NOTIFICATION

No. : 29/ 2017 Date : 27/04/2017

Subject : I) Continuation of Prospectus No.2015125 prescribed for M.Sc. (Chemistry) (Sem-I to IV) for the Session 2017-18.
II) Additional chances for the failure students of M.Sc.Sem-I & II (Che.)

I) It is notified for general information of all concerned that the Prospectus of M.Sc. (Chemistry) Part-I & II (Sem-I to IV) bearing No.2015125 prescribed for the Academic Session 2016-17 shall continue for M.Sc. (Chemistry) Part- II (Sem-III & IV) for the session 2017-18 along with the new syllabi for M.Sc. (Chemistry) Part-I (Sem-I & II). The syllabi for M.Sc. (Chemistry) Part-I (Sem-I & II) printed on page Nos.1-26 be substituted by the **Appendix-A** appended with this Notification."

II) The authorities further provided two additional chances for the failure students of M.Sc. Sem-I & II (Chemistry) after implementation of the aforesaid new syllabi.

Sd/-
(Dr.A.P.Deshmukh)
Registrar
Sant Gadge Baba Amravati University

Appendix-A

Syllabus Prescribed for M.Sc. Semester-I & II (Chemistry) to be implemented from the Academic Session 2017-18
Semester I
Paper-I
Inorganic Chemistry-I

60hrs (4hrs/week). 12hrs/unit 80 Marks

Unit-I : **A) Stereochemistry and Bonding in Main Group elements**: **6L**
VSEPR theory: Prediction of shapes of irregular molecules and ions like SbF_4^-, SF_5^-, SeF_3^-, ICl_2^-, IF_4^-, IOF_4^-, NH_2^-, NH_4^+, I_3^-, PCl_2^+, PCl_6^- etc. Drawbacks, bent rule, energitics of hybridization, d-orbital participation by non-metals, example showing pπ-pπ, pπ-dπ and dπ-dπ bonds.
B) Molecular Orbital Theory: **6L**
Molecular orbital representation of polyatomic molecules with special reference to CH_4, NH_3, H_2O, PF_5, SF_6, B_2H_6 and CO and delocalised molecular orbital of ozone, carbon dioxide, nitrite, nitrate and benzene.

Unit-II : **A) Metal-ligand bonding:** **6L**
Recapulation of CFT, splitting of d orbitals in octahedral, square planar, tetrahedral, square pyramidal and trigonal bipyramidal complexes, Jahn-Teller distortion, spectrochemical series, nephelauxetic series, measurement of CFSE in weak/strong ligand fields, structural consequences of crystal field effects, variation of lattice energy and heats of hydration across 1st row transition metal ions, stabilization of unusual oxidation states and ionization energies, structure of mineral spinels. Limitations of crystal field theory.

B) Molecular orbital theory of coordination compounds: **6L**
Theoretical failure of ionic model of CFT. Experimental evidences in support of metal ligand orbital overlaps. Adjusted crystal field theory (ACFTor LFT), Composition of ligand group orbitals, (SALC principle), molecular orbital energy diagrams of octahedral, tetrahedral, square planar complexes including both σ and π bonding; angular overlap model. Comparison of CFT, LFT and MOT.

Unit-III : **Boron hydrides & Metal Cluster:** **12L**
Boron hydrides: Classification, nomenclature, structure, bonding and topology of boranes, 4-digit coding (s,t,y,x) numbers for B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} and B_6H_{10} and their utilities. Chemistry of diboranes. Acquaintance with metalloboranes, Carboranes and Metallocarboranes.
Preparation, structure and bonding in Non-carbonyl metal clusters viz. Binuclear $(Re_2Cl_8)^{2-}$, Trinuclear ('$ReCl_3)_3$, Tetranuclear $(W_4(OR)_6)$ and Hexanuclear $(Mo_6Cl_6)^{4+}$ ions. Preparation, properties and structures of Zintl anions & cation of the metal Ge, Sn, Pb, Sb, Bi.

Metal clusters: Occurrence of metal-metal bonds, binuclear, trinuclear, tetranuclear, and octahedral clusters. Synthesis, properties and bonding, of carbides, sulphur-nitrogen (SN) compounds, peroxo compound of boron, carbon and sulphur, oxy acids of nitrogen, Isopoly and Heteropoly acids.
Macrocyclic Complexes: Types of macrocyclic ligands-design and synthesis by coordination template effect,di & poly-nuclear macrocyclic complexes, application of macrocyclic complexes

Unit-IV : A) Non-aqueous solvent behavior: 4L

Inorganic solutes in organic solvents. Solvent system concept. The role of solvents in chemical reactions, effect of physical and chemical properties. Inorganic reactions in the following non-aqueous solvents**:** Dinitrogen tetroxide, anhydrous sulphuric acid, bromine trifluride , reaction in molten salts and Ionic liquids and Super critical CO_2 as solvent.

B) Metal-ligand equilibria in solution: 8L

A brief introduction to complex equilibria , outline of thermodynamic stability of metal complexes and factors affecting the such as temperature,dielectric constant and ionic strength, nature of metal ion and ligand, statistical, electrostatics, chelate effect . Experimental methods for the determination of stability constants by spectrophotometric methods (Job's and Mole ratio), Bjerrum's $_pH$ metric method, polarographic method and Conductometric method. Relation between thermodynamic parameters ($\Delta G,\Delta S,\Delta H$) and their importance in complex formation.Protonation and disscociation constant of ligand and their relationship. Mixed ligand complex and application of mixed ligand complexes .General tratment of the determination of formation constant of mixed ligand complexes.

Unit-V : Symmetry and group theory: 12L

Introduction to symmetry elements, symmetry operations, product of symmetry operations, equivalence symmetry elements and equivalence atoms, point group, classifications of point groups, Schoenflies symbols, identification of point groups of simple molecules like HCl, BeF_2, CO, H_2O, NH_3, CO_2, BF_3, C_2H_4, C_2H_6, $C_2H_2Cl_2$, C_6H_6, PCl_3, PCl_5, $[PtCl_4]^{--}$, $[PtCl_2(NH_3)_2]$, $[CoCl_2(NH_3)_4]$, $[FeF_6]^{3-}$substituted benzene molecules, pyridine, ferrocene, SF_4, IF_5, etc., necessary conditions for any set of elements to form a group, subgroups, classes in a group. Application of point group,. Group multiplication table, matrix representation of symmetry elements. Reducible and irreducible representation, character of representation, character of matrix, Conjugate matrix, Properties of irreducible representations, Great orthogonality theorem (without proof) and it's importance, construction of character table of C_{2v} & C_{3v} point group. Mulliken symbolism rules for irreducible representations & it's applications with examples.

BOOK SUGGESTED-

1) S.F. A. Kettle, J. N. Murral & S. T. Teddler: Valency Theory
2) C.A. Coulson: Valency
3) J.E. Huheey :Inorganic Chemistry
4) F.A. Cotton& G. Wilkinson: Advanced Inorganic Chemistry 3rd, 5th & 6th Editions.
5) A.F. Willims: Theoretical Approach in inorganic chemistry.
6) A.Mannas Chanda: Atomic Structure and chemical Bonding
7) L.E. Orgel: An Introduction To transition metal chemistry, Ligand field theory, 2nd Edition.
8) J.J.Logowski: Modern Inorganic Chemistry
9) B.Durrant and P.J.Durrant: Advanced Inorganic Chemistry
10) J.C.Bailar: Chemistry of co-ordination compounds.
11) W.L.Jolly: Modern Inorganic Chemistry
12) R.S.Drago: Physical methods in inorganic chemistry.
13) Waddington: Nonaqueous solvents.
14) Sisler: Chemistry of nonaqueous solvents.
15) A.K.Barnard: Therotical Inorganic Chemistry
16) Emeleus and Sharpe: Modern Aspect of Inorganic Chemistry.
17) F.A.Cotton: Chemical Applications of Group theory.
18) Jones: Elementary Co-ordination chemistry.
19) B.N.Figgis: Introduction to Ligand field.
20) S.F.A.Kettle: Co-ordination chemistry.
21) M.C.Day and J.Selbin: Theoretical Inorganic Chemistry.
22) J.Lewin and Wilkins: Modern Co-ordination chemistry.
23) Gowarikar, Vishwanathan and Sheedar: Polymer science.
24) H.H. Jattey and M. Orchin: Symmetry in chemistry.
25) D.Schonaland: Molecular Symmetry in chemistry.
26) L.H. Hall: Group theory and Symmetry in chemistry
27) H.H. Jattey and M. Orchin: Symmetry in chemistry
28) R.L.Dutta and A.Symal: Elements of magneto chemistry
29) Inorganic Chemistry 4th Edition, P.Atkins, Oxford University Press.
30) Essential Trends in Inorganic Chemistry, D.M.P.Mingos, Oxford University Press

Paper II

Organic Chemistry-I

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit **Total Marks-80**

Unit-I : Nature and Bonding in Organic Molecule **12L**

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyper-conjugation, bonding in fullerenes. strength of acids and bases. cryptands, inclusion compounds, cyclodextrius, catenanes and rotaxanes.

Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternat hydrocarbons Huckel's rule, energy level of pi-molecules orbitals, annulenes, antiaromaticity, homo-aromoaticity. Aromatic characters and chemistry of cyclopentadiene anion, tropyllium cation, tropene and tropelene. anti- and homo-aromatic systems. NMR as a tool for aromaticity.

Conformational analysis of cycloalkanes (5 – 8 membered rings), decalines, effect of conformation on reactivity, steric strain due to unavoidable crowding, Conformation of glucose.

Unit-II : Stereochemistry **12L**

Interconversion of Sawhorse, Newmann and Fischer projection. chirality, examples from common objects to molecules – axis, plane, center, alternating axis of symmetry. Stereoisomerism – definition based on symmetry and energy criteria – configuration and conformational stereoisomers. Center of chirality – molecules with C, N, S based chiral centers – absolute configuration - enantiomers – racemic modifications - R and S nomenclature using Cahn-Ingold-Prelog rules – molecules with a chiral center and Cn axis, molecules with more than one chiral center, threo and erythro isomers, method of resolution, optical purity, enantiotopic and distereotopic atoms, groups and faces, Prochiral relationship, stereospecific and steroselective (w.r.t.Substrate stereoselectivity, product stereoselectivity, enantioselectivity and diastereoselectivity.) synthesis.Asymmetrical synthesis. Axial, planar and helical chirality – examples – stereochemistry and absolute configuration of allenes, biphenyls and binaphthyls, ansa and cyclophanic compounds, spiranes, exo-cyclic alkylidenecycloalkanes.

Topicity and prostereoisomerism – topicity of ligands and faces, and their nomenclature – NMR distinction of enantiotopic/diastereotopic ligands.

Unit-III : Reaction mechanism: Structure and Reactivity **12L**

Types of mechanism, Types of reaction, thermodynamics and kinetics requirements, kinetic and thermodynamic control, Potential energy diagrams, transition states and intermediates, activated complex, methods of determining mechanisms, kinetic isotope effects, Hammond's postulate, Curtin-Hammeett principle, Effect of Structure on reactivity:- Resonance and field effects, Steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

Unit-IV : **12L**

A) Aliphatic nucleophilic substitution: The SN1, SN2 , mixed SN1 , SN2 and SET and SNi mechanisms. Nucleophilicty, effect of leaving group, ambient nucleophiles and ambient substrates regiospeciticity. The neighbouring group. Participation mechanisum, substitution at allylic and vinylic carbon atoms.

B) Elimination Reactions: The E1, E2 and E1 CB mechanisms orientation of the double bond. Saytzeff and Hoffman's rule. Effect of substrate structure, attacking base, leaving group and medium. Pyrolytic elimination mechanism and orientation. Cleavage of quaternary ammonium salts. Conversion of vicinal dihalides and nitro compounds to alkenes.

C) Summary of factors controlling substitution and elimination by unimolecular and bimolecular mechanisms.

Unit-V : A): AROMATIC ELECTROPHILLIC SUBSTITUTION **12L**

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The o/p ratio, ipso attack,orientation in benzene ring with more than one substituents, orientation in other ring system. Diazonium coupling, Gatterman-koch reaction, Pechman reaction,Houben –hoesch reaction, Reimer-Tiemann reaction, Kolbe Schmitt reaction, Recapitulation of halogenation, nitration, sulphonation and F.C. reaction.

B)Aromatic Nucleophilic Substitution: A general introduction to different mechanisms of aromatic nucleophilic substitution SNAr, SN1 , Benzyne and SRN1 mechanisms, Reactivity effect of substrate structure leaving group and attacking nucleophile, The Von Richter, Sommlet-Hauser and Smiles rearrangements.

BOOK SUGGESTED-

1. Advanced organic chemistry –Reaction mechanism and structure. Jerry March, John Wiley.
2. Advanced organic chemistry- F.A. Carey and R.J. Sunberg, Plenum.
3. A Guidebook to mechanism in organic chemistry-Peterskyes, Longman.
4. Structure and mechanism in organic chemistry-C.K. Gold, Cornell University Press.
5. Organic chemistry, R.T. Morrison Boyd. Prentice Hall
6. Modern organic chemistry-H.O. House, Benjamin.
7. Principal of organic chemistry-R.O.C. Norman and J.M. Coxon, Blackie Academic and Professional.
8. Reaction mechanism in organic chemistry-S.M. Mukharji and S.P. Singh, Macmilan.

9. Stereochemistry of organic compounds- D. Nasipuri, New age international.
10. Stereochemistry of organic compounds- P.s.kalsi, New age international.
11. Frontier orbitals and organic chemical reactions-I. Fleming.
12. Orbital Symmetry – R.E.Lehr & A.P. Marchand.
13. Reactive intermediate in organic chemistry-N. S. Isaacs.
14. Stereochemistry of carbon compounds- E.L.Eliel.
15. Physical organic chemistry-J. Hine.
16. Name reaction in organic chemistry –Surrey.
17. Advanced organic chemistry – L.F.Fieser and M. Fieser.
18. Vol.I & II organic chemistry - I. L. Finar.
19. Modern organic chemistry- J.D. Roberts and M. C. Caserio.
20. The search for organic reaction pathways (Longmann), Peter Skyes.
21. Organic chemistry 5th Edition (McGraw Hill), Pine.
22. Organic chemistry (Willard Grant Press Botcon), John Mcmurry.
23. A Textbook of organic chemistry- R.K. Bansal.
24. New trends in green chemistry –V.K. Ahluwalia & M. kidwai, Anamaya publishers New Delhi.
25. Oranic Chemistry, J.Clayden, Oxford University Press.
26. Organic Chemistry, 4th Edition, G Marc Loudon, Oxford University Press.
27.. A guide book to Mechanism in Organic Chemistry:Petetr Sykes
28. Organic Chemistry: F. A. Carrey(Part A & B)

Paper - III

Physical Chemistry-I

60 Hours (4-Hours/week)12 hours/Unit **Total Marks-80**

Unit-I : Quantum Chemistry : **12L.**

A) Schrodinger's equation in one dimensional box (Recapitulation), postulates of quantum mechanics discussion of solution of Schrodinger's equation to particle in a three dimensional box, Harmonic oscillator, Rigid Rotor. The variation theorem, linear variation principle, perturbation theory (First order and non degenerate). Application of variation method and perturbation method to Helium atom.

B) Ordinary angular momentum, generalized angular momentum, eigen functions for angular momentum, eigen value of angular momentum. Pauli exclusion principle. Russel-Saunders terms & coupling schemes, Slatter-Condon parameters Numerical.

Unit-II : Surface Chemistry : **12L.**

A) Adsorption : Freundlich adsorption isotherm, Langmuir adsorption isotherm, Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids, and catalytic activity at surfaces.

B) Micelles : micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass models, solubilization, micro emulsion, reverse micelles. Numericals.

Unit-III : Thermodynamics : **12L**

A) Classical Thermodynamics : Partial molar properties. Partial molar free energy, Chemical Potential, Partial molar volume and Partial molar heat content and their significances. Determination of these quantities. Concept of fugacity and determination of fugacity. Debye-Huckel Theory for Activity coefficient of electrolytic solutions, Ionic strength,Determination of Activity & Activity coefficient.

B) Non equilibrium Thermodynamics : Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow for different irreversible processes (e.g. heat flow, chemical reaction, coupled reactions and electrochemical reactions). Transformations of the generalized fluxes and forces, phenomenological equations. Microscopic reversibility and Onsager's reciprocity relation. Numericals.

Unit-IV : Nuclear Chemistry : **12L.**

A) General characteristics of radioactive decay, decay kinetics, parent daughter decay growth relationship, nuclear de-excitation, secular and transient equilibrium, α-particle energy spectrum, Geiger Nutta Law, theory of a band g decay process.

B) Fission energy natural Ur reactor, classification of reactor, reactor power, critical size of thermal reactor, excess reactivity and control, Breeder reactor, Reprocessing of spent fuel, Recovery of Ur and Plutonium Nuclear wate management.

Unit – V : Chemical Dynamics :

12L.

A) Theories of reaction rates : Collision theory, collision rates in gases, energy requirement and steric requirement. Dynamics of molecular collisions. Transition state theory : assumptions, Statistical Mechanics and Chemical equilibrium, derivations of Eyring equation, Application of transition state theory to reaction between atoms and molecules (e.g. The reaction H + HBr (R) H2+Br)

B) Unimolecular reactions : Lindemann-Christiansen hypothesis and Hinshelwood treatment, Marcus's extension of the RRK treatment.

C) Reactions in solution, Solvent effects on reaction rate. Factors determining reaction rate, Numericals.

BOOK SUGGESTED-

1. Physical chemistry by P. W. Atkins and Depaula 7th Edition
2. Introduction to Quantum chemistry by A. K. Chandra, Tata Mc
3. Quantum chemistry by Ira N. Levine.
4. Molecular quantum mechanics, Vol. I & II, P. W. Atkins, Oxford University Press, 1970.
5. Statistical thermodynamics, by T.L.Hill, Addison Wesley, 1060
6. Chemical thermodynamics, by F.T. Wall, W.H.Freeman & Co. 1965
7. Irreversible thermodynamics, Theory and applications, by K.S.Forland, T. Forland, S.KRatje, Jonny Witey, 1988.
8. Chemical Kinetics,by K. J. Laidler, 3rd Edition, Harper and row, 1987.
9. Chemical Kinetics-A study of reaction rate in solution, K.Conors, V.C.H.Publkatkm 1990.
10. Chemical Kinetics and Dynamics, By J.I.Streinfeld, J.S. Francisco & W.I.Hase, Pritice Hall, 1989.
11. Kinetics and Mechanism of Chemical transformation, J.Rajraman, J. Kucriacose, Mc-Million
12. Molecular reaction Dynamics and chemical reactivity, R.D.Levine and R.B. Benstin, Oxford University press. 1987.
13. Physical Chemistry by Alberty and Silby, Jolly Wiley
14. Essential of Quantum Chemistry by Anant Raman.
15. Introduction to Relativistic Quantum Chemistry, K.G.Dyall, Oxford University Press.
16. Molecular Quantum Mechanics, 4th Edition, P.W.Atkins, Oxford University Press

PAPER-IV
Modern Methods of Separation

60 Hours (4-Hours/week)12 hours/Unit **Total Marks-80**

Unit-I : Basic concepts of Analytical Chemistry : **12L**

Role of Analytical Chemistry: The nature of analytical chemistry, the role of analytical chemistry , qualitative and quantitative analytical methods, Classification of analytical methods-classical & instrumental. Types of instrumental analysis. Selecting an analytical method. Analytical balances: (Semi micro and Micro balances) and their use in analytical chemistry, Techniques of weighing and errors Good Laboratory Practices (GLP) **:** Introduction and principles of GLP,

Purification Techniques : Introduction,purification techniques for solid organic compounds, purification techniques for liquids, chemical method of separation and purification and criteria of purity.

Principal and Methods of sampling: Theory of sampling, pit falls and problems associated with sampling. Techniques of sampling of gases, liquids, solids and particulates. Stoichiometric calculations based on gravimetry and titrimetry analysis of commercial samples. Transmission and storage of samples. Effect of sampling uncertainties samplers' responsibility, sampling hazards.

Unit-II : **12L**

Statistical Analysis: (Emphasis should be placed on numerical problems) Collection, Treatment and presentation of analytical data. True, standard and observed value. Defination of terms in mean and median. Errors in chemical analysis, classification of errors, nature and origin of errors. Accuracy and precession, errors in quantitative analysis and their minimization. Standard deviation, least squares and correlation coefficients. Confidence interval and confidence limit. Graphical method of solution, parameter and variable, comparison of manual mean curve and the computer programmed best fitting curve.Tests for rejection of data. T-test, F-test and Q-test. Significant figures and computation rules. Regression analysis and Statistical analysis of Chemical analysis.Numerical problems.

Unit-III : Separation Techniques: **12L**

Advanced level treatment of solvent Extraction: Introduction, Liquid-liquid extraction-continuous and counter current extractions, synergic extraction, ion-pair or ion association extraction, Extraction by equilibrium shifts. Solid-liquid extraction, discontinuous infusion type extraction, application to the separation of alkali and alkaline earth metals. Numericals.

Ion-Exchange Separation: Fundamental properties of ion exchangers. Theory of ion exchange, exchange capacity, screening effect, penetration of electrolytes into ion exchange resins, sorption of complex ions Cation and Anion exchangers, Action of ion exchange resins. Ion-exchange equilibria and ion exchange capacity. Strongly and weakly acidic cation exchangers. Strongly and weakly basic anion exchangers. Liquid ion exchangers, chelation ion exchangers, techniques of ion exchange, use of non aqueous solvents in one exchange separation, application of ion exchange separation in determination of total salt concentration, removal of interfering ions, separation of anions and metals and application in analytical chemistry. Seperation using solvent mixture.

Unit IV : Gas Chromatography : 12L

Theory and Instrumentation of GC, Sample injection- Split and splitless injection, Column types, Solid/Liquid Stationary phases, Column switching techniques, Basic and specializeddetectors, elemental detection, chiral separations, , Gas chromatographs and chemicalanalysis, Interfacing of gas chromatography with mass spectrometry, Applications of GLC,Use of GC-MS ,High Speed gas chromatography, Gas- solid chromatography and problems,

High Performance Liquid Chromatography (HPLC): Theory and instrumentation of HPLC, Optimization of column performance, Gradient elution and related procedures, Derivatization, Mobile phase delivery system, sample injection, separation column, detectors, Interfacing HPLC with mass spectrometry, Structure types of column packing, adsorption chromatography, Bonded phase chromatography, reverse phase chromatography, ion–pair chromatography, ion exchange chromatography, size exclusion chromatography, GC-MS and LC-MS, Applications and Problems

Unit V : Chemical Safety and Handling of Chemicals: 12L

Safe working procedure and protective environment, protective apparel, emergency, procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Eexplosives &Chemial weapons:

Chemical explosives: Origin of explosive properties in organic compounds, classification, characteristics-special explosives-nitrocellulose- T.N.T, Picric acid,preparation and explosive properties of lead azide, PETN, cyclonite (RDX), Dynamite-cordite and Gunpowder.

Introduction,Classification of chemical weapons, Chemical warfare agents,physical and chemical properties,toxicity and data, Better regulation of potential chemical weapons

BOOK SUGGESTED-

1. Analytical chemistry- Problems and Solution- S. M. Khopkar, New Age International Publication.
2. Day & Underwood: Quantitative Analysis.
3. Findley: Practical Physical Chemistry:
4. A. I. Vogel A Text book of Quantitative inorganic Chemistry, ELBS, London.
5. Strouts Galfillal: Analytical chemistry
6. Y. Lyalikov: Physocochemical Analysis
7. S. Wilson & P. Jones: Chemical Analysis Vol I
8. Meites and Thomas: Advance Analytical Chemistry. (Mc Graw Hill)
9. H.H.Willard ,L.L.Merritt and J.A.Dean: Instrumental Methods of Analysis (Van Nostrand).
10. B. L. Krayer, H. H. Willard. L. Merrit, J. A. Dean & F. A. Settle: Instrumental Methods of Analysis (CBS Publishers, Delhi, 1986)
11. R. D. Brown Instrumental Methods of Chemical Analysis (Mc Graw Hill)
12. L. R. Shyder & C. H. Harvath: An Introduction to Separation Science (Wiley Interscience)
13. F. J. Wicher Robert: Standard Methods Chemical Analysis.
14. G.L.Davis Krupadanam, D.Vijaya Prasad, K.Varaprasad Rao, KLN Reddy, C.Sudhakar, Analytical chemistry.
15. S.M.Khopkar Analytical chemistry of Macrocyclic and supramolecular and compounds, Narosa publication.
16. R. D. Budhiraja Separation Chemistry, New Age.
17. Kaushik & Kaushik Perspectives in Environmental Studies, New Age
18. R.L.Peesok and L.D.Shield: Modern Methods of Chemical Analysis.
19. Data Analysis for Chemistry, D.B.Hibbert, Oxford University Press.
20. Analytical Chemistry, S.P.J. Higson, , Oxford University Press

SEMESER I

Practical - I

Organic Chemistry

Total Hours: 90 hrs. (9 Hours per week) (26 Laboratory Session) Total Marks: 100

A- Organic Synthesis: Single Stage Preparations (25 Marks) (8 Laboratory Session)

i)) Benzaldehyde to cinnamic acid (Perkin Reaction)
ii) p-nitrobromobenzene from bromobenzene. (Nitration)
iii) Dibenzal acetone from Benzaldehyde. (Aldol Condensation)
iv) Anthranilic acid to 2-iodo /2-choro benzoic acid.
v) m-di-nitrobenzene to m-nitroaniline (Reduction).
vi) Diel's Alder reaction of anthracene and maleic anhydride.
vii) Synthesis of dihydropyrimidinone by Green Method (Begenneli reaction)
viii) Preparation of 1,1-bis-2-napthol (Radical Coupling Reaction) by Green Synthesis
ix) Oxidation: Adipic acid by chromic acid oxidation of Cyclohexanol.
x) Sandmeyer reaction: p- Chlorotoulene from p-Toluidine.

Note:

i) The preparations should be carried out using (0.02 to 0.05 mole) of the starting material.
ii) The yield, melting point and TLC of the recrystallized product should be recorded.
iii) The sample of the purified product and TLC plate should be submitted for inspection.

Scheme of Marking:

i). Yield of the crude product	10
ii). MP of the recrystallized product	10
iii). TLC of the recrystallized product	05

B- Qualitative Organic Analysis: (30 Marks) (10 Laboratory Session)

Separation, purification and identification of binary mixtures. The two components may be solid-solid, solid-liquid or liquid-liquid (nonvolatile). The water soluble solid/liquid should also be given. Student should submit the purified samples of the separated compounds and prepare a suitable derivative of the two compounds separated out.

Note : Analysis of at least ten mixtures should be carried out.
Scheme of Marking:

i)	Type of the mixture	10
ii)	Analysis of the individual components: (10 Marks for each component)	
	a). Detection of Elements	02
	b). Detection of functional groups	02
	c). Determination of MP/BP	02
	d). Preparation of the derivative	02
	e). Identification (Spotting)	02

C - Quantitative Analysis: (25 Marks) (8 Laboratory Session)

i) Estimation of Phenol by KBr/KBrO3
ii) Estimation of given carbonyl compound by hydrazone formation
iii) Determination of percentage of number of hydroxyl group in an organic compound by acetylation method.
iv) Estimation of Aspirin. (Potentiometric/Conductometric)
v) Estimation of Streptomycin. (Colorimetric)
vi) Estimation of vit-B12. (Colorimetric)
vii) Estimation of carbohydrates, amino acids, proteins by UV-Vis spectrophotometer
viii) Assay of Diazepam by UV-Vis Spectrophotometer
ix) Assay of Riboflavin by UV-Vis Spectrophotometer.
x) Determination of Hammett constants and determine its substitution effect. i) Benzoic acid, ii) p-Nitro Benzoic acid, iii) p-Methoxy Benzoic acid, iv) p-Methyl benzoic acid, v) p-Chloro benzoic acid. (Out of two compounds one compound must be benzoic acid and another should be substituted benzoic acid is given to the students)

Practical-I
Organic Chemistry

Time : 6-8 Hrs. (One day Examination) Total Marks : 100

(1) Exercise-1 (Organic Synthesis) -	25 Marks
(2) Exercise-2 (Qualitative Analysis) -	30 Marks
(3) Exercise-3 (Quantitative Analysis) -	25 Marks
(4) Record -	10 Marks
(5) Viva-Voce -	10 Marks
Total	-100 Marks

Books Suggested:

1. Experiments and technique in organic experiments- D. Pasto, C. Johnson and M. Miller prentice Hall.
2. Maero- scale and micro-scale organic experiments-K.L. Williaman, D. C. Heath.
3. Systematic quantitative organic analysis – H. Middleton, Edward Arnold.
4. Hand book organic chemistry – quantitative and qualitative, H. Clark, Edward Arnold.
5. Practical organic chemistry –H. Dupent, Durst and George W. Gokel.
6. Textbook of practical organic chemistry-A.I. Vogel.
7. Qualitative organic Chemial analysis-A.I. Vogel.
9. Experiment organic chemistry Vol.I &II –P.R. Singh, D. S. Gupta and K.S. Bajpai.
10. Vogel' textbook practical organic chemistry – A.R. Tatchell, John Willey.
11. Unitised experiment in organic chemistry-Ray Q Brewalter, Calven, A. Vaudenwerf and William

Semester I
Practical - II
Physical Chemistry

Total Hours: 90 hrs. (9 Hours per week) **Total Marks: 100**

Use of Computer Programs 5 terms of practicals: Treatment of experimental data, X-Y plots, programs with data preferably from physical chemistry practicals. Students will operate two packages I) MS-Word and II) MS-Excel.

Part-A

1. To study the surface tension-concentration relationship for solution and determination of surface excess concentration by using Gibbs' adsorption equation.
2. To find out the molecular surface energy and the association factor of ethyl alcohol.
3. To study the effect of concentration of an electrolyte (KC1, NaCl) on solubility of an organic acid.
4. To study the kinetics of iodine clock reaction.
5. To study the reaction between acetone & iodine in presence of acids.
6. Determination of CMC of soap by surface tension method.
7. To minimize a molecule (ibuprofen of aspirin) so as to obtain a stable conformer and calculation of various molecular properties using quantum mechanical calculations.
8. To minimize the water molecule using DFT calculation involving B3LYP basis set.

Part-B

1. To measure refractometrically average polarisablity of some common solvents.
2. To find out the order of reaction and velocity constant of inversion of cane sugar by acid polarimetrically.
3. Polarimetric determination of the specific rotation of camphor in benzene and carbon tetrachloride.
4. Determination of strength of strong and weak acid in given mixture conductometrically.
5. To determine equivalence conductance of strong electrolytes at several concentrations and verification of
6. Debye-Huckel Onsagar principle conductometrically.
7. To study the complex formation between ferric and salicylic acid and find the formula and stability constant of the complex colorimetrically.
8. To determine the dissociation constant of phenolphthalein colorimetrically
9. To determine the dissociation constant of Cu (II) and Fe (III) solution photometrically bt titrating it with EDTA

Practical-II
Physical Chemistry

Time : 6-8 Hrs. (One day Examination) **Marks : 100**

Exercise - 1 (Instrumental)	-	40 Marks
Exercise - 2 (Non-Instrumental)	-	40 Marks
Record	-	10 Marks
Viva-Voce	-	10 Marks
Total	-	100 Marks

Books Suggested:

1. Findley's Practical Physical Chemistry, B.P. Levitt Longman.
2. Practical Physical Chemistry, A.M. James and F.F. Prichanrd Longman.
3. Experimental Physical Chemistry, R.C. Das and B.Behra, Tata McGrawHill.
4. Advanced Physical Chemistry Experimentals Gurtu-Gurtu Pragati Prakashan
5. Experimental Physical Chemistry, V.D. Athanale and Parul Mathur New age International
6. Advance Practical Physical Chemistry J.B. Yadao Goel Pubs. House.
7. Experimentals in Physical Chemistry by Dr. D.VJahagirdhar.
8. Experiments in Physical Chemistry by D.P.Shoemaker.
9. Systematic experimental Physical Chemistry by Dr. T.K. Chandhekar & S.W.Rajbhoj.

Semester II
Paper V
Co-ordination Chemistry

60hrs (4hrs/week). 12hrs/unit **Total Marks 80**

Unit-I : A) Electronic spectra: **12L**

Introduction of electronic spectra of transition metal complexes. Derivation of term symbols for ground and excited states of d^n configurations, (L-S coupling and j-j coupling), microstates, Types of experimental recording of the spectra, Selection rule for ligand-field and charge transfer transitions in metal complexes, Relaxation in Selection rules, Nature of electronic spectral bands, band widths, Band intensities & factors influencing band shapes (Jahn-Teller Effect–Spectrochemical Series–Nephelauxetic Effect),electronic spectra of transition metal complexes of the type[$M(H_2O)_n]^{n+}$ spin free and spin paired ML_6 complexes of other geometries with suitable examples. Spin forbidden transitions and effect of spin-orbit coupling. Evaluation of D_q, B' and β parameters (Konig method), Numericals. Orgel diagrams (d^1-d^9 states) and Tanabe–Sugano diagrams of d^2 and d^8 configurations of an octahedral environment. Charge transfer spectra & its mechanism, Intensity of change transfer bands.

B) Magnetochemistry:
Fundamental equations in molecular magnetism, magnetic susceptibility and magnetic moment; diamagnetic and paramagnetic behavior of transition metal complexes of different geometries, factors affecting the magnetic properties, Temperature dependence of paramagnetism(TDP) and temperature independent paramagnetism(TIP) of complexes, High spin-low spin crossover. Abnormal magnetic properties, orbital contributions and quenching of orbital angular momentum, spin-orbit coupling, magnetic interactions, ferromagnetism and antiferromagnetism. Anomalous magnetic moments and magnetic exchange coupling. Magnetic properties of polynuclear complexes. Magnetic moment, electronic spectra and structure of tetrahalocobalt(II)complexes, tetrahedral and octahedral Ni(II) complexes.

Unit-II : Reaction Mechanism of Transition Metal complexes-I: 12L
Classification of Inorganic reactions, Energy profile diagram with terminology includes transition state or activated complex, substrate, attacking reagents electrophilic and nucleophilic. Reactivity of metal complexes, ligand replacement reaction: classification of mechanism and energy profile of reaction. Inert and labile complexes, interpretation of liability and inertness of transition metal complexes on the basis of VBT and CFT. Factors affecting the lability of a complex, transition state or activated complex, substrate, attacking reagents electrophilic and nucleophilic.Kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct & indirect evidences in favour of conjugate mechanism, anation reaction, reaction without metal ligand bond cleavage, reactions of coordinated ligands. Molecular rearrangement complexes. Geometrical, linkage and optical isomerization reactions. Ligand stereospecificity.

Unit-III : Reaction Mechanism of Transition Metal complexes-II: ` 12L
Substitution reaction in square planer complexes: the trans effect, trans-directing series, cis effect, steric effect, solvent effect, effect of leaving group, effect of charge, effect of nucleophile, effect of temperature. Trans effect theories, uses of trans-effect, mechanism of substitution reactions in Pt(II) complexes. Electron transfer reactions. Types of electron transfer reactions, conditions of electron transfer, and mechanism of one-electron transfer reactions, outer sphere and inner sphere mechanisms, two electron transfer reactions-complimentary and non-complimentary reactions. Tunneling effect, cross-reaction, Marcus-Hush theory, bridged activated mechanism. Synthesis of coordination compounds using electron transfer reactions. Photochemical reaction of Chromium and Ruthenium complexes.

Unit-IV : Metal pi-Complexes: 12L
Metal carbonyls: Structure and bonding, structural elucidation of metal carbonyls (by IR, and ^{13}C NMR spectra), important reaction of metal carbonyls. Metal carbonyl clusters with reference to classification, EAN rule, synthesis and structures. Application of Wilkinson's catalyst and Vaska's compound.
Metal nitrosyls: Nitrosylating agents for synthesis of metal nitrosyls, vibrational spectra and X-ray diffraction studies of transition metal nitrosyls for bonding and structure elucidation, important reactions of transition metal nitrosyls, structure and bonding.
Fluxional Organometallic compounds : Fluxionality and dynamic equilibria in compounds such as η^2-olefin, η^3-allyl and dienyl complexes.

Unit-V : Bio-inorganic chemistry: 12L
Bioinorganic chemistry: Overview of Bioinorganic chemistry, biological role of alkali metal ions, ligands, ion transport across the membrane, Classification as enzymatic and non-enzymatic metals, enzymatic redox metals such as Cu(SOD) and enzymatic non redox metals such as Zn(Hydrolase). 5L
Bioinorganic chemistry of Fe: Hemoglobin and myoglobin, their structures and functions, their coordination geometry and electronic structure, trigger mechanism, Introduction of Fe-S proteins, electron transfer proteins: Rubredoxin, 2Fe-2S Ferredoxins, 4Fe-4S and 8Fe-8S proteins Transport protein(transferrin) and storage protein(ferritin), Oxygenation reactions, Hill constant and Bohr Effect. 5L
Bioinorganic chemistry of Co:Vitamin-B_{12}, its structure and biochemical function and mechanisms of action. 2L

Suggested Books

1. J.E.Huheey :Inorganic Chemistry
2. F.A.Cotton& G. Wilkinson: Advanced Inorganic Chemistry 3rd, 5th & 6th Editions.
3. A.F. Willims: Theoretical Approach in inorganic chemistry.
4. Mannas Chanda: Atomic Structure and chemical Bonding
5. L. E. Orgel: An Introduction To transition metal chemistry, Ligand field theory, 2nd Edition.
6. J. J. Logowski: Modern Inorganic Chemistry
7. B.Durrant and P.J.Durrant: Advanced Inorganic Chemistry
8. J C. Bailar: Chemistry of co-ordination compounds.
9. W. L. Jolly: Modern Inorganic ChemistryJones: Elementry Co-ordination chemistry.
10. B. N. Figgis: Introduction to Ligand field.
11. M.C.Day and J.Selbin: Therotical Inorganic Chemistry.
12. J. Lewin and Wilkins: Modern Co-ordination chemistry.
13. Purcell and Kotz: Inorganic Chemistry.

14. D. Banerjea: Co-ordination chemistry, Tata Mc. Graw. Pub.
15. A.F. Wells: Structural inorganic chemistry, 5th Edition, Oxford.
16. S. G. Davies: Organotransition metal chemistry applications to organic synthesis.
17. R. C. Mehrotra: Organometallic chemistry Tata McGraw Hill. Pub.
18. G. S. Manku: Thereotical priciples of inorganic chemistry
19. A. B. P. Lever: Inorganic electronic spectroscopy.
20. R.C.Maurya:Synthesis and charecterisation of novel nitrosyls compounds, Pioneer Pub. Jabalpur 2000.
21. R.H.Crabtree:The Organometalic chemistry of Transition metals, John Wiley.
22. D.N.Styanaryan:Electronic Absorption Spectroscopy and related techniques, University Press.
23. R. S. Drago: Physical methods in inorganic chemistry
24. F.Basolo &G.Pearson: Inorganic Reaction Mechanism
25. Organometallics II & I complexes with transition metal- carbon bonds: Manfred Bochmann- Oxford Press.
26. Advanced Inorganic Chemistry Vol I & II – Satyaprakash, Tuli, Bassu and Madan- S Chand.
27. M.Tsusui,M.Nlevy,M.Ichikwa and K.Mori:Introduction to metal pi-complexe chemistry,Plenum press,NY
28. A.E.Martel;Coordination Chemistry-VolI&II,VNR.

Paper VI

Organic Chemistry – II

60hrs (4hrs/week). 12hrs/unit **Total Marks 80**

Unit-I : A) ADDITION TO C-C &C-X MULTIPLE BOND **12L**

Mechanistic and stereo chemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, Orientation and stereochemistry, Addition to cyclopropanes, hydroboration, oxy mercuration, Michael reaction, Aldol Condensation (Stereochemistry), Knoevenagel reaction, Hydrolysis of esters and amide

B) MECHANISM OF MOLECULAR REARRANGEMENT

Classification and General mechanistic treatment of electrophilic, nucleophilic and free radical molecule rearrangement. Mechanism of the following rearrangement –

a) Rearrangement to electron deficient carbon: Wagner-Meerwin, Pinacol-Pinacolone, Tiffenev – Demjnov ring expansion,

b) Rearrangement to electron rich carbon: Neber and Steven's rearrangement

c) Rearrangement to electron deficient nitrogen: Beckman, Hoffman, Curtis, Lossen, Schmidt rearrangement.

Unit-II : FREE RADICAL REACTION : **12L**

Radical anions and radical cations, Types of free radical reactions, free radical substitution mechanism at an aromatic substrate, aliphatic substrate, reactivity at a bridgehead position. Neighbouring group assistance, reactivity for aliphatic and aromatic substrates, reactivity in attacking radicals, effect of solvent on reactivity at allylic carbon, hydroxylation at an aromatic carbon by means of Fenton's reagent. Oxidation of aldehydes to carboxylic acids. Chlorosulphoration(Reed Reaction) Coupling of alkynes and arylation of aromatic compounds by Diazonium salts. Sand Meyer reaction, Free radical rearrangement, Hunsdiecker reaction. Singlet oxygen, it's generation and reactions with organic substrates, Barton Deoxygenation, McMurry Coupling.

Unit III : Photochemistry : **12L**

Interaction of radiation with matter, types of excitation, rate of excited molecules, quenching, Quantum efficiency, quantum yield, transfer of excitation energy, actinometry, Photoinducd energy transfer, FRET, singlet and triplet states, experimental methods in photochemistry of carbonyl compounds, and transition, Norrish type I and Norrish type II reactions Paterno –Buchi reaction, Photoreduction, Photochemistry of enones, Hydrogen abstraction rearrangement of unsaturated ketones and cyclohexadienones, Photochemistry of parabenzoquinones,(di-π methane) Photochemistry of Aromatic compounds with reference to isomerisation addition and substitution Photochemical isomerization of cis and trans alkenes, Photochemical cyclization of reaction, Photo-Fries rearrangement, Photo theory reaction of anilides, Fluorescence based sensor, Conversion of solar energy to chemical and other form of energies, Solar PhotoVotaice Cell.

Unit—IV : Pericyclic Reactions **12L**

Molecular orbital symmetry, Frontier orbitals of ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene, allyl system, classification of pericyclic reaction . FMO approach, woodward-Hoffman correlation diagram method and Peturbation of molecular orbital (PMO) approach of pericyclic reaction under photochemical conditions. Electrocyclic reactions,conrotatary and disrotatary motion 4n and (4n+2) systems, with more emphasis on (2+2) and (4n+2) Cycloaddition of ketones Secondary effects in (4+2) cycloaddition. Stereochemical effects and effect of substituents on rate of cycloaddition reaction,1,3-dipolarcycloaddition and chelotropic reaction. Sigmotropic rearrangement, suprafacial and antarafacial shift involving carbon moieties ,retension and inversion of configuration, (3,3) and(3,5) sigma tropic rearrangements, Claisen and Cope rearrangements, Ene reaction, Fluxional Tautomerism, Sigmatropic Migration of Carbon.

Unit-V : GREEN CHEMISTRY : 12L

Designing a green synthesis: Choice of starting material, choice of solvents. Basic principle of green chemistry: Prevention of waste by products, Maximum incorporation of the reactants (starting material and reagents) into the final products. Rearrangements reaction, Addition reaction, substitution, elimination reaction, Prevention or minimization of hazardous products. Designing of safer chemical. Synthesis involving basic principles of green chemistry, some examples-Synthesis of styrene, Synthesis of urethane, Free radical bromination ,Synthesis of paracetamol, Synthesis of Ibuprofen.

Microwave induced green synthesis: Oxidation of Toluene, Synthesis of Chalcones, Fries rearrangement, Diels Alder reaction, Hydrolysis of benzyl chloride. Aqueous phase reactions: Heck reaction, Benzoin condensation, Michael Reaction Bio Catalyst in organic synthesis, Ionic Liquids as Green Solvents.

Books Suggested-

1. Advanced organic chemistry –Reaction mechanism and structure. Jerry March, John Wiley.
2. Advanced organic chemistry- F.A. Carey and R.J. Sunberg, Plenum.
3. A Guidebook to mechanism in organic chemistry-Peterskyes, Longman.
4. Structure and mechanism in organic chemistry-C.K. Gold, Cornell University Press.
5. Organic chemistry, R.T. Morrison Boyd. Prentice Hall
6. Modern organic chemistry-H.O. House, Benjamin.
7. Principal of organic chemistry-R.O.C. Norman and J.M. Coxon, Blackie Academic and Professional.
8. Reaction mechanism in organic chemistry-S.M. Mukharji and S.P. Singh, Macmilan.
9. Stereochemistry of organic compounds- D. Nasipuri, New age international.
10. Stereochemistry of organic compounds- P.s.kalsi, New age international.
11. Frontier orbitals and organic chemical reactions-I. Fleming.
12. Orbital Symmetry – R.E.Lehr & A.P. Marchand.
13. Reactive intermediate in organic chemistry-N. S. Isaacs.
14. Stereochemistry of carbon compounds- E.L.Eliel.
15. Physical organic chemistry-J. Hine.
16. Name reaction in organic chemistry –Surrey.
17. Advanced organic chemistry – L.F.Fieser and M. Fieser.
18. Vol.I & II organic chemistry - I. L. Finar.
19. Modern organic chemistry- J.D. Roberts and M. C. Caserio.
20. The search for organic reaction pathways (Longmann), Peter Skyes.
21. Organic chemistry 5th Edition (McGraw Hill), Pine.
22. Organic chemistry (Willard Grant Press Botcon), John Mcmurry.
23. A Textbook of organic chemistry- R.K. Bansal.
24. New trends in green chemistry –V.K. Ahluwalia & M. kidwai, Anamaya publishers New Delhi.
25. Fundamentals of photochemistry-KK Rohatgi & Mukharji
26. Photochemistry-Cundau & Gilbert
27. Aspects of organic phoptochemistry-WM horspoot
28. Photochemistry-JD calvert
29. Photochemistry-RP Wayne R. M. Acheson : An introduction to chemistry of heterocyclic compounds (Interscience).
30. Pericyclic Reactions and organic photochemistry
31. Green Solvents for organic synthesis: V. Ahluwalia& R. S. Verma
32. Eco Friendly Synthesis of fin Chemicals: Roberto Ballini
33. Essentials of molecular photochemistry, A. Gilbert and J. Baggott. Blackwell Scientific Publication.
34. Molecular photochemistry, N.J. Urro, W. A. Benjamin

Paper - VII

Physical Chemistry - II

60hrs (4hrs/week). 12hrs/unit **Total Marks 80**

Unit-I : Chemical Dynamics :

A) Kinetics of Complex reactions: Chain reaction (H2+Br, ® 2 HBr thermal and photo chemical reaction), Homogeneous catalysis (acid-base and enzymes), oscillating reactions (Belousov-Zhabotinsky reaction, Lotka-Volterra mechanism, the brusselator and the oregonator). 6L

B) Fast reactions: General features of fast reactions, Stopped flow method, relaxation method, Nuclear magnetic resonance method, Flash Photolysis, Numericals. 6L

Unit-II : Quantum Chemistry :

A) Construction of M.O.by LCAO for H2+ ion, Calculation of energy levels from wave functions, physical picture of bonding & anti-bonding wave functions, concept of orbitals and their characteristics. 6L

B) Hybride orbitals sp, sp2, sp3;Calculationof coefficient of A.O. used in hybride orbital;Huckel theory of Conjugated systems, bond order & charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclo- butadiene. Numericals. 6L

Unit-III : **Macromolecules:**

A) Definition of macromolecule (Polymer), types of polymers, Random coils, configuration and conformation of macromolecules, electrically conducting molecular wires, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. stability of biological polymers, Application of polymers. 6L

B) Number average & mass average molecular mass, molecular mass determination by Osmometery, Viscometry, Ultracentrifugation, light scattering & size-exclusion chromatography method, Numericals 6L

Unit-IV : **Electrochemistry :**

A) Electrochemistry of solutions: Debye-Huckel-Onsager treatment and its extension. Ion solvent interactions.. Bio-electrochemistry, Introduction, threshold membrane phenomenon, Nernst - Plank Equation, Hodges Huxley equation, core conductor models, electrocardiography. 6L

B) The rate of charge transfer, the Butler-Volmer equation, the low overpotential limit the high overpotential limit, Tafel plot. Voltammetry, Concentration polarization, experimental techniques, corrosion, Types of corrosion, corrosion inhibitors , Corrosion monitoring. and prevention methods. Numericals. 6L

Unit-V : **Statistical Thermodynamics :**

A) Thermodynamic probability, most probabale distribution. Maxwell-Boltzmann distribution law Fermi-Dirac statistics, distribution law and applications to metals. Bose-Einstein statistics - distribution law and application to helium. 6L

B) Partition function- Translational, rotational, vibrational and electronic partition functions, calculations of thermodynamic properties in terms of partition functions. Applications of partition functions. Numericals. 6L

List of Books:

1. Physical chemistry by P.W.Atkins & dePaula 7th Edition
2. Molecular reaction Dynamics and chemical reactivity, R.D.Levine and R.B. Benstin, Oxford University Press. 1987.
3. Physical Chemistry by Alberty and Silby, Jolly Wiley
4. Adsorption and Catalysis by solids, by D.K.Chakraburti, Wiley Eastern, 1990
5. The Theory of Adsorption and catalysis, by A. Clark, Academic press, 1970
6. Micells Theoretical and applied aspects, by V.Moroy. Plenum
7. Modern Electrochemistry by A.K.N.Raddy
8. Theoretical electrochemistry by D.LAntropov, Mir Publisher WJ2
9. Electrochemistry by J. Dvorak, J. Koryta, V. Bohackova.
10. Introduction to radiation chemistry by J.W.T. Spinks and RJ.Woods

Paper VIII

Optical Methods and Environmental Chemistry

60hrs(4hrs/week), 12hrs/Unit **80Marks**

Unit-I : **Optical Method** **12L**

Spectrophotometry and Colorimetry: Brief introduction of topic,Application of spectrophotometric metods for study of composition of coloured complex ,Multiple analysis, Pk value of indicator etc. Photometric titrations. Applications of quantitative and qualitative analysis, problems.

Principles, Plane polarized and circularly polarized rays, optical rotation, optically active molecules, optical rotator dispersion. Circular dichroism: fundamentals, relationship between ORD and CD curves, methods of measurements, investigation of optically active compounds.

Theory, instrumentation and applications of fluorimetry, Nephelometry, turbidimetry, Polarimetry & Refractometry.

Unit II : **Flame Emission and atomic spectrometry**: **12L**

Flame photometry: Elementary theory of flame photometry. Instrumentation and experimental techniques. Interferences, analytical techniques and applications. Atomic absorption spectrometry (AAS): introduction, principles, Advantages of AAS over FES, Instrumentation, Flame atomization. Hallow cathod lamps, interferences and applications. Comparison of atomic absorption with atomic emission methods.

UNIT-III : **WATER POLLUTION :** **12L**

Origin of wastewater, types, water pollutants and their effects. Sources of water pollution, domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. Objective of analysis, parameter for analysis colour, turbidity, total solid, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Heavy metal pollution, public health significance of Cadmium, Chromium, Copper, zinc Lead, Manganese, Mercury and Arsenic.General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Oxygen content of water and aquatic life. Measurments of DO, BOD, COD and their significance as pollution indicators. Pesticides as water pollutants and analysis. A brief idea of coagulation and flocculation.

Unit IV : **AIR POLLUTION** **12L**

Sources and sinks of gases pollutants, classification of air pollutants, effect of air pollutants on living and non-living things. Sources of air pollution, air quality standards and sampling. Analysis of air pollutants (CO, CO_2, NOx, SOx, H_2S ,NH_3 and Hydrocarbons and particulates). Green house effect, acid rain, ozone depletion and their consequences on environment. Effects of air pollution, photochemical smog and monitoring of air pollution.

Unit-V : Soil Pollution and Pesticide Analysis **12L**

Chemistry of soil, soil irrigation by effluents. Agricultural pollution, role of micronutrients in soil, trace element analysis in soil

Pesticides and pollution. Sources of pesticide residue in the environment, classification of pesticides, pesticide degradation by natural forces, effect of pesticide residue on life. Analytical techniques for pesticide residue analysis**.** DDT problem.

Radiation pollution-Classification and effects of radiation. Effects of ionizing radiation on Man. Effect of nonionizing radiation on life. Radioactivity and nuclear fall out, protection and control from radiation.

List of Books

1. Analytical chemistry- Problems and Solution- S. M. Khopkar, New Age International Publication.
2. Day & Underwood: Quantitative Analysis.
3. Findley: Practical Physical Chemistry:
4. Vogel A Text book of Quantitative inorganic Chemistry, ELBS, London.
5. Strouts Galfillal: Analytical Y. Lyalikov: Physocochemical Analysis
6. S. M.Khopkar:Basic concep in Analytical Chemistry
7. Meites and Thomas: Advance Analytical Chemistry. (Mc Graw Hill)
8. **H.H.Willard ,L.L.Merritt and J.A.Dean: Instrumental Methods of Analysis (Van Nostrand).**
9. **B. L. Krayer, H. H. Willard. L. Merrit, J. A. Dean & F. A. Settle: Instrumental Methods of Analysis (CBS Publishers, Delhi, 1986)**
10. R. D. Brown Instrumental Methods of Chemical Analysis ,McGraw Hill
11. **L. R. Shyder & C. H. Harvath: An Introduction to Separation Science (Wiley Interscience).**
12. **Environmental chemistry, S. E. Manahan, Lewis Publishers.**
13. Environmental chemistry, Sharma & Kaur, Krishna publishers.
14. Environmental chemistry, A. K. De, Wiley Eastern.
15. Environmental Pollution Analysis, S. M. Khopkar, Wiley Eastern.
16. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
17. Elemental Analysis of Airborne Particles, Ed. S. Landberger and M. Creatchman, Gordon and breach Science Publication.
18. Atmospheric pollution, W. Buch, McGraw Hill, New York.
19. Fundamentals of Air Pollution, S. J. Williason, Addison – Wesley Publishers.
20. Analytical Aspect of Environmental chemistry, D. F. S. Natush and P. K. Hopke. John Wiley & sons. New York.
21. Analytical chemistry- Problems and Solution- S. M. Khopkar, New Age.
22. Environmental Chemistry, J.W.Vanloon, Oxford University Press.
23. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
24. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
25. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
26. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
27. K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
28. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
29. S.E. Manahan, Environmental Chemistry, CRC Press (2005). • G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
30. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

Semester II
Practical - III
Physical Chemistry

Total Hours: 90 hrs. (9 Hours per week) **Total Marks: 100**

Use of Computer Programs 5 terms of practicals:

Treatment of experimental data, X-Y plots, programs with data preferably from physical chemistry practicals. Students will operate two packages I) MS-Word and II) MS-Excel.

Part-A

1. Determination of radius of molecules of glycerol by viscometry.
2. Determine the viscosity of unknown mixture of two liquids by viscometry (ethyl alcohol + water)
3. Study the influence of ionic strength on the solubility of CaSO4 and hence to determine thermodynamic solubility product and mean ionic activity.
4. Determine rate constant of reaction between potassium persulphate and potassium iodide having equal concentration of reacting species.
5. Investigate the autocatalysis reaction between KMnO4 and oxalic acid and calculate the energy of activation.
6. Investigate the solubility of three component system and hence draw a tie line on binodal curve.
7. Study the variation of solubility of Ca(OH)2 in pressure of NaOH solution. Hence determine solubility product at room temperature.
8. Determination at surface excess of amyl alcohol by capillary rise method.
9. Part-B
10. Determine Hammett constant of a given substituted benzoic acid by pH measurement.
11. To determine the hydrolysis constant of active hydrochloride by pH measurement.
12. To determine pH of butter solution using quinhydrone electrode.
13. Determination of pK value of aid-base indicator (methyl red, methelene blue and bormo cresol) by spectrophotometrically.
14. Determination of standard electrode potential of Zinc and Copper.
15. To find the strength of HCl and Acetic acid in given mixture potentiometrically.
16. To find the strength of mixture of halides by titrating it against AgNO3 solution potentiometrically.
17. To determine the hydrolysis constant of aniline chloride by emf method.

Practical-III
Physical Chemistry

Time : 6-8 Hrs. (One day Examination)		Marks : 100
Exercise - 1 (Based on Part-A)	-	40 Marks
Exercise - 2 (Based on Part-B)	-	40 Marks
Record	-	10 Marks
Viva-Voce	-	10 Marks
Total	-	100 Marks

Physical Chemistry Practical
Books Suggested:

1) Experimental physical chemistry, R.C. Das and B. Behera, Tata McGraw-Hill
2) Advanced physical chemistry J.B. yadao, Goel Pub House
3) Experiments in physical Chemistry D.P. Shormaker, C.W. Garland and J.W. mbler, Tata McGraw Hill Comp.
4) Post graduate physical chemistry, Patel, Turakhia, Kelkar, Himalaya Pub House
5) Experiments, in physical chemistry, D.V. Jahagirdar, Himalaya Pub House
6) Practical Physical Chemistry, A. Findlay Revised by J.A. Kitehner, Longmans, Green
7) Experiments in Physical Chemistry, F. Daniels and J. Williams, Mc Graw Hill.
8) Systematic Experimental Physical Chemistry, T.K. Chondekar & S.W. Rajbhoj, Anjali Pub. Aurangabad.
9) Advanced Physical Chemistry Experiments, J.N. Gurtu & A. Gurtu, Pragati Prakashan
10) Practical Physical Chemistry, A.M. James & P.E. Prichard, Longam Group Ltd.
11) Experiments in physical Chemistry, J.M.Wilson, KJ.Newcombe, A.R. Denko, and R.M.W.Richett, Pergamon Press,
12) Senior Practical Physical Chemistry, B.D.Khosle and V.S. Garg S.Chand & Comp.

Semester II
Practical IV
Inorganic Chemistry Practicals

Practical Work load 9 Hrs. /Week **Marks 100**

I] Preparation of inorganic compounds by greener methods and their characterization by elemental analysis, MW determination, decomposition temperatures and molar conductance studies. (Minimum 9)

1. $[VO(acac)_2]$
2. Preparation of bis(acetylacetonato)copper(II).
3. Preparation of tris (acetylacetonato) iron (III).
4. Preparation of tris (acetylacetonato) manganese (III).
5. *Cis* $K[Cr(C_2O_4)_2(H_2O)_2]$
6. $Na[Cr(NH_3)_2(SCN)_4]$
7. $K_3[Fe(C_2O_4)_3]$
8. $Hg[Co(SCN)_4]$
9. $[Co(Py)_2Cl_2]$
10. $[Ni(DMG)_2]$
11. $TiO(C_9H_8NO)_2(H_2O)_2$
12. *Cis* $[Co(trine)(NO_2)_2]Cl\,H_2O$
13. $[Cu_2(CH_3COO)_4(H_2O)_2]$
14. $K_3[Al(C_2O_4)_3](H_2O)_3$
15. Preparation and characterization of Isomers of Tris (8-Hydroxyquinolinato) aluminium (III) complex

II] A) Quantitative Analysis of mixture of two cations:

Quantitative analysis of binary mixture of cations involving their chemical separation and separate analysis of one cation by gravimetry and another by volumetric or colorimetric. Certain model examples are given below:

i) Copper (II) and Nickel (II)
ii) Copper (II) and Zinc (II)
iii) Nickel (II)—Zinc (II)
iv) Copper (II)—Iron (III)

B) Analysis of Limestone, Dolomite and Bauxite.

III] Qualitative analysis of radicals

Qualitative analysis of inorganic mixture for a total of five radicals including interfering radicals (not more than one such radical in a mixture), rare earth (not more than two rare earths in a mixture) and combination of cations (minimum 8 mixtures).

Cations: Mercury (I, II), Pb, Ag, Bi (III), Cu (II), Cd (II), As (IV, V), Sb (IV, V), Sn (II, IV), Fe (III), Al (III), Cr (III), Ni (II), Co (II), Mn (II), Zn (II), Barium, Strontium, Calcium and Magnesium.

Interfering radicals: Phosphate, Oxalate, Fluoride and Borate.

Rare Earth: Tl, Mo, W, Se, Ti, Zr, Th, V, U, Ce.

The Practical examination will be based on the Inorganic Chemistry.

Time: 6-8 hours (one day examination) Marks: 100

I) Exercise -1 (Synthesis/Radicals)	- 40 Marks
II) Exercise-2 (Estimation)	- 40 Marks
III) Record	- 10 Marks
IV) Viva- Voce	- 10 Marks
Total	-100 Marks

Books Suggested-

1. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall.
2. Inorganic Experiments, J. Derck Woollins, VCH.
3. Practical Inorganic Chemistry, G. Marrand, B. W. Rockett, Van Nostrand.
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