knovenagel condensations, reaction with ammonia and its derivatives, Wittig reaction and Mannich reaction. Halogenation of enolizable ketones. Mechanisms and one application each of the above reactions.	**09 L**
<u>Section II</u> (Inorganic Chemistry) **I. Oxidation and Reduction** Use of redox potential data-analysis of redox cycle, redox stability in water – frost, Latimer and pourbaix diagrams. Principles involved in the extraction of the elements.	**08 L**

II. Chemistry of the Lanthanide Elements Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds. **Practicals** **Organic Chemistry**: Organic Estimations: Estimations of Acetamide, Aniline and Glucose. Organic Derivatives: Benzoyl Derivative of β-naphthol and aniline. Bromo Derivative of phenol and aniline. Note: 1] The Organic Derivatives to be completed in 2 practicals. 2] Organic Estimations / Organic Derivatives to be given for examination. **Inorganic Chemistry**: Gravimetric Estimations 1. Mn as Mn-pyrophosphate 2. Ni as Ni-DMG 3. Al as Al2O3 from aluminium sulphate	**07 L**

LEARNING OUTCOMES:

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 ?max 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

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th Edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India
2. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia
3. Jerry March, Advanced Organic Chemistry; 3rd Edition, John Wiley
4. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry
Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry,
Wiley Eastern Ltd, 2nd Edition,1993
3. C N R Rao, University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS Publications.New Edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984

Books suggested for laboratory course

1. Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Basset, R.C.
3. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd.,
First Edition, 2006.

CH - 202	Physical and Inorganic Chemistry (SEMESTER IV)	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Physical Chemistry)

- To study conductometric titrations and the graphs involved.
- To interpret the crystal structure of NaCl, KCl and CsCl.
- To define terms involved in electrochemistry, conductance, specific conductance, equivalent conductance.
- To study the applications of conductivity measurements.
- To describe the preparation and properties of colloids.
- To derive and solve numericals on Bragg's equation.
- To study transport number, its determination by Hittorf method and moving boundary method.
- To classify colloids, sols and emulsions.
- To discuss the stability of colloids, protective action, Hardy- Schulze law, gold number.
- To define the terms and laws involved in Electrochemistry, Solid state and Colloidal state.
- To draw and interpret graphs of conductometric titrations.
- To study X-ray diffraction by crystals with examples.

Section II (Inorganic Chemistry)

- To discuss different types of Isomerism in co-ordination compounds with .
- To study the general characteristics of metals of second and third transistion series.
- To discuss the variable oxidation states, complexation tendencies, catalytic behavior and spectral properties and binary compounds of the metals of second and third transition series.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory.(Chemical kinetics, conductometry).
- To understand the principles involved in volumetric estimations by acid-base, redox and precipitation methods.

SYLLABUS

Theory:

Section I (Physical Chemistry)

1. Electrochemistry

Electrical transport –conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law its uses and limitations. Debye –Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method. Applications of conductivity measurements :determination of degree of dissociation , determination of Ka of acids , determination of solubility product of a sparingly soluble salt, conductometric titrations . **12 L**

2. Solid State

Definition of space lattice, unit cell. **11 L**

Laws of crystallography –(i) law of constancy of interfacial angels (ii) law of rationality of indices (iii) law of symmetry elements in crystals. X-ray diffraction by crystals .derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).

3. Colloidal State

Definition of colloids, classification of colloids .

Solids in liquids (sols): properties –kinetic, optical and electrical; stability of colloids, protective action, Hardy- Schulze law gold number. **07 L**

Liquids in liquids (emulsions): types of emulsions, preparation .Emulsifier

Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids

Section II (Inorganic Chemistry)

1. Chemistry of the elements of the second and third transition series **10 L**

Characteristic properties of the d-Block elements. Properties of the elements of the second and third transition series, their binary compounds, and complexes illustrating relative stability of their oxidation states, co-ordination number and geometry.

2. Co-ordination Compounds

Isomerism in co-ordination compounds, valence bond theory of transition metal complexes. **05 L**

Practical

Physical Chemistry

1. To determine the amount of chloride ion present in given solution by conductometric method.
2. To determine the solubility and solubility product of sparingly soluble salts ($BaSO_4$, $PbSO_4$, $CaSO_4$, $SrSO_4$) by conductometric method.
3. To study the kinetics of inversion of cane sugar in the presence of HCl solution
4. To investigate reaction between H_2O_2 and HI.
5. To investigate reaction between $HBrO_3$ and HI.

Note: Polarimeter experiment is to be performed by each student and is not a demonstration experiment.

Inorganic Chemistry

Volumetric analysis

1. Estimation of Cu by EDTA method.
2. Estimation of Fe^{2+} using internal indicator by potassium dichromate method.
3. Determination of alkali content in antacid tablet using Standard HCl solution.

LEARNING OUTCOMES:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th edition

Reference Books

Physical Chemistry

1. Puri, Sharma, Pathania, Principles of Physical Chemistry, Vishal Publishing Company,
   Oxford University Press
2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry

Inorganic Chemistry

1. B.R. Puri, L.R. Sharma, K.C. Kale, Principles of Inorganic Chemistry, Vallabh Publications, First Edition
2. F.A. Cotton and G. Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao, University General Chemistry, Mc Millan, 1993.
4. Sharpe and Emilus, Inorganic Chemistry, ELBS Publications. New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, Pergamon, Oxford,1984

CH -204	Organic and Inorganic Chemistry Semester IV	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Organic Chemistry)

- To know the nomenclature of Phenols, Carboxylic acids, derivatives of carboxylic acids and amines.
- To learn the methods of preparation and reactions of Phenols, Carboxylic acids, derivatives of carboxylic acids, nitroalkanes and nitroarenes and amines.
- To study the physical properties, acidic character and acid strength of alcohols and phenols.
- To study oxidation and reduction reactions of aldehydes.
- To understand the mechanism and know application of each reaction mentioned in the syllabus.
- To study the physical properties, acidity and effect of substituents on acid strength.
- To understand the mechanism of nucleophilic substitution in nitroarenes.
- To learn the preparation and properties of picric acid.
- To study physical properties, stereochemistry of amines and separation of mixtures of primary, secondary and tertiary amines.
- To understand the structural features affecting basicity of amines
- To study the use of amines as phase-transfer catalyst.

Section II (Inorganic Chemistry)

- To define actinides, their position and occurrence in the periodic table.
- To know the method of separation of individual actinides like Np, Pu, Am and U from their ores.
- To define ionic solids and know their properties.
- To understand close packing of spheres and to determine the types of interstitial sites like trigonal, tetrahedral, octahedral and cubic.
- To define lattice energy and to derive the values of lattice energies in various ionic crystals.
- To understand defects in stoichiometric and non-stoichiometric solids.

Practical:

- To gain knowledge and get hands on experience of analysing organic compounds.
- To understand and get hands on experience in performing binary mixture separation
- To understand the volumetric techniques to quantitatively estimate the metal ions calcium and nickel using three different salts of each ion.

SYLLABUS

Theory:

Section I (Organic Chemistry) **I. Phenols** Nomenclature, structure and bonding. Preparation of phenols by alkali fusion of aromatic sulphonic acids, Dow's process from chlorobenzene and from Cumene throughhydroperoxide rearrangement with mechanism. Physical properties and acidic character. Comparative acid strengths of alcohols and phenols, resonance stabilization of the phenoxide ion. Reaction of phenols – Electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement,	**04 L**

Claisen rearrangement, Gattermann synthesis and Riemer-Tiemann reaction. **II. Oxidation and Reduction reactions of carbonyl compounds** Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, Meerwein-Pondorf-Verley, Clemmensen, Wolff-Kischner, $LiAlH_4$ and $NaBH_4$ reduction. Mechanisms and one application each of the above reactions **III. Carboxylic Acids** Nomenclature, structure and bonding. Physical properties, acidity and effects of substituents on acid strength. Preparation of carboxylic acids by oxidation of carbonyl compounds, carbonation of Grignard reagent, hydrolysis of cyanides, preparation of aromatic acids by oxidation of alkyl benzenes. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction, synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Dicarboxylic acids: Methods of preparation and effect of heat and dehydrating agents with reference to malonic acid only. **IV. Carboxylic Acids Derivatives** Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides. Physical properties. Methods of preparation from carboxylic acids and interconversion of acid derivatives by nucleophilic acyl substitution. Mechanisms of esterification and acidic and basic hydrolysis of esters with evidences. **V. Organic Compounds of Nitrogen** Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid – preparation and properties. Structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amine. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines by reduction of nitro compounds and nitriles, reductive amination of carbonyl compounds, Gabriel phthalimide reaction and Hofmann bromamide reaction. **<u>Section II</u> (Inorganic Chemistry)** **I. Chemistry of Actinides** General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between later actinides and later lanthanides. **II. Ionic Solids** Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, salvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule, metallic bond - free electron, valence bond and band theories	**04 L** **05 L** **04 L** **12 L** **04 L** **11 L**

Practicals

Organic Chemistry:

Qualitative Analysis: - At least 5 compounds to be analyzed from the following compounds.

List of compounds

Acids: Cinnamic, o-Chlorobenzoic, Salicylic, Succinic, Oxalic, p-nitrobenzoic, p-hydroxybenzoic, Sulphanic acid.

Phenols: o- and m- Nitrophenols, Resorcinol.

Bases: p-Toluidine, Diphenylamine, o-, m- and p-nitroanilines, N-methylaniline, N,N-dimethylaniline

Hydrocarbons: Naphthalene, Anthracene, Toluene.

Amides: Benzamide, Urea, Thiourea

Carbonyl compounds: Salicylaldehyde, Furfural, Butanone, Acetophenone, Benzophenone, Camphor.

Alkyl and aryl halides: Chloroform, Chlorobenzene, Bromobenzene, p-Dichlorobenzene

Nitrohydrocarbons: m-Dinitrobenzene, p-Nitrotoluene,

Alcohols: 2-Propanol, Cyclohexanol

Esters: Ethyl benzoate, Methyl salicylate

Anilides: Acetanilide, Benzanilide

Note: 5 compounds of the following type to be analyzed in 3 Practical : Acid – 1 , Phenol – 1,Amides – 1 , Hydro carbon – 1 , Anilide – 1; Ester – 1; Alcohol – 1; Nitrohydrocarbons -1; Alkyl or aryl halides – 1; Bases – 1.

Tests to be performed are i. Preliminary tests; ii. Solubility and Chemical type; iii. Elements; iv. Groups and v. Physical constants.

Qualitative analysis is to be performed at a micro scale level using not more than 1g. solid and 1 ml. liquid.

Finding the organic mixture type: Solid-solid-Water Insoluble type.

Acid-Base 2) Acid-Neutral 3) Acid-Phenol 4) Phenol-Base 5) Phenol-Neutral 6) Base-Neutral

Note: 5 mixtures to given for chemical type determination in 2 practicals (not to be given for examination)

Inorganic Chemistry:

Volumetric analysis:

1. Estimation of Ca by EDTA (3 solutions of different salts of Ca).
2. Estimation of Ni by EDTA (3 solutions of different salts of Ni).

LEARNING OUTCOMES:

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 compoundsmentioned 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.

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th Edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India
2. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia
3. Jerry March, Advanced Organic Chemistry; 3rd Edition, John Wiley
4. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry
Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry,
Wiley Eastern Ltd, 2nd Edition,1993
3. C N R Rao, University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS Publications.New Edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984.

Books suggested for laboratory course

1. Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Basset, R.C.
3. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd.,
First Edition, 2006.

CH - 311	Physical Chemistry (SEMESTER V)	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To define the principles, hypothesis, postulates of quantum mechanics in Quantum chemistry.
- To draw the wave functions, orbital diagrams and the graphs involved.
- To solve the numerical, explain and interpret the wave functions.
- To distinguish between reversible and irreversible cells, Different types of reversible cells
- To solve the numerical wrt Nernst equation, to study electrochemical series and applications
- To study optical activity, polarization, dipole moment and methods of determination of dipole moments
- and structure of molecules
- To classify different nuclides. Binding energy and nuclear forces. To study nuclear models, radioactivity.
- To study emf and its measurements. To study concentration cell, its measurements, applications,
- To study decomposition potential, overvoltage and factors affecting them.

Section II

- Molecular structure and molecular spectra:
- To study the electromagnetic spectrum, terms, principles involved. To study Rotational spectra of diatomic molecules, determination of bond lengths and qualitative description
- To study counters used in measurement of radioactivity

SYLLABUS

Theory:

Section I 1. Quantum Chemistry: De Broglie hypothesis, the Heisenberg's uncertainty principle, sinusoidal wave equation, Hamiltonian operator, Schrödinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in one dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave function, radial wave functions, angular wave functions.	12 L
2. Electrochemistry:- I Electrolytic and galvanic cells; reversible and irreversible cells, conventional representation of electrochemical cells; types of reversible electrodes; gas – metal ion, metal-metal ion, metal in soluble salt-anion and redox electrodes, electrode reaction; Nernst equation; derivation of cell E.M.F. and single electrode potential, reference electrodes, standard hydrogen electrode; calomel electrodes ;standard electrodes potential, sign convention, electrochemical series and its applications.	07 L
3. Molecular Structure Optical activity and molecular structure; polarization (Mosotti-Clausius equation), orientation of dipoles in an electric field, dipole moment, induced	05 L

dipole moment, measurement of dipole moment; temperature method and refractivity method, dipole moment and structure of molecules. 4. Nuclear Chemistry: - I Composition of the nucleus. Nuclear binding forces, binding energy, stability, nucleon-nucleon forces and their equality, characteristics and theory of nuclear forces. Nuclear models, the shell model, liquid drop model and its merits. Theory of radioactive disintegration, rate of disintegration half, average life of radio element, units of radioactivity, definition and characteristics of artificial radioactivity.	06 L
Section II 5. Electrochemistry :-II EMF of a cell and its measurements; Concentration cells (both electrodes and electrolytes) with and without transport; liquid junction potential and its measurement; Application of concentration cell; determination of ionic product of water; transport number of ions; solubility and solubility product. Polarization; elimination of polarization; decomposition potential, measurement of decomposition potential ; factor affecting decomposition potential over voltage and types of over voltage; measurement of over voltage ; factor affecting over voltage	13 L
6. Molecular structure and molecular spectra: Introduction to electromagnetic radiation; regions of the spectrum; statement of the BornOppenheimer approximation; degrees of freedom. Rotational Spectrum: Diatomic molecules, energy level of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (MaxewllBoltzmann distribution); determination of bond length, qualitative description of non-rigid rotor, isotope effect.	08 L
7. Nuclear Chemistry:-II Determination and measurements of radioactivity: Ionisation current measurements; saturation collection; multiplicative ion collection; the Geiger-Muller Counter, characteristics of an ideal Geiger-Muller Counter, proportional counter. methods based on photon collection, Scintillation counter, characteristics of a suitable Scintillator.	09 L

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2 U.N.Dash, Nuclear Chemistry, by Sultan Chand & Sons, New Delhi.

Reference Books

1. Puri, Sharma, Pathania, Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press

2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,

3. Donald McQuarrie, Physical Chemistry

CH- 321	Inorganic Chemistry (SEMESTER V)	Number of lectures:60

COURSE OBJECTIVES:

Theory:

Section I

- To discuss the drawbacks of Valence bond theory for co-ordination compounds.
- To generalise the postulates of Crystal field theory
- To define the terms Crystal field splitting, Crystal field splitting energy, Crystal field stabilization energy.
- To draw the crystal field splitting diagram for octahedral, tetrahedral and square planar complexes.
- To evaluate the magnetic properties of transition metal complexes.
- To calculate the magnetic moments for different transition metal complexes having octahedral, tetrahedral and square planar geometry.
- Toknow the classification of elements as essential or trace and their uses in biological processes.
- To study the roles of myoglobin and hemoglobin with respect to the transfer and storage of oxygen in biological systems and the process of respiration.
- To introduce basic synthesis concepts of solid-state chemistryand provide introductory knowledge on concept of band gap and classification of materials based on it.

Section II

- To define the terms Organometallic compounds, mononuclear, polynuclear metal carbonyls.
- To state the Effective atomic number rule, 18 electron rule for metal carbonyls and organometallic compounds.
- To state the names of metal carboyls and organometallic as per the IUPAC system.
- To generalise the methods of preparation, properties and bonding in $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$, $Mn_2(CO)_{10}$,$Fe_2(CO)_9$,$Fe_3(CO)_{12}$ and ferrocene.
- To classify the ligands based on hapticity,.
- To prepare by various methods alkyls and aryls of Li ,Al ,Hg and Ti and to study their physical and chemicals properties.
- To learn general methods of preparationsof organometallic compounds
- To understand the model systems prepared to study macromolecular biological molecules.
- To know the types of alkali and alkaline earth metals and their roles in biological systems.
- To define metalloenzymes and to study their roles in biological systems.
- To introduce concept of defects in solids and define Schottky and Frenkel defects, Color center, extended defects and Non-stoichiometry

SYLLABUS	
Theory:	
Section I **1)Metal-Ligand Bonding in Transition Metal Complexes:** Limitations of Valence bond theory, Crystal field theory (CFT) splitting of d-orbitals in octahedral, tetrahedral and square planar complexes. Crystal Field Stabilization Energy (CFSE), Measurement of 10 Dq for $[Ti(H_2O)_6]^{3+}$ complex, Factors affecting 10 Dq, Spectrochemical series, Effect of crystal field splitting on properties of Octahedral complexes: Magnetic, Spectral.	**20L**
2)Bio-inorganic Chemistry (I) Overview, essential and trace elements in biological processes, Metalloporphyrin special reference to hemoglobin and myoglobin.	**05L**
3)Inorganic solid-state chemistry (I) Introduction, Preparation of Nonmolecular solids, Band gaps, Metals, Insulators and Semi-conductors.	**05L**
Section II **4)Organometallic chemistry** **A)** Definition, nomenclature and classification of organometallic compounds, EAN rule, 18 electron rules. General methods of preparations and properties. Structure and bonding in mononuclear metal carbonyls: $Ni(CO)_4$, $Fe(CO)_5$ and $Cr(CO)_6$ (Orbital diagram not expected) B) Polynuclear metal carbonyl: preparation and structures of $Mn_2(CO)_{10}$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$ (Orbital diagram not expected) C) Sandwich compounds like Ferrocene: preparation, properties, reactions, structure and bonding. D) Preparation and properties of alkyl and aryls of Li, Al, Hg and Ti.	**20L**
5) **Bio-inorganic Chemistry (II)** The role of Model systems, The alkali and alkaline earth metals,Metalloenzymes, Nitrogen fixation cycle.	**05L**
6) **Inorganic solid-state chemistry (II)** Defects in Solids Point defects: Schottky and Frenkel, Color center, extended defects, Non-stoichiometry.	**05 L**

LEARNING OUTCOMES:

Theory:

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 carboyls 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.

  .

REFERENCES

Text- Books:

1. Concise Inorganic Chemistry. 5th edition, J. D. Lee
2. Basic Inorganic Chemistry, 5th edition, F.A. Cotton, G. Wilkinson.

Reference books:

3. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit 18th revised edition, Himalaya Publishing House.
4. Principles of Inorganic Chemistry, B.R Puri, L. R. Sharma, Milestone Publishers.
5. Inorganic Chemistry, (Principles of Structure and Reactivity). James E. Huheey, Ellen A. Keiter, Richard L. Keiter
6. Inorganic Chemistry D. E. Shriver, P.W. Atkins and C.H. Langford, Oxford.
7. Advance Inorganic Chemistry, 6th edition, F.A. Cotton and G. Wilkinson
8. Comprehensive Inorganic Chemistry, B.S. Bahl and Sharma
9. Group theory and its Chemical applications, P. K. Bhattacharya, Himalaya Publication.
10. Environmental Chemistry, A. K. De.

CH-331	Organic Chemistry Semester V	Number of lectures:60

COURSE OBJECTIVES:

Theory:60 L

Section I

- To understand important concepts in NMR and Mass spectroscopic methods.
- To learn the structure elucidation of simple organic molecules using spectroscopictechniques (UV, IR, PMR, CMR and MS).
- To study the Structure elucidation and synthesis of Nicotine, Atropine and Papaverine.
- To understand the mechanism and stereochemistry of addition of halogens and halogen acids to open chain alkenes, substitution reactions and elimination reactions.

Section II

- To understand the molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine.
- To learn 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 andBischler-Napieralski synthesis.
- To understand the mechanism of, nucleophilic substitution reactions in pyridine derivatives and electrophilic substitution reactions of indole, quinoline and isoquinoline.
- To compare basicity of pyridine, piperidine and pyrrole.
- To study condensed 5 and 6 membered heterocycles.
- To learn the importance of vitamins, hormones and the classification of vitamins.
- To study the structure elucidation and synthesis of vitamin A, C, thyroxine and adrenaline.
- To study the structure of amino acids, peptides and proteins.
- To learn the preparation and reactions of α-amino acids.
- To understand the concept of isoelectric point, electrophoresis, protein denaturation/renaturation, nucleic acids and double helical structure of DNA.
- To learn the reactions for peptide synthesis, hydrolysis of peptides, nucleic acids and methods for peptide structure determination.

SYLLABUS

Section I

1. Spectroscopy Proton Magnetic Resonance (^{1}H NMR) spectroscopy, theory, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, intensity of peaks, interpretation of PMR spectra of simple organic molecules. ^{13}C Magnetic Resonance: Number of signals, splitting of signals – proton coupled and decoupled spectra, off resonance decoupled spectra. ^{13}CMR chemical shifts – identification of hybridization of carbons and nature of functionalization. Mass Spectrometry: Simple idea of instrumentation, Definitions of parent or molecular ion peak and base peak. Isotope effect with respect to alkyl halides, Fragmentation of ketones – α cleavage and Mc Lafferty rearrangement. Problems pertaining to the structure elucidation of simple organic molecules using spectroscopic techniques (UV, IR, PMR, CMR and MS). Types of problems to be	18 L

specified. UV and IR to be used as supporting data. Types of CMR and Mass spectroscopy problems to be specified. 2. Alkaloids Structure elucidation and synthesis of Nicotine, Atropine and Papaverine. 3. Stereochemistry of Reactions: Mechanism and stereochemistry of (i) Addition of halogens and halogen acids to open chain alkenes. Markownikoff's and anti- Markownikoff's addition. (ii) SN_1, SN_2, SN_i , substitutions and (iii) E_1, E_2 and E_{1cb} elimination reactions.	05L 07 L
Section II 4. **Heterocyclic Compounds** Introduction, Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed 5 and 6 membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis andBischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline. 5. **Vitamins and Hormones** Vitamins: Importance and classification. Structure elucidation and synthesis of Vitamins A and C. Hormones: Important hormones and their uses. Structure elucidation and synthesis of Thyroxine and Adrenaline. 6. **Amino acids, Peptides, Proteins and Nucleic Acids** Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical methods of peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structures. Protein denaturation/renaturation. Nucleic acids: Introduction. Hydrolysis of nucleic acids. Ribonucleosides and ribonucleotides. General idea of the double helical structure of DNA.	12L 08 L 10 L
LEARNING OUTCOMES:	
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.

REFERENCES:

Reference Books

1. I.L.Finar, Organic Chemistry Vols I and II, Orient Longman
2. Morrison and Boyd, Organic Chemistry; 6th Edn. Prentice Hall India
3. Francis Carey, Organic Chemistry
4. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edn. Pearson Education Asia
5. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds.

CH - 341	ANALYTICAL CHEMISTRY SEMESTER V	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

- Define the terms involved in sampling techniques, data handling and solvent extraction, electrolytic methods, potentiometric titrations.
- State the laws and principles involved in solvent extraction, electrolytic methods, potentiometric titrations.
- Explain scope and importance of analytical chemistry, sampling of liquid,solid and gases, different types of tests related to data handling, the different types of extraction.
- Differentiate between various electrolytic methods, state and explain limits and merits of the various methods.
- Draw theamperometric titration curves, schematic diagram of instruments and explain its working.
- Classify and explain different types of errors, sampling techniques and types of extraction.
- Derive and use the equations of linear least squares and method of averages and solvent extraction to solve numerical.
- Interpret steps involved in chemical analysis.
- Explain the principle of potentiometric titrations, location of equivalence point and types of potentiometric titrations.

SYLLABUS

Theory:

Section I **1. Introduction** Scope and importance of analytical chemistry Chemical analysis and analytical chemistry Analytical process (steps involved in chemical analysis): defining the problem, sampling,separation of desired components, actual analysis, presentation and interpretation of results. Basic components of instruments for analysis Signal generators, detectors (input transducers) Signal processors, read out devices, circuits & electrical devices in instruments. References:1,2,3	**4 L**
2. Sampling Techniques Terms encountered in sampling: the population or the universe, Sample, Sampling unit, increment, the gross sample, the sub sample, Analysis sample, Bulk ratio, Size to weight ratio, Random sampling, Systematic sampling, Multistage sampling, Sequential sampling. Sampling of Gases, Liquids and Solids Preservation, storage and preparation of sample solution (References: 1,2,3)	**4 L**
3. Data handling Significant figures and rounding off. Accuracy and precision Errors : determinate and indeterminate error, Constant and proportionate errors ,	**11 L**

Minimization of errors Standard deviation. Histogram and Frequency polygon Measures of central tendency and dispersion.Gaussian distribution curve Confidence limit. Test of significance: F test, Students T Rejection of the results: Q test, 2.5d & 4d rule. Linear least squares/ Method of averages (Numerical problems are expected to be solved) Reference:1,35	
4. Solvent Extraction Basic principle, percentage extraction, role of complexing agents in solvent extraction, separation factor, Types of extraction (continuous, batch). (Numerical problems are to be solved) References: 1,2,3	**3L**
Section II	
5. Electrolytic methods Introduction: principles involved in Electrogravimetric analysis, Instrumentation, Electrolysis at constant current principle, apparatus, determination of copper by constant current electrolysis. Coulometry: Introduction, constant Current measuring device, Hydrogen-Oxygen coulometer, Silver coulometer. General characteristics of coulometric method, Coulometric titrationsApplications of coulometric titrations (References: 1,3,) Polarography:Introduction, Basic principles of instrumentation of polarography, Deposition potential, Dissolution potential, Polarisation of electrode, Polarographic wave, Ilkovic equation, Half wave equation (derivation not expected) Supporting electrolytes, Interference of oxygen, Applications of polarography – inorganic and organic. (Refences: 1,3,5) Amperometric titrations: Introduction, Instrumentation, Titration Curves, advantages of amperometric titrations.(Reference:1,3)	**12 L**
6. Potentiometric Titrations Principles of potentiometric titrations, Location of equivalent point, Different types of potentiometric titrations. (References :1,2,3)	**5 L**
7. **Atomic spectrometric methods:** Flame Photometry:Introduction, Principle, Instrumentation, applications, Limitations. Atomic absorption Spectroscopy: Introduction, Principle, Instrumentation, applications, limitations.	**6 L**

Differences between flame photometry and atomic absorption spectroscopy. Inducted coupled plasma. (References: 1,2,3)	

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Book

B.K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut

Reference Books

1. G. D.Christan Analytical Chemistry by, 5th edition Wiley publications.
2. G. Chatwal and S. Anand, Instrumental Methods of Chemical Analysis 5th edition (reprint 2003), Himalaya publication.
3. B. S. Baliga and A.Zaveri, College Analytical Chemistry, 15th edition, Himalaya Publishing House, 2004
4. Vogels Textbook of Quantitative Inorganic Analysis 4th edition ELBS.
5. Willard, Meritt and Dean. Instrumental Methods of Analysis
6. Skoog and Leary, Principles of Analytical Chemistry 4th International edition.

7. P.R.Trivedi and Gurdeep Raj, Environmental Water and Soil Analysis, Akashdeep Publishing House, New Delhi.
8. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.

CH – 301	Experiments in Physical and Analytical Chemistry SEMESTER V	Number of hours: 45

COURSE OBJECTIVES:

Practical:

- To understand and develop the problem solving skills and hands on experience with refrence to concepts studied in theory(potentiometry , pH metry, partition coefficient, Chemical kinetics)
- To understand and develop the problem solving skills and hands on experience with refrence to instrumentation and techniques studied in theory.(spectrophotometry,chromatography and conductometry)

SYLLABUS

Practical

Physical

Conductometry

1. To determine the percent composition of acid mixture (strong and weak acid) by titrating against standard 0.1 N NaOH solution.
2. To verify Ostwald's dilution law using CH3COOH Potentiometry
3. To determine the formal redox potential of Fe2+/Fe3+ system using standard 0.1N K2Cr2O7 solution.
4. To determine the solubility product of AgCl/AgBr.

pH metry

5. To determine the dissociation constant of weak monobasic acid (CH3COOH) by titrating against standard 0.1N NaOH solution

General

6. Partition Coefficient: To determine the equilibrium constant for the reaction KI +I2 === KI3
7. Adsorption: To study the adsorption of acetic acid from aqueous solution by activated charcoal and verify Freundlich adsorption isotherm.
8. Chemical Kinetics: To study the acid hydrolysis of methyl acetate at two different temperature and determine the energy of activation.

Analytical

A] Spectrophotometry.

1. Determination of Mn2+ in steel or Mn2+ ion concentration periodate method.
2. Determination of iron by salicylic acid method.

B] Chromatography

3. Separation of metal ions by paper chromatography.(demonstration)
4. Separation of organic compounds by TLC.(demonstration)
5. Zn2+ /Mg2+ separation by an anion exchanger & their volumetric estimation of with standard EDTA.

C] Conductometry

6. Estimate the amount of Pb present in a solution of Pb(NO3)2 by conductometric titration with Na2SO4

D] Other Experiments

7. Determination of ascorbic acid in Vitamin C tablets by iodometry
8. Estimation of Ca in milk powder using EDTA method (volumetry) and also by precipitation as oxalate followed by titration with KMnO4 (not for examination)

LEARNING OUTCOMES:

Practical:

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.
- 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.

REFERENCES:

1.Basic Principles of Analytical Chemistry. To be used as text book.
K. Raghuraman, D.V.Prabhu, C.S. Prabhu and P.A.Sathe
3rd, 4th and 5th edition, Sheth Publishers.
2.Analytical Chemistry.
Gary Christian, 4th Edition, International Edition.
3.Principles of Analytical Chemistry.
Skoog and Leary, 4th International Edition.

CH-:303	Experiments in Inorganic and Organic Chemistry (Semester V)	Number of hours: 60

COURSE OBJECTIVES:

Practical:

- To understand and systematically estimate quantitatively the desired metal ions by gravimetry in presence of interfering ions and also quantitatively estimate inorganic complexes of different metal ions.
- To understand theoretical concepts required for experiments and develop hands on experience with reference to basic laboratory techniques required for organic estimations, synthesis and finding the organic mixture type.

SYLLABUS

Practical:

Inorganic Chemistry

Gravimetric Estimations .

1. To estimate the amount of Fe as Fe_2O_3 in the given solution of ferric chloride containing barium chloride and free HCl.
2. To estimate the amount of nickel as Ni-DMG in the solution of nickel chloride containing copper chloride and free HCl.
3. To estimate the amount of barium as $BaCrO_4$ in the solution of barium chloridecontaining ferric chloride and free HCl.
4. To estimate the amount of Zinc as $Zn_2P_2O_7$ in the given solution of zinc sulphate containing copper sulphate and free H_2SO_4.

Inorganic Preparations

1. Preparation of Sodium trioxalatoferrate(III); $Na_3[Fe(C_2O_4)_3]$ complex.
2. Preparation of Tristhioureacopper (I) sulphate.
3. Preparation of Trisethylenediaminenickel(II) complex.
4. Preparation of Chrome Red.

Organic Chemistry

1. Organic Estimations:
   a) Mixture of acid and ester
   b) Mixture of acid and amide
   c) Saponification value of oil
2. Organic synthesis: Nitration of nitrobenzene and acetanilide, p-bromoacetanilide from acetanilide, m-nitroaniline from m-dinitrobenzene, synthesis of osazone of glucose and oxime of cyclohexanone
3. Finding the organic mixture type: Solid-solid-Water Soluble- Insoluble type.
   1)Acid-Acid 2) Acid-Neutral 3) Neutral-Neutral
   Liquid-liquid mixture type as well as the separation.
   Note: 1) 6 Organic Synthesis to be completed in 3 practicals.
   2) At least 5-6 mixture type determination to be given (not to be given for examination)

LEARNING OUTCOMES:

Practical:

At the end of the course students will be able to

- 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.
- 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.

REFERENCES:

Inorganic Chemistry:

Books for Practicals:

1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham ELBS.
3. Standard Methods of Chemical Analysis W.W. Scott, Technical Press.
4. Experimental Inorganic Chemistry W.G. Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol. I and II Brauer, Academic Press.
6. Inorganic Synthesis, Mc Graw Hill.

Organic Chemistry:

1. Vogel's Qualitative Organic Analysis, Orient Longman.
2. Textbook of Practical Organic Chemistry, N.K.Vishnoi.

CH - 312	Physical Chemistry (Semester VI)	Number of lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To study the molecular orbital theory diagrams and the graphs involved.
- To interpret the physical picture of bonding and antibonding wavefuction.
- To define terms involved in electrochemistry, pH, poH, pKa, pKb. Buffer solution, buffer capacity. Measurement of pH using different electrodes by potentiometric methods.
- To describe the mechanism of buffer action.
- To derive and solve numerical on Henderson's equation.
- To study energy released in nuclear fission, fission products.
- To classify various nuclear reactors. To describe the working of reactors and its parts.
- To know nuclear reactors in India.
- To define the terms and laws involved in photochemistry.
- To draw and interpret Jablonski diagrams
- To study photochemical and photosensitized reactions with examples

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Section II

- To describe types of theories in corrosion
- To explain the types of energy sources
- To study vibrational spectroscopy, ir, harmonic and anharmonic oscillator, Raman spectroscopy,
- Define terms , force constants, bond energy, polarizability.
- To study stokes and antistock lines, Raman shift and selection rules involved.
- Chain reactions, terms involved and units of radioactivity, applications of radioactive isotopes Biological effects of radiations.

SYLLABUS

Theory:

Section I 1. Quantum Chemistry: Molecular orbital theory, basic ideas-criteria for forming M.O from A.O, construction of M.O's by LCAO-H2+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions.	06 L
2. Applied Electrochemistry - I Definition of pH, pOH pKa,and pKb; introduction to potentiometer; determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric method; Buffer solution, types, buffer action, buffer capacity ,mechanics of buffer action, Henderson-Hazelbulch equation.	08 L
3. Nuclear Chemistry - I Nuclear fission, energy released in fission and fission products, neutron emission in fission, nuclear energy, classification of reactors, the breeder reactor, nuclear reactors in India.	06 L

4. Photochemistry: Interaction of radiation with matter, differences between thermal and photochemical processes, laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagram; depicting various processes occurring in the excited state, quantum yield and its measurements qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, inter system crossing), photosensitized reactions-energy transfer processes (simple examples).	10 L
Section II 5. Applied Electrochemistry:- II Corrosion-Types, theories - electrochemical and chemical. Energy sources: Acid and alkaline battery. Ni-Cd cell fuel cells, solar cells. Secondary batteries.	08 L
6. Spectroscopy: Vibrational Spectrum: Infrared spectrum: energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of an- harmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. Raman spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.	16 L
7. Nuclear Chemistry: - II Chain reaction and conditions for its control ; reprocessing of spent fuels; units of radiation energy ;applications of radioactive isotopes; radioisotopes as tracers; biological effects of radiation.	06 L

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2 U.N.Dash, Nuclear Chemistry, by Sultan Chand & Sons, New Delhi.

Reference Books

1. Puri, Sharma, Pathania, Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press

2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,

3. Donald McQuarrie, Physical Chemistry

CH- 322	Inorganic Chemistry SEMESTER VI	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To study types of electronic transitions and selection rules for transitions to take place
- To study the applications to determine ligand field strength, color of complexes, Cis-trans isomerism and Geometry of complexes.
- To define the terms fuel gases, calorific value, benzol.
- To state the composition ,draw the flow sheet and equipment for manufacture of of coal gas, producer gas and water gas
- To explain the advantages of fuel gases over liquid and solid fuels.
- To discuss the physicochemical principles involved in the synthesis of ammonia by Haber's process and Nitric acid by Ostwald's method.
- Todefine pollutant, primary and secondary pollutant, air pollution
- To discuss sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur.
- To understand Photochemical smog.
- To discuss the phenomenon of acid rain, greenhouse effect.
- To introduce concept of Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rotation – reflection axis and Identity and apply to different molecules

Section II

- To define the terms Magnetic susceptibility, magnetic moment, diamagnetism, paramagnetism.
- To explain the different types of magnetic behaviour- diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, measurement of susceptibility by Gouy's method.
- To draw the graph of susceptibility v/s temperature for paramagnetic, ferromagnetic and antiferromagnetic substances.
- To calculate magnetic moment by spin formula for different transition metal complexes.
- To interpret the magnetic behaviour of different transition metal complexes based on observed and calculated magnetic moments.
- To introduce Nanochemistry and explain nano particles, their properties and applications.
- To introduce zeolites, their structure and applications.
- To define the terms Meissner effect,critical temperature.
- To explain the mechanism of superconductivity.
- To discuss the different types of superconductors.
- To define and study the properties of inorganic polymers.
- To classify condensation, addition and coordination Polymers
- To introduce preparation, structure & bonding and applications of silicones.
- To study stability constants of reactions in terms of thermodynamic and kinetic stability and the various factors affecting the stability constants of complexes.
- To study the substitution reaction mechanisms of octahedral complexes and the trans effect observed in square planar complexes.

SYLLABUS

Theory:

Section I

1.Electronic spectra of Transition Metal Complexes:
Introduction, Types of electronic transitions: The d-d transitions (d^1/d^9 and d^2/d^8), Charge transfer transitions and Ligand-ligand transitions, Selection rules (Laporte Orbital and Spin), Applications (Ligand field strength, Colour of complexes, Cis-trans isomerism and Geometry of complexes). **10L**
Ref: 3,7

2.Industrial fuels and chemicals.
(A) Industrial fuels like coal gas, producer gas and water gas.
(B) Physico chemical principles involved in the manufacture of HNO_3 (Ostwald's method) and NH_3 (Haber's method). **8L**
Ref: 8

3.Air Pollution:
Introduction, classification of pollutants, sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur, Photochemical smog, acid rain and House effect. **7L**
Ref: 10

4.Symmetry and Term symbols:
(A) Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rota reflection axis, Identity (Trans dichloroethylene, H_2O and BCl_3) **5L**
Ref: 9

Section II

5. Magnetic properties of transition metal complexes:
Types of magnetic behaviour, Methods of determining magnetic susceptibility (Gouy's method), spin only formula, application of magneticmoment data for 3d – metal complexes. **5L**
Ref: 1, 4

6.Selected topics: **(A) Nano chemistry:** Introduction to Nano particles, their properties and applications. **(B) Solid acids:** Introduction to zeolites, structure and applications. **(C)Superconductors:** Discovery, critical temperature, Meissner effect, Conventional and High Temperature superconductors. **Ref:** 3, 5	**10L**
7.Inorganic Polymers: Definition, Properties, Glass transition temperature, Classification (Condensation, addition and coordination Polymers) **Silicones:** Preparation, structure & bonding and applications. **Ref:** 3, 4	**6L**
8.Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamicstability of metal complexes and factors affecting the stability, substitution reactions of Octahedral complexes. Trans effect with respect to square planar complexes. **Ref:** 5	**9 L**

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text- Books:

1. Concise Inorganic Chemistry. 5th edition, J. D. Lee
2. Basic Inorganic Chemistry, 5th edition, F.A. Cotton, G. Wilkinson.

Reference books:

3. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit 18th revised edition, Himalaya Publishing House.
4. Principles of Inorganic Chemistry, B.R Puri, L. R. Sharma, Milestone Publishers.
5. Inorganic Chemistry, (Principles of Structure and Reactivity). James E. Huheey, Ellen A. Keiter, Richard L. Keiter
6. Inorganic Chemistry D. E. Shriver, P.W. Atkins and C.H. Langford, Oxford.
7. Advance Inorganic Chemistry, 6th edition, F.A. Cotton and G. Wilkinson
8. Comprehensive Inorganic Chemistry, B.S. Bahl and Sharma
9. Group theory and its Chemical applications, P. K. Bhattacharya, Himalaya Publication.
10. Environmental Chemistry, A. K. De.

CH-332:	Organic Chemistry (Semester VI)	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To know nomenclature of different carbohydrates.
- To know classification of carbohydrates and terpenes.
- To study general reactions of Monosaccharides.
- To study the determination of configuration and ring size of monosaccharides with reference to glucose, interconversion of glucose.
- To know cyclic structure of D(+)- glucose and study mutarotation, formation of glycerides, ethers, esters and structure elucidation of sucrose.
- To learn the general methods of structure elucidation of terpenes.
- To learn the synthesis of α-terpineol, camphor, citral. ethyl acetoacetate by Claisen condensation.
- To study the chemistry of α-terpineol, camphor, citral. α-pinene and zingiberene.
- To understand the acidity of α-hydrogens, keto-enol tautomerism in ethyl acetoacetate, hydrogenation of unsaturated oils,
- To study the alkylation of diethyl malonate, ethyl acetoacetate, 1,3-dithianes, enamines and acylation of enamines.
- To study the chemistry of following- Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, soaps, synthetic detergents, alkyl and aryl sulphonates.
- To learn the various terms such as saponification value, iodine value and acid value of oils.

Section II

- To learn the definition of the terms involved.
- To know the classification of dyes, synthetic drugs, polymers and types of polymerization.
- To learn the preparations of various polymers mentioned in the syllabus.
- To understand the difference between natural and synthetic rubber with examples.
- To learn the vulcanization of rubber.
- To understand the effect of constitution on colour of different organic compounds based on electronic concept.
- To study the chemistry and the synthesis of various dyes mentioned in syllabus.
- To learn nomenclature and structure of one compound from all classes of pharmacodynamic agents and chemotherapeutic agents.
- To learn synthesis and application of various synthetic drugs.
- To know the nomenclature and structural features of Organosulphur and Organophosphorus compounds.
- To learn the methods of preparations and reactions of thiols, thioethers, sulphonic acids, phosphines and phosphonium salts including Wittig reaction and its applications.
- To understand the chemistry of ylides and Organophosphorus compounds.
- To understand chemistry of photochemical reactions, Jablonskii diagram, Norrish type I and Norrish type II cleavage of ketones
- To understand electronic transitions and transition states.

SYLLABUS	
Section I 1. **Carbohydrates** Classification and nomenclature. Monosaccharides: General reactions, chain lengthening by Killiani-Fischer synthesis and chain shortening by Ruff degradation of aldoses, mechanism of osazone formation. Configuration of monosaccharides with reference to glucose. d(+)/l(-) and D/L systems of nomenclature. Interconversion of glucose to fructose and glucose to mannose. Determination of ring size of monosaccharides with reference to glucose. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. Formation of glycosides, ethers and esters. Structure elucidation of sucrose.	10L
2. Terpenes Classification. General methods of structure elucidation. Chemistry and synthesis of citral and its conversion to ionones. Chemistry and synthesis of α-terpineol, camphor. Chemistry of α-pinene. Chemistry of zingiberene.	10L
3. **Organic synthesis via Enolates**: Acidity of α-hydrogens, Synthesis of ethyl acetoacetate by Claisen condensation, keto-enol tautomerism in ethyl acetoacetate. Alkylation of diethyl malonate and ethyl acetoacetate. Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.	08L
4. **Fats, Oils and Detergents:** Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides. Hydrogenation of unsaturated oils. Saponification value, iodine value and acid value of oils. Soaps, synthetic detergents, alkyl and aryl sulphonates.	02L
Section II **5. Synthetic Polymers:** Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Zeigler-Natta polymerization and vinyl polymers. Condensation or step-growth polymerization. Polyesters, polyamides, phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.	05L
6. **Synthetic Dyes**: Color and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of methyl orange, Congo Red, Malachite Green, Crystal Violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.	08L

7. Synthetic Drugs: Classification according to use. One compound with name and structure from all classes of pharmacodynamic agents and chemotherapeutic agents. Synthesis and uses of the following drugs: Phenobarbital, Chlorpheniramine, Atenolol, Ibuprofen, Naproxen, Methyldopa, Chloramphenical, Metronidazole and Ethambutol.	06L
8. Organosulphur and Organophosphorus Compounds: Nomenclature, structural features. Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids. General reactions only. Introduction to organophosphorus compounds. General methods of preparation of phosphines and phosphonium salts. Wittig reaction and its applications.	08L
9. Photochemistry: General idea of photochemical reactions. Electronic transitions and transition states. Jablonskii diagram. Norrish type I and Norrish type II cleavage of ketones.	03L

LEARNING OUTCOMES:

Theory:

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,

transition states and photochemical reactions.

REFERENCES:

1. I.L.Finar, Organic Chemistry Vols I and II, Orient Longman
2. Morrison and Boyd, Organic Chemistry; 6th Edn. Prentice Hall India
3. Francis Carey, Organic Chemistry
4. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edn. Pearson Education Asia
5. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds;

CH - 342	*Analytical Chemistry* **(SEMISTER VI)**	**Number of hours: 45**

COURSE OBJECTIVES:

Theory:

SECTION I & II

- Define the terms involved in basic electronics and thermal methods, radiochemical methods, UV Visible Spectroscopy, Chromatographic methods, Fluorimetry
- State the principles in thermal methods of chemical analysis and basic electronics, UV Visible Spectroscopy and Fluorimetry, principles of isotope dilution method and neutron activation analysis.
- Draw the schematic diagrams, diagrams of instruments, circuit diagrams and the graphs involved.
- Describe the working of instruments, electronic components and circuits.
- Explain the terms involved giving examples, interpret the graphsin UV Visible Spectroscopy , chromatographic methods and fluorimetry.
- Classify and explain the different types of chromatographic technique.
- Derive and use the equations of Beer Lamberts law, Gas chromatography to solve numericals.
- Discuss applications of UV Visible Spectroscopy , chromatographic technique and fluorimetry.
- Analyse different parameters of water,air and soil analysis.

SYLLABUS

Theory:

Section I **1. UV-Visible Spectroscopy** Interaction of electromagnetic radiation with matter, Quantitative calculations- Beer's and Lambert's law. Deviations from Beer's law Principles of instrumentation: Sources, monochromators, cells. Types of instruments. Photoelectric colorimeters: Single & Double beam photoelectric colorimeters; comparison between colorimeter and spectrophotometer ; applications of colorimetry and/or spectrophotometry ; quantative analysis; identification of structural groups in a molcule ; study of co-ordination compound, photometric titrations, cis-trans isomerism; chemical kinetics & others limitations. *(Reference: 1,3)(numerical problems are expected to be solved)*	**09 L**
2. Chromatographic Methods Principles. Classification of chromatographic techniques Techniques of column chromatography Paper and thin layer chromatography: Principles, techniques and applications of paper and thin layer chromatography.Theory of chromatographic separation :DistributionEquilibria, Rate of travel, Retention time,Retention volume and relative retention.Ion exchange chromatography: Principles, classification of ion exchange materials, Nature of exchanging ions, Ion exchange capacity, applications in analytical chemistry.VGas chromatography and HPLC : Gas chromatography: Basic principles, Graphic diagram of apparatus, Explanation	**14 L**

of factors affecting separation, Thermal conductivity and Flame ionization detectors, Identification and estimation of sample components, Applications GC-MS and HPLC in detail. HPLC: principles equipment for HPLC , applications. *(Numerical problems are to be solved.References: 1, 2,3)* **Section II** **3. Basic Electronics** Introduction to diodes, rectifiers, zener diodes, regulated power supply, SCR's, triac and control circuits, Transistors, FET, Linear Integrated circuits and operational amplifiers.Binary arithmetic. *(Reference : 6)* **4. Thermal Methods** Thermogravimetric Methods (TG):Instrumentation, applications with respect to CaC2O4.H2O and CuSO4.5H2O Differential Thermal Analysis (DTA): General principles and applications. Differential Scanning Calorimetry (DSC): Applications. *References:2,4,5* **5. Fluorimetry** Principles of Fluorescence, chemical structure and Fluorescence. Relationship between concentration & fluorescence intensity Instrumentation & applications.*(numerical problems are expected to be solved)* *References:2,3* **6. Radiochemical methods** Isotope dilution Analysis: Principles and applications. Neutron activation analysis: principle, calibration curve method, advantages and limitations of neutron activation analysis. *(Reference : 6)* **7. Environmental Chemistry: Air, Water and Soil Analysis** Water analysis: Dissolved oxygen, free carbon dioxide, B.O.D., C.O.D. and total carbohydrates. Soil/ sediment analysis: Bulk density, Specific gravity, moisture content, water holding capacity, pH, electrical conductivity, alkalinity, detection of sulphate (By colorimeter or turbidimeter), nitrogen, nitrate, total phosphorus, phosphate, calcium, magnesium, sodium, potassium, iron and organic matter. Air analysis: SO2, H2S, NO-NO2, CO-CO2, O3 and NH3 *References: 8,9,*	**07 L** **04 L** **03 L** **03 L** **05 L**
LEARNING OUTCOMES:	
Theory:	

- 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 chemicalanalysis.
- 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

REFERENCES:

Text Book

B.K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut

Reference Books

1. G. D.Christan Analytical Chemistry by, 5th edition Wiley publications.
2. G. Chatwal and S. Anand, Instrumental Methods of Chemical Analysis 5th edition (reprint2003), Himalaya publication.
3. B. S. Baliga and A.Zaveri, College Analytical Chemistry, 15th edition, Himalaya PublishingHouse, 2004
4.Vogels Textbook of Quantitative Inorganic Analysis 4th edition ELBS.
5. Willard, Meritt and Dean. Instrumental Methods of Analysis
6.Skoog and Leary, Principles of Analytical Chemistry 4th International edition.
7. P.R.Trivedi and Gurdeep Raj, Environmental Water and Soil Analysis, Akashdeep Publishing
House, New Delhi.
8. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.

CH-302	Experiments in Physical and Analytical Chemistry SEMESTER VI	Number of hours: 45

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory(potentiometry , pH metry, partition coefficient, Chemical kinetics)
- To understand and develop the problem solving skills and hands on experience with refrence to instrumentation and techniques studied in theory.(spectrophotometry,chromatography and conductometry)

SYLLABUS

Practical

PHYSICAL CHEMISTRY

Conductometry

1. To determine the strength of mixture containing weak acid (CH3COOH) and weak base (NH4OH) by titrating against standard 0.1N NaOH solution.
2. To determine the degree of hydrolysis and hydrolysis constant of
a) CH3COONa b) NH4Cl c) C6H5NH2.HCl at room temperature.

Potentiometry:

3. To determine the standard oxidation potential of Zn/Zn2+ and Cu/Cu2+ at three different concentrations.
4. To determine the percent composition and amount of halide ions from their mixture (any two halides) using standard 0.1N AgNO3 solution.
5. To determine the dissociation constant of weak dibasic acid(H2C2O4) by titrating against standard 0.1N NaOH solution.
6. To investigate the influence of ionic strength on the rate constant between potassium per sulphate and potassium iodide.
7. To study the kinetics of ethyl acetate by NaOH at two different temperatures and hence the energy of activation.
8. To determine the formula of the complex formed between cupric ion and ammonia by distribution method.

ANALYTICAL CHEMISTRY

A] Spectrophotometry

1. Determination of nitrite in water
2. Estimation of Cr and Mn from a mixture
3. Comparison of spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10 – phenanthroline by three methods: continuous variations, mole ratio and slope ratio (not for examination)

B] Chromatography

4. Estimation of Na+ from NaCl using cation exchange resin in H – form using standard NaOH.

C] Conductometry

5. Estimation of boric acid by conductometric titration

D] Other Experiments

6. Determination of hardness of water by EDTA i.e estimate Ca asCaCO3 and report analysis in ppm. (the candidate should record more than 5 observations and carry out statistical analysis to find out mean, median, range, standard deviation, absolute error, relative error and possibly Q test.(not for examination)
7. Determination of Mg in antacid drugs

8. Estimation of aspirin	
LEARNING OUTCOMES:	
Practical:	
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.	
REFERENCES:	
1.Basic Principles of Analytical Chemistry. To be used as text book. K. Raghuraman, D.V.Prabhu, C.S. Prabhu and P.A.Sathe 3rd, 4th and 5th edition, Sheth Publishers. 2.Analytical Chemistry. Gary Christian, 4th Edition, International Edition. 3.Principles of Analytical Chemistry. Skoog and Leary, 4th International Edition.	

CH-304:	Experiments in Inorganic and Organic Chemistry (Semester VI)	Number of hours: 60

COURSE OBJECTIVES:

Practical:

- To study the volumetric methods to quantitatively estimate with precision the desired amount of the metal ions.
- To study the volumetric methods for determination of some physicochemical parameters in sea and mineral water.
- To get hands on experience for the binary mixture separation and the analysis of separated compounds.

SYLLABUS

Practical:

Inorganic Chemistry

1. Estimation of Iron(II) by dichromate method from the given solution of ferric alum byusing SnCl2.
2. Estimation of Nitrite using Ceric ammonium sulphate from the given sample of Water.
3. Estimation of Copper(II) by thiosulphate method from the solution of copper sulphate.
4. Estimation of Calcium in the given sample using KMnO4.
5. Preparation of Tetraamine Copper (II) sulphate complex.
6. Estimation of Copper from Tetraamine Copper (II) sulphate complex by iodometry.
7. Determination of dissolved oxygen from sea and mineral water using Winkler's method.
8. Determination of alkalinity of sea and mineral water using phenolphthalein and methylorange indicator.

Organic Chemistry

1. Organic mixture separation and analysis. At least 08 mixtures of compounds out of which 4 should be solid-solid, 2 liquid-liquid, and 2 solid-liquid from the following list, to be analyzed on small scale using 1 gm of mixture in case of solids and 3 to 4 ml. in case of liquids. (Existing list of mixtures to be continued)

LEARNING OUTCOMES:

Practical:

At the end of the course students will be able to

- 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.

- 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.

REFERENCES:

Inorganic Chemistry:
1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham ELBS.
3. Standard Methods of Chemical Analysis W.W. Scott, Technical Press.
4. Experimental Inorganic Chemistry W.G. Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol. I and II Brauer, Academic Press.
6. Inorganic Synthesis, Mc Graw Hill.

Organic Chemistry:
1. Vogel's Qualitative Organic Analysis, Orient Longman
2. Textbook of Practical Organic Chemistry, N.K.Vishnoi

List of Courses for B.Sc. Chemistry Program w.e.f. 2017-2018

Course Name		Credits	
		Theory	Practical
A. Discipline Specific Core Courses (DSC)- Code: CHC; (6 Credits each)			
1	Semester I: CHC-101(DSC-2A) Inorganic Chemistry and Organic Chemistry	4	2
2	Semester II: CHC-102 (DSC-2B) Physical Chemistry and Organic Chemistry	4	2
B. Chemistry Courses – Code: CH			
3	Semester III: CH-201: Physical and Inorganic Chemistry CH-203: Organic and Inorganic Chemistry		
4	Semester IV: CH-202: Physical and Inorganic Chemistry CH-204: Organic and Inorganic Chemistry		
5	Semester V: Theory CH-311: Physical Chemistry CH-321: Inorganic Chemistry CH-331: Organic Chemistry CH-341: Analytical Chemistry		
	Practical CH-301: Experiments in Physical and Analytical Chemistry CH-303: Experiments in Inorganic and Organic Chemistry		
6	Semester VI: Theory CH-312: Physical Chemistry CH-322: Inorganic Chemistry CH-332: Organic Chemistry CH-342: Analytical Chemistry		
	Practical CH-302: Experiments in Physical and Analytical Chemistry CH-304: Experiments in Inorganic and Organic Chemistry		

Year	Semester	Discipline Specific Core DSC (CHC)	Chemistry Courses (CH)
Credits		**6 credits each**	
First Year	I	CHC-101(DSC-2A) Inorganic Chemistry and Organic Chemistry	
	II	CHC-102 (DSC-2B) Physical Chemistry and Organic Chemistry	
Second Year	III		CH-201: Physical and Inorganic Chemistry CH-203: Organic and Inorganic Chemistry
	IV		CH-202: Physical and Inorganic Chemistry CH-204: Organic and Inorganic Chemistry
Third Year	V		Theory CH-311: Physical Chemistry CH-321: Inorganic Chemistry CH-331: Organic Chemistry CH-341: Analytical Chemistry
			Practical CH-301: Experiments in Physical and Analytical Chemistry CH-303: Experiments in Inorganic and Organic Chemistry
	VI		Theory CH-312: Physical Chemistry CH-322: Inorganic Chemistry CH-332: Organic Chemistry CH-342: Analytical Chemistry
			Practical CH-302: Experiments in Physical and Analytical Chemistry CH-304: Experiments in Inorganic and Organic Chemistry

PROGRAMME SPECIFIC OUTCOME (PSO)

- Students will be able to acquire core knowledge in Chemistry in the key areas, develop written & oral communication skills in communicating chemistry-related topics.
- Design & conduct an experiment, demonstrate their understanding of the scientific methods & processes.
- Develop proficiency in acquiring data using a variety of instruments, analyze & interpret the data, learn applications of numerical techniques.
- Realize & develop an understanding of the impact of Chemistry & science on society.

CHC-101 DSC 2A	**Inorganic Chemistry& Organic Chemistry (SEMESTER I)**	**Credits: 06 (Theory: 04 & Practical: 02)**

COURSE OBJECTIVES:

Theory:

Section A

- To discuss Bohr's theory, Quantum theory for structure of an atom.
- To draw the radial plots, probability distribution curves.
- To generalize the rules for electronic configuration of an atom.
- To explain the general characteristics of ionic compounds and covalent compounds.
- To discuss valence bond theory, VSEPR, and molecular orbital theory for covalent compounds.

Section B

- To understand the curved arrow notations in organic reaction mechanisms.
- To understand the concept of physical effects and electronic displacement with reference to organic molecules.
- To understand the structure, shape and reactivity of organic molecules.
- To study the strength of organic acids and bases.
- To understand the aromaticity of compound.
- To understand the concept of isomerism, stereoisomerism, configuration, chirality and optical rotation.
- To understand the difference between conformational and configurational isomers.
- To draw conformations with respect to ethane, butane and cyclohexane.
- To learn the interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations.
- To understand rules for nomenclature and assigning configuration to configurational isomers.
- To understand various methods of preparation and reactions of alkanes, alkenes and alkynes.

Practical:

- To estimate the metal ions by volumetric methods employing redox and complexometric and acid-base titration concepts.
- To get hands on experience for the systematic qualitative analysis of the organic compounds.
- To learn the purification and separation techniques for organic compounds.

SYLLABUS	
Theory:	**Number of hours: 60**
Section A **1. Atomic Structure:** Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Quantum numbers and their significance, Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	**14 H**
2. Chemical Bonding and Molecular Structure *Ionic Bonding:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. *Covalent bonding:* VB Approach, Shapes of some inorganic molecules and ions on the basis of VSEPRand hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of Resonance and Resonating structures in various Inorganic and Organic compounds.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, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.	**16 H**
Section B **1. Fundamentals of Organic Chemistry** Curved arrow notation, drawing electron movement with arrows, half and double headed arrows, in organic reaction mechanisms. Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive	**8 H**

Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pk values. Aromaticity: Benzenoids and Hückel's rule. **2. Stereochemistry** Concept of isomerism. Types of isomerism. Stereoisomerism, conformational isomerism. Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis – trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=Csystems). **3. Aliphatic Hydrocarbons** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. **Alkanes**: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radicalSubstitution:Halogenation. **Alkenes:** (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration - demercuration,Hydroboration-oxidation. **Alkynes**: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.	**10 H** **12 H**

Practical	**Number of hours: 60**
Section A-(Inorganic Chemistry) **Volumetric Analysis:** 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Estimation of oxalic acid by titrating with $KMnO_4$. 3. Estimation of water of crystallization in Mohr's salt by titrating with standardized $KMnO_4$. 4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. 5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.	**30 H**

Section B:(Organic Chemistry) 1. Purification of organic compounds: i. Solids by recrystallization process using water and ethanol as solvent. Determination of melting point. ii. Liquids by distillation process, a) acetone b) nitrobenzene. Determination of boiling point. 2. Determination of chemical type, detection of elements, group test for any one compound. 3. Identification of unknown organic compounds. i. Water insoluble solids (Acid, Base, Phenol and Neutral) ii. Water soluble solid (Acid and Neutral) 4. Thin layer chromatographic techniques: plate preparation, spotting, Separation of mixtures by thin layer Chromatography: Measure the Rf value in each case (combination of two compounds to be given eg. Mixture of o- and p-nitroaniline).	**30 H**

LEARNING OUTCOMES:

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

- Interpret the atomic structure based on postulates of Bohr's theory, Quantum mechanics and Valence bond theory.
- Predict the structure and distortion of molecules based on VSEPR theory.
- Evaluate the stability and magnetic property based on molecular diagrams of homonuclear and heteronuclear molecules.
- Identify and use the curved arrow notations in organic reaction mechanisms.
- Explain the concept of physical effects and electronic displacement with reference to organic molecules.
- Describe structure, shape and reactivity of organic molecules.
- Interpret strength of organic acids and bases.
- Identify if the given organic compound is aromatic.
- Classify isomers giving examples.
- Discuss the concept of stereoisomerism , configuration, chirality and optical rotation.
- Distinguish between conformational and configurational isomers and also geometrical and optical isomers, giving examples.
- Draw conformations with respect to ethane butane and cyclohexane.
- Draw and interconvert WedgeFormula, Newman, Sawhorse and Fischer representations.
- Give the nomenclature and assign configuration to configurational isomers.
- Give various methods of preparation and reactions of alkanes, alkenes and alkynes.

Practical:

- The students will acquire the skill and knowledge to carry out volumetric estimation of metal ions.
- 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.

Reference Books

Inorganic Chemistry

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.

Organic Chemistry

1. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
4. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
5. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
7. Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
8. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India.
9. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia.
10. Jerry March, Advanced Organic Chemistry; 4rd Edition, John Wiley.

CHC-102 (DSC 2B)	Physical Chemistry and Organic Chemistry (Semester II)	Credits: 06 (Theory: 04 & Practical: 02)

COURSE OBJECTIVES:

Theory:

Section A

- To define the terms and state laws involved in thermodynamics, thermochemistry and chemical equilibrium.
- To explain the concept of enthalpies of solution, buffer solutions.
- To derive the Thermodynamic derivation of the law of chemical standard state, enthalpies of solution, chemical equilibrium and relationships between different equilibrium constants based on ideal gases.
- To solve numerical based on chemical energetics, chemical equilibrium and ionic equilibrium.

Section B

- To learn the preparation methods and reactions of Aromatic hydrocarbons, Alkyl and Aryl Halides, Phenols, Ethers and Carbonyl Compounds.
- To learn the various named reactions mentioned in the syllabus.
- To understand Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.
- To understand Benzyne mechanism with respect to aromatic nucleophilic substitution.
- To understand Pinacol-pinacolone rearrangement with mechanism.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory pH metry, thermochemistry
- To understand the mechanism of reactions involved in organic preparation experiments and develop hands on experience with reference to basic laboratory techniques required for organic preparations.

SYLLABUS

Theory: **Number of Hours: 60**

Section A: Physical Chemistry- I

1. Chemical Energetics — **10 H**

Need of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

2. Chemical Equilibrium — **08 H**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Definition of ΔG and ΔGo, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

3. Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts.	**12 H**
Section B: Organic Chemistry – II **1. Aromatic hydrocarbons** *Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. *Reactions*: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).	**08 H**
2. Alkyl and Aryl Halides **Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions. *Preparation:* from alkenes *and* alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile &isonitrile formation. Elimination vs substitution. **Aryl Halides** *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and arylhalides.	**08 H**
3. Alcohols, Phenols, Ethers and Carbonyl Compounds **Alcohols:** *Preparation:* Preparation of 1°, 2°and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions:* With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3). Oppeneauer oxidation *Diols:* oxidation of diols using HIO4. Pinacol-Pinacolone rearrangement with mechanism. **Phenols:** (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch	**14 H**

Condensation, Schotten –Baumann Reaction.

Ethers (aliphatic and aromatic): Williamson's synthesis of ethers. Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles. *Reactions* – Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensenreduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Practical	**Number of Hours: 60**
Section A-(Physical Chemistry) 1. Thermochemistry (Any three) i. Determination of heat capacity of the calorimeter. ii. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. iii. Determination of enthalpy of ionization of acetic acid. iv. Study of the solubility of benzoic acid in water and determination of ΔH.	**18 H**
2. Chemical Kinetics: i. To study the effect of nature of reactants on the rate of reactions ii. Determination of relative strength between HCl and Urea hydrochloride for hydrolysis of methyl acetate Ionic equilibria.	**10 H**
3. pH measurements Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using ph meter.	**02 H**
Section B-(Organic Chemistry) 1. **Preparations**: Mechanisms involved in the following reactions to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done. Each preparation for a. Bromination of Phenol/Aniline (b) Benzoylation of amines/phenols b. 2,4-dinitrophenylhydrazone of benzaldehyde/acetophenone c. Nitration of acetanilide to p-nitroacetanilide. (e) Oxime of Cyclohexanone d. Chalcone from benzaldehyde and acetophenone (g) Iodoform from acetone	**30 H**

LEARNING OUTCOMES:

Theory:

At the end of the course students will be able to

- Define the terms involved in chemical energetics, chemical equilibrium, ionic equilibrium and state the laws used in thermodynamics, thermochemical equilibrium .
- Describe enthalpy, buffer solutions, factors affecting ionization.
- Derive and use the equations thermochemistry, chemical equilibrium and ionic equillibria of to solve the numericals.
- Give methods of preparation and reactions of aromatic hydrocarbons, alkyl and aryl halides, phenols, ethers and carbonyl compounds.
- Identify and give the named reactions mentioned in the syllabus.
- Explain reactivity and relative strength of c-halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.
- Explain benzyne mechanism with respect to aromatic nucleophilic substitution.
- Explain pinacol-pinacolone rearrangement with mechanism.

Practical:

At the end of the course students will be able to

- Understand the concepts of thermochemistry, pHmetry, chemical kinetics.
- Develop skills of working and set up of calorimeter.
- Solve numericals on and verify the graph of chemical kinetics
- Discuss the mechanisms involved in the organic preparation experiments.
- Develop skills of common laboratory techniques including recrystallisation, recording of melting point required for organic preparations and perform calculations for quantitative analysis.

REFERENCES:

Section A

1. Bahl, A. &Bahl, B.S. Advanced Physical Chemistry, S. Chand, 2010.
2. J. N. Gurtu and AayushiGurtu, Undergraduate Physical Chemistry, Vol I, Vol II and Vol III Pragati Prakashan
3. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
4. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
5. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
6. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
7. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

Section B

1. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons, (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition,2013.

3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).
4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
6. Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
7. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India.
8. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia.
9. Jerry March, Advanced Organic Chemistry; 4rd Edition, John Wiley.
10. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
11. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
12. Pandey, O.P., Bajpai D. N. &Giri S. Practical Chemistry, Revised Edition, (For BSc. I, II, III Year Students of All Indian Universities) S. Chand Company Pvt Limited, 2014.
13. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: NewDelhi(2011).

CH - 201	Physical and Inorganic Chemistry (SEMESTER III)	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Physical Chemistry)

- To define the principles, laws, theorems in Thermodynamics, Chemical equilibrium and Phase equilibrium.
- To draw the phase diagrams, schematic diagrams and the graphs involved.
- To explain and interpret the Nernst distribution law.
- To distinguish between liquid-liquid and ideal liquid mixtures, different types of systems.
- To solve the numerical with respect to Gibbs free energy, to derive Clapeyron equation and Clausius-Clapeyron equation and its applications.
- To study concept of residual entropy, evaluation of absolute entropy from heat capacity data and thermodynamic quantities.
- To classify different component systems, types of mixtures.
- To study equilibrium constant and free energy, reaction isotherm and reaction isochore.
- To study entropy as a state function and its change in ideal gas and mixing of gases.

Section II (Inorganic Chemistry)

- To generalise the IUPAC nomenclature rules for co-ordination compounds.
- To discuss Werner's co-ordination theory for co-ordination compounds.
- To classify ligands based as monodentate and polydentate citing different examples.
- To study the general characteristics of 3d metals of first transistion series.
- To discuss the variable oxidation states, magnetic properties, complexation tendencies, catalytic behavior and spectral properties of 3d metals.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory (conductometry, partition coefficient, volumetric estimation, gravimetric estimation).

SYLLABUS

Theory:

Section I

1. Thermodynamics

Second law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature.

Concept of entropy :entropy as a state function ,entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality ,entropy as a criteria of spontaneity and equilibrium .Entropy change in ideal gases and mixing of gases.

Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantages over entropy change. Variation of G and A with P, V & T.

14 L

2. Chemical Equilibrium

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle.

Reaction isotherm and reaction isochore – Clapeyron equation and Clausius – Clapeyron equation, applications.

05 L

3. Phase Equilibrium

Statement and meaning of the terms–phase , component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system–water, CO_2 and S systems.

Phase equilibria of two component system – solid –liquid equilibria, simple eutectic –Bi-Cd, Pb-Ag systems, desilverisation of lead.

Solid solutions –compound formation with congruent melting point (Mg-Zn) and incongruent melting point, ($NaCl$-H_2O), ($FeCl_3$-H_2O) and ($CuSO_4$-H_2O) system. Freezing mixtures, acetone –dry ice.

Liquids –liquid mixtures – ideal liquid mixtures, Raoult's and Henry's law.

Non –ideal system –azeotropes- HCl-H_2O and ethanol – water systems

Partially miscible liquids –phenol –water, trimethylamine –water, nicotine – water systems.

Lower and upper consolute temperature. Effect of impurity on consolute temperature. Immiscible liquids, steam distillation.

Nernst distribution law – thermodynamic derivation, applications**.**

11 L

Section II

1. Chemistry of the Elements of the First Transition Series.

General characteristics, comparative treatment with their 3d analogues in respect of Ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.	10 L
1. Co-ordination compounds Werner's co-ordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of co-ordination compounds.	05 L

Practical

Physical Chemistry

1. To determine the partition coefficient of I_2 between $C_2H_4Cl_2$ and H_2O.
2. To determine molecular condition of the given acid in benzene/toluene by the partition coefficient method.
3. To determine the amount of strong acid (HCl) present in the given solution by conductometric titration using standard NaOH solution.
4. To determine the amount of weak acid (CH_3COOH) present in the given solution by conductometric titration using standard NaOH solution.
5. To study the solubility of benzoic acid at room temperature and below room temperature by volumetric method.

Inorganic Chemistry

Gravimetric estimations:

1 Ba as $BaSO_4$
2 Fe as Fe_2O_3

LEARNING OUTCOMES:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th edition.

Reference Books

Physical Chemistry

1. Puri, Sharma, Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Oxford University Press
2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry

Inorganic Chemistry

1. B.R. Puri, L.R. Sharma, K.C. Kale, Principles of Inorganic Chemistry, Vallabh Publications, First Edition
2. F.A. Cotton and G. Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao, University General Chemistry, Mc Millan, 1993.
4. Sharpe and Emilus, Inorganic Chemistry, ELBS Publications. New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, Pergamon, Oxford,1984

CH -203	Organic and Inorganic Chemistry Semester III	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Organic Chemistry)

- To learn the terms involved, the laws, the rules and the principles in UV –Visible Spectroscopy and Infra Red (IR) absorption spectroscopy.
- To understand various electronic transitions in UV –Visible Spectroscopy.
- To know Woodward - Fieser rules for calculation of λmax for Conjugated dienes and enones.
- To understand the various factors which effects the intensity and position of IR bands to know the characteristic absorptions of various functional groups.
- To know the use of Finger print region to establish the identity of unknown compound in Infra Red (IR) absorption spectroscopy.
- To know the applications of UV –Visible Spectroscopy and Infra Red (IR) absorption spectroscopy.
- To learn the interpretation of the IR and UV spectra of simple organic compounds.
- To know the classification and nomenclature of monohydric alcohols and dihydric alcohols.
- To learn the methods of preparations and reactions of alcohols
- To understand the concept of hydrogen bonding and acidity of alcohols.
- To know the nomenclature of ethers
- To learn the preparation, physical properties and chemical reactions of ethers.
- To study the synthesis and reactions of epoxides
- To know the nomenclature of aldehydes and ketones.
- To study the synthesis, physical properties and reactions of aldehydes and ketones with mechanism

Section II(Inorganic Chemistry)

- To define the basic concepts of oxidation and reduction and the study of electrochemical series.
- To define and draw Frost, latimer and Pourbaix diagrams for various types of reactions and to study the principles involved in extraction of elements
- To define lanthanides, their occurrence and position in the periodic table, their electronic structure and the oxidation states exhibited by them
- To study lanthanide contraction and its effects on the elements of the periodic table.
- To understand the technique of isolation of individual lanthanides from its ores by complex formation method

Practical:

- To understand and quantitatively estimate the desired organic compounds.
- To learn the preparation of desired Organic derivatives.
- To understand and systematically estimate quantitatively the desired metal ions by gravimetry.

SYLLABUS

Theory:

Section I (Organic Chemistry)	

I. Electromagnetic Spectrum: Absorption Spectra Ultraviolet (UV) absorption spectroscopy – Absorption laws (Beer-Lambert law), Molar absorptivity, presentation and analysis of UV spectra, Types of electronic transitions, effect of conjugation. Concept of chromophore and auxochromes, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones, Woodward-Fieser rules for calculation of UV maxima of the above two systems. Numerical problems on above. Infra Red (IR) absorption spectroscopy – Molecular vibrations, Hooke's law, selection rules, Intensity and position of IR bands, measurement of IR spectrum, Finger print region and its use to establish identity, Applications to determine purity, to study progress of chemical reactions and hydrogen bonding. Characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Simple problems in structure elucidation using UV and IR spectroscopy.	**12 L**
II. Alcohols Classification and nomenclature. Monohydric alcohols – Methods of preparations by reduction of carbonyl compounds, carboxylic acids, and esters, using Grignard reaction. Hydrogen bonding, acidic nature. Reactions of alcohols – esterification, oxidation and dehydration. Dihydric alcohols – Nomenclature, methods of preparation by hydroxylation of alkenes and acid catalyzed opening of epoxides. Reactions of vicinal glycols – pinacol-pinacolone rearrangement with mechanism.	**05 L**
III. Ethers and Epoxides Nomenclature of ethers and methods of preparation by Williamson synthesis, from alcohols by use of diazomethane and by use of H_2SO_4. Physical properties. Chemical reactions: cleavage with HI. Synthesis of epoxides by reaction of alkenes with peracids and by elimination from vicinal halohydrins. Acid and base catalyzed ring opening of epoxides, orientation of ring opening, reactions of Grignard and organolithium reagents with epoxides.	**04 L**
II. Aldehydes and Ketones Nomenclature and structure of the carbonyl group. Synthesis of aldehydes by oxidation of alcohols and reduction of acid chlorides, synthesis of ketones by oxidation of alcohols, from nitriles by Grignard reaction and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knovenagel condensations, reaction with ammonia and its derivatives, Wittig reaction and Mannich reaction. Halogenation of enolizable ketones. Mechanisms and one application each of the above reactions.	**09 L**
<u>Section II</u> (Inorganic Chemistry) **I. Oxidation and Reduction** Use of redox potential data-analysis of redox cycle, redox stability in water – frost, Latimer and pourbaix diagrams. Principles involved in the extraction of the elements.	**08 L**

II. Chemistry of the Lanthanide Elements Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds. **Practicals** **Organic Chemistry**: Organic Estimations: Estimations of Acetamide, Aniline and Glucose. Organic Derivatives: Benzoyl Derivative of β-naphthol and aniline. Bromo Derivative of phenol and aniline. Note: 1] The Organic Derivatives to be completed in 2 practicals. 2] Organic Estimations / Organic Derivatives to be given for examination. **Inorganic Chemistry**: Gravimetric Estimations 1. Mn as Mn-pyrophosphate 2. Ni as Ni-DMG 3. Al as Al2O3 from aluminium sulphate	**07 L**

LEARNING OUTCOMES:

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 ?max 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

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th Edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India
2. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia
3. Jerry March, Advanced Organic Chemistry; 3rd Edition, John Wiley
4. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry
Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry,
Wiley Eastern Ltd, 2nd Edition,1993
3. C N R Rao, University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS Publications.New Edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984

Books suggested for laboratory course

1. Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Basset, R.C.
3. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd.,
First Edition, 2006.

CH - 202	Physical and Inorganic Chemistry (SEMESTER IV)	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Physical Chemistry)

- To study conductometric titrations and the graphs involved.
- To interpret the crystal structure of NaCl, KCl and CsCl.
- To define terms involved in electrochemistry, conductance, specific conductance, equivalent conductance.
- To study the applications of conductivity measurements.
- To describe the preparation and properties of colloids.
- To derive and solve numericals on Bragg's equation.
- To study transport number, its determination by Hittorf method and moving boundary method.
- To classify colloids, sols and emulsions.
- To discuss the stability of colloids, protective action, Hardy- Schulze law, gold number.
- To define the terms and laws involved in Electrochemistry, Solid state and Colloidal state.
- To draw and interpret graphs of conductometric titrations.
- To study X-ray diffraction by crystals with examples.

Section II (Inorganic Chemistry)

- To discuss different types of Isomerism in co-ordination compounds with .
- To study the general characteristics of metals of second and third transistion series.
- To discuss the variable oxidation states, complexation tendencies, catalytic behavior and spectral properties and binary compounds of the metals of second and third transition series.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory.(Chemical kinetics, conductometry).
- To understand the principles involved in volumetric estimations by acid-base, redox and precipitation methods.

SYLLABUS

Theory:

Section I (Physical Chemistry) 1. Electrochemistry Electrical transport –conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law its uses and limitations. Debye –Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method. Applications of conductivity measurements :determination of degree of dissociation , determination of Ka of acids , determination of solubility product of a sparingly soluble salt, conductometric titrations .	**12 L**
2. Solid State Definition of space lattice, unit cell. Laws of crystallography –(i) law of constancy of interfacial angels (ii) law of rationality of indices (iii) law of symmetry elements in crystals. X-ray diffraction by crystals .derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).	**11 L**
3. Colloidal State Definition of colloids, classification of colloids . Solids in liquids (sols): properties –kinetic, optical and electrical; stability of colloids, protective action, Hardy- Schulze law gold number. Liquids in liquids (emulsions): types of emulsions, preparation .Emulsifier Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids	**07 L**
Section II (Inorganic Chemistry)	
1. Chemistry of the elements of the second and third transition series Characteristic properties of the d-Block elements. Properties of the elements of the second and third transition series, their binary compounds, and complexes illustrating relative stability of their oxidation states, co-ordination number and geometry.	**10 L**
2. Co-ordination Compounds Isomerism in co-ordination compounds, valence bond theory of transition metal complexes.	**05 L**
Practical	
Physical Chemistry 1. To determine the amount of chloride ion present in given solution by conductometric method. 2. To determine the solubility and solubility product of sparingly soluble salts ($BaSO_4$, $PbSO_4$, $CaSO_4$, $SrSO_4$) by conductometric method.	

3. To study the kinetics of inversion of cane sugar in the presence of HCl solution
4. To investigate reaction between H_2O_2 and HI.
5. To investigate reaction between $HBrO_3$ and HI.

Note: Polarimeter experiment is to be performed by each student and is not a demonstration experiment.

Inorganic Chemistry

Volumetric analysis

1. Estimation of Cu by EDTA method.
2. Estimation of Fe^{2+} using internal indicator by potassium dichromate method.
3. Determination of alkali content in antacid tablet using Standard HCl solution.

LEARNING OUTCOMES:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th edition

Reference Books

Physical Chemistry

1. Puri, Sharma, Pathania, Principles of Physical Chemistry, Vishal Publishing Company,
   Oxford University Press
2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,
3. Donald McQuarrie, Physical Chemistry

Inorganic Chemistry

1. B.R. Puri, L.R. Sharma, K.C. Kale, Principles of Inorganic Chemistry, Vallabh Publications, First Edition
2. F.A. Cotton and G. Wilkinson Basic Inorganic Chemistry, Wiley Eastern Ltd, 2nd edition,1993
3. C N R Rao, University General Chemistry, Mc Millan, 1993.
4. Sharpe and Emilus, Inorganic Chemistry, ELBS Publications. New edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, Pergamon, Oxford,1984

CH -204	Organic and Inorganic Chemistry Semester IV	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

Section I (Organic Chemistry)

- To know the nomenclature of Phenols, Carboxylic acids, derivatives of carboxylic acids and amines.
- To learn the methods of preparation and reactions of Phenols, Carboxylic acids, derivatives of carboxylic acids, nitroalkanes and nitroarenes and amines.
- To study the physical properties, acidic character and acid strength of alcohols and phenols.
- To study oxidation and reduction reactions of aldehydes.
- To understand the mechanism and know application of each reaction mentioned in the syllabus.
- To study the physical properties, acidity and effect of substituents on acid strength.
- To understand the mechanism of nucleophilic substitution in nitroarenes.
- To learn the preparation and properties of picric acid.
- To study physical properties, stereochemistry of amines and separation of mixtures of primary, secondary and tertiary amines.
- To understand the structural features affecting basicity of amines
- To study the use of amines as phase-transfer catalyst.

Section II (Inorganic Chemistry)

- To define actinides, their position and occurrence in the periodic table.
- To know the method of separation of individual actinides like Np, Pu, Am and U from their ores.
- To define ionic solids and know their properties.
- To understand close packing of spheres and to determine the types of interstitial sites like trigonal, tetrahedral, octahedral and cubic.
- To define lattice energy and to derive the values of lattice energies in various ionic crystals.
- To understand defects in stoichiometric and non-stoichiometric solids.

Practical:

- To gain knowledge and get hands on experience of analysing organic compounds.
- To understand and get hands on experience in performing binary mixture separation
- To understand the volumetric techniques to quantitatively estimate the metal ions calcium and nickel using three different salts of each ion.

SYLLABUS

Theory:

Section I (Organic Chemistry) **I. Phenols** Nomenclature, structure and bonding. Preparation of phenols by alkali fusion of aromatic sulphonic acids, Dow's process from chlorobenzene and from Cumene throughhydroperoxide rearrangement with mechanism. Physical properties and acidic character. Comparative acid strengths of alcohols and phenols, resonance stabilization of the phenoxide ion. Reaction of phenols – Electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement,	**04 L**

Claisen rearrangement, Gattermann synthesis and Riemer-Tiemann reaction. **II. Oxidation and Reduction reactions of carbonyl compounds** Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, Meerwein-Pondorf-Verley, Clemmensen, Wolff-Kischner, $LiAlH_4$ and $NaBH_4$ reduction. Mechanisms and one application each of the above reactions	**04 L**
III. Carboxylic Acids Nomenclature, structure and bonding. Physical properties, acidity and effects of substituents on acid strength. Preparation of carboxylic acids by oxidation of carbonyl compounds, carbonation of Grignard reagent, hydrolysis of cyanides, preparation of aromatic acids by oxidation of alkyl benzenes. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction, synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Dicarboxylic acids: Methods of preparation and effect of heat and dehydrating agents with reference to malonic acid only.	**05 L**
IV. Carboxylic Acids Derivatives Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides. Physical properties. Methods of preparation from carboxylic acids and interconversion of acid derivatives by nucleophilic acyl substitution. Mechanisms of esterification and acidic and basic hydrolysis of esters with evidences.	**04 L**
V. Organic Compounds of Nitrogen Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid – preparation and properties. Structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amine. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines by reduction of nitro compounds and nitriles, reductive amination of carbonyl compounds, Gabriel phthalimide reaction and Hofmann bromamide reaction.	**12 L**
<u>Section II</u> (Inorganic Chemistry) **I. Chemistry of Actinides** General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between later actinides and later lanthanides.	**04 L**
II. Ionic Solids Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, salvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule, metallic bond - free electron, valence bond and band theories	**11 L**

Practicals

Organic Chemistry:

Qualitative Analysis: - At least 5 compounds to be analyzed from the following compounds.

List of compounds

Acids: Cinnamic, o-Chlorobenzoic, Salicylic, Succinic, Oxalic, p-nitrobenzoic, p-hydroxybenzoic, Sulphanic acid.

Phenols: o- and m- Nitrophenols, Resorcinol.

Bases: p-Toluidine, Diphenylamine, o-, m- and p-nitroanilines, N-methylaniline, N,N-dimethylaniline

Hydrocarbons: Naphthalene, Anthracene, Toluene.

Amides: Benzamide, Urea, Thiourea

Carbonyl compounds: Salicylaldehyde, Furfural, Butanone, Acetophenone, Benzophenone, Camphor.

Alkyl and aryl halides: Chloroform, Chlorobenzene, Bromobenzene, p-Dichlorobenzene

Nitrohydrocarbons: m-Dinitrobenzene, p-Nitrotoluene,

Alcohols: 2-Propanol, Cyclohexanol

Esters: Ethyl benzoate, Methyl salicylate

Anilides: Acetanilide, Benzanilide

Note: 5 compounds of the following type to be analyzed in 3 Practical : Acid – 1 , Phenol – 1,Amides – 1 , Hydro carbon – 1 , Anilide – 1; Ester – 1; Alcohol – 1; Nitrohydrocarbons -1; Alkyl or aryl halides – 1; Bases – 1.

Tests to be performed are i. Preliminary tests; ii. Solubility and Chemical type; iii. Elements; iv. Groups and v. Physical constants.

Qualitative analysis is to be performed at a micro scale level using not more than 1g. solid and 1 ml. liquid.

Finding the organic mixture type: Solid-solid-Water Insoluble type.

Acid-Base 2) Acid-Neutral 3) Acid-Phenol 4) Phenol-Base 5) Phenol-Neutral 6) Base-Neutral

Note: 5 mixtures to given for chemical type determination in 2 practicals (not to be given for examination)

Inorganic Chemistry:

Volumetric analysis:

1. Estimation of Ca by EDTA (3 solutions of different salts of Ca).
2. Estimation of Ni by EDTA (3 solutions of different salts of Ni).

LEARNING OUTCOMES:

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 compoundsmentioned 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.

REFERENCES:

Text Books

1. Morrison and Boyd, Organic Chemistry; 6th Edition, Prentice Hall India
2. J.D. Lee, Concise Inorganic Chemistry, ELBS Publications, 4th Edition

Reference Books

Organic Chemistry

1. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India
2. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia
3. Jerry March, Advanced Organic Chemistry; 3rd Edition, John Wiley
4. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds

Inorganic Chemistry

1. B.R. Puri, L.R.Sharma, K.C. Kale, Principles of Inorganic Chemistry
Vallabh Publications, First Edition
2. F.A. Cotton and G.Wilkinson Basic Inorganic Chemistry,
Wiley Eastern Ltd, 2nd Edition,1993
3. C N R Rao, University General Chemistry , Mc Millan , 1993.
4. Sharpe and Emilus, Inorganic Chemistry , , ELBS Publications.New Edition
5. N.N. Greenwood and Earnshaw, Chemistry of Elements, , Pergamon, Oxford,1984.

Books suggested for laboratory course

1. Vogel's Qualitative Inorganic Analysis, (revised) Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Basset, R.C.
3. P. S. Sindhu, Practicals in Physical Chemistry, Macmillan India Ltd.,
First Edition, 2006.

CH - 311	Physical Chemistry (SEMESTER V)	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To define the principles, hypothesis, postulates of quantum mechanics in Quantum chemistry.
- To draw the wave functions, orbital diagrams and the graphs involved.
- To solve the numerical, explain and interpret the wave functions.
- To distinguish between reversible and irreversible cells, Different types of reversible cells
- To solve the numerical wrt Nernst equation, to study electrochemical series and applications
- To study optical activity, polarization, dipole moment and methods of determination of dipole moments
- and structure of molecules
- To classify different nuclides. Binding energy and nuclear forces. To study nuclear models, radioactivity.
- To study emf and its measurements. To study concentration cell, its measurements, applications,
- To study decomposition potential, overvoltage and factors affecting them.

Section II

- Molecular structure and molecular spectra:
- To study the electromagnetic spectrum, terms, principles involved. To study Rotational spectra of diatomic molecules, determination of bond lengths and qualitative description
- To study counters used in measurement of radioactivity

SYLLABUS

Theory:

Section I 1. Quantum Chemistry: De Broglie hypothesis, the Heisenberg's uncertainty principle, sinusoidal wave equation, Hamiltonian operator, Schrödinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in one dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave function, radial wave functions, angular wave functions.	12 L
2. Electrochemistry:- I Electrolytic and galvanic cells; reversible and irreversible cells, conventional representation of electrochemical cells; types of reversible electrodes; gas – metal ion, metal-metal ion, metal in soluble salt-anion and redox electrodes, electrode reaction; Nernst equation; derivation of cell E.M.F. and single electrode potential, reference electrodes, standard hydrogen electrode; calomel electrodes ;standard electrodes potential, sign convention, electrochemical series and its applications.	07 L
3. Molecular Structure Optical activity and molecular structure; polarization (Mosotti-Clausius equation), orientation of dipoles in an electric field, dipole moment, induced	05 L

dipole moment, measurement of dipole moment; temperature method and refractivity method, dipole moment and structure of molecules. 4. Nuclear Chemistry: - I Composition of the nucleus. Nuclear binding forces, binding energy, stability, nucleon-nucleon forces and their equality, characteristics and theory of nuclear forces. Nuclear models, the shell model, liquid drop model and its merits. Theory of radioactive disintegration, rate of disintegration half, average life of radio element, units of radioactivity, definition and characteristics of artificial radioactivity. **Section II** 5. Electrochemistry :-II EMF of a cell and its measurements; Concentration cells (both electrodes and electrolytes) with and without transport; liquid junction potential and its measurement; Application of concentration cell; determination of ionic product of water; transport number of ions; solubility and solubility product. Polarization; elimination of polarization; decomposition potential, measurement of decomposition potential ; factor affecting decomposition potential over voltage and types of over voltage; measurement of over voltage ; factor affecting over voltage 6. Molecular structure and molecular spectra: Introduction to electromagnetic radiation; regions of the spectrum; statement of the BornOppenheimer approximation; degrees of freedom. Rotational Spectrum: Diatomic molecules, energy level of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (MaxewllBoltzmann distribution); determination of bond length, qualitative description of non-rigid rotor, isotope effect. 7. Nuclear Chemistry:-II Determination and measurements of radioactivity: Ionisation current measurements; saturation collection; multiplicative ion collection; the Geiger-Muller Counter, characteristics of an ideal Geiger-Muller Counter, proportional counter. methods based on photon collection, Scintillation counter, characteristics of a suitable Scintillator.	06 L 13 L 08 L 09 L

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2 U.N.Dash, Nuclear Chemistry, by Sultan Chand & Sons, New Delhi.

Reference Books

1. Puri, Sharma, Pathania, Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press

2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,

3. Donald McQuarrie, Physical Chemistry

CH- 321	Inorganic Chemistry (SEMESTER V)	Number of lectures:60

COURSE OBJECTIVES:

Theory:

Section I

- To discuss the drawbacks of Valence bond theory for co-ordination compounds.
- To generalise the postulates of Crystal field theory
- To define the terms Crystal field splitting, Crystal field splitting energy, Crystal field stabilization energy.
- To draw the crystal field splitting diagram for octahedral, tetrahedral and square planar complexes.
- To evaluate the magnetic properties of transition metal complexes.
- To calculate the magnetic moments for different transition metal complexes having octahedral, tetrahedral and square planar geometry.
- Toknow the classification of elements as essential or trace and their uses in biological processes.
- To study the roles of myoglobin and hemoglobin with respect to the transfer and storage of oxygen in biological systems and the process of respiration.
- To introduce basic synthesis concepts of solid-state chemistryand provide introductory knowledge on concept of band gap and classification of materials based on it.

Section II

- To define the terms Organometallic compounds, mononuclear, polynuclear metal carbonyls.
- To state the Effective atomic number rule, 18 electron rule for metal carbonyls and organometallic compounds.
- To state the names of metal carboyls and organometallic as per the IUPAC system.
- To generalise the methods of preparation, properties and bonding in $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$, $Mn_2(CO)_{10}$,$Fe_2(CO)_9$,$Fe_3(CO)_{12}$ and ferrocene.
- To classify the ligands based on hapticity,.
- To prepare by various methods alkyls and aryls of Li ,Al ,Hg and Ti and to study their physical and chemicals properties.
- To learn general methods of preparationsof organometallic compounds
- To understand the model systems prepared to study macromolecular biological molecules.
- To know the types of alkali and alkaline earth metals and their roles in biological systems.
- To define metalloenzymes and to study their roles in biological systems.
- To introduce concept of defects in solids and define Schottky and Frenkel defects, Color center, extended defects and Non-stoichiometry

SYLLABUS

Theory:	
Section I **1)Metal-Ligand Bonding in Transition Metal Complexes:** Limitations of Valence bond theory, Crystal field theory (CFT) splitting of d-orbitals in octahedral, tetrahedral and square planar complexes. Crystal Field Stabilization Energy (CFSE), Measurement of 10 Dq for $[Ti(H_2O)_6]^{3+}$ complex, Factors affecting 10 Dq, Spectrochemical series, Effect of crystal field splitting on properties of Octahedral complexes: Magnetic, Spectral.	**20L**
2)Bio-inorganic Chemistry (I) Overview, essential and trace elements in biological processes, Metalloporphyrin special reference to hemoglobin and myoglobin.	**05L**
3)Inorganic solid-state chemistry (I) Introduction, Preparation of Nonmolecular solids, Band gaps, Metals, Insulators and Semi-conductors.	**05L**
Section II **4)Organometallic chemistry** **A)** Definition, nomenclature and classification of organometallic compounds, EAN rule, 18 electron rules. General methods of preparations and properties. Structure and bonding in mononuclear metal carbonyls: $Ni(CO)_4$, $Fe(CO)_5$ and $Cr(CO)_6$ (Orbital diagram not expected) B) Polynuclear metal carbonyl: preparation and structures of $Mn_2(CO)_{10}$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$ (Orbital diagram not expected) C) Sandwich compounds like Ferrocene: preparation, properties, reactions, structure and bonding. D) Preparation and properties of alkyl and aryls of Li, Al, Hg and Ti.	**20L**
5) **Bio-inorganic Chemistry (II)** The role of Model systems, The alkali and alkaline earth metals,Metalloenzymes, Nitrogen fixation cycle.	**05L** **05 L**
6) **Inorganic solid-state chemistry (II)** Defects in Solids Point defects: Schottky and Frenkel, Color center, extended defects, Non-stoichiometry.	
LEARNING OUTCOMES:	
Theory:	
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 carboyls 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.

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REFERENCES

Text- Books:

1. Concise Inorganic Chemistry. 5th edition, J. D. Lee
2. Basic Inorganic Chemistry, 5th edition, F.A. Cotton, G. Wilkinson.

Reference books:

3. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit 18th revised edition, Himalaya Publishing House.
4. Principles of Inorganic Chemistry, B.R Puri, L. R. Sharma, Milestone Publishers.
5. Inorganic Chemistry, (Principles of Structure and Reactivity). James E. Huheey, Ellen A. Keiter, Richard L. Keiter
6. Inorganic Chemistry D. E. Shriver, P.W. Atkins and C.H. Langford, Oxford.
7. Advance Inorganic Chemistry, 6th edition, F.A. Cotton and G. Wilkinson
8. Comprehensive Inorganic Chemistry, B.S. Bahl and Sharma
9. Group theory and its Chemical applications, P. K. Bhattacharya, Himalaya Publication.
10. Environmental Chemistry, A. K. De.

CH-331	Organic Chemistry Semester V	Number of lectures:60

COURSE OBJECTIVES:

Theory:60 L

Section I

- To understand important concepts in NMR and Mass spectroscopic methods.
- To learn the structure elucidation of simple organic molecules using spectroscopictechniques (UV, IR, PMR, CMR and MS).
- To study the Structure elucidation and synthesis of Nicotine, Atropine and Papaverine.
- To understand the mechanism and stereochemistry of addition of halogens and halogen acids to open chain alkenes, substitution reactions and elimination reactions.

Section II

- To understand the molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine.
- To learn 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 andBischler-Napieralski synthesis.
- To understand the mechanism of, nucleophilic substitution reactions in pyridine derivatives and electrophilic substitution reactions of indole, quinoline and isoquinoline.
- To compare basicity of pyridine, piperidine and pyrrole.
- To study condensed 5 and 6 membered heterocycles.
- To learn the importance of vitamins, hormones and the classification of vitamins.
- To study the structure elucidation and synthesis of vitamin A, C, thyroxine and adrenaline.
- To study the structure of amino acids, peptides and proteins.
- To learn the preparation and reactions of α-amino acids.
- To understand the concept of isoelectric point, electrophoresis, protein denaturation/renaturation, nucleic acids and double helical structure of DNA.
- To learn the reactions for peptide synthesis, hydrolysis of peptides, nucleic acids and methods for peptide structure determination.

SYLLABUS

Section I

1. Spectroscopy Proton Magnetic Resonance (^{1}H NMR) spectroscopy, theory, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, intensity of peaks, interpretation of PMR spectra of simple organic molecules. ^{13}C Magnetic Resonance: Number of signals, splitting of signals – proton coupled and decoupled spectra, off resonance decoupled spectra. ^{13}CMR chemical shifts – identification of hybridization of carbons and nature of functionalization. Mass Spectrometry: Simple idea of instrumentation, Definitions of parent or molecular ion peak and base peak. Isotope effect with respect to alkyl halides, Fragmentation of ketones – α cleavage and Mc Lafferty rearrangement. Problems pertaining to the structure elucidation of simple organic molecules using spectroscopic techniques (UV, IR, PMR, CMR and MS). Types of problems to be	18 L

specified. UV and IR to be used as supporting data. Types of CMR and Mass spectroscopy problems to be specified. 2. Alkaloids Structure elucidation and synthesis of Nicotine, Atropine and Papaverine. 3. Stereochemistry of Reactions: Mechanism and stereochemistry of (i) Addition of halogens and halogen acids to open chain alkenes. Markownikoff's and anti- Markownikoff's addition. (ii) SN_1, SN_2, SN_i , substitutions and (iii) E_1, E_2 and E_{1cb} elimination reactions.	05L 07 L
Section II 4. **Heterocyclic Compounds** Introduction, Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed 5 and 6 membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis andBischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline. 5. **Vitamins and Hormones** Vitamins: Importance and classification. Structure elucidation and synthesis of Vitamins A and C. Hormones: Important hormones and their uses. Structure elucidation and synthesis of Thyroxine and Adrenaline. 6. **Amino acids, Peptides, Proteins and Nucleic Acids** Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical methods of peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structures. Protein denaturation/renaturation. Nucleic acids: Introduction. Hydrolysis of nucleic acids. Ribonucleosides and ribonucleotides. General idea of the double helical structure of DNA.	12L 08 L 10 L
LEARNING OUTCOMES:	
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.

REFERENCES:

Reference Books

1. I.L.Finar, Organic Chemistry Vols I and II, Orient Longman
2. Morrison and Boyd, Organic Chemistry; 6th Edn. Prentice Hall India
3. Francis Carey, Organic Chemistry
4. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edn. Pearson Education Asia
5. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds.

CH - 341	ANALYTICAL CHEMISTRY SEMESTER V	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

- Define the terms involved in sampling techniques, data handling and solvent extraction, electrolytic methods, potentiometric titrations.
- State the laws and principles involved in solvent extraction, electrolytic methods, potentiometric titrations.
- Explain scope and importance of analytical chemistry, sampling of liquid,solid and gases, different types of tests related to data handling, the different types of extraction.
- Differentiate between various electrolytic methods, state and explain limits and merits of the various methods.
- Draw theamperometric titration curves, schematic diagram of instruments and explain its working.
- Classify and explain different types of errors, sampling techniques and types of extraction.
- Derive and use the equations of linear least squares and method of averages and solvent extraction to solve numerical.
- Interpret steps involved in chemical analysis.
- Explain the principle of potentiometric titrations, location of equivalence point and types of potentiometric titrations.

SYLLABUS

Theory:

Section I **1. Introduction** Scope and importance of analytical chemistry Chemical analysis and analytical chemistry Analytical process (steps involved in chemical analysis): defining the problem, sampling,separation of desired components, actual analysis, presentation and interpretation of results. Basic components of instruments for analysis Signal generators, detectors (input transducers) Signal processors, read out devices, circuits & electrical devices in instruments. References:1,2,3	**4 L**
2. Sampling Techniques Terms encountered in sampling: the population or the universe, Sample, Sampling unit, increment, the gross sample, the sub sample, Analysis sample, Bulk ratio, Size to weight ratio, Random sampling, Systematic sampling, Multistage sampling, Sequential sampling. Sampling of Gases, Liquids and Solids Preservation, storage and preparation of sample solution (References: 1,2,3)	**4 L**
3. Data handling Significant figures and rounding off. Accuracy and precision Errors : determinate and indeterminate error, Constant and proportionate errors ,	**11 L**

Minimization of errors Standard deviation. Histogram and Frequency polygon Measures of central tendency and dispersion.Gaussian distribution curve Confidence limit. Test of significance: F test, Students T Rejection of the results: Q test, 2.5d & 4d rule. Linear least squares/ Method of averages (Numerical problems are expected to be solved) Reference:1,35	
4. Solvent Extraction Basic principle, percentage extraction, role of complexing agents in solvent extraction, separation factor, Types of extraction (continuous, batch). (Numerical problems are to be solved) References: 1,2,3	**3L**
Section II	
5. Electrolytic methods Introduction: principles involved in Electrogravimetric analysis, Instrumentation, Electrolysis at constant current principle, apparatus, determination of copper by constant current electrolysis. Coulometry: Introduction, constant Current measuring device, Hydrogen-Oxygen coulometer, Silver coulometer. General characteristics of coulometric method, Coulometric titrationsApplications of coulometric titrations (References: 1,3,) Polarography:Introduction, Basic principles of instrumentation of polarography, Deposition potential, Dissolution potential, Polarisation of electrode, Polarographic wave, Ilkovic equation, Half wave equation (derivation not expected) Supporting electrolytes, Interference of oxygen, Applications of polarography – inorganic and organic. (Refences: 1,3,5) Amperometric titrations: Introduction, Instrumentation, Titration Curves, advantages of amperometric titrations.(Reference:1,3)	**12 L**
6. Potentiometric Titrations Principles of potentiometric titrations, Location of equivalent point, Different types of potentiometric titrations. (References :1,2,3)	**5 L**
7. **Atomic spectrometric methods:** Flame Photometry:Introduction, Principle, Instrumentation, applications, Limitations. Atomic absorption Spectroscopy: Introduction, Principle, Instrumentation, applications, limitations.	**6 L**

Differences between flame photometry and atomic absorption spectroscopy. Inducted coupled plasma. (References: 1,2,3)	

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Book

B.K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut

Reference Books

1. G. D.Christan Analytical Chemistry by, 5th edition Wiley publications.
2. G. Chatwal and S. Anand, Instrumental Methods of Chemical Analysis 5th edition (reprint 2003), Himalaya publication.
3. B. S. Baliga and A.Zaveri, College Analytical Chemistry, 15th edition, Himalaya Publishing House, 2004
4. Vogels Textbook of Quantitative Inorganic Analysis 4th edition ELBS.
5. Willard, Meritt and Dean. Instrumental Methods of Analysis
6. Skoog and Leary, Principles of Analytical Chemistry 4th International edition.

7. P.R.Trivedi and Gurdeep Raj, Environmental Water and Soil Analysis, Akashdeep Publishing House, New Delhi.
8. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.

CH – 301	Experiments in Physical and Analytical Chemistry SEMESTER V	Number of hours: 45

COURSE OBJECTIVES:

Practical:

- To understand and develop the problem solving skills and hands on experience with refrence to concepts studied in theory(potentiometry , pH metry, partition coefficient, Chemical kinetics)
- To understand and develop the problem solving skills and hands on experience with refrence to instrumentation and techniques studied in theory.(spectrophotometry,chromatography and conductometry)

SYLLABUS

Practical

Physical

Conductometry

1. To determine the percent composition of acid mixture (strong and weak acid) by titrating against standard 0.1 N NaOH solution.
2. To verify Ostwald's dilution law using CH3COOH Potentiometry
3. To determine the formal redox potential of Fe2+/Fe3+ system using standard 0.1N K2Cr2O7 solution.
4. To determine the solubility product of AgCl/AgBr.

pH metry

5. To determine the dissociation constant of weak monobasic acid (CH3COOH) by titrating against standard 0.1N NaOH solution

General

6. Partition Coefficient: To determine the equilibrium constant for the reaction KI +I2 === KI3
7. Adsorption: To study the adsorption of acetic acid from aqueous solution by activated charcoal and verify Freundlich adsorption isotherm.
8. Chemical Kinetics: To study the acid hydrolysis of methyl acetate at two different temperature and determine the energy of activation.

Analytical

A] Spectrophotometry.

1. Determination of Mn2+ in steel or Mn2+ ion concentration periodate method.
2. Determination of iron by salicylic acid method.

B] Chromatography

3. Separation of metal ions by paper chromatography.(demonstration)
4. Separation of organic compounds by TLC.(demonstration)
5. Zn2+ /Mg2+ separation by an anion exchanger & their volumetric estimation of with standard EDTA.

C] Conductometry

6. Estimate the amount of Pb present in a solution of Pb(NO3)2 by conductometric titration with Na2SO4

D] Other Experiments

7. Determination of ascorbic acid in Vitamin C tablets by iodometry
8. Estimation of Ca in milk powder using EDTA method (volumetry) and also by precipitation as oxalate followed by titration with KMnO4 (not for examination)

LEARNING OUTCOMES:

Practical:

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.
- 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.

REFERENCES:

1.Basic Principles of Analytical Chemistry. To be used as text book.
K. Raghuraman, D.V.Prabhu, C.S. Prabhu and P.A.Sathe
3rd, 4th and 5th edition, Sheth Publishers.
2.Analytical Chemistry.
Gary Christian, 4th Edition, International Edition.
3.Principles of Analytical Chemistry.
Skoog and Leary, 4th International Edition.

CH-:303	Experiments in Inorganic and Organic Chemistry (Semester V)	Number of hours: 60

COURSE OBJECTIVES:

Practical:

- To understand and systematically estimate quantitatively the desired metal ions by gravimetry in presence of interfering ions and also quantitatively estimate inorganic complexes of different metal ions.
- To understand theoretical concepts required for experiments and develop hands on experience with reference to basic laboratory techniques required for organic estimations, synthesis and finding the organic mixture type.

SYLLABUS

Practical:

Inorganic Chemistry

Gravimetric Estimations .

1. To estimate the amount of Fe as Fe_2O_3 in the given solution of ferric chloride containing barium chloride and free HCl.
2. To estimate the amount of nickel as Ni-DMG in the solution of nickel chloride containing copper chloride and free HCl.
3. To estimate the amount of barium as $BaCrO_4$ in the solution of barium chloridecontaining ferric chloride and free HCl.
4. To estimate the amount of Zinc as $Zn_2P_2O_7$ in the given solution of zinc sulphate containing copper sulphate and free H_2SO_4.

Inorganic Preparations

1. Preparation of Sodium trioxalatoferrate(III); $Na_3[Fe(C_2O_4)_3]$ complex.
2. Preparation of Tristhioureacopper (I) sulphate.
3. Preparation of Trisethylenediaminenickel(II) complex.
4. Preparation of Chrome Red.

Organic Chemistry

1. Organic Estimations:
   a) Mixture of acid and ester
   b) Mixture of acid and amide
   c) Saponification value of oil
2. Organic synthesis: Nitration of nitrobenzene and acetanilide, p-bromoacetanilide from acetanilide, m-nitroaniline from m-dinitrobenzene, synthesis of osazone of glucose and oxime of cyclohexanone
3. Finding the organic mixture type: Solid-solid-Water Soluble- Insoluble type.
   1)Acid-Acid 2) Acid-Neutral 3) Neutral-Neutral
   Liquid-liquid mixture type as well as the separation.
   Note: 1) 6 Organic Synthesis to be completed in 3 practicals.
   2) At least 5-6 mixture type determination to be given (not to be given for examination)

LEARNING OUTCOMES:

Practical:

At the end of the course students will be able to

- 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.
- 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.

REFERENCES:

Inorganic Chemistry:

Books for Practicals:

1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham ELBS.
3. Standard Methods of Chemical Analysis W.W. Scott, Technical Press.
4. Experimental Inorganic Chemistry W.G. Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol. I and II Brauer, Academic Press.
6. Inorganic Synthesis, Mc Graw Hill.

Organic Chemistry:

1. Vogel's Qualitative Organic Analysis, Orient Longman.
2. Textbook of Practical Organic Chemistry, N.K.Vishnoi.

CH - 312	Physical Chemistry (Semester VI)	Number of lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To study the molecular orbital theory diagrams and the graphs involved.
- To interpret the physical picture of bonding and antibonding wavefuction.
- To define terms involved in electrochemistry, pH, poH, pKa, pKb. Buffer solution, buffer capacity. Measurement of pH using different electrodes by potentiometric methods.
- To describe the mechanism of buffer action.
- To derive and solve numerical on Henderson's equation.
- To study energy released in nuclear fission, fission products.
- To classify various nuclear reactors. To describe the working of reactors and its parts.
- To know nuclear reactors in India.
- To define the terms and laws involved in photochemistry.
- To draw and interpret Jablonski diagrams
- To study photochemical and photosensitized reactions with examples

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Section II

- To describe types of theories in corrosion
- To explain the types of energy sources
- To study vibrational spectroscopy, ir, harmonic and anharmonic oscillator, Raman spectroscopy,
- Define terms , force constants, bond energy, polarizability.
- To study stokes and antistock lines, Raman shift and selection rules involved.
- Chain reactions, terms involved and units of radioactivity, applications of radioactive isotopes Biological effects of radiations.

SYLLABUS

Theory:

Section I 1. Quantum Chemistry: Molecular orbital theory, basic ideas-criteria for forming M.O from A.O, construction of M.O's by LCAO-H2+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions.	06 L
2. Applied Electrochemistry - I Definition of pH, pOH pKa,and pKb; introduction to potentiometer; determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric method; Buffer solution, types, buffer action, buffer capacity ,mechanics of buffer action, Henderson-Hazelbulch equation.	08 L
3. Nuclear Chemistry - I Nuclear fission, energy released in fission and fission products, neutron emission in fission, nuclear energy, classification of reactors, the breeder reactor, nuclear reactors in India.	06 L

4. Photochemistry: Interaction of radiation with matter, differences between thermal and photochemical processes, laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagram; depicting various processes occurring in the excited state, quantum yield and its measurements qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, inter system crossing), photosensitized reactions-energy transfer processes (simple examples).	10 L
Section II 5. Applied Electrochemistry:- II Corrosion-Types, theories - electrochemical and chemical. Energy sources: Acid and alkaline battery. Ni-Cd cell fuel cells, solar cells. Secondary batteries.	08 L
6. Spectroscopy: Vibrational Spectrum: Infrared spectrum: energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of an- harmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. Raman spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.	16 L
7. Nuclear Chemistry: - II Chain reaction and conditions for its control ; reprocessing of spent fuels; units of radiation energy ;applications of radioactive isotopes; radioisotopes as tracers; biological effects of radiation.	06 L

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2 U.N.Dash, Nuclear Chemistry, by Sultan Chand & Sons, New Delhi.

Reference Books

1. Puri, Sharma, Pathania, Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press

2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,

3. Donald McQuarrie, Physical Chemistry

CH- 322	Inorganic Chemistry SEMESTER VI	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To study types of electronic transitions and selection rules for transitions to take place
- To study the applications to determine ligand field strength, color of complexes, Cis-trans isomerism and Geometry of complexes.
- To define the terms fuel gases, calorific value, benzol.
- To state the composition ,draw the flow sheet and equipment for manufacture of of coal gas, producer gas and water gas
- To explain the advantages of fuel gases over liquid and solid fuels.
- To discuss the physicochemical principles involved in the synthesis of ammonia by Haber's process and Nitric acid by Ostwald's method.
- Todefine pollutant, primary and secondary pollutant, air pollution
- To discuss sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur.
- To understand Photochemical smog.
- To discuss the phenomenon of acid rain, greenhouse effect.
- To introduce concept of Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rotation – reflection axis and Identity and apply to different molecules

Section II

- To define the terms Magnetic susceptibility, magnetic moment, diamagnetism, paramagnetism.
- To explain the different types of magnetic behaviour- diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, measurement of susceptibility by Gouy's method.
- To draw the graph of susceptibility v/s temperature for paramagnetic, ferromagnetic and antiferromagnetic substances.
- To calculate magnetic moment by spin formula for different transition metal complexes.
- To interpret the magnetic behaviour of different transition metal complexes based on observed and calculated magnetic moments.
- To introduce Nanochemistry and explain nano particles, their properties and applications.
- To introduce zeolites, their structure and applications.
- To define the terms Meissner effect,critical temperature.
- To explain the mechanism of superconductivity.
- To discuss the different types of superconductors.
- To define and study the properties of inorganic polymers.
- To classify condensation, addition and coordination Polymers
- To introduce preparation, structure & bonding and applications of silicones.
- To study stability constants of reactions in terms of thermodynamic and kinetic stability and the various factors affecting the stability constants of complexes.
- To study the substitution reaction mechanisms of octahedral complexes and the trans effect observed in square planar complexes.

SYLLABUS

Theory:

Section I

1.Electronic spectra of Transition Metal Complexes: **10L**

Introduction, Types of electronic transitions: The d-d transitions (d^1/d^9 and d^2/d^8), Charge transfer transitions and Ligand-ligand transitions, Selection rules (Laporte Orbital and Spin), Applications (Ligand field strength, Colour of complexes, Cis-trans isomerism and Geometry of complexes).

Ref: 3,7

2.Industrial fuels and chemicals. **8L**

(A) Industrial fuels like coal gas, producer gas and water gas.

(B) Physico chemical principles involved in the manufacture of HNO_3 (Ostwald's method) and NH_3 (Haber's method).

Ref: 8

3.Air Pollution: **7L**

Introduction, classification of pollutants, sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur, Photochemical smog, acid rain and House effect.

Ref: 10

4.Symmetry and Term symbols: **5L**

(A) Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rota reflection axis, Identity (Trans dichloroethylene, H_2O and BCl_3)

Ref: 9

Section II **5L**

5. Magnetic properties of transition metal complexes:

Types of magnetic behaviour, Methods of determining magnetic susceptibility (Gouy's method), spin only formula, application of magneticmoment data for 3d – metal complexes.

Ref: 1, 4 **10L**

6.Selected topics: **(A) Nano chemistry:** Introduction to Nano particles, their properties and applications. **(B) Solid acids:** Introduction to zeolites, structure and applications. **(C)Superconductors:** Discovery, critical temperature, Meissner effect, Conventional and High Temperature superconductors. **Ref:** 3, 5	**6L**
7.Inorganic Polymers: Definition, Properties, Glass transition temperature, Classification (Condensation, addition and coordination Polymers) **Silicones:** Preparation, structure & bonding and applications. **Ref:** 3, 4	**9 L**
8.Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamicstability of metal complexes and factors affecting the stability, substitution reactions of Octahedral complexes. Trans effect with respect to square planar complexes. **Ref:** 5	

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text- Books:

1. Concise Inorganic Chemistry. 5th edition, J. D. Lee
2. Basic Inorganic Chemistry, 5th edition, F.A. Cotton, G. Wilkinson.

Reference books:

3. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit 18th revised edition, Himalaya Publishing House.
4. Principles of Inorganic Chemistry, B.R Puri, L. R. Sharma, Milestone Publishers.
5. Inorganic Chemistry, (Principles of Structure and Reactivity). James E. Huheey, Ellen A. Keiter, Richard L. Keiter
6. Inorganic Chemistry D. E. Shriver, P.W. Atkins and C.H. Langford, Oxford.
7. Advance Inorganic Chemistry, 6th edition, F.A. Cotton and G. Wilkinson
8. Comprehensive Inorganic Chemistry, B.S. Bahl and Sharma
9. Group theory and its Chemical applications, P. K. Bhattacharya, Himalaya Publication.
10. Environmental Chemistry, A. K. De.

CH-332:	Organic Chemistry (Semester VI)	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To know nomenclature of different carbohydrates.
- To know classification of carbohydrates and terpenes.
- To study general reactions of Monosaccharides.
- To study the determination of configuration and ring size of monosaccharides with reference to glucose, interconversion of glucose.
- To know cyclic structure of D(+)- glucose and study mutarotation, formation of glycerides, ethers, esters and structure elucidation of sucrose.
- To learn the general methods of structure elucidation of terpenes.
- To learn the synthesis of α-terpineol, camphor, citral. ethyl acetoacetate by Claisen condensation.
- To study the chemistry of α-terpineol, camphor, citral. α-pinene and zingiberene.
- To understand the acidity of α-hydrogens, keto-enol tautomerism in ethyl acetoacetate, hydrogenation of unsaturated oils,
- To study the alkylation of diethyl malonate, ethyl acetoacetate, 1,3-dithianes, enamines and acylation of enamines.
- To study the chemistry of following- Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, soaps, synthetic detergents, alkyl and aryl sulphonates.
- To learn the various terms such as saponification value, iodine value and acid value of oils.

Section II

- To learn the definition of the terms involved.
- To know the classification of dyes, synthetic drugs, polymers and types of polymerization.
- To learn the preparations of various polymers mentioned in the syllabus.
- To understand the difference between natural and synthetic rubber with examples.
- To learn the vulcanization of rubber.
- To understand the effect of constitution on colour of different organic compounds based on electronic concept.
- To study the chemistry and the synthesis of various dyes mentioned in syllabus.
- To learn nomenclature and structure of one compound from all classes of pharmacodynamic agents and chemotherapeutic agents.
- To learn synthesis and application of various synthetic drugs.
- To know the nomenclature and structural features of Organosulphur and Organophosphorus compounds.
- To learn the methods of preparations and reactions of thiols, thioethers, sulphonic acids, phosphines and phosphonium salts including Wittig reaction and its applications.
- To understand the chemistry of ylides and Organophosphorus compounds.
- To understand chemistry of photochemical reactions, Jablonskii diagram, Norrish type I and Norrish type II cleavage of ketones
- To understand electronic transitions and transition states.

SYLLABUS	
Section I 1. **Carbohydrates** Classification and nomenclature. Monosaccharides: General reactions, chain lengthening by Killiani-Fischer synthesis and chain shortening by Ruff degradation of aldoses, mechanism of osazone formation. Configuration of monosaccharides with reference to glucose. d(+)/l(-) and D/L systems of nomenclature. Interconversion of glucose to fructose and glucose to mannose. Determination of ring size of monosaccharides with reference to glucose. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. Formation of glycosides, ethers and esters. Structure elucidation of sucrose.	10L
2. Terpenes Classification. General methods of structure elucidation. Chemistry and synthesis of citral and its conversion to ionones. Chemistry and synthesis of α-terpineol, camphor. Chemistry of α-pinene. Chemistry of zingiberene.	10L
3. **Organic synthesis via Enolates**: Acidity of α-hydrogens, Synthesis of ethyl acetoacetate by Claisen condensation, keto-enol tautomerism in ethyl acetoacetate. Alkylation of diethyl malonate and ethyl acetoacetate. Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.	08L
4. **Fats, Oils and Detergents:** Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides. Hydrogenation of unsaturated oils. Saponification value, iodine value and acid value of oils. Soaps, synthetic detergents, alkyl and aryl sulphonates.	02L
Section II **5. Synthetic Polymers:** Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Zeigler-Natta polymerization and vinyl polymers. Condensation or step-growth polymerization. Polyesters, polyamides, phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.	05L
6. **Synthetic Dyes**: Color and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of methyl orange, Congo Red, Malachite Green, Crystal Violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.	08L

7. Synthetic Drugs: Classification according to use. One compound with name and structure from all classes of pharmacodynamic agents and chemotherapeutic agents. Synthesis and uses of the following drugs: Phenobarbital, Chlorpheniramine, Atenolol, Ibuprofen, Naproxen, Methyldopa, Chloramphenical, Metronidazole and Ethambutol.	06L
8. Organosulphur and Organophosphorus Compounds: Nomenclature, structural features. Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids. General reactions only. Introduction to organophosphorus compounds. General methods of preparation of phosphines and phosphonium salts. Wittig reaction and its applications.	08L
9. Photochemistry: General idea of photochemical reactions. Electronic transitions and transition states. Jablonskii diagram. Norrish type I and Norrish type II cleavage of ketones.	03L

LEARNING OUTCOMES:

Theory:

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,

transition states and photochemical reactions.

REFERENCES:

1. I.L.Finar, Organic Chemistry Vols I and II, Orient Longman
2. Morrison and Boyd, Organic Chemistry; 6th Edn. Prentice Hall India
3. Francis Carey, Organic Chemistry
4. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edn. Pearson Education Asia
5. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds;

CH - 342	*Analytical Chemistry* (SEMISTER VI)	Number of hours: 45

COURSE OBJECTIVES:

Theory:

SECTION I & II

- Define the terms involved in basic electronics and thermal methods, radiochemical methods, UV Visible Spectroscopy, Chromatographic methods, Fluorimetry
- State the principles in thermal methods of chemical analysis and basic electronics, UV Visible Spectroscopy and Fluorimetry, principles of isotope dilution method and neutron activation analysis.
- Draw the schematic diagrams, diagrams of instruments, circuit diagrams and the graphs involved.
- Describe the working of instruments, electronic components and circuits.
- Explain the terms involved giving examples, interpret the graphsin UV Visible Spectroscopy , chromatographic methods and fluorimetry.
- Classify and explain the different types of chromatographic technique.
- Derive and use the equations of Beer Lamberts law, Gas chromatography to solve numericals.
- Discuss applications of UV Visible Spectroscopy , chromatographic technique and fluorimetry.
- Analyse different parameters of water,air and soil analysis.

SYLLABUS

Theory:

Section I

1. UV-Visible Spectroscopy

Interaction of electromagnetic radiation with matter, Quantitative calculations- Beer's and Lambert's law. Deviations from Beer's law

Principles of instrumentation: Sources, monochromators, cells. Types of instruments.

Photoelectric colorimeters: Single & Double beam photoelectric colorimeters; comparison between

colorimeter and spectrophotometer ; applications of colorimetry and/or spectrophotometry ;

quantative analysis; identification of structural groups in a molcule ; study of co-ordination **09 L**

compound, photometric titrations, cis-trans isomerism; chemical kinetics & others limitations.

(Reference: 1,3)(numerical problems are expected to be solved)

2. Chromatographic Methods

Principles. Classification of chromatographic techniques

Techniques of column chromatography **14 L**

Paper and thin layer chromatography: Principles, techniques and applications of paper and thin layer chromatography.Theory of chromatographic separation :DistributionEquilibria, Rate of travel, Retention time,Retention volume and relative retention.Ion exchange chromatography: Principles, classification of ion exchange materials, Nature of exchanging ions, Ion exchange capacity, applications in analytical chemistry.VGas chromatography and HPLC :

Gas chromatography: Basic principles, Graphic diagram of apparatus, Explanation

of factors affecting separation, Thermal conductivity and Flame ionization detectors, Identification and estimation of sample components, Applications GC-MS and HPLC in detail. HPLC: principles equipment for HPLC , applications. *(Numerical problems are to be solved.References: 1, 2,3)* **Section II** **3. Basic Electronics** Introduction to diodes, rectifiers, zener diodes, regulated power supply, SCR's, triac and control circuits, Transistors, FET, Linear Integrated circuits and operational amplifiers.Binary arithmetic. *(Reference : 6)* **4. Thermal Methods** Thermogravimetric Methods (TG):Instrumentation, applications with respect to CaC2O4.H2O and CuSO4.5H2O Differential Thermal Analysis (DTA): General principles and applications. Differential Scanning Calorimetry (DSC): Applications. *References:2,4,5* **5. Fluorimetry** Principles of Fluorescence, chemical structure and Fluorescence. Relationship between concentration & fluorescence intensity Instrumentation & applications.*(numerical problems are expected to be solved)* *References:2,3* **6. Radiochemical methods** Isotope dilution Analysis: Principles and applications. Neutron activation analysis: principle, calibration curve method, advantages and limitations of neutron activation analysis. *(Reference : 6)* **7. Environmental Chemistry: Air, Water and Soil Analysis** Water analysis: Dissolved oxygen, free carbon dioxide, B.O.D., C.O.D. and total carbohydrates. Soil/ sediment analysis: Bulk density, Specific gravity, moisture content, water holding capacity, pH, electrical conductivity, alkalinity, detection of sulphate (By colorimeter or turbidimeter), nitrogen, nitrate, total phosphorus, phosphate, calcium, magnesium, sodium, potassium, iron and organic matter. Air analysis: SO2, H2S, NO-NO2, CO-CO2, O3 and NH3 *References: 8,9,*	**07 L** **04 L** **03 L** **03 L** **05 L**
LEARNING OUTCOMES:	
Theory:	

- 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 chemicalanalysis.
- 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

REFERENCES:

Text Book

B.K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut

Reference Books

1. G. D.Christan Analytical Chemistry by, 5th edition Wiley publications.
2. G. Chatwal and S. Anand, Instrumental Methods of Chemical Analysis 5th edition (reprint2003), Himalaya publication.
3. B. S. Baliga and A.Zaveri, College Analytical Chemistry, 15th edition, Himalaya PublishingHouse, 2004
4. Vogels Textbook of Quantitative Inorganic Analysis 4th edition ELBS.
5. Willard, Meritt and Dean. Instrumental Methods of Analysis
6. Skoog and Leary, Principles of Analytical Chemistry 4th International edition.
7. P.R.Trivedi and Gurdeep Raj, Environmental Water and Soil Analysis, Akashdeep Publishing House, New Delhi.
8. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.

CH-302	Experiments in Physical and Analytical Chemistry SEMESTER VI	Number of hours: 45

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory(potentiometry , pH metry, partition coefficient, Chemical kinetics)
- To understand and develop the problem solving skills and hands on experience with refrence to instrumentation and techniques studied in theory.(spectrophotometry,chromatography and conductometry)

SYLLABUS

Practical

PHYSICAL CHEMISTRY

Conductometry

1. To determine the strength of mixture containing weak acid (CH3COOH) and weak base (NH4OH) by titrating against standard 0.1N NaOH solution.
2. To determine the degree of hydrolysis and hydrolysis constant of
a) CH3COONa b) NH4Cl c) C6H5NH2.HCl at room temperature.

Potentiometry:

3. To determine the standard oxidation potential of Zn/Zn2+ and Cu/Cu2+ at three different concentrations.
4. To determine the percent composition and amount of halide ions from their mixture (any two halides) using standard 0.1N AgNO3 solution.
5. To determine the dissociation constant of weak dibasic acid(H2C2O4) by titrating against standard 0.1N NaOH solution.
6. To investigate the influence of ionic strength on the rate constant between potassium per sulphate and potassium iodide.
7. To study the kinetics of ethyl acetate by NaOH at two different temperatures and hence the energy of activation.
8. To determine the formula of the complex formed between cupric ion and ammonia by distribution method.

ANALYTICAL CHEMISTRY

A] Spectrophotometry

1. Determination of nitrite in water
2. Estimation of Cr and Mn from a mixture
3. Comparison of spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10 – phenanthroline by three methods: continuous variations, mole ratio and slope ratio (not for examination)

B] Chromatography

4. Estimation of Na+ from NaCl using cation exchange resin in H – form using standard NaOH.

C] Conductometry

5. Estimation of boric acid by conductometric titration

D] Other Experiments

6. Determination of hardness of water by EDTA i.e estimate Ca asCaCO3 and report analysis in ppm. (the candidate should record more than 5 observations and carry out statistical analysis to find out mean, median, range, standard deviation, absolute error, relative error and possibly Q test.(not for examination)
7. Determination of Mg in antacid drugs
8. Estimation of aspirin

LEARNING OUTCOMES:

Practical:

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.

REFERENCES:

1.Basic Principles of Analytical Chemistry. To be used as text book.K. Raghuraman, D.V.Prabhu, C.S. Prabhu and P.A.Sathe 3rd, 4th and 5th edition, Sheth Publishers.
2.Analytical Chemistry. Gary Christian, 4th Edition, International Edition.
3.Principles of Analytical Chemistry. Skoog and Leary, 4th International Edition.

CH-304:	Experiments in Inorganic and Organic Chemistry (Semester VI)	Number of hours: 60

COURSE OBJECTIVES:

Practical:

- To study the volumetric methods to quantitatively estimate with precision the desired amount of the metal ions.
- To study the volumetric methods for determination of some physicochemical parameters in sea and mineral water.
- To get hands on experience for the binary mixture separation and the analysis of separated compounds.

SYLLABUS

Practical:

Inorganic Chemistry

1. Estimation of Iron(II) by dichromate method from the given solution of ferric alum byusing SnCl2.
2. Estimation of Nitrite using Ceric ammonium sulphate from the given sample of Water.
3. Estimation of Copper(II) by thiosulphate method from the solution of copper sulphate.
4. Estimation of Calcium in the given sample using KMnO4.
5. Preparation of Tetraamine Copper (II) sulphate complex.
6. Estimation of Copper from Tetraamine Copper (II) sulphate complex by iodometry.
7. Determination of dissolved oxygen from sea and mineral water using Winkler's method.
8. Determination of alkalinity of sea and mineral water using phenolphthalein and methylorange indicator.

Organic Chemistry

1. Organic mixture separation and analysis. At least 08 mixtures of compounds out of which 4 should be solid-solid, 2 liquid-liquid, and 2 solid-liquid from the following list, to be analyzed on small scale using 1 gm of mixture in case of solids and 3 to 4 ml. in case of liquids. (Existing list of mixtures to be continued)

LEARNING OUTCOMES:

Practical:

At the end of the course students will be able to

- 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.

- 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.

REFERENCES:

Inorganic Chemistry:
1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham ELBS.
3. Standard Methods of Chemical Analysis W.W. Scott, Technical Press.
4. Experimental Inorganic Chemistry W.G. Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol. I and II Brauer, Academic Press.
6. Inorganic Synthesis, Mc Graw Hill.

Organic Chemistry:
1. Vogel's Qualitative Organic Analysis, Orient Longman
2. Textbook of Practical Organic Chemistry, N.K.Vishnoi

List of Courses for B.Sc. Chemistry Program w.e.f 2018-2019

Course Name		Credits	
		Theory	Practical
A. Discipline Specific Core Courses (DSC)- Code: CHC; (6 Credits each)			
1	Semester I: CHC-101(DSC-2A) Inorganic Chemistry and Organic Chemistry	4	2
2	Semester II: CHC-102 (DSC-2B) Physical Chemistry and Organic Chemistry	4	2
3	Semester III: CHC-103 Physical Chemistry and Organic Chemistry	4	2
4	Semester IV: CHC-104 Physical Chemistry and Inorganic Chemistry	4	2
B. Chemistry Courses – Code: CH			
5	Semester V: Theory CH-311: Physical Chemistry CH-321: Inorganic Chemistry CH-331: Organic Chemistry CH-341: Analytical Chemistry		
	Practical CH-301: Experiments in Physical and Analytical Chemistry CH-303: Experiments in Inorganic and Organic Chemistry		
6	Semester VI: Theory CH-312: Physical Chemistry CH-322: Inorganic Chemistry CH-332: Organic Chemistry CH-342: Analytical Chemistry		
	Practical CH-302: Experiments in Physical and Analytical Chemistry CH-304: Experiments in Inorganic and Organic Chemistry		

Year	Semester	Discipline Specific Core DSC (CHC)	Chemistry Courses (CH)
Credits		**6 credits each**	
First Year	I	CHC-101(DSC-2A) Inorganic Chemistry and Organic Chemistry	
	II	CHC-102 (DSC-2B) Physical Chemistry and Organic Chemistry	
Second Year	III	CHC-103 Physical Chemistry and Organic Chemistry	
	IV	CHC-104 Physical Chemistry and Inorganic Chemistry	
Third Year	V		Theory CH-311: Physical Chemistry CH-321: Inorganic Chemistry CH-331: Organic Chemistry CH-341: Analytical Chemistry
			Practical CH-301: Experiments in Physical and Analytical Chemistry CH-303: Experiments in Inorganic and Organic Chemistry
	VI		Theory CH-312: Physical Chemistry CH-322: Inorganic Chemistry CH-332: Organic Chemistry CH-342: Analytical Chemistry
			Practical CH-302: Experiments in Physical and Analytical Chemistry CH-304: Experiments in Inorganic and Organic Chemistry

PROGRAMME SPECIFIC OUTCOME (PSO)

- Students will be able to acquire core knowledge in Chemistry in the key areas, develop written & oral communication skills in communicating chemistry-related topics.
- Design & conduct an experiment, demonstrate their understanding of the scientific methods & processes.
- Develop proficiency in acquiring data using a variety of instruments, analyze & interpret the data, learn applications of numerical techniques.
- Realize & develop an understanding of the impact of Chemistry & science on society.

CHC-101 DSC 2A	**Inorganic Chemistry& Organic Chemistry (SEMESTER I)**	**Credits: 06 (Theory: 04 & Practical: 02)**

COURSE OBJECTIVES:

Theory:

Section A

- To discuss Bohr's theory, Quantum theory for structure of an atom.
- To draw the radial plots, probability distribution curves.
- To generalize the rules for electronic configuration of an atom.
- To explain the general characteristics of ionic compounds and covalent compounds.
- To discuss valence bond theory, VSEPR, and molecular orbital theory for covalent compounds.

Section B

- To understand the curved arrow notations in organic reaction mechanisms.
- To understand the concept of physical effects and electronic displacement with reference to organic molecules.
- To understand the structure, shape and reactivity of organic molecules.
- To study the strength of organic acids and bases.
- To understand the aromaticity of compound.
- To understand the concept of isomerism, stereoisomerism, configuration, chirality and optical rotation.
- To understand the difference between conformational and configurational isomers.
- To draw conformations with respect to ethane, butane and cyclohexane.
- To learn the interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations.
- To understand rules for nomenclature and assigning configuration to configurational isomers.
- To understand various methods of preparation and reactions of alkanes, alkenes and alkynes.

Practical:

- To estimate the metal ions by volumetric methods employing redox and complexometric and acid-base titration concepts.
- To get hands on experience for the systematic qualitative analysis of the organic compounds.
- To learn the purification and separation techniques for organic compounds.

SYLLABUS	
Theory:	**Number of hours: 60**
Section A **1. Atomic Structure:** Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Quantum numbers and their significance, Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	**14 H**
2. Chemical Bonding and Molecular Structure *Ionic Bonding:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. *Covalent bonding:* VB Approach, Shapes of some inorganic molecules and ions on the basis of VSEPRand hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of Resonance and Resonating structures in various Inorganic and Organic compounds.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, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.	**16 H**
Section B **1. Fundamentals of Organic Chemistry** Curved arrow notation, drawing electron movement with arrows, half and double headed arrows, in organic reaction mechanisms. Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive	**8 H**

Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pk values. Aromaticity: Benzenoids and Hückel's rule. **2. Stereochemistry** Concept of isomerism. Types of isomerism. Stereoisomerism, conformational isomerism. Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis – trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=Csystems). **3. Aliphatic Hydrocarbons** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. **Alkanes**: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radicalSubstitution:Halogenation. **Alkenes:** (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration - demercuration,Hydroboration-oxidation. **Alkynes**: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.	**10 H** **12 H**

Practical	**Number of hours: 60**
Section A-(Inorganic Chemistry) **Volumetric Analysis:** 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Estimation of oxalic acid by titrating with $KMnO_4$. 3. Estimation of water of crystallization in Mohr's salt by titrating with standardized $KMnO_4$. 4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. 5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.	**30 H**

Section B:(Organic Chemistry) 1. Purification of organic compounds: i. Solids by recrystallization process using water and ethanol as solvent. Determination of melting point. ii. Liquids by distillation process, a) acetone b) nitrobenzene. Determination of boiling point. 2. Determination of chemical type, detection of elements, group test for any one compound. 3. Identification of unknown organic compounds. i. Water insoluble solids (Acid, Base, Phenol and Neutral) ii. Water soluble solid (Acid and Neutral) 4. Thin layer chromatographic techniques: plate preparation, spotting, Separation of mixtures by thin layer Chromatography: Measure the Rf value in each case (combination of two compounds to be given eg. Mixture of o- and p-nitroaniline).	**30 H**

LEARNING OUTCOMES:

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

- Interpret the atomic structure based on postulates of Bohr's theory, Quantum mechanics and Valence bond theory.
- Predict the structure and distortion of molecules based on VSEPR theory.
- Evaluate the stability and magnetic property based on molecular diagrams of homonuclear and heteronuclear molecules.
- Identify and use the curved arrow notations in organic reaction mechanisms.
- Explain the concept of physical effects and electronic displacement with reference to organic molecules.
- Describe structure, shape and reactivity of organic molecules.
- Interpret strength of organic acids and bases.
- Identify if the given organic compound is aromatic.
- Classify isomers giving examples.
- Discuss the concept of stereoisomerism , configuration, chirality and optical rotation.
- Distinguish between conformational and configurational isomers and also geometrical and optical isomers, giving examples.
- Draw conformations with respect to ethane butane and cyclohexane.
- Draw and interconvert WedgeFormula, Newman, Sawhorse and Fischer representations.
- Give the nomenclature and assign configuration to configurational isomers.
- Give various methods of preparation and reactions of alkanes, alkenes and alkynes.

Practical:

- The students will acquire the skill and knowledge to carry out volumetric estimation of metal ions.
- 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.

Reference Books

Inorganic Chemistry

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.

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2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
4. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
5. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
7. Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
8. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India.
9. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia.
10. Jerry March, Advanced Organic Chemistry; 4rd Edition, John Wiley.

CHC-102 (DSC 2B)	Physical Chemistry and Organic Chemistry (Semester II)	Credits: 06 (Theory: 04 & Practical: 02)

COURSE OBJECTIVES:

Theory:

Section A

- To define the terms and state laws involved in thermodynamics, thermochemistry and chemical equilibrium.
- To explain the concept of enthalpies of solution, buffer solutions.
- To derive the Thermodynamic derivation of the law of chemical standard state, enthalpies of solution, chemical equilibrium and relationships between different equilibrium constants based on ideal gases.
- To solve numerical based on chemical energetics, chemical equilibrium and ionic equilibrium.

Section B

- To learn the preparation methods and reactions of Aromatic hydrocarbons, Alkyl and Aryl Halides, Phenols, Ethers and Carbonyl Compounds.
- To learn the various named reactions mentioned in the syllabus.
- To understand Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.
- To understand Benzyne mechanism with respect to aromatic nucleophilic substitution.
- To understand Pinacol-pinacolone rearrangement with mechanism.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory pH metry, thermochemistry
- To understand the mechanism of reactions involved in organic preparation experiments and develop hands on experience with reference to basic laboratory techniques required for organic preparations.

SYLLABUS

Theory: **Number of Hours: 60**

Section A: Physical Chemistry- I

1. Chemical Energetics — **10 H**

Need of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

2. Chemical Equilibrium — **08 H**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Definition of ΔG and ΔGo, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

3. Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts.	**12 H**
Section B: Organic Chemistry – II **1. Aromatic hydrocarbons** *Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. *Reactions*: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).	**08 H**
2. Alkyl and Aryl Halides **Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions. *Preparation:* from alkenes *and* alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile &isonitrile formation. Elimination vs substitution. **Aryl Halides** *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and arylhalides.	**08 H**
3. Alcohols, Phenols, Ethers and Carbonyl Compounds **Alcohols:** *Preparation:* Preparation of 1°, 2°and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions:* With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3). Oppeneauer oxidation *Diols:* oxidation of diols using HIO4. Pinacol-Pinacolone rearrangement with mechanism. **Phenols:** (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch	**14 H**

Condensation, Schotten –Baumann Reaction.

Ethers (aliphatic and aromatic): Williamson's synthesis of ethers. Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles. *Reactions* – Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensenreduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Practical	**Number of Hours: 60**
Section A-(Physical Chemistry) 1. Thermochemistry (Any three) i. Determination of heat capacity of the calorimeter. ii. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. iii. Determination of enthalpy of ionization of acetic acid. iv. Study of the solubility of benzoic acid in water and determination of ΔH.	**18 H**
2. Chemical Kinetics: i. To study the effect of nature of reactants on the rate of reactions ii. Determination of relative strength between HCl and Urea hydrochloride for hydrolysis of methyl acetate Ionic equilibria.	**10 H**
3. pH measurements Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using ph meter.	**02 H**
Section B-(Organic Chemistry) 1. **Preparations**: Mechanisms involved in the following reactions to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done. Each preparation for a. Bromination of Phenol/Aniline (b) Benzoylation of amines/phenols b. 2,4-dinitrophenylhydrazone of benzaldehyde/acetophenone c. Nitration of acetanilide to p-nitroacetanilide. (e) Oxime of Cyclohexanone d. Chalcone from benzaldehyde and acetophenone (g) Iodoform from acetone	**30 H**

LEARNING OUTCOMES:

Theory:

At the end of the course students will be able to

- Define the terms involved in chemical energetics, chemical equilibrium, ionic equilibrium and state the laws used in thermodynamics, thermochemical equilibrium .
- Describe enthalpy, buffer solutions, factors affecting ionization.
- Derive and use the equations thermochemistry, chemical equilibrium and ionic equillibria of to solve the numericals.
- Give methods of preparation and reactions of aromatic hydrocarbons, alkyl and aryl halides, phenols, ethers and carbonyl compounds.
- Identify and give the named reactions mentioned in the syllabus.
- Explain reactivity and relative strength of c-halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.
- Explain benzyne mechanism with respect to aromatic nucleophilic substitution.
- Explain pinacol-pinacolone rearrangement with mechanism.

Practical:

At the end of the course students will be able to

- Understand the concepts of thermochemistry, pHmetry, chemical kinetics.
- Develop skills of working and set up of calorimeter.
- Solve numericals on and verify the graph of chemical kinetics
- Discuss the mechanisms involved in the organic preparation experiments.
- Develop skills of common laboratory techniques including recrystallisation, recording of melting point required for organic preparations and perform calculations for quantitative analysis.

REFERENCES:

Section A

1. Bahl, A. &Bahl, B.S. Advanced Physical Chemistry, S. Chand, 2010.
2. J. N. Gurtu and AayushiGurtu, Undergraduate Physical Chemistry, Vol I, Vol II and Vol III Pragati Prakashan
3. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
4. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
5. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
6. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
7. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

Section B

1. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons, (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition,2013.

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7. Francis Carey, Organic Chemistry; 3rd Edition, Tata McGraw Hill India.
8. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edition, Pearson Education Asia.
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10. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
11. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
12. Pandey, O.P., Bajpai D. N. &Giri S. Practical Chemistry, Revised Edition, (For BSc. I, II, III Year Students of All Indian Universities) S. Chand Company Pvt Limited, 2014.
13. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: NewDelhi(2011).

CHC 103	Physical Chemistry and Organic Chemistry (Semester III)	Credits: 06 (Theory: 04 & Practical: 02)

COURSE OBJECTIVES:

Theory:

Section A- Physical Chemistry

- To understand the difference between ideal and non-ideal solutions.
- To study phase diagrams of various systems and to apply the phase rule equation.
- To study the conductance of strong and weak electrolytes.
- To study reversible and irreversible cells and measurement of EMF.
- To solve the numerical problems based on standard electrode potentials and conductance measurement of solutions.

Section B- Organic Chemistry

- To learn the preparation/synthesis and reactions of carboxylic acids and their derivatives, amines, diazonium salts, amino acids and simple peptides.
- To understand the mechanism of reactions.
- To compare Hofmann and Saytzeff elimination.
- To learn and remember the terms involved such as zwitterion, isoelectric point, electrophoresis with examples.
- To learn the laws, the terms involved and the principles in UV –Visible spectroscopy.
- To study various electronic transitions, λmax and effect of conjugation on colour.
- To know Woodward-Fieser rules for calculation of λmax for conjugated dienes and α, β unsaturated carbonyl compounds.
- To acquire knowledge to distinguish between *cis* and *trans* isomers using UV – Visible Spectroscopy
- To know classification of carbohydrates and their general properties.
- To know the open chain and cyclic structure of Glucose and Fructose.
- To gain knowledge of determining the configuration of monosaccharides.
- To study the terms involved with examples.
- To learn the synthesis involved.

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory. (phase equilibria, conductometry and potentiometry)
- To get hands on experience for the preparation of derivatives.
- To gain knowledge of analyzing organic compounds.
- To learn to perform estimations.

SYLLABUS

Theory: **Number of hours: 60**

Section A

1. **Solutions**

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Azeotropes. Partial miscibility of liquids: Critical solution temperature, distillation and fractional distillation. **07 H**

2. **Phase Equilibrium**

Phases, components and degrees of freedom of a system, criteria of phase Equilibrium.Phase diagrams of one-component systems (water, sulphur and CO2) Component and two systems involving eutectics, congruent and incongruent melting points (Zn-Mg, NaCl-H_2O). **08 H**

3. **Conductance**

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch's law of independent migration of ions. Ionic mobility and factors affecting ionic mobility. Transference number and its experimental determination using moving boundary methods. Applications of conductance water, measurements: solubility and solubility products of sparingly soluble salts, ionic product of conductometric titrations (only acid-base). **05 H**

4. **Electrochemistry**

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using a hydrogen electrode and quinhydrone electrode. **10 H**

Section B

1. **Carboxylic acids and their derivatives**

Carboxylic acids (aliphatic and aromatic)
Preparation: Acidic and Alkaline hydrolysis of esters.
Reactions: Hell - Volhard - Zelinsky Reaction.
Carboxylic acid derivatives (aliphatic): (up to 5 carbons)
Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversions.
Reactions: Comparative study of the nucleophilicity of acyl derivatives.
Reformatsky reaction, Perkin condensation (mechanism). **06 H**

2. **Amines and Diazonium Salts**

Amines (aliphatic and aromatic): (upto 5 carbons)
Preparation: from alkyl halides, Gabriel's phthalimide synthesis, Hofmann bromamide reaction (Hofmann rearrangement). **06 H**

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann reaction. Electrophilic substitution (case aniline): nitration,bromination, sulphonation. Diazonium salts: Preparation from aromatic amines, conversion to benzene, phenol, dyes.	
3. Amino Acids and Peptides Preparation of Amino Acids: Strecker synthesis, Gabriel's phthalimide synthesis. Terms: Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: Ester of – COOH group, acetylation of –NH2 group, complexation with Cu^{2+} ions, ninhydrin test. Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.	**06 H**
4. UV –Visible Spectroscopy in Organic Chemistry Introduction to spectroscopy: UV Spectroscopy: Beer-Lambert's law, Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption. Visible Spectroscopy: Effect of conjugation on colour. Application of Woodward - Fieser rules for calculation of λmax for the following systems: α, β unsaturated aldehydes, ketones. Conjugated dienes: alicyclic, homoannular and heteroannular, extended conjugated systems (aldehydes, ketones and dienes). Distinction between cis and trans isomers.	**08 H**
5. Carbohydrates Classification and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, Osazone formation, Killiani Fischer synthesis.	**04 H**
Practical	**Number of hours: 60**
<u>Section A: Physical Chemistry</u> **Phase Equilibria** a. To draw the phase diagram of the binary system - diphenyl amine and α – Naphthol and find the eutectic temperature. b. Study the mutual solubility of phenol and water at various temperatures and hence determine the critical solution temperature. c. Study the effect of addition of NaCl on critical solution temperature of phenol water system and study of the effect of impurities on it.	**12 H**
Conductance a. Determination of cell constant. b. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. c. Conductometric titrations: i. Strong acid vs. strong base	**10 H**

ii. Weak acid vs. strong base **Potentiometry** Potentiometric titrations i. Strong acid vs. strong base (Quinhydrone method) ii. Potassium dichromate vs. Ferrous Ammonium sulphate **Section B: Organic Chemistry** 1. **Systematic Qualitative Organic Analysis** Analysis of Organic Compounds possessing monofunctional groups (carboxylic, aldehyde, ketone, amide, nitro, amines) and preparation of one derivative of each group. (Analysis of single compound and its derivative preparation) ethylacetoacetate. 2. **Organic Preparations :** Synthesis, yield, recrystallisation and Melting Point. i. Hippuric acid from glycine (Benzoylation-Schotten Baumann reaction) (4 Hours) ii. Osazone from Glucose (Nucleophilic addition) (2 Hours) iii. Phthalic acid to Phthalic Anhydride to Phthalimide (4 Hours) iv. Preparation of Azo dye (4 Hours) 3. **Organic Estimations: (**Any 2**)** i. Estimation of glycine by formylation method (2 Hours) ii. Estimation of Glucose by oxidation (2 Hours) iii. Estimation of Acetamide by hydrolysis	**08 H** **12 H** **14 H** **04 H**

LEARNING OUTCOMES:

Theory:

At the end of the course students will be able to

1. Define the terms involved in Phase Equilibria, Solutions, Conductance and Electrochemistry.
2. State the Raoult's Law and the Kohlrausch's law of independent migration of ions.
3. Draw the schematic diagrams of instruments used in Conductance and Electrochemistry.
4. Interpret the graphs based on Raoult;s law and in Conductometric titrations.
5. Define and explain the terms involved giving examples.
6. Describe the preparation of various compounds involved.
7. Classify carbohydrates.
8. Draw the structures of carbohydrates.
9. Predict and compare the mechanism of reactions involved.
10. Explain and propose the mechanism of similar reactions.
11. Predict the products, intermediates, reactants and reaction conditions for a given chemical reaction.
12. State the laws involved in UV –Visible Spectroscopy and will be able to distinguish between *cis* and *trans* isomers.
13. Calculate λmax for Conjugated dienes and α, β unsaturated carbonyl compounds using Woodward – Fieser rules which will help them to predict the structure of organic compound with the help of other spectroscopic data.

Practical:

At the end of the course students will be able to

- Understand the concepts of phase equilibria, conductometric titration and potentiometric
- Develop skills of working and carrying out conductometric and potentiometric titrations.
- Draw Phase equilibria curve, Conductometric and Potentiometric titration curves.
- Perform reactions and prepare derivatives.
- Develop skills of identification and analysis of organic compounds at microscale level.
- Carry out organic estimations by formylation, oxidation and hydrolysis.

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Theory

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2. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009)
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12. Pavia, D. L. et al. Introduction to Spectroscopy 5th Ed. Cengage Learning India
13. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds.

Practical

Reference books:

Physical Chemistry

1. Systematic experimental physical Chemistry by S.W. Rajbhoj, Dr. T. K. Chondhekar, Anjali Publication, Aurangabad.
2. Practical Chemistry by O.P. Pandey, D. N. Bajpai, S. Giri, S. Chand Publication
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CHS-101	Skill Enhancement Course (Semester III)	Credits:04 (Theory: 03 & Practical: 01)

COURSE OBJECTIVES:

Theory:

- To define renewable, non-renewable and alternative energy sources.
- To define fuel, calorific value and the characteristics of a good fuel.
- To understand composition and uses of coal gas, producer gas and water gas.
- To study coal gasification (Hydrogasification and Catalytic gasification), coal liquefaction and solvent refining.
- To study different types of petroleum products and their applications.
- To understand idea about food processing and food preservation and adulteration.
- To understand the concept of pH and pH measurement with respect different types of soils...
- To study the use of different indicators for mapping various soil characteristics to improve soil fertility.
- To find out the sources responsible for contaminating water, study water sampling methods and methods employed for the purification of water.

Practical:

- To understand the different methods employed for the determination of various physico-chemical parameters of water.
- To understand the method of determination of soil pH.

SYLLABUS

Theory: **Number of hours: 45**

1. Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.	**2 H**
2. Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, Producer gas and Water gas—composition and uses. Fractionation of coal tar, uses of coal tar, requisites of a good metallurgical coke, coal gasification (Hydrogasification and Catalytic gasification), coal liquefaction and solvent refining.	**10 H**
3. Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its Derivatives.	**10 H**
4. Analysis of food products: Nutritional value of foods, idea about food processing and food preservation and adulteration.	**10 H**

a) Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder, pulses etc. b) Analysis of preservatives and colouring matter. **5. Analysis of soil**: Composition of soil, Concept of pH and pH measurement, complexometric titrations, chelation, chelating agents, use of indicators. **6. Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.	**7 H** **6 H**
Practical	**30 Hours**
1. Determination of pH of soil samples. 2. Determination of pH of water samples 3. Estimation of Calcium and Magnesium ions as calcium carbonate by complexometric titration. 4. Determination of dissolved oxygen (DO) in a given water sample. 5. Determination of acidity of a water sample 6. Determination of alkalinity in a given water sample 7. Measurement of dissolved CO_2. 8. Percentage of available chlorine in bleaching powder.	**30 H**

LEARNING OUTCOMES:

Theory:

At the end of the course students will be able to

- Define the terms renewable, non-renewable and alternative energy sources.
- Define fuel, its calorific value and know the properties of fuels
- Understand production of coal gas, producer gas and water gas and their uses.
- Explain composition of crude petroleum, Refining and different types of petroleum products and their applications.
- Define Nutritional value of foods, idea about food processing and food preservation and adulteration.
- Apply the concept of pH to understand reactions in soil.
- Define chelate, chelating agent and know the method of preserving important cations in soil
- Use different types of indicators for soil mapping to understand soil fertility
- Identify various sources of water pollution and understand the use of water sampling methods to sample water.

Practicals:

- To determine various physico-Chemical parameters of water.
- To determine pH of any soil sample.

Reference Books for Theory and Practicals:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).

4. Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996).
5. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
6. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
7. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
8. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India
9. Jain, P.C. & Jain, M. *Engineering Chemistry*

CHC 104	Physical Chemistry and Inorganic Chemistry (Semester IV)	Credits: 06 (Theory: 04 & Practical 02)

COURSE OBJECTIVES:

Theory:

Section A –Physical Chemistry

- To study the postulates of kinetic theory of gases and understand the deviations of real gases from ideal behavior.
- To understand properties of liquids such as surface tension and viscosity and the methods to measure them.
- To study the structures of cubic crystals and the laws explaining their structure.
- To understand rates of chemical reactions of zero, first and second orders.
- To apply reaction rate theories for chemical reactions.

Section B-Inorganic Chemistry

- To understand electronic configuration, variable valency, color, magnetic and catalytic properties of 3d series.
- To understand the complexing ability and stability of various oxidation states (Latimer diagrams) for Mn, Fe, and Cu.
- To understand electronic configurations, oxidation states, color, magnetic properties of lanthanides.
- To explain lanthanide contraction, separation of lanthanides (ion exchange method only).
- To understand the IUPAC system of nomenclature for coordination compounds.
- To understand the bonding in complexes using valence bond theory.
- To study the different types of isomerism's associated with coordination compounds.
- To understand the factors affecting the magnitude of 10Dq.
- To study the effect of strong field and weak field ligands on CFSE.
- To study crystal field splitting in tetrahedral and octahedral complexes and to calculate CFSE.

Practical:

- To understantod and develop the problem solving skills and hands on experience with reference to concepts studied in theory.
- To systematically analyze the cation and anion in a given mixture.
- To quantitatively estimate several metal ions using the gravimetric and volumetric techniques.
- To determine the concentration of colored compounds using the colorimetric technique.

SYLLABUS

Theory: **Number of hours: 60**

Section A –Physical Chemistry

1. **Kinetic Theory of Gases** — **08 H**

Postulates of Kinetic Theory of Gases, deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms for CO_2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation), collision number, collision frequency, collision diameter and mean free path of molecules.

2. **Liquids** — **06 H**

Surface tension and its determination using stalagmometer. Effect of temperature on surface tension. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer and factors affecting viscosity.

3. **Solids** — **08 H**

Forms of solids, symmetry elements, unit cells, crystal systems, Bravais lattice. Laws of crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices, X–Ray diffraction by crystals, Bragg's law. Particle size determination using powder method. Structures of NaCl, KCl and CsCl (qualitative treatment only).

4. **Chemical Kinetics** — **08 H**

The concept of reaction rates. Effect of temperature, pressure and catalyst on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Section B- Inorganic Chemistry

1. Transition Elements — **10 H**

General characteristic properties of 3d series with special reference to electronic configuration, variable valency, color, magnetic and catalytic properties. Ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe, and Cu. Lanthanides: Electronic configurations, oxidation states, color, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only). Actinides: Electronic configuration and general characteristics.

2. Coordination Chemistry — **10 H**

IUPAC system of nomenclature. Bonding in complexes based on Valence Bond Theory (VBT), Inner and outer orbital complexes of Cr, Fe, Co, Ni, and Cu (coordination numbers 4 and 6). Different types of structural and stereo-isomerism including optical isomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT.

3. Crystal Field Theory — **10 H**

Crystal field splitting in octahedral complexes. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Spectrochemical series. Crystal Field Splitting in Tetrahedral complexes. Calculation of CFSE. Comparison of CFSE for *Oh* and *Td* complexes. Factors affecting the magnitude of 10Dq. Merits and Demerits of Crystal Field Theory.

Practical **Number of hours: 60**

Section A –Physical Chemistry

I. **Surface Tension measurement** — **04 H**

Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

II. **Solutions of Solids in Liquids (4 Hours)** — **04 H**

Determine solubility curve for KCl from 25^0C to 50^0C.

III. **Viscosity measurement (10 Hours)** — **10 H**

a. Determination of the viscosity of a liquid or dilute solution using an Ostwald's viscometer.
b. Study of the variation of viscosity of an aqueous solution with concentration of solute.

IV. **Chemical Kinetics** — **12 H**

a. To determine the rate constant and order of reaction between KI and $K_2S_2O_8$.

b. Study of saponification of ethyl acetate with sodium hydroxide at equal concentration of ester and alkali. c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.	
Section B: Inorganic Chemistry	
I. Semi-micro qualitative analysis: not more than four ionic species (two anions and two cations): (4 Mixtures) **Cations** : NH_4^+, Pb^{2+}, Ag^+, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+. **Anions**: CO_3^{2-}, S^{2-}, SO^{2-}, SO_4^{2-}, NO_3^-, Cl^-, Br^-, I^-, NO_2^-, PO_4^{3-}, F^-	**12 H**
II. **Gravimetric/Volumetric** 1. Estimate the amount of Nickel present in a given solution as bis(dimethylglyoximato) Nickel(II) gravimetrically by counterpoise filter paper. 2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA. 3. To estimate the amount of Bismuth present in the given solution of $Bi(NO_3)_2.3H_2O$ by complexometric titration. 4. To estimate the amount of Nitrite present in the given $NaNO_2$ solution by titrating v/s Ceric ammonium sulphate / Ceric sulphate.	**12 H**
III. **Colorimetric Experiments** 1. Draw calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given colored compound ($KMnO_4$/ $CuSO_4$) and estimate the concentration of the same in a given solution. **2.** Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.	**06 H**
LEARNING OUTCOMES:	
Theory:	
At the end of the course, students will be able to **Section A :Physical Chemistry** • Define the terms involved in Kinetic Theory of Gases, Liquids, Solids, and Chemical Kinetics. • Draw the schematic diagrams of stalagmometer, Ostwald viscometer,and cubic crystal structures. • Draw the graphs for first order and second order reactions. • Explain the terms involved like unit cell, space lattice, activation enery, surface tension, viscosity, average velocity, root mean square velocity.	

Section B: Inorganic Chemistry

- Explain general characteristics and electronic configuration of 3d Lanthanide and Actinide elements.
- Explain oxidation states, color, and magnetic properties of 3d and lanthanide elements.
- Understand the Latimer diagram for Mn, Fe, and Cu.
- Name coordination compounds using IUPAC nomenclature.
- Explain inner and outer orbital complexes.
- Identify the different types of isomerism's associated with coordination complexes.
- Calculate crystal field stabilization energy of coordination complexes.
- Understand the effect of strong field and weak field ligands on the crystal field splitting of coordination complexes.

Practical:

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

- Understand the concepts of surface tension, viscosity, and solubility.
- Develop skills for doing chemical kinetics titrations.
- Draw graphs and determine order of reactions.
- Understand on how to use a stalagmometer and Ostwald's viscometer.
- Develop skills in the identification and analysis of cations and anions.
- Perform gravimetric, volumetric and colorimetric experiments.
- Carry out quantitative estimations of various metal ions.

REFERENCES:

Section A : Physical Chemistry

1. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
2. Khosla, B. D.; Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry,* R.
3. Chand & Co.: New Delhi (2011).
4. Systematic experimental physical Chemistry by S.W. Rajbhoj, Dr. T. K. Chondhekar, Anjali Publication.
5. Practical Chemistry by O.P. Pandey, D. N. Bajpai, S. Giri, S. Chand Publication.
6. Senior Practical Physical Chemistry, B.D. Khosla, V.C. Garg, A. Gulati, R. Chand & Comp , New-Delhi

Section B: Inorganic Chemistry

1. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.
2. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
3. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
4. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd.,2008.
5. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India
   Pvt. Ltd., New Delhi (2009).
6. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
7. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
8. Principles of Inorganic chemistry by B.R. Puri, S. Sharma, and Kalia, Vallabh Publication.
9. Inorganic Chemistry Principles of Structure and Reactivity James E Huheey, Ellen A. Keiter, Richard L.Keiter, Okhil K Medhi

CHS-102	Chemistry of Cosmetics and Perfumes (Semester IV)	Credits: 04 (Theory: 03 & Practical: 01)

COURSE OBJECTIVES:

Theory:

- To explain the term cosmeticology.
- To give examples of marketed products and describe the preparation formulation and packaging of various cosmetic products.
- To define herb and other terms involved.
- To describe the preparation of herbal drug.
- To classify herbal cosmetics.
- To describe the development of Ayurvedic and Herbal formulations and their evaluation by physical methods, chemical methods and microscopical techniques.
- To describe the formulation and preparation of Herbal cosmetics for skin care and hair care products.
- To define the terms involved in perfumes and flavours.
- To understand the classification of perfumes and categorise as per the ingredients.
- To understand the importance of essential oils in cosmetic industries.
- To describe the general methods of obtaining volatile oils from plants.
- To describe the composition of volatile oils.

Practical:

- To understand the concept of cosmetics and develop preparation and skills of working and preparation of various cosmetic products.

SYLLABUS

Theory: **45 Hours**

1. **Cosmetic Formulation, principles and preparations** — **15 H**

   Introduction to cosmeticology. Definition of cosmetics as per EU and Indian guidelines. Cleansing and care needs for face, eye lids, lips, hands, feet, nail, scalp, neck, body, and underarms. Examples of marketed products. A general study including preparation and uses of the following: Hair dye, hair spray, sunscreen lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving), Formulation, preparation and packaging of cosmetics for hair - Shampoo and conditioners**.** Examples from marketed products.

2. **Herbal Cosmetics** — **15 H**

   Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation. Classification of herbal cosmetics. Development of Ayurvedic and Herbal formulations and their evaluation by physical methods, chemical methods and microscopical techniques. Herbal cosmetics for skin care (lotions, vanishing cream, foundation creams, anti sunburn preparations, face packs, lipsticks, face powders, soaps). Herbal cosmetics for hair care: Henna and Hibiscus.

3. **Perfumes and Flavors** — **15 H**

   Classification of perfumes. Perfume ingredients listed as allergens. Deodorants, antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone,

Civetone, Muscone. Volatile Oils : General methods of obtaining volatile oils from plants; Study of volatile oils of Mentha, Lemon peel, Orange peel, Lemon grass, Eucalyptus, Musk, Sandal wood.	
Practical	**30 Hours**
1. Demonstration/Practicals 2. Preparation of talcum powder. 3. Preparation of shampoo. 4. Preparation of enamels. 5. Preparation of hair remover. 6. Preparation of cold cream. 7. Preparation of nail polish and nail polish remover. 8. Preparation of vanishing cream. 9. Preparation of shaving cream. 10. Herbal preparations and evaluations of lotions. 11. Herbal preparations and evaluations of face packs. 12. Herbal preparations and evaluations of soaps. 13. Extraction of volatile oil from lemon peel. 14. Extraction of volatile oil from lemon grass. 15. Extraction of volatile oil from orange peel.	**30 H**

LEARNING OUTCOMES:

Theory

At the end of the course students will be able to

- Define cosmetics as per EU and Indian guidelines
- Describe the preparation and uses of various cosmetic products mentioned.
- Describe the formulation and packaging of cosmetics for hair - Shampoo and conditioners.
- Classify herbal cosmetics.
- Explain the terms herbal medicine and herbal medicinal products.
- Describe the preparation of herbal drug.
- Describe the development of Ayurvedic and Herbal formulations and their evaluation by physical methods, chemical methods and microscopical techniques.
- Describe the formulation and preparation of Herbal cosmetics for skin care and hair care.
- Classify the perfumes and categorize the perfume ingredients.
- Explain the importance of essential oil in cosmetic industries.
- Describe the composition of different volatile oils and methods of obtaining them.

Practical:

At the end of the course students will be able to

- Understand the concepts various cosmetic products.
- Prepare various cosmetic products.

REFERENCES:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, DhanpatRai& Sons, Delhi.
3. Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996).
4. G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK. 65.
5. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry,*

VallabhPrakashan, Pitampura, New Delhi.
6. Keith Wilson and John Walker: Practical Biochemistry.
7. Thomas M. Devlin: Textbook of Biochemistry.
8. Talwar, G.P. &Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed.PHI Learning.
9. Text book of herbal cosmetics by Vimaladevi M. CBS Publishing 1st Ed. 2015.
10. The complete technology book on herbal beauty products with formulation and processes by H. Panda, Asia pacific business press Inc. 2005.
11. Essential oils: A practical guide by John Gordon, Aetheric publishing.

CH - 311	Physical Chemistry (SEMESTER V)	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To define the principles, hypothesis, postulates of quantum mechanics in Quantum chemistry.
- To draw the wave functions, orbital diagrams and the graphs involved.
- To solve the numerical, explain and interpret the wave functions.
- To distinguish between reversible and irreversible cells, Different types of reversible cells
- To solve the numerical wrt Nernst equation, to study electrochemical series and applications
- To study optical activity, polarization, dipole moment and methods of determination of dipole moments
- and structure of molecules
- To classify different nuclides. Binding energy and nuclear forces. To study nuclear models, radioactivity.
- To study emf and its measurements. To study concentration cell, its measurements, applications,
- To study decomposition potential, overvoltage and factors affecting them.

Section II

- Molecular structure and molecular spectra:
- To study the electromagnetic spectrum, terms, principles involved. To study Rotational spectra of diatomic molecules, determination of bond lengths and qualitative description
- To study counters used in measurement of radioactivity

SYLLABUS

Theory:

Section I 1. Quantum Chemistry: De Broglie hypothesis, the Heisenberg's uncertainty principle, sinusoidal wave equation, Hamiltonian operator, Schrödinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in one dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave function, radial wave functions, angular wave functions.	12 L
2. Electrochemistry:- I Electrolytic and galvanic cells; reversible and irreversible cells, conventional representation of electrochemical cells; types of reversible electrodes; gas – metal ion, metal-metal ion, metal in soluble salt-anion and redox electrodes, electrode reaction; Nernst equation; derivation of cell E.M.F. and single electrode potential, reference electrodes, standard hydrogen electrode; calomel electrodes ;standard electrodes potential, sign convention, electrochemical series and its applications.	07 L
3. Molecular Structure Optical activity and molecular structure; polarization (Mosotti-Clausius equation), orientation of dipoles in an electric field, dipole moment, induced	05 L

dipole moment, measurement of dipole moment; temperature method and refractivity method, dipole moment and structure of molecules. 1. Nuclear Chemistry: - I Composition of the nucleus. Nuclear binding forces, binding energy, stability, nucleon-nucleon forces and their equality, characteristics and theory of nuclear forces. Nuclear models, the shell model, liquid drop model and its merits. Theory of radioactive disintegration, rate of disintegration half, average life of radio element, units of radioactivity, definition and characteristics of artificial radioactivity. **Section II** 2. Electrochemistry :-II EMF of a cell and its measurements; Concentration cells (both electrodes and electrolytes) with and without transport; liquid junction potential and its measurement; Application of concentration cell; determination of ionic product of water; transport number of ions; solubility and solubility product. Polarization; elimination of polarization; decomposition potential, measurement of decomposition potential ; factor affecting decomposition potential over voltage and types of over voltage; measurement of over voltage ; factor affecting over voltage 3. Molecular structure and molecular spectra: Introduction to electromagnetic radiation; regions of the spectrum; statement of the BornOppenheimer approximation; degrees of freedom. Rotational Spectrum: Diatomic molecules, energy level of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (MaxewllBoltzmann distribution); determination of bond length, qualitative description of non-rigid rotor, isotope effect. 4. Nuclear Chemistry:-II Determination and measurements of radioactivity: Ionisation current measurements; saturation collection; multiplicative ion collection; the Geiger-Muller Counter, characteristics of an ideal Geiger-Muller Counter, proportional counter. methods based on photon collection, Scintillation counter, characteristics of a suitable Scintillator.	06 L 13 L 08 L 09 L
LEARNING OUTCOMES:	
Theory:	
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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2 U.N.Dash, Nuclear Chemistry, by Sultan Chand & Sons, New Delhi.

Reference Books

1. Puri, Sharma, Pathania, Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press

2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,

3. Donald McQuarrie, Physical Chemistry

CH- 321	Inorganic Chemistry (SEMESTER V)	Number of lectures:60

COURSE OBJECTIVES:

Theory:

Section I

- To discuss the drawbacks of Valence bond theory for co-ordination compounds.
- To generalise the postulates of Crystal field theory
- To define the terms Crystal field splitting, Crystal field splitting energy, Crystal field stabilization energy.
- To draw the crystal field splitting diagram for octahedral, tetrahedral and square planar complexes.
- To evaluate the magnetic properties of transition metal complexes.
- To calculate the magnetic moments for different transition metal complexes having octahedral, tetrahedral and square planar geometry.
- Toknow the classification of elements as essential or trace and their uses in biological processes.
- To study the roles of myoglobin and hemoglobin with respect to the transfer and storage of oxygen in biological systems and the process of respiration.
- To introduce basic synthesis concepts of solid-state chemistryand provide introductory knowledge on concept of band gap and classification of materials based on it.

Section II

- To define the terms Organometallic compounds, mononuclear, polynuclear metal carbonyls.
- To state the Effective atomic number rule, 18 electron rule for metal carbonyls and organometallic compounds.
- To state the names of metal carboyls and organometallic as per the IUPAC system.
- To generalise the methods of preparation, properties and bonding in $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$, $Mn_2(CO)_{10}$,$Fe_2(CO)_9$,$Fe_3(CO)_{12}$ and ferrocene.
- To classify the ligands based on hapticity,.
- To prepare by various methods alkyls and aryls of Li ,Al ,Hg and Ti and to study their physical and chemicals properties.
- To learn general methods of preparationsof organometallic compounds
- To understand the model systems prepared to study macromolecular biological molecules.
- To know the types of alkali and alkaline earth metals and their roles in biological systems.
- To define metalloenzymes and to study their roles in biological systems.
- To introduce concept of defects in solids and define Schottky and Frenkel defects, Color center, extended defects and Non-stoichiometry

SYLLABUS

Theory:	
Section I **1)Metal-Ligand Bonding in Transition Metal Complexes:** Limitations of Valence bond theory, Crystal field theory (CFT) splitting of d-orbitals in octahedral, tetrahedral and square planar complexes. Crystal Field Stabilization Energy (CFSE), Measurement of 10 Dq for $[Ti(H_2O)_6]^{3+}$ complex, Factors affecting 10 Dq, Spectrochemical series, Effect of crystal field splitting on properties of Octahedral complexes: Magnetic, Spectral.	**20L**
2)Bio-inorganic Chemistry (I) Overview, essential and trace elements in biological processes, Metalloporphyrin special reference to hemoglobin and myoglobin.	**05L**
3)Inorganic solid-state chemistry (I) Introduction, Preparation of Nonmolecular solids, Band gaps, Metals, Insulators and Semi-conductors.	**05L**
Section II **4)Organometallic chemistry** **A)** Definition, nomenclature and classification of organometallic compounds, EAN rule, 18 electron rules. General methods of preparations and properties. Structure and bonding in mononuclear metal carbonyls: $Ni(CO)_4$, $Fe(CO)_5$ and $Cr(CO)_6$ (Orbital diagram not expected) B) Polynuclear metal carbonyl: preparation and structures of $Mn_2(CO)_{10}$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$ (Orbital diagram not expected) C) Sandwich compounds like Ferrocene: preparation, properties, reactions, structure and bonding. D) Preparation and properties of alkyl and aryls of Li, Al, Hg and Ti.	**20L**
5) **Bio-inorganic Chemistry (II)** The role of Model systems, The alkali and alkaline earth metals,Metalloenzymes, Nitrogen fixation cycle.	**05L**
6) **Inorganic solid-state chemistry (II)** Defects in Solids Point defects: Schottky and Frenkel, Color center, extended defects, Non-stoichiometry.	**05 L**
LEARNING OUTCOMES:	
Theory:	

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 carboyls 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.

.

REFERENCES

Text- Books:

1. Concise Inorganic Chemistry. 5th edition, J. D. Lee
2. Basic Inorganic Chemistry, 5th edition, F.A. Cotton, G. Wilkinson.

Reference books:

3. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit 18th revised edition, Himalaya Publishing House.
4. Principles of Inorganic Chemistry, B.R Puri, L. R. Sharma, Milestone Publishers.
5. Inorganic Chemistry, (Principles of Structure and Reactivity). James E. Huheey, Ellen A. Keiter, Richard L. Keiter
6. Inorganic Chemistry D. E. Shriver, P.W. Atkins and C.H. Langford, Oxford.
7. Advance Inorganic Chemistry, 6th edition, F.A. Cotton and G. Wilkinson
8. Comprehensive Inorganic Chemistry, B.S. Bahl and Sharma
9. Group theory and its Chemical applications, P. K. Bhattacharya, Himalaya Publication.
10. Environmental Chemistry, A. K. De.

CH-331	Organic Chemistry Semester V	Number of lectures:60

COURSE OBJECTIVES:

Theory:60 L

Section I

- To understand important concepts in NMR and Mass spectroscopic methods.
- To learn the structure elucidation of simple organic molecules using spectroscopictechniques (UV, IR, PMR, CMR and MS).
- To study the Structure elucidation and synthesis of Nicotine, Atropine and Papaverine.
- To understand the mechanism and stereochemistry of addition of halogens and halogen acids to open chain alkenes, substitution reactions and elimination reactions.

Section II

- To understand the molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine.
- To learn 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 andBischler-Napieralski synthesis.
- To understand the mechanism of, nucleophilic substitution reactions in pyridine derivatives and electrophilic substitution reactions of indole, quinoline and isoquinoline.
- To compare basicity of pyridine, piperidine and pyrrole.
- To study condensed 5 and 6 membered heterocycles.
- To learn the importance of vitamins, hormones and the classification of vitamins.
- To study the structure elucidation and synthesis of vitamin A, C, thyroxine and adrenaline.
- To study the structure of amino acids, peptides and proteins.
- To learn the preparation and reactions of α-amino acids.
- To understand the concept of isoelectric point, electrophoresis, protein denaturation/renaturation, nucleic acids and double helical structure of DNA.
- To learn the reactions for peptide synthesis, hydrolysis of peptides, nucleic acids and methods for peptide structure determination.

SYLLABUS

Section I

1. Spectroscopy Proton Magnetic Resonance (^{1}H NMR) spectroscopy, theory, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, intensity of peaks, interpretation of PMR spectra of simple organic molecules. ^{13}C Magnetic Resonance: Number of signals, splitting of signals – proton coupled and decoupled spectra, off resonance decoupled spectra. ^{13}CMR chemical shifts – identification of hybridization of carbons and nature of functionalization. Mass Spectrometry: Simple idea of instrumentation, Definitions of parent or molecular ion peak and base peak. Isotope effect with respect to alkyl halides, Fragmentation of ketones – α cleavage and Mc Lafferty rearrangement. Problems pertaining to the structure elucidation of simple organic molecules using spectroscopic techniques (UV, IR, PMR, CMR and MS). Types of problems to be	18 L

specified. UV and IR to be used as supporting data. Types of CMR and Mass spectroscopy problems to be specified. 2. Alkaloids Structure elucidation and synthesis of Nicotine, Atropine and Papaverine. 3. Stereochemistry of Reactions: Mechanism and stereochemistry of (i) Addition of halogens and halogen acids to open chain alkenes. Markownikoff's and anti- Markownikoff's addition. (ii) SN_1, SN_2, SN_i , substitutions and (iii) E_1, E_2 and E_{1cb} elimination reactions.	05L 07 L
Section II 4. **Heterocyclic Compounds** Introduction, Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed 5 and 6 membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis andBischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline. 5. **Vitamins and Hormones** Vitamins: Importance and classification. Structure elucidation and synthesis of Vitamins A and C. Hormones: Important hormones and their uses. Structure elucidation and synthesis of Thyroxine and Adrenaline. 6. **Amino acids, Peptides, Proteins and Nucleic Acids** Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical methods of peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structures. Protein denaturation/renaturation. Nucleic acids: Introduction. Hydrolysis of nucleic acids. Ribonucleosides and ribonucleotides. General idea of the double helical structure of DNA.	12L 08 L 10 L
LEARNING OUTCOMES:	
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.

REFERENCES:

Reference Books

1. I.L.Finar, Organic Chemistry Vols I and II, Orient Longman
2. Morrison and Boyd, Organic Chemistry; 6th Edn. Prentice Hall India
3. Francis Carey, Organic Chemistry
4. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edn. Pearson Education Asia
5. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds.

CH - 341	ANALYTICAL CHEMISTRY SEMESTER V	Number of lectures: 45

COURSE OBJECTIVES:

Theory:

- Define the terms involved in sampling techniques, data handling and solvent extraction, electrolytic methods, potentiometric titrations.
- State the laws and principles involved in solvent extraction, electrolytic methods, potentiometric titrations.
- Explain scope and importance of analytical chemistry, sampling of liquid,solid and gases, different types of tests related to data handling, the different types of extraction.
- Differentiate between various electrolytic methods, state and explain limits and merits of the various methods.
- Draw the amperometric titration curves, schematic diagram of instruments and explain its working.
- Classify and explain different types of errors, sampling techniques and types of extraction.
- Derive and use the equations of linear least squares and method of averages and solvent extraction to solve numerical.
- Interpret steps involved in chemical analysis.
- Explain the principle of potentiometric titrations, location of equivalence point and types of potentiometric titrations.

SYLLABUS

Theory:

Section I **1. Introduction** Scope and importance of analytical chemistry Chemical analysis and analytical chemistry Analytical process (steps involved in chemical analysis): defining the problem, sampling,separation of desired components, actual analysis, presentation and interpretation of results. Basic components of instruments for analysis Signal generators, detectors (input transducers) Signal processors, read out devices, circuits & electrical devices in instruments. References:1,2,3	**4 L**
2. Sampling Techniques Terms encountered in sampling: the population or the universe, Sample, Sampling unit, increment, the gross sample, the sub sample, Analysis sample, Bulk ratio, Size to weight ratio, Random sampling, Systematic sampling, Multistage sampling, Sequential sampling. Sampling of Gases, Liquids and Solids Preservation, storage and preparation of sample solution (References: 1,2,3)	**4 L**
3. Data handling Significant figures and rounding off. Accuracy and precision Errors : determinate and indeterminate error, Constant and proportionate errors ,	**11 L**

Minimization of errors Standard deviation. Histogram and Frequency polygon Measures of central tendency and dispersion.Gaussian distribution curve Confidence limit. Test of significance: F test, Students T Rejection of the results: Q test, 2.5d & 4d rule. Linear least squares/ Method of averages (Numerical problems are expected to be solved) Reference:1,35	
4. Solvent Extraction Basic principle, percentage extraction, role of complexing agents in solvent extraction, separation factor, Types of extraction (continuous, batch). (Numerical problems are to be solved) References: 1,2,3	**3L**
Section II	
5. Electrolytic methods Introduction: principles involved in Electrogravimetric analysis, Instrumentation, Electrolysis at constant current principle, apparatus, determination of copper by constant current electrolysis. Coulometry: Introduction, constant Current measuring device, Hydrogen-Oxygen coulometer, Silver coulometer. General characteristics of coulometric method, Coulometric titrationsApplications of coulometric titrations (References: 1,3,) Polarography:Introduction, Basic principles of instrumentation of polarography, Deposition potential, Dissolution potential, Polarisation of electrode, Polarographic wave, Ilkovic equation, Half wave equation (derivation not expected) Supporting electrolytes, Interference of oxygen, Applications of polarography – inorganic and organic. (Refences: 1,3,5) Amperometric titrations: Introduction, Instrumentation, Titration Curves, advantages of amperometric titrations.(Reference:1,3)	**12 L**
6. Potentiometric Titrations Principles of potentiometric titrations, Location of equivalent point, Different types of potentiometric titrations. (References :1,2,3)	**5 L**
7. **Atomic spectrometric methods:** Flame Photometry:Introduction, Principle, Instrumentation, applications, Limitations. Atomic absorption Spectroscopy: Introduction, Principle, Instrumentation, applications, limitations.	**6 L**

Differences between flame photometry and atomic absorption spectroscopy. Inducted coupled plasma. (References: 1,2,3)	

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Book

B.K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut

Reference Books

1. G. D.Christan Analytical Chemistry by, 5th edition Wiley publications.
2. G. Chatwal and S. Anand, Instrumental Methods of Chemical Analysis 5th edition (reprint 2003), Himalaya publication.
3. B. S. Baliga and A.Zaveri, College Analytical Chemistry, 15th edition, Himalaya Publishing House, 2004
4. Vogels Textbook of Quantitative Inorganic Analysis 4th edition ELBS.
5. Willard, Meritt and Dean. Instrumental Methods of Analysis
6. Skoog and Leary, Principles of Analytical Chemistry 4th International edition.

7. P.R.Trivedi and Gurdeep Raj, Environmental Water and Soil Analysis, Akashdeep Publishing House, New Delhi.
8. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.

CH – 301	Experiments in Physical and Analytical Chemistry SEMESTER V	Number of hours: 45

COURSE OBJECTIVES:

Practical:

- To understand and develop the problem solving skills and hands on experience with refrence to concepts studied in theory(potentiometry , pH metry, partition coefficient, Chemical kinetics)
- To understand and develop the problem solving skills and hands on experience with refrence to instrumentation and techniques studied in theory.(spectrophotometry,chromatography and conductometry)

SYLLABUS

Practical

Physical

Conductometry

1. To determine the percent composition of acid mixture (strong and weak acid) by titrating against standard 0.1 N NaOH solution.
2. To verify Ostwald's dilution law using CH3COOH Potentiometry
3. To determine the formal redox potential of Fe2+/Fe3+ system using standard 0.1N K2Cr2O7 solution.
4. To determine the solubility product of AgCl/AgBr.

pH metry

5. To determine the dissociation constant of weak monobasic acid (CH3COOH) by titrating against standard 0.1N NaOH solution

General

6. Partition Coefficient: To determine the equilibrium constant for the reaction KI +I2 === KI3
7. Adsorption: To study the adsorption of acetic acid from aqueous solution by activated charcoal and verify Freundlich adsorption isotherm.
8. Chemical Kinetics: To study the acid hydrolysis of methyl acetate at two different temperature and determine the energy of activation.

Analytical

A] Spectrophotometry.

1. Determination of Mn2+ in steel or Mn2+ ion concentration periodate method.
2. Determination of iron by salicylic acid method.

B] Chromatography

3. Separation of metal ions by paper chromatography.(demonstration)
4. Separation of organic compounds by TLC.(demonstration)
5. Zn2+ /Mg2+ separation by an anion exchanger & their volumetric estimation of with standard EDTA.

C] Conductometry

6. Estimate the amount of Pb present in a solution of Pb(NO3)2 by conductometric titration with Na2SO4

D] Other Experiments

7. Determination of ascorbic acid in Vitamin C tablets by iodometry
8. Estimation of Ca in milk powder using EDTA method (volumetry) and also by precipitation as oxalate followed by titration with KMnO4 (not for examination)

LEARNING OUTCOMES:

Practical:

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.
- 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.

REFERENCES:

1.Basic Principles of Analytical Chemistry. To be used as text book.
K. Raghuraman, D.V.Prabhu, C.S. Prabhu and P.A.Sathe
3rd, 4th and 5th edition, Sheth Publishers.
2.Analytical Chemistry.
Gary Christian, 4th Edition, International Edition.
3.Principles of Analytical Chemistry.
Skoog and Leary, 4th International Edition.

CH-:303	Experiments in Inorganic and Organic Chemistry (Semester V)	Number of hours: 60

COURSE OBJECTIVES:

Practical:

- To understand and systematically estimate quantitatively the desired metal ions by gravimetry in presence of interfering ions and also quantitatively estimate inorganic complexes of different metal ions.
- To understand theoretical concepts required for experiments and develop hands on experience with reference to basic laboratory techniques required for organic estimations, synthesis and finding the organic mixture type.

SYLLABUS

Practical:

Inorganic Chemistry

Gravimetric Estimations .

1. To estimate the amount of Fe as Fe_2O_3 in the given solution of ferric chloride containing barium chloride and free HCl.
2. To estimate the amount of nickel as Ni-DMG in the solution of nickel chloride containing copper chloride and free HCl.
3. To estimate the amount of barium as $BaCrO_4$ in the solution of barium chloridecontaining ferric chloride and free HCl.
4. To estimate the amount of Zinc as $Zn_2P_2O_7$ in the given solution of zinc sulphate containing copper sulphate and free H_2SO_4.

Inorganic Preparations

1. Preparation of Sodium trioxalatoferrate(III); $Na_3[Fe(C_2O_4)_3]$ complex.
2. Preparation of Tristhioureacopper (I) sulphate.
3. Preparation of Trisethylenediaminenickel(II) complex.
4. Preparation of Chrome Red.

Organic Chemistry

1. Organic Estimations:
   a) Mixture of acid and ester
   b) Mixture of acid and amide
   c) Saponification value of oil
2. Organic synthesis: Nitration of nitrobenzene and acetanilide, p-bromoacetanilide from acetanilide, m-nitroaniline from m-dinitrobenzene, synthesis of osazone of glucose and oxime of cyclohexanone
3. Finding the organic mixture type: Solid-solid-Water Soluble- Insoluble type.
   1)Acid-Acid 2) Acid-Neutral 3) Neutral-Neutral
   Liquid-liquid mixture type as well as the separation.
   Note: 1) 6 Organic Synthesis to be completed in 3 practicals.
   2) At least 5-6 mixture type determination to be given (not to be given for examination)

LEARNING OUTCOMES:

Practical:

At the end of the course students will be able to

- 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.
- 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.

REFERENCES:

Inorganic Chemistry:

Books for Practicals:

1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham ELBS.
3. Standard Methods of Chemical Analysis W.W. Scott, Technical Press.
4. Experimental Inorganic Chemistry W.G. Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol. I and II Brauer, Academic Press.
6. Inorganic Synthesis, Mc Graw Hill.

Organic Chemistry:

1. Vogel's Qualitative Organic Analysis, Orient Longman.
2. Textbook of Practical Organic Chemistry, N.K.Vishnoi.

CH - 312	Physical Chemistry (Semester VI)	Number of lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To study the molecular orbital theory diagrams and the graphs involved.
- To interpret the physical picture of bonding and antibonding wavefuction.
- To define terms involved in electrochemistry, pH, poH, pKa, pKb. Buffer solution, buffer capacity. Measurement of pH using different electrodes by potentiometric methods.
- To describe the mechanism of buffer action.
- To derive and solve numerical on Henderson's equation.
- To study energy released in nuclear fission, fission products.
- To classify various nuclear reactors. To describe the working of reactors and its parts.
- To know nuclear reactors in India.
- To define the terms and laws involved in photochemistry.
- To draw and interpret Jablonski diagrams
- To study photochemical and photosensitized reactions with examples

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Section II

- To describe types of theories in corrosion
- To explain the types of energy sources
- To study vibrational spectroscopy, ir, harmonic and anharmonic oscillator, Raman spectroscopy,
- Define terms , force constants, bond energy, polarizability.
- To study stokes and antistock lines, Raman shift and selection rules involved.
- Chain reactions, terms involved and units of radioactivity, applications of radioactive isotopes Biological effects of radiations.

SYLLABUS

Theory:

Section I 1. Quantum Chemistry: Molecular orbital theory, basic ideas-criteria for forming M.O from A.O, construction of M.O's by LCAO-H2+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions.	06 L
2. Applied Electrochemistry - I Definition of pH, pOH pKa,and pKb; introduction to potentiometer; determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric method; Buffer solution, types, buffer action, buffer capacity ,mechanics of buffer action, Henderson-Hazelbulch equation.	08 L
3. Nuclear Chemistry - I Nuclear fission, energy released in fission and fission products, neutron emission in fission, nuclear energy, classification of reactors, the breeder reactor, nuclear reactors in India.	06 L

4. Photochemistry: Interaction of radiation with matter, differences between thermal and photochemical processes, laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagram; depicting various processes occurring in the excited state, quantum yield and its measurements qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, inter system crossing), photosensitized reactions-energy transfer processes (simple examples).	10 L
Section II 5. Applied Electrochemistry:- II Corrosion-Types, theories - electrochemical and chemical. Energy sources: Acid and alkaline battery. Ni-Cd cell fuel cells, solar cells. Secondary batteries.	08 L
6. Spectroscopy: Vibrational Spectrum: Infrared spectrum: energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of an- harmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. Raman spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.	16 L
7. Nuclear Chemistry: - II Chain reaction and conditions for its control ; reprocessing of spent fuels; units of radiation energy ;applications of radioactive isotopes; radioisotopes as tracers; biological effects of radiation.	06 L

LEARNING OUTCOMES:

Theory:

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.

REFERENCES:

Text Books

1. P.W. Atkins et al., Physical Chemistry, 7th edition

2 U.N.Dash, Nuclear Chemistry, by Sultan Chand & Sons, New Delhi.

Reference Books

1. Puri, Sharma, Pathania, Principles of Physical Chemistry by Vishal Publishing Company, Oxford University Press

2. G. K. Vemulapalli, Physical Chemistry, Prentice Hall India, 1993,

3. Donald McQuarrie, Physical Chemistry

CH- 322	Inorganic Chemistry SEMESTER VI	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To study types of electronic transitions and selection rules for transitions to take place
- To study the applications to determine ligand field strength, color of complexes, Cis-trans isomerism and Geometry of complexes.
- To define the terms fuel gases, calorific value, benzol.
- To state the composition ,draw the flow sheet and equipment for manufacture of of coal gas, producer gas and water gas
- To explain the advantages of fuel gases over liquid and solid fuels.
- To discuss the physicochemical principles involved in the synthesis of ammonia by Haber's process and Nitric acid by Ostwald's method.
- Todefine pollutant, primary and secondary pollutant, air pollution
- To discuss sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur.
- To understand Photochemical smog.
- To discuss the phenomenon of acid rain, greenhouse effect.
- To introduce concept of Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rotation – reflection axis and Identity and apply to different molecules

Section II

- To define the terms Magnetic susceptibility, magnetic moment, diamagnetism, paramagnetism.
- To explain the different types of magnetic behaviour- diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, measurement of susceptibility by Gouy's method.
- To draw the graph of susceptibility v/s temperature for paramagnetic, ferromagnetic and antiferromagnetic substances.
- To calculate magnetic moment by spin formula for different transition metal complexes.
- To interpret the magnetic behaviour of different transition metal complexes based on observed and calculated magnetic moments.
- To introduce Nanochemistry and explain nano particles, their properties and applications.
- To introduce zeolites, their structure and applications.
- To define the terms Meissner effect,critical temperature.
- To explain the mechanism of superconductivity.
- To discuss the different types of superconductors.
- To define and study the properties of inorganic polymers.
- To classify condensation, addition and coordination Polymers
- To introduce preparation, structure & bonding and applications of silicones.
- To study stability constants of reactions in terms of thermodynamic and kinetic stability and the various factors affecting the stability constants of complexes.
- To study the substitution reaction mechanisms of octahedral complexes and the trans effect observed in square planar complexes.

SYLLABUS

Theory:

Section I

1.Electronic spectra of Transition Metal Complexes: **10L**

Introduction, Types of electronic transitions: The d-d transitions (d^1/d^9 and d^2/d^8), Charge transfer transitions and Ligand-ligand transitions, Selection rules (Laporte Orbital and Spin), Applications (Ligand field strength, Colour of complexes, Cis-trans isomerism and Geometry of complexes).

Ref: 3,7

2.Industrial fuels and chemicals. **8L**

(A) Industrial fuels like coal gas, producer gas and water gas.

(B) Physico chemical principles involved in the manufacture of HNO_3 (Ostwald's method) and NH_3 (Haber's method).

Ref: 8

3.Air Pollution: **7L**

Introduction, classification of pollutants, sources, control, effect w.r.t. oxides of Nitrogen, Carbon and Sulphur, Photochemical smog, acid rain and House effect.

Ref: 10

4.Symmetry and Term symbols: **5L**

(A) Symmetry elements: Centre of symmetry, Rotation axis, Mirror plane, rota reflection axis, Identity (Trans dichloroethylene, H_2O and BCl_3)

Ref: 9

Section II

5. Magnetic properties of transition metal complexes: **5L**

Types of magnetic behaviour, Methods of determining magnetic susceptibility (Gouy's method), spin only formula, application of magneticmoment data for 3d – metal complexes.

Ref: 1, 4

6.Selected topics: **(A) Nano chemistry:** Introduction to Nano particles, their properties and applications. **(B) Solid acids:** Introduction to zeolites, structure and applications. **(C)Superconductors:** Discovery, critical temperature, Meissner effect, Conventional and High Temperature superconductors. **Ref:** 3, 5	**10 L**
7.Inorganic Polymers: Definition, Properties, Glass transition temperature, Classification (Condensation, addition and coordination Polymers) **Silicones:** Preparation, structure & bonding and applications. **Ref:** 3, 4	**6 L**
8.Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamicstability of metal complexes and factors affecting the stability, substitution reactions of Octahedral complexes. Trans effect with respect to square planar complexes. **Ref:** 5	**9 L**

LEARNING OUTCOMES:

Theory:

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

- Discuss preparation, 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.

REFERENCES:

Text- Books:

1. Concise Inorganic Chemistry. 5th edition, J. D. Lee
2. Basic Inorganic Chemistry, 5th edition, F.A. Cotton, G. Wilkinson.

Reference books:

3. College Inorganic Chemistry for T.Y. B. Sc. Laxmi Devi, Patel, Dhume, Turakia, Dixit 18th revised edition, Himalaya Publishing House.
4. Principles of Inorganic Chemistry, B.R Puri, L. R. Sharma, Milestone Publishers.
5. Inorganic Chemistry, (Principles of Structure and Reactivity). James E. Huheey, Ellen A. Keiter, Richard L. Keiter
6. Inorganic Chemistry D. E. Shriver, P.W. Atkins and C.H. Langford, Oxford.
7. Advance Inorganic Chemistry, 6th edition, F.A. Cotton and G. Wilkinson
8. Comprehensive Inorganic Chemistry, B.S. Bahl and Sharma
9. Group theory and its Chemical applications, P. K. Bhattacharya, Himalaya Publication.
10. Environmental Chemistry, A. K. De.

CH-332	Organic Chemistry (Semester VI)	Number of Lectures: 60

COURSE OBJECTIVES:

Theory:

Section I

- To know nomenclature of different carbohydrates.
- To know classification of carbohydrates and terpenes.
- To study general reactions of Monosaccharides.
- To study the determination of configuration and ring size of monosaccharides with reference to glucose, interconversion of glucose.
- To know cyclic structure of D(+)- glucose and study mutarotation, formation of glycerides, ethers, esters and structure elucidation of sucrose.
- To learn the general methods of structure elucidation of terpenes.
- To learn the synthesis of α-terpineol, camphor, citral. ethyl acetoacetate by Claisen condensation.
- To study the chemistry of α-terpineol, camphor, citral. α-pinene and zingiberene.
- To understand the acidity of α-hydrogens, keto-enol tautomerism in ethyl acetoacetate, hydrogenation of unsaturated oils,
- To study the alkylation of diethyl malonate, ethyl acetoacetate, 1,3-dithianes, enamines and acylation of enamines.
- To study the chemistry of following- Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, soaps, synthetic detergents, alkyl and aryl sulphonates.
- To learn the various terms such as saponification value, iodine value and acid value of oils.

Section II

- To learn the definition of the terms involved.
- To know the classification of dyes, synthetic drugs, polymers and types of polymerization.
- To learn the preparations of various polymers mentioned in the syllabus.
- To understand the difference between natural and synthetic rubber with examples.
- To learn the vulcanization of rubber.
- To understand the effect of constitution on colour of different organic compounds based on electronic concept.
- To study the chemistry and the synthesis of various dyes mentioned in syllabus.
- To learn nomenclature and structure of one compound from all classes of pharmacodynamic agents and chemotherapeutic agents.
- To learn synthesis and application of various synthetic drugs.
- To know the nomenclature and structural features of Organosulphur and Organophosphorus compounds.
- To learn the methods of preparations and reactions of thiols, thioethers, sulphonic acids, phosphines and phosphonium salts including Wittig reaction and its applications.
- To understand the chemistry of ylides and Organophosphorus compounds.
- To understand chemistry of photochemical reactions, Jablonskii diagram, Norrish type I and Norrish type II cleavage of ketones
- To understand electronic transitions and transition states.

SYLLABUS	
Section I 1. **Carbohydrates** Classification and nomenclature. Monosaccharides: General reactions, chain lengthening by Killiani-Fischer synthesis and chain shortening by Ruff degradation of aldoses, mechanism of osazone formation. Configuration of monosaccharides with reference to glucose. d(+)/l(-) and D/L systems of nomenclature. Interconversion of glucose to fructose and glucose to mannose. Determination of ring size of monosaccharides with reference to glucose. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. Formation of glycosides, ethers and esters. Structure elucidation of sucrose.	10L
2. Terpenes Classification. General methods of structure elucidation. Chemistry and synthesis of citral and its conversion to ionones. Chemistry and synthesis of α-terpineol, camphor. Chemistry of α-pinene. Chemistry of zingiberene.	10L
3. **Organic synthesis via Enolates**: Acidity of α-hydrogens, Synthesis of ethyl acetoacetate by Claisen condensation, keto-enol tautomerism in ethyl acetoacetate. Alkylation of diethyl malonate and ethyl acetoacetate. Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.	08L
4. **Fats, Oils and Detergents:** Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides. Hydrogenation of unsaturated oils. Saponification value, iodine value and acid value of oils. Soaps, synthetic detergents, alkyl and aryl sulphonates.	02L
Section II **5. Synthetic Polymers:** Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Zeigler-Natta polymerization and vinyl polymers. Condensation or step-growth polymerization. Polyesters, polyamides, phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.	05L
6. **Synthetic Dyes**: Color and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of methyl orange, Congo Red, Malachite Green, Crystal Violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.	08L

7. Synthetic Drugs: Classification according to use. One compound with name and structure from all classes of pharmacodynamic agents and chemotherapeutic agents. Synthesis and uses of the following drugs: Phenobarbital, Chlorpheniramine, Atenolol, Ibuprofen, Naproxen, Methyldopa, Chloramphenical, Metronidazole and Ethambutol.	06L
8. Organosulphur and Organophosphorus Compounds: Nomenclature, structural features. Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids. General reactions only. Introduction to organophosphorus compounds. General methods of preparation of phosphines and phosphonium salts. Wittig reaction and its applications.	08L
9. Photochemistry: General idea of photochemical reactions. Electronic transitions and transition states. Jablonskii diagram. Norrish type I and Norrish type II cleavage of ketones.	03L

LEARNING OUTCOMES:

Theory:

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,

transition states and photochemical reactions.

REFERENCES:

1. I.L.Finar, Organic Chemistry Vols I and II, Orient Longman
2. Morrison and Boyd, Organic Chemistry; 6th Edn. Prentice Hall India
3. Francis Carey, Organic Chemistry
4. Paula Yurkanis Bruice, Organic Chemistry; 3rd Edn. Pearson Education Asia
5. Silverstein, Bassler and Morill, Spectrometric Identification of Organic Compounds;

CH - 342	Analytical Chemistry (SEMISTER VI)	Number of hours: 45

COURSE OBJECTIVES:

Theory:

SECTION I & II

- Define the terms involved in basic electronics and thermal methods, radiochemical methods, UV Visible Spectroscopy, Chromatographic methods, **Fluorimetry**
- State the principles in thermal methods of chemical analysis and basic electronics, UV Visible Spectroscopy and **Fluorimetry,** principles of isotope dilution method and neutron activation analysis.
- Draw the schematic diagrams, diagrams of instruments, circuit diagrams and the graphs involved.
- Describe the working of instruments, electronic components and circuits.
- Explain the terms involved giving examples, interpret the graphsin UV Visible Spectroscopy , chromatographic methods and fluorimetry.
- Classify and explain the different types of chromatographic technique.
- Derive and use the equations of Beer Lamberts law, Gas chromatography to solve numericals.
- Discuss applications of UV Visible Spectroscopy , chromatographic technique and fluorimetry.
- Analyse different parameters of water,air and soil analysis.

SYLLABUS

Theory:

Section I **1. UV-Visible Spectroscopy** Interaction of electromagnetic radiation with matter, Quantitative calculations- Beer's and Lambert's law. Deviations from Beer's law Principles of instrumentation: Sources, monochromators, cells. Types of instruments. Photoelectric colorimeters: Single & Double beam photoelectric colorimeters; comparison between colorimeter and spectrophotometer ; applications of colorimetry and/or spectrophotometry ; quantative analysis; identification of structural groups in a molcule ; study of co-ordination compound, photometric titrations, cis-trans isomerism; chemical kinetics & others limitations. *(Reference: 1,3)(numerical problems are expected to be solved)*	**09 L**
2. Chromatographic Methods Principles. Classification of chromatographic techniques Techniques of column chromatography Paper and thin layer chromatography: Principles, techniques and applications of paper and thin layer chromatography.Theory of chromatographic separation :DistributionEquilibria, Rate of travel, Retention time,Retention volume and relative retention.Ion exchange chromatography: Principles, classification of ion exchange materials, Nature of exchanging ions, Ion exchange capacity, applications in analytical chemistry.VGas chromatography and HPLC : Gas chromatography: Basic principles, Graphic diagram of apparatus, Explanation	**14 L**

of factors affecting separation, Thermal conductivity and Flame ionization detectors, Identification and estimation of sample components, Applications GC-MS and HPLC in detail. HPLC: principles equipment for HPLC , applications. *(Numerical problems are to be solved.References: 1, 2,3)* **Section II** **3. Basic Electronics** Introduction to diodes, rectifiers, zener diodes, regulated power supply, SCR's, triac and control circuits, Transistors, FET, Linear Integrated circuits and operational amplifiers.Binary arithmetic. *(Reference : 6)* **4. Thermal Methods** Thermogravimetric Methods (TG):Instrumentation, applications with respect to CaC2O4.H2O and CuSO4.5H2O Differential Thermal Analysis (DTA): General principles and applications. Differential Scanning Calorimetry (DSC): Applications. *References:2,4,5* **5. Fluorimetry** Principles of Fluorescence, chemical structure and Fluorescence. Relationship between concentration & fluorescence intensity Instrumentation & applications.*(numerical problems are expected to be solved)* *References:2,3* **6. Radiochemical methods** Isotope dilution Analysis: Principles and applications. Neutron activation analysis: principle, calibration curve method, advantages and limitations of neutron activation analysis. *(Reference : 6)* **7. Environmental Chemistry: Air, Water and Soil Analysis** Water analysis: Dissolved oxygen, free carbon dioxide, B.O.D., C.O.D. and total carbohydrates. Soil/ sediment analysis: Bulk density, Specific gravity, moisture content, water holding capacity, pH, electrical conductivity, alkalinity, detection of sulphate (By colorimeter or turbidimeter), nitrogen, nitrate, total phosphorus, phosphate, calcium, magnesium, sodium, potassium, iron and organic matter. Air analysis: SO2, H2S, NO-NO2, CO-CO2, O3 and NH3 *References: 8,9,*	**07 L** **04 L** **03 L** **03 L** **05 L**
LEARNING OUTCOMES:	
Theory:	

- 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 chemicalanalysis.
- 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

REFERENCES:

Text Book

B.K. Sharma. Instrumental Methods of Chemical Analysis: Goel Publishing House, Meerut

Reference Books

1. G. D.Christan Analytical Chemistry by, 5th edition Wiley publications.
2. G. Chatwal and S. Anand, Instrumental Methods of Chemical Analysis 5th edition (reprint2003), Himalaya publication.
3. B. S. Baliga and A.Zaveri, College Analytical Chemistry, 15th edition, Himalaya PublishingHouse, 2004
4. Vogels Textbook of Quantitative Inorganic Analysis 4th edition ELBS.
5. Willard, Meritt and Dean. Instrumental Methods of Analysis
6. Skoog and Leary, Principles of Analytical Chemistry 4th International edition.
7. P.R.Trivedi and Gurdeep Raj, Environmental Water and Soil Analysis, Akashdeep Publishing House, New Delhi.
8. A. K. De, Environmental Chemistry, Wiley Eastern Ltd.

CH-302	Experiments in Physical and Analytical Chemistry SEMESTER VI	Number of hours: 45

Practical:

- To understand and develop the problem solving skills and hands on experience with reference to concepts studied in theory(potentiometry , pH metry, partition coefficient, Chemical kinetics)
- To understand and develop the problem solving skills and hands on experience with refrence to instrumentation and techniques studied in theory.(spectrophotometry,chromatography and conductometry)

SYLLABUS

Practical

PHYSICAL CHEMISTRY

Conductometry

1. To determine the strength of mixture containing weak acid (CH3COOH) and weak base (NH4OH) by titrating against standard 0.1N NaOH solution.
2. To determine the degree of hydrolysis and hydrolysis constant of
a) CH3COONa b) NH4Cl c) C6H5NH2.HCl at room temperature.

Potentiometry:

3. To determine the standard oxidation potential of Zn/Zn2+ and Cu/Cu2+ at three different concentrations.
4. To determine the percent composition and amount of halide ions from their mixture (any two halides) using standard 0.1N AgNO3 solution.
5. To determine the dissociation constant of weak dibasic acid(H2C2O4) by titrating against standard 0.1N NaOH solution.
6. To investigate the influence of ionic strength on the rate constant between potassium per sulphate and potassium iodide.
7. To study the kinetics of ethyl acetate by NaOH at two different temperatures and hence the energy of activation.
8. To determine the formula of the complex formed between cupric ion and ammonia by distribution method.

ANALYTICAL CHEMISTRY

A] Spectrophotometry

1. Determination of nitrite in water
2. Estimation of Cr and Mn from a mixture
3. Comparison of spectrophotometric methods for determining the stoichiometry of a complex formed between iron and 1,10 – phenanthroline by three methods: continuous variations, mole ratio and slope ratio (not for examination)

B] Chromatography

4. Estimation of Na+ from NaCl using cation exchange resin in H – form using standard NaOH.

C] Conductometry

5. Estimation of boric acid by conductometric titration

D] Other Experiments

6. Determination of hardness of water by EDTA i.e estimate Ca asCaCO3 and report analysis in ppm. (the candidate should record more than 5 observations and carry out statistical analysis to find out mean, median, range, standard deviation, absolute error, relative error and possibly Q test.(not for examination)
7. Determination of Mg in antacid drugs

8. Estimation of aspirin	
LEARNING OUTCOMES:	
Practical:	
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.	
REFERENCES:	
1.Basic Principles of Analytical Chemistry. To be used as text book. K. Raghuraman, D.V.Prabhu, C.S. Prabhu and P.A.Sathe 3rd, 4th and 5th edition, Sheth Publishers. 2.Analytical Chemistry. Gary Christian, 4th Edition, International Edition. 3.Principles of Analytical Chemistry. Skoog and Leary, 4th International Edition.	

CH-304:	Experiments in Inorganic and Organic Chemistry (Semester VI)	Number of hours: 60

COURSE OBJECTIVES:

Practical:

- To study the volumetric methods to quantitatively estimate with precision the desired amount of the metal ions.
- To study the volumetric methods for determination of some physicochemical parameters in sea and mineral water.
- To get hands on experience for the binary mixture separation and the analysis of separated compounds.

SYLLABUS

Practical:

Inorganic Chemistry

1. Estimation of Iron(II) by dichromate method from the given solution of ferric alum byusing SnCl2.
2. Estimation of Nitrite using Ceric ammonium sulphate from the given sample of Water.
3. Estimation of Copper(II) by thiosulphate method from the solution of copper sulphate.
4. Estimation of Calcium in the given sample using KMnO4.
5. Preparation of Tetraamine Copper (II) sulphate complex.
6. Estimation of Copper from Tetraamine Copper (II) sulphate complex by iodometry.
7. Determination of dissolved oxygen from sea and mineral water using Winkler's method.
8. Determination of alkalinity of sea and mineral water using phenolphthalein and methylorange indicator.

Organic Chemistry

1. Organic mixture separation and analysis. At least 08 mixtures of compounds out of which 4 should be solid-solid, 2 liquid-liquid, and 2 solid-liquid from the following list, to be analyzed on small scale using 1 gm of mixture in case of solids and 3 to 4 ml. in case of liquids. (Existing list of mixtures to be continued)

LEARNING OUTCOMES:

Practical:

At the end of the course students will be able to

- 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.

- 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.

REFERENCES:

Inorganic Chemistry:
1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's textbook of Quantitative Inorganic Analysis (revised) J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham ELBS.
3. Standard Methods of Chemical Analysis W.W. Scott, Technical Press.
4. Experimental Inorganic Chemistry W.G. Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol. I and II Brauer, Academic Press.
6. Inorganic Synthesis, Mc Graw Hill.

Organic Chemistry:
1. Vogel's Qualitative Organic Analysis, Orient Longman
2. Textbook of Practical Organic Chemistry, N.K.Vishnoi