M.Sc. Analytical Chemistry

SEMESTER - I

CHE-101T: INORGANIC CHEMISTRY- I

52 Hours

UNIT- I

13h

Chemical Bonding

VSEPR model, shapes of molecules-ClF_3, ICl_4^-, TeF_5^-, I_3^-, $TeCl_6^{2-}$, XeF_6,$SbCl_6^{3-}$, IF_7, ReF_7, XeF_8^{2-}, TaF_8^{3-}; Bent rules and energetics of hybridization; electronegativity: Pauling, Allred-Rochow and Mulliken, electronegativity and partial ionic character; Bonds: Multicenter, Synergic and Agostic bonding. Lattice energy: Born-Lande equation, Kapustinskii equation; Fajan's rules- polarizability and partial covalent character, radius-ratio rules-limiting radius ratios of trigonal, tetrahedral, octahedral and cubic. Structures of solids-NaCl, CsCl ,ZnS (zinc blende and wurtzite), rutile (TiO2), pervoskite ($CaTiO_3$), fluorite and anti-fluorite. Zintl ions, Molecular orbital theory: formation of sigma, pi and delta bonds, LCAO and MO diagrams of heteronuclear diatomic (CO, NO, HF and ICl) and triatomic molecules (CO_2 and NO_2^-).

UNIT- II

13h

Chemistry of main group elements

Boranes- nomenclature, synthesis, structure and bonding in boranes, styx code, carboranes- classification, structures of ortho, meta, para-$C_2B_{10}H_{12}$,Wades rules, Metallocarboranes- synthesis and structure of $[Fe(\eta^5\text{-}C_2B_9H_{11})]^{2-}$, $Fe[(\eta^5\text{-}C_2B_9H_{11})](\eta^5\text{-}C_5H_5)$, $[Mo(CO)_3(\eta^5\text{-}C_2B_9H_{11})]^{2-}$, synthesis, structure and bonding in borazine, phosphazenes- synthesis, structure and bonding in $(PNCl_2)_3$, S, N- compounds- S_4N_4, S_2N_2 and polythiazyl.

Silicates

Principles of silicates structures, classification with examples, pyro, cyclo,ino, phyllo and tecto silicates, isomorphous replacement; zeolites- sodalite and pentasil units, synthesis and structures of ZSM-5, zeoliteA, faujasite and their uses. Introduction to Nanosilica.

UNIT-III

13h

HSAB concept

Basis of HSAB concept, acid-base strength, hardness and softness, symbiosis, applications and limitations of HSAB concept; Acid- base concept in non-aqueous media, reactions in BrF_3, N_2O_4, anhydrous H_2SO_4, CH_3CO_2H. Isopoly and heteropoly acids of W and Mo, preparations, properties, structure and applications.

Stereoisomerism

Chirality, optical activity- CD, ORD, Cotton effect, absolute configuration of metal complexes, magnetic circular dichroism and its uses.

UNIT-IV

13h

Metal clusters

Factors favoring M-M bond, classification, synthesis, structure and bonding in $[Re_2Cl_8]^{2-}$. Metal carbonyl clusters- LNCC's and HNCC's. Electron counting in carbonyl clusters, Wades-Mingos and Lauher rules.

Nuclear Chemistry

The atomic nucleus-elementary particles, quarks, classification of nuclides based on Z and N values, nuclear stability, nuclear potential, binding energy.
Nuclear Models: Shell model-salient features, forms of the nuclear potential, filling of orbitals, nuclear configuration, Liquid drop model. Radioactivity, radioactive decay kinetics, parent-daughter decay-growth relationship-secular and transient equilibria, theories of α, β^-, β^+ and γ-decay, internal conversion, Auger effect.

Reference Books:

1. L. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 3rd edition (2004).
2. Advanced Inorganic Chemistry, F.A.Cotton and G.wilkinson. 6th Edition (1999).
3. Inorganic chemistry, J. E. Huheey, E. A. Keiter and R. L. Keiter, IV edition Addison; Wesley (1993).
4. Inorganic chemistry, D.F. Shriver, P. W. Atkins and C. H. Langford, v edition ELBS; Oxford University Press, (2010)
5. Chemistry of elements; N. N. Greenwood and A. E. Earnshaw, Butterworth, II edition Heinemann (1997).
6. Concise Inorganic Chemistry, J. D. Lee,5th edition; (1996).
7. Essentials of nuclear chemistry, H. J. Arniker, 4th, edition; NAIL publishers (2011) Chapters 1, 3 and 4.
8. Nuclear and Radiochemistry; G.Friedlander, J.W.Kennedy, ES Macias and JM Miller; 1981, Chapters 8 and 9.
9. Inorganic chemistry, Gary. L. Miessler and Donald . A. Tarr 5th, Edition; (2014).
10. Inorganic Chemistry CE House croft and A G Sharpe 4th'edition, Pearson (2012).

M.Sc. Analytical Chemistry

SEMESTER - I

CHE-102T: ORGANIC CHEMISTRY- I

52 Hours

UNIT-I

13h

Nature of Bonding in Organic Molecules

Delocalized chemical bonding: conjugation, cross conjugation, resonance. Hyperconjugation. Tautomerism.
Aromaticity: Huckel's MO theory. HMO diagram for benzene. Huckel's rules of aromaticity. Aromatic systems with electron numbers other than six (including azulene, tropone, tropolone and annulenes). Anti-aromaticity. Aromaticity in benzenoids. Homo-aromaticity. Alternant and non-alternant hydrocarbons. Energy levels in odd and even-alternant hydrocarbons, energy levels for the benzyl cation, benzyl free-radical and benzyl carbanion. Mesoionic compounds. Heteroannulenes. Fullerenes: C-60.
Synthetic Molecular Receptors: Definition and significance. Structure and function of receptors with molecular clefts, molecular tweezers, receptors with multiple hydrogen bonding sites. Crown ethers, cryptates, cyclodextrins, cyclophanes, catenanes and rotoxanes, calixarenes, ionophores and micelles.

UNIT-II

13h

Reaction Mechanisms:

Reactive intermediates: Generation, structure, stability and reactivity of carbocations, carbanions, carbon-free radicals, carbenes. Non-classical carbocations, nitrenes. Reactions and mechanisms: Thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates.
Methods of determining mechanisms: Based on the structure of products, determination of the presence of intermediates, isotopic labeling, isotope effects, from stereochemical evidence.
Acids and bases: Hard and soft acids and bases. Effect of structure on the strengths of acids and bases.
Effect of structure on reactivity: Resonance and field effects; steric effects. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.
Aliphatic substitution reactions *:*
Nucleophilic substitution reaction at a saturated carbon: SN^1, SN^2, and SET mechanisms. Effect

of substrate structure, attacking nucleophile and leaving group. Neighboring group participation by sigma and pi bonds. Anchimeric effect. Ambident nucleophiles and substrates. Electrophilic substitution reaction at a saturated carbon: SE^1, SE^2 and SE^i mechanisms. Effect of substrate structure, leaving group and solvent polarity on the reactivity.

UNIT-III

13h

Stereochemistry

Projection formulae: **Fischer, Newman, Sawhorse and flying wedge projections - their interconversions for acyclic and cyclic compounds.**
Conformational analysis:-D/L, R/S and M/P conventions. Cahn-Ingold Prelog (CIP) sequence rules.
Optical isomerism: Elements of symmetry and chirality. Chirality in compounds with a stereogenic center. Elements of Chirality and helicity. Stereochemistry of allenes, alkylidene cycloalkanes and spiranes (with a stereogenic axis), biphenyls, cyclophanes, ansa compounds, trans-cyclooctene, helicenes, benzphenanthrenes. Configurational nomenclature.
Conformational analysis: Conformational analysis of cycloalkanes: cyclobutane, cyclopentane, cyclohexanes (mono-substituted e.g., methyl, iso-propyl, tert-butyl and di-substituted cyclohexanes e.g., dialkyl-, dihalo-, diols), and cycloheptane.
Nomenclature and conformations of fused rings and bridged ring systems.
Prochirality: Enantiotopic and diastereotopic atoms, groups and faces. [Si/Re]. Basics of Cram's and Prelog's rules of asymmetric induction.

UNIT-IV

13h

Carbohydrates:

Introduction. Determination of configuration of the monosaccharides, and conformational analysis of monosaccharides. Synthesis of aldonic, uronic. Derivatives of monosaccharides: acetals, ethers, aminosugars and deoxysugars. Structural elucidation of sucrose and maltose. Structures of lactose, gentiobiose and meliobiose. Photosynthesis of carbohydrates.

Heterocyclic compounds:

Introduction. Nomenclature of simple and fused heterocyclic compounds. Synthesis and reactions of pyrazole, imidazole, oxazole, isoxazole, thiazole and isothiazole. Synthesis of benzimidazole,
benzoxazole, benzisoxazole.

Vitamins

Introduction. Biological importance and synthesis of Vitamin A, Vitamin B1 (thiamine), Vitamin B6 (pyridoxine), folic acid, pantothenic acid, riboflavin, Vitamin C, Vitamin E (α-tocopherol), Vitamin H (biotin), Vitamin K1 and K2.

Reference Books:

l. Organic Chemistry, R T Morrison, R N Boyd and S K Bhattacharjee, 7th edition, Pearson, (2018).
2. Organic chemistry, J Clayden, N Greeves and S Warren, 2nd edition, Oxford University Press, (2014)
3. Advanced Organic Chemistry - Reactions, Mechanism and Structure, J March, John Wiley (2008).
4. Advanced organic chemistry, F A. Carey and R J Sundberg plenum, (2000).
5. A Guide Book to Mechanism in Organic Chemistry, P Sykes, 6th edition, Pearson, (2003).
6. Structure and mechanism of organic chemistry, C K Ingold, 2nd Edition, CBS, (2016).
7. Principles of organic Synthesis, 3rd edition, R O C Norman and J M Coxon,
8. Stereochemistry, V R Dani, Asian Books, New Delhi, (2014).
9. Stereochemistry of Organic Compounds, D Nasipuri, 3rd edition, New-Age International, (2018).
10. Organic Stereochemistry, M J T Robinson, Oxford University press, (2005).
11. Stereochemistry of carbon Compounds, E L Eliel, S H Wilen and L N Mander, John Wiley, (1994).
12. Heterocyclic Chemistry at a Glance, II edition, J A Joule and K Mills, Wiley, New York, (2012).
13. Organic Chemistry, Volume I, I L Finar, 6th edition, Pearson, (2018).
14. Organic Chemistry, Volume II, I L Finar, 6th edition, Pearson, (2018)

M.Sc. Analytical Chemistry

SEMESTER - I

CHE-103T: PHYSICAL CHEMISTRY- I

52 Hours

UNIT- I

13h

Quantum Mechanics-I

Introduction to quantum mechanics. Schrodinger wave equation. Time-independent and time-dependent Schrodinger wave equations and the relation between their solutions. Eigen functions and Eigen values. Physical Interpretation of wave function. Concepts of Operators: Laplacian, Hamiltonian, Linear and Hermitian operators. Angular Momentum operators and their properties. Commutation of operators. Normalization, orthogonality and orthonormality of wave functions. Average (expectation) values. Postulates of quantum mechanics. Solutions of Schrodinger wave equation for a free particle, particle in a ring, and particle in a three-dimensional box. Quantum mechanical degeneracy, tunneling (no derivation). Application of Schrodinger equation to harmonic oscillator, rigid rotator. Eigen functions and Eigen values of angular momentum. Ladder operator method for angular momentum.

UNIT- II

13h

Quantum Mechanics-II

Schrödinger equation to hydrogen atom in spherical polar coordinates. Solution of equation and statements of solution of R equation. Total wave functions of hydrogen atom. Quantum numbers and their characteristics. List of wave functions for few initial states of hydrogen like atoms. Diagrams of radial and angular wave functions. Radial and angular distribution function and their significance. Electron spin (Stern-Gerlach experiment), spin-orbital, anti-symmetry and Pauli-exclusion principle, Slater determinants. Coupling of Angular momenta. Russell-Saunders and JJ-coupling, AtomicTerm symbols. Spin- orbital interaction and explanation of term multiplicities (Na-D doublet). Zeeman effect.
Approximate methods: Need for approximation methods. Perturbation method. Rayleigh Schrödinger perturbation theory for time-independent non-degenerate system. Application to electron in a box under the influence of an electric field. Application to He atom. Variation theory-statement and proof. Application of variation method to particle in a one-dimensional box and He atom.

UNIT- III

13h

Chemical Dynamics-I

Review of theories of reaction rate-Collision theory and Transition state theory.

Macroscopic and microscopic kinetics. Comparison of collision theory with transition state theory, Arrhenius equation-characteristics, Significance of energy of activation, Temperature coefficient and its evaluation. Thermodynamical formulation of reaction rates (Wyne-Jones and Eyring treatment), Reaction between ions in solutions - Influence of ionic strength on reaction rates (primary and secondary salt effects).

Concept of Steady-state kinetics, Chain reactions - chain length and chain inhibition, comparison of photochemical and thermal reactions, Mechanisms of thermal and photochemical reactions between hydrogen-bromine and hydrogen-chlorine. Comparative study of thermal and photochemical hydrogen-halogen reactions. Pyrolysis of acetaldehyde, Decomposition of ethane.

Kinetics of fast reactions- Introduction, Study of reactions by relaxation method (Temperature and pressure jump), flow method (Plug flow method and Stopped flow method), Flash photolysis and Shock tube method.

UNIT- IV

13h

Chemical Dynamics-II

Kinetics of homogeneous catalysis: kinetics of auto catalytic reactions, the kinetics of acid-base catalysed reactions. Comparison of enzyme catalysed and chemical catalysed reactions, Mechanism (Lock and Key theory), Kinetics of enzyme catalyzed, reactions - Henri- Michaelis-Menten mechanism, Significance of Michaelis-Menten constant, Lineweaver-Burk plot. Effects of enzyme concentration, pH, Temperature, Activators and Inhibitors on enzyme activity.
Unimolecular reactions: Perrin theory, Lindemann theory, and Hinshelwood theory.
Surface chemistry: Types of adsorption isotherm, Effect of temperature on adsorption, Mechanical adsorption, Estimation of surface area using BET equation, Gibbs adsorption isotherm and its significance, Surface tension and surface energy, Pressure difference across the curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Surface film on liquids (electro-kinetic phenomena), Catalytic activity of surfaces.

Reference Books

1. Physical Chemistry- P. Atkins and J. D. Paula, 9th Edn., Oxford University press (2010).
2. Physical Chemistry: A Molecular Approach,D. A.Mc Quarie and Simon, Viva, New Delhi,(2003).
3. Introduction to Quantum Chemistry, A. K. Chandra, 3rdEdn. Tata McGraw Hill, (1991).

4. Quantum chemistry, Ira. N. Levine, Prentice Hall, New Jersey, (1991).
5. Quantum chemistry, R. K. Prasad, New Age International, 4th Edn., (2010).
6. Quantum Mechanics by G R Chatwal and S K Anand, Himalaya publications, 8th Edn, 2012
7. Chemical Kinetics- K. J. Laidler, McGraw Hill. Inc. New York (1988).
8. Principles of Chemical Kinetics - House J. E. Wm C Brown publisher, Boston, (I997).
9. Kinetics and Mechanism of Chemical Transformations- J. Rajaraman and J. Kuriakose, Mc Millan India Ltd. (2011).
10. Biochemistry, - Geoffrey Zubay,2nd Edn., Macmillan Publishing Co. New York (1988).
11. Physical Chemistry of Surfaces- A. W. Adamson, Wiley-Interscience publisher Inc., New York (1997).
12. Introduction to surface chemistry and Catalysis by Gabor A. Somorjai and Yimin Li, John 2nd Edn. Wiley and Sons Ltd, Hoboken, United States, 2010.

M.Sc. Analytical Chemistry

SEMESTER - I

CHE-104T: ANALYTICAL CHEMISTRY- I

52 Hours

UNIT- I

Basic concepts **13 h**

Safety measures in chemical laboratories, Fire hazards, toxic chemicals: Acids/bases/solvents handling, storage, dilution, disposal of chemicals, acid/ solvent bottles etc. toxic chemicals sampling and handling hazards, material safety data sheets (MSDS), miniaturization of analytical instruments, their significance in modem chemical analysis. Preparation of dilute acids from concentrated/fuming acids like H_2SO_4/HF, handling liquid, bromine, elemental mercury, solvent ether, liquor ammonia, liquid nitrogen.

Errors in chemical analysis: absolute, relative error, random error distribution, Gaussian curve, Limitations of analytical methods, determinate and indeterminate errors, minimization of errors. Accuracy and precision, distribution of random errors, and the normal error curve. Statistical treatment of finite samples- measures of central tendency and variability: mean, median, range, standard deviation, variance, correlation, regression, confidence limits, Comparison of an experimental mean and a true mean. F-test, rejection of result - Q-test, Student's t-test, numerical problems.

UNIT-II

Quantitative Analysis-Classical methods **13h**

Classification of analytical methods, types of instrumental analysis, factors influencing the choice of analytical method, qualitative and quantitative analysis, Units used in chemical analysis, their conversion, ppm, ppb, ppt etc.

Titrimetry

Acid-Base: Theory of indicators, Ex: Phenophthalien, Methyl red. Titration curves for monofunctional acid and base, pH calculations, fractions of phosphoric acid species as a function of pH. Titration curves for H_3PO_4.

Complexometry: Theory of metal ion indicators, EDTA titrations, suitability of polydentate ligands as titrants, expressions for the different forms of EDTA in solution as a function of pH, conditional stability constants, effect of pH and nature of titration curve. Masking and demasking, type of EDTA titrations, titrations involving monodentate, bidentate and polydentate ligands.

Redox: Mechanism of indicator action, criteria for the selection of indicators. Feasibility of redox titration. Titration of multicomponent system. Nernst equation. Applications: Oxidants such as Ce(IV), bromate, Iodates. Karl-Fischer titration, Non-aqueous titrations.

Precipitation: Solubility product. Theoretical principles of precipitation: Titration curve, endpoint detection, Mohr, Volhard and adsorption indicators. Applications: Estimation of F-, K^+,CO_3^{2-}, C_2O4^{2-} acetylenes and a mixture of halides.

Gravimetry

Quantitative precipitation: Precipitation from Homogeneous Solution (PFHS), Formation and treatment of precipitates, co-precipitation, post precipitation. Conditions for precipitation, washing, drying and igniting the precipitates, important precipitating agents such as DMG, oxine, and thiocyanate and their significance in inorganic analysis. Errors in gravimetric analysis.

Unit-III

Quantitative Analysis - Instrumental methods **13h**

Electromagnetic radiation, interaction with matter, absorption, Beer-Lambert's law, derivation, molar absorptivity, Sandell sensitivity, Ringbom plot, deviations, limitations, Calibration with standards, standard addition, internal standard addition, limit of detection, limit of quantification, Validation parameters, Instrumentation, radiation sources, wavelength selection devices, optical slits, single beam and double beam instruments, photoelectric colorimeter, scanning devices, merits and limitations, numerical problems on application of Beer's law.

Unit IV

Separation Methods **13h**

Solvent Extraction - Types, batch, continuous, efficiency, selectivity. Distribution coefficient, Nernst distribution law, derivation, factors affecting the partition, applications. Chromatography- Types, Terminology, Principles of paper, thin layer, column, gas chromatography, column efficiency, plate theory, factors affecting the column efficiency, band broadening, R_f factor, Van-Deemter equation, medium performance liquid chromatography, high-performance liquid chromatography, reversed-phase liquid chromatography, supercritical fluid chromatography, characteristics of supercritical fluids, 2D-thin layer chromatography, electrophoresis, principles, applications etc. numerical problems on solvent extraction, R_f factor and van-Demeter equation.

Reference Books:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, 2005.
2. Analytical Chemistry, G.D. Christian, 6th edition, John Wiley & Sons, Inc, India, 2004.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, prentice Hall, Inc. New Delhi, 1993
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd., New Delhi, 2003.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, Blackwell Sci., Ltd. Malden, USA, 2000.
7. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
8. Practical Volumetric Analysis, Peter A C McPherson, RSC, Cambridge, UK, 2015.
9. Analytical Chemistry for Technicians, John Kenkel, 4th edn. CRC Press, London, 2014.
10. Undergraduate Instrumental Analysis, J.W. Robinson, E.M. Skelly Frame, G. M. Frame II, 6thedn. Marcel Dekker, New York, 2009.

M.Sc. Analytical Chemistry

SEMESTER - I

CHE-105T: MATHEMATICS FOR CHEMISTS (SOFT CORE)

UNIT- I

12h

Vectors: vectors, dot and cross products; scalar and vector triple products and their applications.
Tensors and their applications.
Matrix Algebra: Review of different types of matrices (including Hermetian and skew Hermetian); matrix addition and multiplication; determinant of a square matrix, transpose, adjoint and inverse of a square matrix. Solution to system of linear equation (a) by matrix method and (b) by Cramer's Rule. Characteristic equation of a square matrix, eigenvalues and eigenvectors.

UNIT-II

l2h

Calculus: Rule for differentiation; Chainrule (forf(x):U^n, sinu,logu etc). Implicit differentiation and parametric differentiation and successive differentiation of order 2 (for explicit functions only).
Applications of differentiation: Derivative as a slope of the tangent, derivative as a rate measure velocity and acceleration. Increasing and decreasing functions- Maxima and minima-second derivative test-point of inflections-problems restricted to polynomial.

UNIT-III

12h

Integrations: Basic rules-simple substitution-Method of partial fractions-Integration by parts.
Define integral and application to areas of plane curves. Functions of several variables: partial derivatives; coordinate transformation from cartesian coordinates to spherical and cylindrical coordinates and vice-versa.

Elementary differential equation: Variable separable, exact first order equations, linear and homogeneous equation.

Second-order homogeneous differential equation with constant coefficients f(D), y=0. Solution of differential equation by power series method.
Fourier series: Simple problems.
Probability: Review of permutations and combinations. Probability and addition theorem for mutually exclusive events and multiplication theorem for independent events. Curve fitting Method of least squares.

Reference Books:

1. Mathematical Preparation for physical chemistry, F. Daniells, M.Graw Hill Inc., US, 1959.
2. Mathematics for chemists, D. M. Hirst, Chemical Publishing Company Incorporated, New York, 1979.
3. Mathematics for chemists, P. G. Francis, Springer, 20ll.
4. Basic Mathematics for chemists, P. Jebutt, Wiley-Blackwell, 1994.
5. Calculus and analytic geometry, 9th editior, G. B.Thomas, R.L. Finney, Addison-Wesley Publish Company,lnc. 1996.
6. Short Course in differential equations, Rainvilles and Bedient, IBH publishers, 1968.
7. Mathematics for chemistry, G. Doggett and B. T. Sutcliffe Longmann publishers, 1995.

INORGANIC CHEMISTRY PRACTICALS
(2 days a week, 4 hours a day)

CHE-l06P: Inorganic Practical-I (Semi-micro qualitative Analysis)

Semi-micro qualitative analysis of mixtures containing two anions, two common cations, and one less familiar elements: W, Mo, Ce, Zr, V and Li.

CHE-107P: Inorganic practical-Il (Complex preparation)

Preparation of inorganic complexes:
l. Cis- potassium dioxalatodiaquachromium(III) complex.
2. Hexamminecobalt(III) chloride.
3. Mercury tetrathiocyanatocobaltate.
4. Pentamminechlorocobalt(III)chloride.
5. Potassium tris(oxalato)ferrate trihydrate.
6. Potassium tris(oxalato)aluminate trihydrate.

PHYSICAL CHEMISTRY PRACTICALS
(2 days a week, 4 hours a day)

CHE-108P: Physical Chemistry Practical –I

1. Study of Acid catalysed hydrolysis of methyl acetate at lab temperature and reporting the calculated and graphical rate constants.
2. Determination of Velocity constant for the saponification of Ethyl acetate at lab temperature and comparing it with graphical value.
3. Verification of Beer's Law: Colorimetric estimation of Cu^{2+} ions and reporting the Molar extinction coefficient.
4. Determination of heat of solution of a sparingly soluble salt.
5. Colorimetric estimation of Fe2+ ions in a given solution by titrating FAS versus KMnO4 solution.
6. Study of kinetics of the reaction between KI and K2S2O8 solution.
7. Construction of phase diagram of two component systems and determination of Ec , ET and the composition of given unknown.
8. Determination of partial molar volume of solute - water system by apparent molar volume method.
9. Analysis of a binary mixture by viscosity measurement method.
10. Verification of Freundlich and Langmuir isotherm for adsorption of oxalic/acetic acid on activated charcoal.

CHE-109P: Physical Practical –II

Conductometric Experiments

1. Precipitation titration of lithium sulphate versus $BaCl_2$ and reporting the concentration of Li_2SO_4.
2. Determination of concentration of a weak acid by titrating against a weak base.

3. Determination of a dissociation constant of weak acid (CH_3COOH).
4. Determination of Equivalent conductance of a given strong electrolyte.
5. Determination of the concentration of a strong acid and a salt in a given mixture of by titrating against a strong base.

Potentiometric Experiments

6. Determination of single electrode potential of Cu^{2+}/Cu and estimate the given unknown concentration.
7. Determination of single electrode potential of Zn^{2+}/Zn and estimate the given unknown concentration.
8. Titration of AgNO3 versus KCI and estimation of the concentration of AgNO3.
9. Determination of pKa and Ka values of the weak acid by titrating against a strong base using quinhydrone electrode.
10. Determination and comparison of pH values of buffer solutions by using quinhydrone electrode and glass electrode.

Reference Books

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, 7th edition, ELBS (2013).
2. Vogel's text book of Quantitative Chemical Analysis, 6th Edition, J. Bassett, G. H. Jefferyand J. Mendham, and R. C. Denny, J D Bames, M.Thomas Prentice Hall (2000)
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National pub. Co. (1990).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co.,London (1972).
5. Advanced inorganic analysis, S K Agarwal and Keemtilal; Pragati prakashan, 12th edition 2014.
Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications, Meerut (2012).
6. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers, New Delhi (1987).
7. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
8. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968).
9. Experimental Physical Chemistry by Wilson, Newcombe& others, Pergamon press, New York. (1962).
10. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983).
11. Experimental Physical Chemistry by V. D. Atavale and ParulMathur, New Age International, New York (2001).
12. Practical's in physical chemistry A. Modern Approach by P.S Sindhu, Mac. Millan publishers, Delhi (2006).

M.Sc. Analytical Chemistry

SEMESTER – II

CHE-201T: INORGANIC CHEMISTRY- II

UNIT-I

13h

Metal-Ligand equilibria in solution- Step-wise and overall formation constant and their relationship, trends in step-wise constant, kinetic and thermodynamic stability of metal complexes, factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, chelate effect, macrocyclic effect and their thermodynamic origin. Determination of binary formation constant by pH metry, spectrophotometry, polarography and ion exchange methods.

Structure and bonding- hydride, dihydrogen, dioxygen, isocyanide, N_2 and tertiary phosphine complexes of transition metals, metal carbonyls-terminal and bridge carbonyls, detection, metal nitrosyls- terminal (linear and bent) and bridge.

UNIT-II

13h

Metal- ligand bonding- Coordination numbers 3 to 8. Crystal field theory, salient features, spectrochemical series, splitting of d-orbitals in tetrahedral, square planar, trigonal bipyramidal, square-pyramidal and octahedral geometry, applications of CFT- colors of transition metal complexes, magnetic properties of octahedral complex, Jahn Teller distortion, CFSE and their uses, factors affecting CFSE, limitations of CFT, experimental evidences for metal-ligand covalent bonding in complexes, nephelauxetic effect, Ligand Field Theory, MO theory: tetrahedral and octahedral complexes (including π-bonding), angular overlap model. Stereochemical non-rigidity and its detection.

UNIT-III

13h

Electronic spectra of coordination compounds- Spectroscopic ground states, selection rules, term symbols for d^n ions Racah parameters, Orgel, Correlation and Tanaube-Sugano diagrams, spectra of 3d metal-aqua complexes of trivalent V, Cr, divalent Mn, Co and Ni, $CoCl_4^{2-}$, calculation of Dq, B and β parameters, CT spectra. Spectral properties of Lanthanide and Actinide metal complexes.

UNIT-IV

13h

Magnetic properties of coordination compounds- Types of magnetism, temperature effect, magnetic susceptibility and its determination- Gouy, Faraday, VSM method. Diamagnetic correction, orbital contribution, spin-orbital coupling, ferro- and antiferromagnetic coupling, spincrossover. Magnetic properties of Lanthanide and Actinide metal complexes.

Photochemical reactions of transition metal complexes: Basic photochemical processes, Kasha's rule, quantum yield, Jabolnskii diagrams, photo substitution reactions, photo-redox reactions, ligand photoreactions.

Reference Books:

1. Advanced Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 6th edition (1999).
2. Chemistry of elements- N. N. Greenwood and A. E. Earnshaw,2nd edition, Butterworth Heinemann (1997).
3. Inorganic Chemistry J. E. Huheey, E. A. Keiter R. L. Keiter, 4thedition; Addison; Wesley. (1993)
4. Inorganic Chemistry, D. F. Shriver, P. W. Atkins and C. H. Langford, 5th edition, ELBS; Oxford University Press, (2010)
5. Inorganic Electronic spectroscopy, A.B. P. Lever, 2nd edition, Elsevier. (1984).
6. Magnetochemistry, R.L. Carlin, Springer Verlag (1986).
7. Electronic Absorption Spectroscopy and related Techniques, D. N. Sathyanarayana, University Press (2001).
8. Inorganic Chemistry A Unified Approach by W. W. Porterfield, Elsevier 2005 2nd edition.
9. Inorganic chemistry G L Miessler, P J Fisher and D A Tarr 5th edition (2008).

SEMESTER – II

CHE-202T: ORGANIC CHEMISTRY-II

UNIT-I

13h

Aromatic Substitution Reactions

Electrophilic Substitution Reactions; The arenium ion mechanism. Orientation and reactivity. Energy profile diagrams. The ortho/para ratio, ipso attack, and orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Effect of leaving group. Amination, sulfonylation reactions; Diazonium coupling, Vilsmeier-Haack reaction, Gattermann reaction, Gatterman-Koch reaction,. and Hoesch reaction.

Nucleophilic substitution reactions: The SNAr, SN1, benzyne and S_{RN}l mechanisms. Reactivity: effect of substrate structure, leaving group and attacking nucleophile. Goldberg reaction, Bucherer reaction, Schiemann reaction, von Richter reaction, Sommelet-Hauser and Smiles rearrangements.

UNIT-II

Addition Reaction **13h**

Addition to carbon-carbon multiple bonds: mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals. Regio-, stereo- and chemo- selectivities. Orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Addition of alkenes and/or alkynes to alkenes and/or alkynes. Ene synthesis. Michael reaction.

Addition to carbon-heteroatom multiple bonds; Mechanism of metal hydride reduction (NaH, LiH, $LiAlH_4$, $NaBH_4$) of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents and organolithium reagents to carbonyl compounds and unsaturated carbonyl compounds. Conversion of aldehydes to nitriles. Hydrolysis of nitriles and addition of amines to isocyanates. Formation of xanthates. Wittig, Mannich and Stobbe reactions.

UNIT-III

13h

Elimination Reactions

The E2, E1 and ElcB mechanisms and their spectrum. E2C and E2H mechanisms. Orientation of the double bond. Reactivity-effects of substrate structure, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination reactions (including Chagaev reaction).

Rearrangement Reactions

Carbon-carbon: Wagner-Meerwein, Pinacol-Pinacolone, Fries, Benzil-benzilic acid and Wolff rearrangement. Arndt-Eistert synthesis and Tiffeneau- Demjanov reaction. Fritsch-Buttenberg-Wiechell, Favorskii, Dienone-phenol and Baker-Venkataraman rearrangement.

Carbon-nitrogen: Beckmann, Hofmann, Curtius, Lossen, Schmidt, Stevens, Neber and Benzidine rearrangement.

Carbon-oxygen: Wittig rearrangement and Baeyer-Villiger oxidation.

UNIT-IV

Amino acids and Peptides **13h**

Amino acids essential and non-essential. Classification and nomenclature of peptides. Sanger and Edman methods of sequencing. Cleavage of peptide bond by chemical and enzymatic methods.
Peptide synthesis- Protection of amino group (Boc-, Z- and Fmoc-) and carboxyl group as alkyl and aryl esters. Use of DCC, EEDQ, HOBt and active esters, in peptide bond formation reactions. Deprotection and racemization in peptide synthesis. Solid phase peptide synthesis carbohydrates techniques. Synthesis of oxytocin, and enkephalins.

Reference Books:

1. Advanced Organic Chemistry - Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F A Carey and R J Sundberg Plenum, (2000).
3. A Guide Book to Mechanism in Organic Chemistry, P Sykes, VI edition, Pearson, (2003).
4. Structure and Mechanism of Organic Chemistry, C. K. Ingold, II Edition, CBS, (2016).
5. Organic Chemistry, R T Morrison, R N Boyd and S K Bhattacharjee, VII edition, Pearson, (2018).
6. Principles of Organic Synthesis, III edition), R O C Norman and J M Coxon, Blackie Academic and Professional (Indian Reprint), (2012).
7. Natural Products: their chemistry and biological significance, J Mann, Longman, (2000)
8. Organic Chemistry, Volume I, I L Finar, VI edition, Pearson, (2018).
9. Organic Chemistry, Volume II, I L Finar, VI edition, Pearson, (2018).
10. Organic Chemistry, J Clayden, N Greeves, and S Warren, II edition, Oxford University Press, (2014)
11. Name Reactions - A collection of detailed reaction mechanisms, J J Li Springer, (2012)
12. Modern Methods of Organic Synthesis W Carruthers and I Coldham, IV edition, Cambridge University Press, (2015).
13. Peptides Chemistry: A practical text book, M. Bodansky, Springer-Verlag NY, (1988).
14. Solid-phase peptide synthesis: A practical Approach-E. Artherton & R.C. Sheppard, I R L Oxford Univ. Press, (1989).
15. Peptides: Chemistry and Biology, N Selwad and H.-D. Jakubke, Wiley-VCH, (2002).

M.Sc. Analytical Chemistry

SEMESTER – II

CHE-203T: PHYSICAL CHEMISTRY- II

UNIT-I

13h

Thermodynamics-I

Thermodynamics: Concepts of partial molar properties - partial molar free energy, chemical potential, partial molar volume and its significance. Gibbs-Duhem equation, Gibbs-Duhem Margulus equation. Determination of partial molar volume: Graphical method, intercept method and Apparent molar volume method. Concept of fugacity; Determination of fugacity by graphical method and compressibility factor method. Activity and activity coefficient: Determination of activity coefficient by EMF and solubility method.

Thermodynamics of nonideal system-Excess thermodynamic function, GE, SE, HE etc. Phase Rule: Derivation of phase rule from the concept of chemical potential. Application of Phase Rule to three components system: Principle of triangular diagram: Plots for a mixture of three liquids consisting of one, two and three pairs of partially miscible liquids.

Statistical Thermodynamics: Objectives of statistical thermodynamics, Concept of distributions, Types of ensembles. Thermodynamic probability, Most probable distribution Law - Partition Function, (Definition and significance): Molar and molecular partitions translational, rotational, vibrational and electronic partition functions- Relation between thermodynamic functions (E, H, S, G and Cv) and the partition functions.

UNIT-II

Thermodynamics-II **13h**

Sackur-Tetrode equation for entropy of translation function. Relation between equilibrium constant and partition function. Different Distribution Laws: Types of Statistics : Maxwell - Boltzmann , Bose-Einstein and Fermi-Dirac statistics. Derivation of the equations for above three distribution Laws. Comparison of Bose-Einstein and Fermi-Dirac statistics with Maxwell - Boltzmann statistics. Problems and their Solutions.

Non-equilibrium Thermodynamics: Thermodynamic criteria for non-equilibrium states Phenomenological Laws and Onsager's reciprocity relations, Coupled and Non-coupled reactions, Entropy production and entropy flow. Electro kinetic Phenomenon. Postulates and methodologies: Uncompensated heat and thermodynamics function production. deDonder's inequality. Rate of entropy production. Transformations of the generalized fluxes and forces: eg., Chemical reaction, heat flow, Diffusion or material flow, flow of electric current.

UNIT-III

Electrochemistry-I **13h**

Electrochemistry of solutions: Ionic atmosphere, Debye-Huckel theory for the problem of activity coefficient, Debye-Huckel limiting Law, Debye-Huckel equation for appreciable concentration, Debye-

Huckel Onsager conductance equation and its extension to ion solvent interactions, Debye Huckel Bjerrum mode, Ion association, triple ions, triple ions and conductance minima. Thermodynamics of electrified interface, derivation of electro capillary Lipmann's equation, surface excess, thermodynamic aspects of surface excess. The method of determination and measurement of interfacial tension as a function of applied potential difference across the interface.

UNIT-IV

13h

Electrochemistry-II

Structure of electrified interface: Helmholtz theory, Guoy- Chapman theory, Stem model.
Overpotential: Concentration, activation and ohmic overpotential; Derivation of Butler- Volmer equation.
Semiconductor- solution interface: Theory of double layers at semiconductor- electrolyte interface.
Electrocatalysis: Definition and Influence of various parameters. Quantum aspects of charge transfer at electrode solution interface, quantization of charge transfer, tunnelling of electrons for hydrogen evolution with reference to electrocatalysis.
Polarography technique-Principle, DME- Merits and limitations, experimental, polarogram, half wave potential, diffusion controlled current, Ilkovic equation (including derivation), qualitative and quantitative estimation of toxic metal ions (Pb, As, Cd, Cr^{6+}, Hg)
Advanced Electrodes: Rotating disc electrodes, Membrane electrodes (Definition, examples with diagrams and applications to each), carbon electrodes.

Reference Books:

1. Molecular thermodynamics, Donald A. Mc Quarrie, John D. Simon University Science Books California, (1999).
2. Thermodynamics for Chemists by S. Glasstone, East-West Press, New Delhi, (1960).
3. Thermodynamics, by Rajaraman and Kuriacose, East-West Press, (1986).
4. Statistical Thermodynamics, M. C. Gupta (Wiley Eastern Ltd.) 1993.
5. Elements of Classical and Statistical Thermodynamics, L.K. Nash, Addison-Wiley (1979).
6. Thermodynamics, Statistical Thermodynamics and Kinetics by Thomas Engel & Philip Reid, Pearson Education Inc. (2007).
7. Modern Electrochemistry Vol-l and 2, J. O. M. Bockrisand A. K. N. Raddy, Plenum, NewYork (1978).
8. An introduction to electrochemistry: Samuel Glastone East-West, edition New Delhi (1942)
9. Text book of physical chemistry Samuel Glastone, 2nd edition, Mac Millan India Ltd (1991)
10. Principles and applications of Electrochemistry- D. R. Crow 3rd edition, Chapman Hall London (1988).
11. Physical chemistry through problems by S K Dogra and S Dogra, Wiley Eastern Ltd., 4th Edn. 1993.
12. Electrochemical methods by A J Bard and I R Faulkner,2nd Edn., Wiley New York, 2000.

M.Sc. Analytical Chemistry

SEMESTER – II

CHE-204T: MOLECULAR SPECTROSCOPY

UNIT-I

13h

Symmetry and Group Theory in Chemistry

Definition of groups, subgroups, cyclic groups, conjugate relationships, classes, simple theorems in group theory. Symmetry elements and symmetry operations point-groups, Schoenflies notations, representations of groups by matrices, reducible and irreducible representations. characters of representations, Great Orthogonality Theorem (without proof) and its applications, character tables and their uses (representations for the C_n, C_{nv}, C_{nh}, D_{nh}, etc 'groups to be worked out explicitly) Mulliken symbols for irreducible representations. Direct products, Applications of group theory to quantum mechanics identifying non-zero matrix elements, derivation of the orthonormalization conditions.

UNIT-II

13h

Unifying principles

Interaction of electromagnetic radiation with matter- time-dependent perturbation theory, transition moment integral, selection rules- symmetry and spin forbidden transitions.

Infrared Spectroscopy-I

Vibrations of molecules, harmonic and anharmonic oscillators- vibrational energy expression,
energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computation of intensities, hot bands, effect of isotopic substitution.
Diatomic vibrating rotor, Born-Oppenheimer approximation, vibrational-rotational spectra of diatomic molecules, P, Q and R branches, breakdown of the Born-Oppenheimer approximation.

Infrared Spectroscopy-II

Vibrations of polyatomic molecules: Normal coordinates, translations, vibrations and rotations, vibrational energy levels and wave functions, fundamentals, overtones and combinations Vibration-rotation spectra of polyatomic molecules- parallel and perpendicular vibrations of linear and symmetric top molecules Techniques and instrumentation, F

UNIT-III

13h

Microwave Spectroscopy

Rotations of molecules, rigid diatomic molecule- rotational energy expression, energy level diagram, rotational wave functions and their symmetry, selection rules, expression-for the energies of spectral lines, computation of intensities, effect of isotopic substitution, centrifugal distortion and the spectrum of a non-rigid rotor.
Rotational spectra of polyatomic molecules- linear, symmetric top and asymmetric top molecules, Stark effect, techniques and instrumentation.

Raman Spectroscopy

Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetry. Top molecules, vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure- O and S branches, Polarization of Raman scattered photons Structure determination from Raman and IR spectroscopy-AB_2 and AB_3 molecules Techniques and instrumentation.

UNIT-IV

13h

Electronic Spectroscopy

Born-Oppenheimer approximation, vibrational coarse structure, intensities by Franck-Condon principle, Dissociation energy, rotational fine structure, Fortrat diagram, pre-dissociation Electronic structure of diatomic molecules- basic results of MO theory, classification of states by electronic angular momentum- !,n,!, and ! molecular orbitals, selection rules, spectrum of singlet and triplet molecular hydrogen. Electronic spectra of polyatomic molecules- localized MOs, spectrum of HCHO, change of shape on excitation Decay of excited states- radioactive (fluorescence and phosphorescence) and non-radioactive decay, internal conversion.

Reference Books:

1. Chemical Applications of Group Theory, F. A. Cotton, Wiley Eastern (1976).
2. Molecular Symmetry, D. S. Schonland, Van Nostrand (1965).
3. Introduction to Molecular Spectroscopy, C. N. Banwell, TMH Edition (1994).
4. Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw Hill (Int. Students Edition) (1988).
5. Molecular Spectroscopy, J. D. Graybeal, McGraw Hill (Int. Students Edition) (1990).
6. Spectroscopy, Vols. 1-3, B. P. Straughan and W. Walker, Chapman Hall (1976).

CHE -205T: PHOTO CHEMISTRY (SOFTCORE)

36hours

UNIT-I

12h

Importance of Photochemistry, Laws of Photochemistry: Grothus -Draper Law, Stark-Einsteins Law, Laws of light absorption, Quantum yield and numerical problems. Photochemistry and spectroscopy, units and dimensions. Electronic energy states of atoms, term symbols for atoms, energy levels for the electronic configuration of carbon and oxygen illustrating spin orbit coupling and Hunds rules, inverted multiplets as applied to simple atoms and also for inner transition metals, Laporte's selection rules. Physicochemical Properties of electronically excited molecules: Nature of changes on electronic excitation: acidity, dipole moment, redox potentials etc. Fates of excited species, Electronic, vibrational, rotational energies-potential energies diagram. Shapes of absorption band and Franck Condon principle.

UNIT-II

12h

Quantum mechanical formulation of Franck Condon, crossing of potential energy surfaces, Non crossing rule of Teller for potential energy surface. Emission spectra, fluorescence and phosphorescence Environmental effect on absorption and emission spectra, solvent red shift and blue shift in absorption spectra. Experimental techniques to determine the intermediates in photochemical reactions Classification of photochemical reactions, Rate constants and life times of reactive energy state Effect of light intensity on the rate of photochemical reaction.

UNIT-III

12h

Photosensitized reactions: photodissociation-Gas phase photolysis, photofragmentation in liquid phase, photodegradation of polymers, Isomerization and other rearrangement reactions, Atmospheric photochemistry.

Photo electrochemistry: Introduction, efficiency of conversion of light to chemical and electrical energy, frequently measured quantities. Photosplitting of water using colloidal suspension.

Semiconductors: Bonding, conductivity, mechanism of using colloidal suspensions.Conductivity, energy bands in semiconductors; impurity semiconductors.

Photo voltaic effect: p-n junction, solar cells, silicon solar cells. cells, GaAs solar cells, Schottky barrier solar cell.

Photocatalysis: Photocleavage of environmentally hazardous waste matter by using TiO2, ZnO and MgO. Photooxidation and photoreduction reactions.

Reference Books:

1. Fundamentals of photochemistry, K.K. Rohatgi Mukhergee, Wiley Eastern Limited (1986)
2. Photochemistry, Carol E Wayne and Richard P Wayne, Oxford University press (1996)
3. Introduction to Semiconductor Materials and devices M S Tyagi, John Wiley and sons (1991)
4. Organic Photochemistry, J. M. Cozen and B. Halton, Cambridge University Press (1st Edition) 1974.

5. Molecular Reactions and Photochemistry, C H Deputy and D S Chapman, Prentice Hall India, New Delhi (1st Edition),1972.
6. Concepts of Inorganic photochemistry, A. W. Adamson and P D Fleischaves, John Wiley & Sons Inc. (1975).
7. Physical chemistry, P. W. Atkins, Julio de Paulo ELBS 7th Edition (2002)

INORGANIC CHEMISTRY PRACTICALS
(2 days a week, 4 hours a day)

CHE-206P: Inorganic Practical-IlI (Gravimetry)

Gravimetric analysis
l. Determination of Fe in iron ore as Fe_2O_3.
2. Determination of Ni as nickel dimethylglyoximate in Cu and Ni solution.
3. Determination of Ca as $CaC_2O_4.H_2O$.
4. Determination of Al as aluminium oxinate.
5. Determination of Cu as CuSCN in Cu and Fe solution.
6. Determination of Zn as $ZnNH_4PO_4$.

CHE-207P: Inorganic Practical-IV (Volumetry)

Volumetric analysis
1. Determination of Ca and Mg in Dolomite solution using EDTA.
2. Determination of Cu in Cu and Ni solution iodometrically.
3. Determination of Fe in Cu and Fe solution (using $K_2Cr_2O_7$).
4. Determination of Cr and Fe in a mixture using ceric ammonium sulphate.
5. Determination of Fe and Al in mixture using EDTA.
6. Determination of percentage of Fe and oxalate in $K_3Fe(C_2O_4)_3.3H_2O$

PHYSICAL CHEMISTRY PRACTICALS
(2 days a week, 4 hours a day)

CHE-208P: Physical Chemistry Practical –III

1. Study of acid hydrolysis of methyl acetate for two different concentrations of HCl and reporting the relative strength.
2. Study the hydrolysis of methyl acetate in the presence of HCl at two different temperatures and reporting the energy of activation.
3. Determination of dissociation constant of a given indicator by colorimetric method.
4. Study of kinetics of autocatalytic reaction between KMnO4 versus oxalic acid.
5. Determination of degree of hydrolysis of aniline hydrochloride at room temperature and calculation of dissociation constant of the base by pH metry.
6. Study of variation of viscosity of a liquid with temperature and determination of the constants A and B.
7. Analysis of a binary mixture of two miscible liquids by surface tension method.
8. Construction of phase diagram of Urea - KCl -H2O system.
9. Determination of heat of neutralization of two acids and their relative strength.
10. Evaluation of Arrhenius parameter for the reaction between K2S2O8 versus KI (first order)

CHE-209P: Physical Chemistry Practical –IV

Conductometry
1 . Determination of concentration of mixture of strong acid and weak acid versus strong base.
2. Determination of concentration of Weak acid with salt versus strong base.

3. Determination of strength of a strong acid, weak acid and a salt versus strong base
pH metry
5 Determination of the acidic and basic dissociation constant and isoelectric point of an amino acid by pH metry.
6. Determination of pKa values or Dissociation constant of phosphoric acid.
7. Determination of pH of acetic acid with sodium acetate buffer.

Potentiometry

8. Determination of concentration and amount of K2Cr2O7 by titrating against FAS and calculation of redox potential.
9. Determination of concentration of mixture of acids by titrating against NaOH solution.
10. Determination of concentration of KMnO4 by titrating against FAS and calculation of redox potential.

Reference Books:

1. Vogel's text book of Quantitative Chemical Analysis, 6th Edition, J. Bassett, G. H. Jefferyand J. Mendham, and R. C. Denny, J D Bames, M.Thomas Prentice Hall (2000)
2. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co.,London (1972).
3. An Advance course in practical chemistry, A Ghoshal, B Mahapatra and A K Nad; New central book agency Pvt.Ltd. 3rd eidition 2007.
4. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications, Meerut (2012).
5. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers, New Delhi (1987).
6. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
7. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968).
8. Experimental Physical Chemistry by Wilson, Newcombe& others, Pergamon press, New York. (1962).
9. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983).
10. Experimental Physical Chemistry by V. D. Atavale and ParulMathur, New Age International, New York (2001).
11. Practical's in physical chemistry A. Modern Approach by P.S Sindhu, Mac. Millan Publishers, Delhi (2006).