GOVERNMENT ARTS COLLEGE
(Autonomous)
COIMBATORE – 641 018

DEPARTMENT OF CHEMISTRY

M.Sc., CHEMISTRY – SYLLABUS
(*Effective from 2015 – 16 onwards*)

Board of Studies meeting to be held on 30-09-2014

GOVERNMENT ARTS COLLEGE (Autonomous), COIMBATORE – 641 018

DEPARTMENT OF CHEMISTRY

M.Sc., CHEMISTRY – SYLLABUS (*Effective from 2015 - 16 onwards*)

SEMESTER	No	Sub. code	SUBJECT TITLE		Hrs. Per week	MARKS				No. of credits
						CA	SE	TOTAL	SE-MIN	
I	01	1M1	Paper I	Inorganic Chemistry - I	5	25	75	100	38	05
	02	1M2	Paper II	Organic Chemistry - I	5	25	75	100	38	05
	03	1M3	Paper III	Physical Chemistry – I	5	25	75	100	38	05
II	04	2M1	Paper IV	Inorganic Chemistry - II	5	25	75	100	38	05
	05	2M2	Paper V	Organic Chemistry - II	5	25	75	100	38	05
	06	2M3	Paper VI	Physical Chemistry – II	5	25	75	100	38	05
	07	2P4	Practical I	Inorganic Chemistry - I	5	40	60	100	30	03
	08	2P5	Practical II	Organic Chemistry - I	5	40	60	100	30	04
	09	2P6	Practical III	Physical Chemistry – I	5	40	60	100	30	03
III	10	3M1	Paper VII	Organic Chemistry - III	5	25	75	100	38	05
	11	3M2	Paper VIII	Physical Chemistry – III	5	25	75	100	38	05
	12	3M3	Paper IX –E1*	Instrumental Methods- I	5	25	75	100	38	05
	13	3M4	Paper X- E2*	Green and Nano Chemistry	3	25	75	100	38	05
	14	4M1	Paper XI	Organic Chemistry - IV	5	25	75	100	38	05
	15	4M2	Paper XII-E3*	Instrumental Methods – II	5	25	75	100	38	05
	16	4M3	Paper XIII-	Applied	5	25	75	100	38	05

			E4*	Electrochemistry						
IV	17	4P4	Practical IV	Inorganic Chemistry - II	4	40	60	100	30	04
	18	4P5	Practical V	Organic Chemistry - II	4	40	60	100	30	03
	19	4P6	Practical VI	Physical Chemistry – II	4	40	60	100	30	03
	20	4V7	PROJECT AND VIVA VOCE		3	20	80	100	40	05
TOTAL								**2000**		**90**

CA- Continuous Assessment, **SE**- Semester Examination

SE-MIN- Passing minimum in the Semester Examination

***E1, E2, E3 & E4 are ELECTIVE PAPERS**

Industrial visit, up to three days, is included in I & III semesters (optional)

Semester	**:**	**I**	**Credits:**		**05**
Paper	**:**	**Paper – I: INORGANIC CHEMISTRY – I**	**Code: 1M1**	**Hours/week:**	**05**

UNIT-I : Homocyclic and Heterocyclic Ring Compounds: (15 hrs)

Borazines, phosphonitrilic compounds, sulphur-nitrogen compounds, organohalosilanes, silanols, siloxanes, silylamines (silazenes) Isopoly and heteropoly acids of vanadium, chromium, molybdenum and tungsten

UNIT-II: Reactions in Non-aqueous Solvents (15 hrs)

Classification of solvents – properties of ionizing solvents – a general study of the typical reactions in liquid ammonia, sulphur dioxide, anhydrous hydrogen fluoride, hydrogen sulphide and hydrogen cyanide – a comparative study, organophosphorus compounds, alkyllithium compounds.

Acids and Bases: Lowry-Bronsted theory-Lewis concept– Hardness and softness of acids and bases.

UNIT-III: Nuclear Chemistry (15 hrs)

The nucleus – subatomic particles and their properties – binding energy- n:p ratios in stable and metastable nuclei – Different types of nuclear forces – Liquid drop model and Shell model. Modes of radioactive decay – Theory of alpha decay, beta decay and gamma radiation. Orbital electron capture, nuclear isomerism – Internal conversion.

UNIT-IV: Experimental Methods (15 hrs)

Cloud chamber, nuclear emulsion, bubble chamber, proportional counters, G M counter, Scintillation and Cherenkov counters

Particle Accelerators: Linear accelerators – cyclotron, synchrotron, Betatron and Bevatron.

UNIT-V: Nuclear Reactions (15 hrs)

Q – value, coulombic barrier – nuclear cross section – different types of nuclear reactions- projectile capture – particle emission, spallation, fission and fusion – Product distributions – theories of fission, use of fission products, fissile and fertile isotopes- U-238, U-235, Pu-239, Th-232 – Stellar energy – Synthesis of new elements.

Radio Isotopes: Applications – isotopes as tracers – neutron activation analysis and isotopic dilution analysis – uses in structure and mechanistic studies – carbon dating - Hot-atom chemistry-Safty measures- Disposal of nuclear waste.

REFERENCES

1. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry
2. Emeleus and Sharpe, Modern aspects of Inorganic chemistry
3. S. Glasstone, Source book on Atomic Energy
4. Gurdeep and Harish, Advanced Inorganic Chemistry
5. Sisler, Chemistry in Non-aqueous solvents
6. Friedlander, Kennedy and Miller, Nuclear and Radiochemistry
7. Huheey, Inorganic Chemistry
8. Nuclear chemistry, Arnikar

Semester	**:**	**I**	**Credits:**		**05**
Paper	**:**	**Paper – II: ORGANIC CHEMISTRY – I (Organic Reaction Mechanisms)**	**Code: 1M2**	**Hours/week:**	**05**

UNIT-I **(15 hrs)**

Aromaticity: Criteria - Huckel's rule – diatropic molecules-Aromaticity of Benzenoids and aromatic heterocyclic compounds. Non-benzenoid aromatics – azulene, ferrocene, tropolone, sydnones and annulenes (synthesis not required) - Non-aromatic and anti-aromatic systems.

Study of Organic Reaction Mechanism - non-kinetic methods – product analysis intermediate criteria (isolation, trapping and detection) - isotopic labelling and cross over experiments-stereochemical evidence - energy profile diagrams – intermediate vs. transition state. Kinetic methods - mechanistic implications of rate law - isotope effects – kinetic and thermodynamic control of reactions – Hammond's postulate – linear free energy relationship - Hammett and Taft equations.

UNIT - II **(15 hrs)**

Aromatic Electrophilic Substitution - Mechanism, orientation and reactivity in mono and disubstituted benzenes- partial rate factors. Specific reactions - Friedel - Craft's alkylation and acylation – Formylations (Gattermann, Gattermann-Koch, Reimer-Tiemann, Kolbe's, Vilsmeier-Haack), Bischler-Napieralski, Hofmann-Martius and Jacobson reactions.

Aliphatic Electrophilic Substitution - SE^1, SE^2 and SE^i mechanisms - Friedel-Craft's acylation at olefinic carbon - Stork-enamine reaction - decarboxylation of aliphatic acids.

UNIT - III **(15 hrs)**

Aliphatic Nucleophilic Substitution – SN^1, SN^2, ion-pair, SN^i mechanisms-neighbouring group participation – stereochemistry – Reactivity - effect of substrate structure, nucleophile, leaving group, and the reaction medium - ambient nucleophiles (regioselectivity) and ambient substrate- hydrolysis of esters.

Aromatic Nucleophilic Substitution - SN^1, SNAr and benzyne mechanisms - structure and reactivity - effect of substrate structure, leaving groups and nucleophile -typical reactions - Bucherer, Rosenmund, Von-Braun, Ziegler, Chichibabin reactions - Von-Richter, Sommlett – Hauser and Smiles rearrangements.

UNIT - IV **(15 hrs)**

Elimination Reactions – E_1, E_2 and E_1cB mechanisms-structural and stereochemical factors governing eliminations, Hofmann and Saytzeff rule – Bredt's rule –elimination vs. substitution-pyrolytic eliminations-Chugaev reaction-Hofmann degradation - Cope elimination.

Carbenes and Nitrenes - structure, generation and reactions.

UNIT – V **(15 hrs)**

Addition Reactions : Electrophilic, nucleophilic and free radical addition to double and triple bonds-hydration, hydroxylation (OsO_4, $KMnO_4$, H_2O_2, Woodward & Prevost methods), Michael addition, hydroboration and epoxidation- sharpless asymmetric epoxidation, Skraup synthesis.

Stability and Structure of Carbocations, Carbanions and Free Radicals:

Free radicals –generation of short-lived and long-lived free radicals- detection of free radicals- addition, substitution, elimination and rearrangement reactions of free radicals- typical reactions: Sandmeyer, Gomberg-Bachmann, Ullmann, Pschorr and Hunsdieker reactions.

REFERENCES

1. J. March, Advanced Organic chemistry
2. I.L. Finar, Organic Chemistry Vol I, ELBS Edn.,
3. C.K. Ingold, Structure and Mechanism in Organic Chemistry (II edn.)
4. E.S. Gould, Mechanism and Structure in Organic Chemistry
5. P. Sykes, Guide Book to Mechanism in Organic Chemistry
6. F.A. Carey, R.J. Sundberg, Advanced Organic Chemistry, Part A and Part B
7. T.H. Lowry K.S. Richardson, Mechanism and Theory in Organic Chemistry
8. G. Solomons, Organic Chemistry
9. Cram, Hammond and Hendrickson, Organic Chemistry
10. Alexander, Principles of Ionic Organic Reactions
11. Ferguson, The Modern Structural Theory of Organic Chemistry
12. Jack Hine, Physical Organic Chemistry
13. Neil S. Isaacs, Physical Organic Chemistry
14. Stanley H. Pine, Organic Chemistry
15. Morrison and Boyd, Organic Chemistry
16. Raj K. Bansal, Organic Reaction Mechanisms
17. Mukherji and Singh, Reaction Mechanism in Organic Chemistry
18. Roberts and Casserio, Organic Chemistry
19. Chatwal, Reaction Mechanism and Reagents in Organic Chemistry
20. Badger, Aromatic character and Aromaticity
21. Garratt, Aromaticity
22. Guinsberg, Non-benzenoid Aromatic Compounds
23. Harris and Wamser, Fundamentals of Organic Reaction Mechanisms
24. Banthorpe Eliminations
25. Miller, Aromatic Nucleophilic Substitution
26. Nonhebel and Walton, Free Radical Chemistry
27. Bunton, Nucleophilic Substitution at the Saturated Carbon
28. Jagdamba Singh and L.D.S. Yadav, Advanced Organic Chemistry
29. Jagdamba Singh and L.D.S. Yadav, Organic Synthesis

Semester	**:**	**I**	**Credits:**		**05**
Paper	**:**	**Paper – III: PHYSICAL CHEMISTRY – I (*Quantum Chemistry and Group Theory*)**	**Code: 1M3**	**Hours/week:**	**05**

UNIT – I **(15 Hrs)**

Quantum Chemistry – Introductory Concepts: Basic Concepts – Black body radiation - Time dependent and time independent Schrodinger equation – requirement of an acceptable wave function – operator concept as applied to quantum mechanics (basic ideas) - postulates of quantum mechanics – Hermitian operators – application of Schrodinger equation to the particle in a box (1D & 3D Boxes) – Particle in a ring & Particle in Sphere

UNIT - II **(15 Hrs)**

Application to Hydrogen Atom Problem :Harmonic oscillator and rigid rotator – Central force problem – H-atom – method of separation of variables – final solution – the energy and wave function for the problem – quantum numbers – shapes of the wave functions – electron spin and Pauli's principle

Approximation Methods: Approximate methods in quantum mechanics – need for the approximation methods – perturbation and variation methods applicable to H_2 molecule in the ground and excited states – He atom in the ground state, He_2^+ in the ground and excited state.

UNIT – III **(15 Hrs)**

Bonding's in Many Electron Systems: LCAO – MO methods – Slater determinants – HMO treatment of simple and conjugated π- electron systems – ethylene, allyl, butadiene and benzene systems – delocalization energy – construction and use of hybrid orbitals – directional character – determination of bond angles.

UNIT – IV **(15 Hrs)**

Group Theory & Molecular Symmetry Molecular symmetry and group theory – Point symmetry – Schonfloes and Herman-Mauguin notations – identification of point groups of simple molecules – postulates of group theory – group multiplication table – orthogonality and irreducible representations – application of the orthogonality theorem to obtain the irreducible representations of the point groups C_{2v} and C_{3v} only – character table (explanation) different areas of the character tables.

UNIT – V **(15 Hrs)**

Group Theory & Normal Modes of Vibrations, Orbital Splitting: Application of the group theoretical methods to find the total number of vibrations of simple molecules such as H_2O and NH_3 – Selection rules with regard to Raman and IR activities and electronic transitions – splitting of orbitals in O_h, T_d and D_{4h} symmetries – hybridization as applied to methane and water – simplification of MO calculations employing symmetry adopted linear combination molecular orbital procedure – application to butadiene.

A minimum of 10% problem oriented questions to be asked

REFERENCES

1. L. Pauling, E.B. Wilson, Introduction to Quantum Mechanics with Applications to Chemistry, McGraw Hill Book Company, Inc., New York, (1935).
2. Ira. N. Levine, Quantum Chemistry, Prentice Hall, New Jersey, V Edn., (2000).
3. A. K. Chandra, Introduction to Quantum Chemistry, TMH, Chennai, (1988).
4. D.A. McQuarie, Quantum Chemistry, Oxford University Press, Calcutta, (1982).
5. R.S. Drago, Physical Methods in Inorganic Chemistry
6. W.J. Moore, Physical Chemistry (1962).
7. P.W. Atkins, J. De. Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, Oxford, (2006).
8. R.K. Prasad, Quantum Chemistry, Wiley Eastern Ltd., Chennai, (1992)
9. Lowe and Peterson, Quantum Chemistry.
10. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., Jalandar, 41st Edn., (2006).
11. Ramakrishnan, Gobinathan, Group Theory in Chemistry.
12. K.V. Raman, Group Theory.
13. .F.A. Cotton, Chemical Applications of Group Theory.
14. Carter, Molecular Symmetry and Group Theory.

Semester	**:**	**II**	**Credits:**		**05**
Paper	**:**	**Paper – IV: INORGANIC CHEMISTRY – II (*Co-ordination Chemistry*)**	**Code: 2M1**	**Hours/week:**	**05**

UNIT – I **(15 Hrs)**

Types of ligands – nomenclature and isomerism.

Bonding: Valence bond theory-Crystal field theory – crystal field effects in tetrahedral, octahedral and square planar symmetries – crystal field stabilization energy – weak and strong field effects – spectrochemical series

Molecular Orbital Theory-based on group theoretical approach MO diagrams of O_h, T_d and square planar symmetries with and without π bonding – experimental evidence for the presence of π bonding – Magnetic behaviour of the transition metal ions in crystal field and molecular orbital theories.

UNIT – II **(15 Hrs)**

Microstates and Term symbols for (d^2& d^5) ions characteristic of d-d transitions and selection rules. Weak and strong field limits – Energy level diagrams – Orgel and Tanabe- Sugano diagrams – John-Teller tetragonal distortions and spin- orbit couplings – Nephelauzetic effect – charge transfer spectra – applications of IR, Raman, ESR, photo-electron and Mossbauer spectroscopy methods in characterization of coordination compounds.

UNIT – III **(15 Hrs)**

Metal carbonyls, methods of preparation, structure , bonding and reactions – carboxylate ions – carbonyl hydrates, carbonyl halides – Vaska's compound – compounds of molecular nitrogen and oxygen – Nitrosyl complexes, β-diketones,– complexes of unsaturated hydrocarbons alkenes, allyls and dienyls.

UNIT –IV **(15 hrs)**

Carbocyclic π –Complexes: Cyclopentadienyl and related complexes (synthesis, bonding, structure and reactions) – Arene complexes : Complexes formed by seven and eight membered aromatic rings

Complexes of Biochemical Importances: Cytochromes, haemoglobin, myoglobin, cyanocobalamine, chlorophyll (structure and functions), sodium and potassium ion pumps-nitrogen fixation-metal poisons and chelating agents in medicine.

UNIT – V **(15 hrs)**

Reactions of Co-ordination Compounds

Ligand substitution reaction in octahedral complexes – mechanism of nucleophilic substitution reaction in octahedral and square planar complexes – Trans effect – Theories – electron transfer reactions in co-ordination compounds – theory of redox reactions.

Homogenous Catalysis of Co-ordination Compounds: Hydroformylation, Carbonylation of methanol and methylacetate, Hydrogenation of unsaturated organic compounds , Wacker process – Ziegler- Natta polymerization.

REFERENCES

1. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry
2. Emeleus and Sharpe, Modern Aspects of Inorganic Chemistry
3. S.F.A. Kettle, Co-ordination Compounds
4. Bassalo and Pearson, Mechanism of Inorganic Reactions, II edn.
5. R.S. Drago, Physical Methods in Inorganic Chemistry
6. W.L. Jolly, Modern Inorganic Chemistry
7. J.E. Huheey, Keiter and Keiter, Inorganic Chemistry IV edn.
8. Cartmell and Fowles, Valence and Molecular Structure
9. J.D. Lee, Modern Concepts in Inorganic Chemistry

Semester	**:**	**II**	**Credits:**		**05**
Paper	**:**	**Paper – V: ORGANIC CHEMISTRY – II (Photochemistry, Carbonyl addition, Molecular rearrangements and Stereochemistry)**	**Code: 2M1**	**Hours/week:**	**05**

UNIT-I **(15 hrs)**

Organic Photochemistry - Theory of light absorption –electronic excitation - properties & energies of excited states – Jablonski diagram – photo physical processes - fluorescence and phosphorescene - excimers and exciplexes – intersystem crossing – energy transfer - geometry of excited states - quantum efficiency.

Photochemical reactions of ketones – Norrish Type I, Norrish Type II – Paterno – Buchi reaction – Photo reduction and oxidation – α, β- unsaturated ketones- Photochemistry of olefins, conjugated olefins and aromatic compounds – *cis-trans* isomerisation - di – π methane rearrangement of cyclohexdienones – Barton's reaction.

UNIT –II **(15 hrs)**

Pericyclic Reactions – classification – Theories – The Frontier Orbital approach – The Woodward – Hoffmann rules – Correlation diagrams, Huckel – Mobius approach, Dewar – Zimmermann Approach Electrocyclic reactions of 1,3-dienes and 1,3,5-trienes. [2+2] and [4+2]cycloadditions, Diels – Alder reaction, Retro Diels – Alder reaction, 1,3 – diploar addition – Cheleotropic reaction. Sigmatropic reactions – [1,3], [1,5] and [3,3] Sigmatropic shifts – Claisen and Cope rearrangements, ene reactions.

UNIT III **(15 hrs)**

Addition Reactions to Carbonyl Compounds - Mannich, Aldol, Grignard, Claisen & Dieckmann, Stobbe, Perkin, Knoevenagel, Darzen, Wittig, Thorpe, Reformatsky and Benzoin reactions, Friedlander quinoline synthesis, Strecker and Peterson synthesis. Stereo selectivity in carbonyl addition reactions - Cram's rule.

UNIT IV **(15 hrs)**

Molecular Rearrangements – Wagner – Meerwein rearrangement – Migratory aptitudes- Memory effects – Demyanov, Neber, Baeyer–Villiger, Dienone – phenol, Favorski, Fries and Benzidine, Wolff, Steven's, Lossen and Schmidt rearrangements – Non-cyclic rearrangements – Chapman and Wallach rearrangement, Arndt-Eistert synthesis, Fischer Indole synthesis.

UNIT V **(15 hrs)**

Stereochemistry: Optical isomerism – concept of chirality- stereochemistry of sulfur and nitrogen compounds – concept of prochirality- enantiotopic and diastereotopic ligands & faces- stereo selective and stereo specific reactions - R, S – nomenclature of compounds having one and more than one chiral centres – axial chirality - (optical isomerism of biphenyls, allenes and spirans)- planar chirality (optical isomerism of ansa compounds and cyclophanes) - helicity (optical isomerism of over – crowded molecules)

Geometrical Isomerism – E, Z – notation – Determination of configuration of geometrical isomers- stereoismerism of cycilc compounds (up to six membered ring)– aldoximes & ketoximes.

Conformational Analysis - configuration and conformation – Conformation of acyclic compounds – cyclohexanes, decalins – stability and reactivity in relation to conformation – perhydrophenanthrenes.

REFERENCES

1. E.S. Eliel, Stereochemistry of Carbon compounds
2. Eliel, Allinger, Angyal and Morrison, Conformational Analysis
3. Mislow, Introduction to Stereochemistry
4. Potapov, Stereochemistry
5. Kagan, Organic Chemistry
6. Testa, Principles of Organic Stereochemistry
7. Newman, Steric Effects in Organic Chemistry
8. Jerry March, Advanced Organic Chemistry
9. DE Mayo, Molecular Rearrangements
10. Stevens and Watts, Selected Molecular Rearrangements
11. Reutov, Theoretical Principles of Organic Chemistry
12. Kalsi, Stereochemistry
13. Nasipuri, Stereochemistry of Organic Compounds
14. Nogradi, Stereochemistry – Concepts and Applications
15. Carey and Sundberg, Advanced Organic Chemistry , Part A
16. Lowry and Richardson, Mechanism and Theory in Organic Chemistry
17. Turro, Molecular Photochemistry
18. Deputy and Chapman, Molecular reactions and Photochemistry
19. Rohatgi Mukherjee, Fundamentals of Photochemistry
20. Jaffee and Orchin, Orbital Symmetry
21. Orchin, Antibonding Orbitals
22. Cowan and Drisko, Elements of Organic Photochemistry
23. Coxon and Halton, Organic Photochemistry
24. Jagdamba Singh and L.D.S. Yadav, Advanced Organic Chemistry
25. Mukherji and Singh, Reaction Mechanism in Organic Chemistry
26. Jagdamba Singh and L.D.S. Yadav, Organic Synthesis

Semester: II **Credits: 05**
Subject Code : 2M3 **Hours/week: 05**

Paper – VI: PHYSICAL CHEMISTRY – II (Thermodynamics)

UNIT – I: Statistical Concepts & Fugacity (15 Hrs)

Theories of permutations and combinations – law of probability - distribution law – Guassian distribution – Binomial distribution.

Fugacity – definition – determination – Graphical, Equation of States and Approximate method of Calculation – Variation of fugacity with Temperature and Pressure – Fugacity of Real and Ideal Gases – Mixture of Real Gases – Determination of Fugacity in Gas Mixtures (The Lewis – Randall Rule) – Variation of Fugacity with T & P for mixture of gases. Fugacity in Liquid Mixtures –

UNIT – II: Quantum Statistics – Molecular Gas Distribution (15 Hrs)

Maxwell Distribution Law for Molecular velocities – for Ideal Gas – Evaluation of Average Velocity (C_{av}), – Root Mean Square Velocity (C_{RMS}), Most Probable Velocity (C_{MPV}), – Distribution Function in terms of the Kinetic Energy for Ideal gas – Experimental Verifications of Maxwell Distribution – the Principle of Equipartition of Energy and the Calculation of Heat Capacities of Ideal Gases and Limitations

UNIT – III: III Law of Thermodynamics and Entropy (15 Hrs)

Probability and III Law of Thermodynamics – Need for III Law – Nernst Heat Theorem and Other Statements of III Law – Thermodynamic Quantities at Absolute Zero – Statistical Meaning of III Law – Apparent Exceptions – Helium at Low Temperature – Negative Absolute Temperature – Entropy of Gases – Entropy at Absolute Zero – Entropy and Probability (Boltzmann Expression) – Boltzmann – Planck Equation – Significance of Thermodynamic Probability – Entropy of Expansion of Ideal Gas.

UNIT – IV Theromodynamic Distributions (15 Hrs)

Thermodynamic Probabilities of Systems involving Energy Levels – Maxwell-Boltzmann Distribution law – Evaluation of α and β in Maxwell- Boltzmann Distribution Law (Lagrangian Multipliers). Bose – Einstein and Fermi – Dirac Statistics – Bose – Einstein Distribution Law – Entropy of Bose – Einstein Gas – Fermi – Dirac gas – Heat Capacity of the Electron Gas and the Heat Capacity of Metals

UNIT V: Quantum Statistics for Solids & Partition Function (15 Hrs)

Einstein's and Debye's Theories of Heat Capacities of Solids – Maxwell-Boltzmann Statistics – Phase Space – Thermodynamic Probabilities of Systems in Equilibrium – Boltzmann Expression of

Entropy – Stirling's approximation – states of maximum thermodynamic probability.

Partition function – Definition – Justification & Nomenclature – Barometric Distribution Law – Boltzmann Distribution – Relation between Total Partition Functions & Translational, Rotational Vibrational & Electronic Partition Functions – *Ortho & para* Hydrogen – Evaluation of Thermodynamic Properties (E, H, A and G, C_V and C_P, – Entropy of Monoatomic Molecules (Sackur – Tetrode Equation) and Calculation of Equilibrium Constants of Reactions.

A minimum of 10% problem oriented questions to be asked

REFERENCES

1. S. Glasstone, Thermodynamics for Chemists;
2. N.M. Laurendeau, Statistical Thermodynamics Fundamentals and Applications
3. Kuriakose and Rajaram Thermodynamics;
4. Lee, Sears and Turcotte – Statistical Thermodynamics;
5. Sears and Salinger, Thermodynamics, Kinetic theory and Statistical Thermodynamics;
6. Klotz, Chemical Thermodynamics
7. Atkins, Physical Chemistry;
8. Gupta, Statistical Thermodynamics.

Semester: III **Credits: 05**
Subject code: 3M1 **Hours/week: 5**

Paper VII: ORGANIC CHEMISTRY - III
(*Synthetic Methodology, Oxidation and Reduction*)

UNIT I **(15 hrs)**

Nomenclature - IUPAC nomenclature of acyclic and monocyclic compounds-

Nomenclature of bicyclic system – large ring compounds (muscone, civetone) Novel ring system – adamantane – diadamantane, cubane (strained ring) catenane (interlocked system), bulvalene (fluxional molecule)

(Synthesis only for catenanes, synthesis for others not necessary)

Reagents in Organic Synthesis - Hexamethylphosphorictiamide (HMPT), 1,5- diaza-bicyclo[5,4-c]-undecene-3 (DBU), Polyphosphoric acid (PPA), 1,3-dithiane (umpolung), Lithium dimethylcuprate (LDC), Lithium disopropylamide (LDA), crown ethers, Phase transfer catalysts (PTC), Merrifield resin, Trimethylsilyliodide.

UNIT II **(15 hrs)**

Synthetic Methodology – Retrosynthesis – disconnection approach – synthons and synthetic equivalents – guidelines for choosing disconnections– linear and convergent synthesis – controlling and enhancing the reactivity - functional group interconversions – functional group addition-one group C-X disconnections – two group C-X bond disconnections – one group C-C bond disconnections – regioselectivity – two- group C-C bond disconnections - 1,3- difunctional, 1,5 – difunctional compounds and Robinson annelation reaction - importance of the order of events – chemoselectivity – reversal of polarity. Protecting groups – protection of alcohols, carbonyl groups, carboxylic group and amino group. Modern methods of functional group interconversions (FGI) involving >C=O, -CHO, OH, SH, -COOH, >C=C<, -NH_2, -COOR, -CONHR functions.

Synthetic examples: β-vetivone, Vitamin A and longifoline.

UNIT III **(15 hrs)**

Oxidation – Jone's reagent, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Chromyl chloride, Dioxiranes, Dicyclohexylcarbodiamide (DCC), DMSO, DMSO-Ac_2O, DMSO-oxalyl chloride (Swern reaction), Oppenaur oxidation, Sommelet reaction - oxidative cleavage of 1, 2 – diols (lead tetra acetate and periodic acid), Etard reaction, Dichlorodicyanobenzoquinone (DDQ), SeO_2, ozonolysis, Lemieux reagents ($NaIO_4$ with $KMnO_4$ & OsO_4), allylic oxidation (SeO_2 & NBS), Fenton's reagent.oxidation of amines and sulphides, Wacker process (ketone from alkene) and ceric ammonium nitrate (CAN).

UNIT IV **(15 hrs)**

Reduction –catalytic hydrogenation – typical reactions – catalysts and solvents, catalytic dehydrogenation.

Metal hydride reduction – typical reactions and conditions used – $LiAlH_4$, $NaBH_4$ and $NaCNBH_3$ reductions, hydroboration, 9BBN, tri –n- butyl tinhydride (TBH), DIBAL–H, Me_3SiCN, tri tertiarybutoxy aluminum hydride, stereochemistry of reduction of cyclic ketones with metal hydrides.

Dissolving metal reductions – Birch reduction, Clemmensen reduction, electro-organic reduction, Wolff-Kishner, Meerwein-Pondorff-Verley and Rosenmund reduction, McMurrays coupling, cannizzaro reaction, acyloin condensation, Wilkinson's catalyst, Bakers yeast.

UNIT V **(15 hrs)**

Applications of UV, IR, ^{1}H NMR and Mass spectral techniques to solve the structures of simple organic molecules (problems based on data)

REFERENCES

1. Jerry March, Advanced Organic Chemistry
2. House, Modern Synthetic Reactions
3. Carruthers, Some Modern Methods of Organic Synthesis
4. Norman, Principles of Organic Synthesis
5. Pine, Organic Chemistry
6. Ireland, Organic Synthesis
7. Waren, Designing Organic Synthesis-A Programmed Introduction to Synthetic Approach
8. Furthrhop and Penzlin, Organic Synthesis Concepts, Methods and Starting Materials
9. Mackie and Smith, Guide lines to Organic Synthesis
10. Gurtu and Kapoor, Organic Reactions and Reagents
11. Fieser and Fieser, Reagents in Organic Synthesis
12. Jagdamba Singh and L.D.S. Yadav, Organic Synthesis
13. Silverstein, Bassler and Morril, Spetrometric identification of Organic Compounds
14. Kemp, Organic Spectroscopy
15. Kalsi, Spectroscopy of Organic Compounds
16. Y. R. Sharma, Elementary Organic Absorption Spectroscopy
17. Silverstein and Webster, Spectrometric Identification of Organic Compounds
18. S.C. Pal, Nomenclature of Organic Compounds

Semester: III **Credits: 05**
Subject code: 3M2 **Hours/week: 5**

Paper-VIII: PHYSICAL CHEMISTRY – III
(Electrochemistry and Chemical Kinetics)

UNIT – I **(15 hrs)**

Calculation of heat of solvation, hydration of ionic species – Ionic strength – concentration and activity coefficient – Debye-Huckel limiting law- Electrochemical Method of determining activity coefficients of electrolytic solutions – Electrolytic conductances – Debye-Huckel-Onsager equation – verification – Wien effect and Debye-Falkenhagen effect – Thermodynamics of electrochemical reactions – Free energy and emf – Standard and formal electrode potentials – Problems based on electrode potentials and their measurements – Ion selective electrodes.

UNIT – II **(15 hrs)**

Electrode – Electrolytic interface – electrical double layer – electrocapillary thermodynamics – Lippman equation – Measurements of double layer capacitances – Theoretical models of double layers – Helmholtz and Guoy-Chapman models – Potential of zero charge – Stern model – outer and inner Helmholtz planes – Specific adsorption of cations, anions and neutral molecules – a brief outline of electrokinetic phenomenon and memberane potentials.

UNIT – III **(15hrs)**

Electrode Kinetics - Kinetics of electron transfer – Butler-Volmer equation – the transfer coefficient – double layer effects – The Tafel equation – Charge transfer resistance – reversibility and irreversibility in electrochemical reactions – Nernst relation from Butler-Volmer relation – multi-step process – the effect of electrode on electron transfer rate – Hydrogen evolution reaction as a case study – processes associated with electron transfer – mass transfer effects – over-voltages - activation concentration and resistance over-voltage.

UNIT – IV **(15hrs)**

Chemical Kinetics - The ARRT – thermodynamic treatment of ARRT – significance of reaction co-ordinate – application of ARRT – Unimolecular and bimolecular processes – potential energy surface – Kinetic isotopic effect – Principles of microscopic reversibility – Steady State Approximation – third order and termolecular reactions – Applications of ARRT to solution kinetics – Factors affecting reaction rates in solution.

Chain reactions and explosions – Homogeneous catalysis, Acid – base catalysis – salt effects – acidity functions – Zucker-Hammet hypothesis – Bunnett criterion.

UNIT – V **(15 hrs)**

Enzyme catalysis – Mechanism of single substrate reaction – influence of P^H and temperature – fast reactions – Kinetics of polymerization in solution – Heterogeneous catalysis – adsorption and free energy relation at interfaces – Gibbs adsorption isotherm – Physical adsorption – Chemisorption – Potential energy diagram and Lennard-Jones plots – Langmuir and BET isotherms – Measurement of surface area – Semiconductor catalysis – Langmuir – Hinshelwood and Langmuir – Rideal – Eley mechanisms

A minimum of 10% problem oriented questions to be asked

REFERENCES

1. Crow, Principles and Applications of Electrochemistry
2. Koryta and Drorek, Principles of Electrochemistry
3. Rieger, Electrochemistry
4. Antropov, Theoretical Electrochemistry
5. Bockris and Reddy, Modern Electrochemistry (Vol. I & II)
6. Glasstone, Laidler and Eyring The Theory of Rate Processes
7. Pilling, Reaction Kinetics
8. Atkins, Physical Chemistry
9. Laidler, Chemical kinetics
10. Frost and Pearson, Kinetics and mechanism
11. Glasstone, Introduction to Electrochemistry
12. Moore, Physical Chemistry

Semester: III **Credits: 05**
Subject code: 3M3 **Hours/week: 5**

Paper IX: Elective Paper I - INSTRUMENTAL METHODS – I
(IR, UV, NMR spectroscopy & Mass spectrometry)

UNIT – I **(15 hrs)**

Infrared Spectroscopy-The vibrating diatomic molecules – the simple harmonic oscillator – the diatomic rotator – vibrations of polyatomic molecules – the influence of rotation on the spectrum of polyatomic molecules – factors influencing vibrational frequencies – characteristic group absorbtions of organic molecules-identification of functional groups – Applications to organic and inorganic compounds –medical diagnosis(cancer)- Instrumentation- FT- IR.

UNIT –II **(15 hrs)**

Ultraviolet and Visible Spectroscopy-Electronic spectra of diatomic molecules – Laws of photometry – Electronic absorption transitions – Correlation of electronic structure with molecular structure – Simple chromophoric groups – Effects of conjugation – Woodward – Fieser rules – Aromatic system and systems with extended conjugation – applications to organic and inorganic compounds – Instrumentation.

UNIT – III **(15 hrs)**

^{1}H NMR Spectroscopy-magnetic properties of nuclei – theory of nuclear resonance – Chemical shift and its measurement – Factors influencing chemical shift – Chemical equivalence and magnetic equivalence – solvents and NMR spectra – Spin –Spin coupling – Spin-Spin splitting systems – Proton exchange reactions – Heteronuclear coupling – Deuterium exchange – Double resonances – Chemical shift reagents – Applications to organic and inorganic compounds - Instrumentation –CW and FT NMR

UNIT – IV **(15 hrs)**

^{13}C NMR Spectroscopy- magnetic moment and natural abundance- broad band decoupling- deuterium coupling- NOE effect- Off-resonance decoupling- peak assignments using DEPT spectrum – structural applications of ^{13}C NMR spectroscopy.

Correlation NMR Spectroscopy- theory- ^{1}H-^{1}H COSY, ^{1}H-^{13}C COSY: HETCOR, Proton-detected HETCOR: HMQC, Proton-Detected Long-Range ^{1}H-^{13}C Heteronuclear Correlation: HMBC, NOESY

UNIT – V **(15 hrs)**

Mass Spectrometry-Theory – Instrumentation – Isotopic abundance – Determination of molecular weights and formulae, Ionisation techniques(CI, FD, FAB &ESI) – Nitrogen rule – Metastable ions and peaks – Ion fragmentation mechanisms – Retro Diels-Alder rearrangement – Mclafferty rearrangement – Fragmentation associated with functional groups – aliphatic and aromatic compounds – Elimination due to ortho groups.

REFERENCES

1. Drago, Physical Methods in Inorganic Chemistry
2. Silverstein, Basler and Morril, Spetrometric identification of Organic Compounds
3. Kemp, Organic Spectroscopy
4. Kalsi, Spectroscopy of Organic Compounds
5. Banwell, Fundamentals of Spectroscopy
6. Das and James, Mass Spectrometry
7. McLafferty, Mass Spectrometry
8. Sheinmann, Introduction to Spectroscopic Methods
9. Pavia and Lampman, Introduction to Spectroscopy
10. Silverstein and Webster, Spectrometric Identification of Organic Compounds
11. Y. R. Sharma, Elementary Organic Absorption Spectroscopy
12. R. Chang, Basic Principles of Spectroscopy
13. B. Stuart, Infrared Spectroscopy: Fundamentals and Applications, John Wiley & Sons Ltd (2004)

Semester: III **Credits: 05**
Subject code: 3M4 **Hours/week: 3**

Paper X: Elective Paper 2 – GREEN AND NANO CHEMISTRY

(*Green Chemistry, Nano Science & Research Methodology*)

UNIT – I **(8 hrs)**

Green Chemistry Principles - Definition, need of green chemistry, twelve basic principles of green chemistry-planning a green synthesis in a chemical laboratory- solvent-less reactions, selection of appropriate solvent, use of microwaves-fundamentals of closed-vessel heating and sonication. Atom efficient processes and atom efficiency, atom economy (with specific reaction).

UNIT – II **(7 hrs)**

Greener Reactions – Water as greener solvent- reactions in ionic-liquid, solvent free reaction- solid supported organic synthesis, phase transfer catalyst (PTC), use of microwaves and sonication (any four specific reactions with mechanism).

UNIT – III **(10 hrs)**

Nano Science- Introduction- definition-types-quantum dots, wires and wells, nano rods, fullerenes and carbon nanotubes - nanowires and crystals, nano composites and clusters – properties of nano materials- Plasmon resonance

Preparation of Nano Structured Materials – Bottom up and Top down approaches-methods of preparation of nano materials – plasma arching, chemical vapour deposition, electrodeposition, sol-gel synthesis, ball-milling and use of natural nano particles.

UNIT –IV **(10 hrs)**

Chemical Synthesis of Nanomaterials - chemical reduction (borohydride, citrate and polyol), high temperature thermal decomposition, liquid-liquid interface reaction, solution state polymerization

Experimental Techniques - Instrumentation, principle and applications of Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunnelling Microscopy (STM) and ESCA

Applications of Nanomaterials- catalysis, environmental and biomedical (drug delivery) applications. Nanomaterials-environmental hazards.

UNIT – V **(10 hrs)**

Research Methodology- problem selection- literature survey-primary sources-journals, patents, journals of different fields of chemistry (organic, inorganic, physical, polymer, analytical and nano) - secondary sources- books, indexes, chemical abstracts, review articles - literature searching online.

Writing a project report – dissertation-style and conventions – title, abstract, introduction, review of literature, experiments, results and discussion, foot notes, figures, presenting data, tables, summary and bibliography.

REFERENCES

1. M. Wilson, K.Kannangara, G. Smith, M. Simmons and B. Ragase, Nanotechnology (2005)
2. R. Booker and E. Boysen, Nanotechnology (2007)
3. G. Timp, nanotechnology
4. J. Ying, Nanostructured Materials
5. C. P. Poole Jr., F.J. Owens, Introduction to Nanotechnology
6. Jerry March, Advanced Organic Chemistry
7. J. Anderson, Thesis and Assignment Writing
8. V.K.Ahluwalia, Green Chemistry
9. S. Delvin, Green Chemistry
10. R. Sanghi and M.M. Srivastva, Green Chemistry
11. M.M. Srivastva and R. Sanghi, Chemistry for Green Environment
12. P.T. Anastas and J. C. Warner, Green Chemistry (1998)
13. A.S. Matlack, Introduction to Green Chemistry (2001)
14. C. R. Kothari, Research methodology

Semester: IV **Credits: 05**
Subject code: 4M1 **Hours/week: 5**

Paper XI: ORGANIC CHEMISTRY – IV
(*Chemistry of Natural Products*)

UNIT – I (**15 hrs**)

Terpenoids – isolation and classification – methods of structural elucidation and synthesis as applied to zingiberine, β-eudesmol, caryophyllene, santonin and abietic acid – Biosynthesis of terpenoids.

UNIT – II **(15 hrs)**

Steroids – structural elucidation of cholesterol (synthesis not necessary), ergosterol, vitamin–D, oestrone, equilenin, progesterone, androsterone and testosterone– Biosynthesis of steroids – Bile acids.

UNIT – III **(15 hrs)**

Alkaloids – structural elucidation, synthesis and biosynthesis of the following alkaloids : reticuline , glaucine, morphine, quinine, narcotine, reserpine, acronycine and tylophorine.

UNIT – IV **(15 hrs)**

Proteins and Polypeptides– Primary, secondary and tertiary structures of proteins – the N – terminal and C- terminal residue analysis, synthesis of polypeptides, enzymes, biosynthesis of proteins, structure of DNA and RNA and their biological importance.

UNIT – V **(15 hrs)**

Heterocyclic Compounds-pyrimidines and purines, anthocyanine and flavones (cyanidine chloride, flavone, quercetin).

Anti-biotics – penicillins, chloramphenicol(structure and synthesis).

REFERENCES

1. Bently, Alkaloids
2. Pelletier, Alkaloids
3. Swain, An Introduction to Alkaloids
4. Finar, Organic Chemistry (Vol. II)
5. Agarwal, Natural Products
6. Pinder, Terpenes
7. De Mayo, Mono and Sesquiterpenoids (Vol. II)
8. De Mayo, Higher Terpenoids (Vol. II)
9. Newman, Terpenes and Terpenoids
10. Chatwal, The Chemistry of Organic Natural Products (Vol. I & II)
11. Fieser and Fieser, Steroids

12. Shoppe, The Chemistry of Steroids
13. Joule and Smith, Heterocyclic Chemistry
14. Acheson, Introduction to Heterocyclic Chemistry
15. Gilchrist, Chemistry of Heterocyclic Compounds
16. Nakanishi, Natural Products Chemistry (Vol.I & II)
17. Bornfield, Biogenesis of Natural products
18. Bulock, The Biosynthesis of Natural products
19. Harborne, The Flavanoids

Semester: IV **Credits: 05**
Subject code: 4M2 **Hours/week: 5**

Paper XII: Elective Paper 3 – INSTRUMENTAL METHODS – II

UNIT – I **(15 hrs)**

Thermal analysis – Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) – Basic principles.

Refractometry- Refractometer theory – basic principles – Abbey Refractometer – Applications.

Molecular fluorescence and phosphorescence – Principles – Fluorometers – Phosphorometers – applications.

UNIT II **(15 hrs)**

Chromatography – Principles, theory, instrumentation and applications in chemical analysis of the following – column, paper, thin layer and ion-exchange – GC, GLC and HPLC. Purification of common organic solvents.

Atomic absorption spectroscopy and Flame emission spectroscopy – basic principles – Instrumentation and applications.

UNIT III **(15 hrs)**

Metallic State- Free electron, band and zone theories-non-stoichiometry – point defects in solids- Schottky and Frenkel defects – linear effects – dislocation – effects due to dislocation – electrical properties of solids – insulators – intrinsic semiconductors (n & p type) and super conductors, ceramics (elementary treatment)

Chemical Crystallography – Diffraction methods – X-ray , neutron and electron Diffraction – Structure of NaCl , KCl and CsCl – Determination of lattice type and unit Cell dimensions – Power Camera – indexing the powder pattern – An elementary discussion of structural factors and scattering factor – Structures of rutile , fluorite , Antifluorite , zinc blende ,wurtzite , diamond and graphite.

UNIT IV **(15 hrs)**

Poarimetry – Circular Dichroism and Optical rotatory dispersion –Basic principles of ORD and CD – Cotton effects – Octant rule – axial halo ketone rules - applications of ORD and CD

Photoelectron Spectroscopy- ESCA (XPS): principle, chemical shifts-description of ESCA spectrometer, X-ray sources, samples, analysis, detectors and recording devices –applications. Auger electron spectroscopy (AES) and UV photo electron spectroscopy (UPS) – principles, applications and instrumentation.

UNIT V **(15 hrs)**

Mossbauer Spectroscopy - principles – Spectrometer – Isomer shift – Quadruple interaction – Nuclear Zeeman Splitting – Applications

ESR Spectroscopy - theory – Derivative curves – ‘g’ shift – hyperfine splitting – Isotropic and anisotropic systems – Zero field splitting and Kramer degeneracy – Identification of free radicals – Applications.

REFERENCES

1. Straughan and Walker, Spectroscopy
2. Drago, Physical methods in Inorganic Chemistry
3. Finar, Organic Chemistry (Vol. II)
4. Eliel, Stereochemistry of Carbon compounds
5. Djerassi, Optical Rotatory Dispersion
6. Skoog, West and Holler, Analytical Chemistry
7. Willard, Merrit and Dean, Instrumental Methods of Chemical Analysis
8. Chatwal, Instrumental Methods of Analysis
9. Sharma, Instrumental Methods of Chemical Analysis
10. Kenner, Analytical Separations and Determinations
11. Sharma, Chromatography
12. Arora, Solid State Chemistry
13. Alberty and Silbey, Solid State Chemistry
14. Ewing, Instrumental Methods of Chemical Analysis
15. Ghosh, Introduction to Photoelectron Spectroscopy

Semester: IV **Credits: 05**
Subject code: 4M3 **Hours / Week: 5**

Paper XIII: Elective Paper 4 – APPLIED ELECTROCHEMISTRY

UNIT – I **(15 hrs)**

Current–voltage relationships – mass transfer – diffusion limited currents – kinetic currents – adsorption currents – Polarography – DC and pulse polarographic methods – Cyclic voltametry – Rotating disc electrodes – Chronoamperometry – Chronopotentiometry – Chronocoulometry (Basic principles and applications only in all the above methods)

UNIT – II **(15 hrs)**

Electrochemical cells – components of electrochemical cells – Types of cells – divided and undivided cells – Chlor-alkali cells mercury, diaphragm and membrane cells – electro-inorganic chemicals – Chlorates, perchlorates – electrosynthesis of fluorine – electro-organic chemicals – electro-reduction of nitro and carbonyl groups – Kolbe synthesis – electrodimerisation – adiponitrile.

UNIT – III **(15 hrs)**

Electrometallurgy and Electroplating – Electro winning and electro refining of Cu and Ni, production of aluminium – Hall-Heroult process – Electrolytic production of magnesium and sodium – Electroplating operations – Preplating operations – electroplating of nickel and chromium – precious metal plating – anodizing of Al.

UNIT – IV **(15 hrs)**

Batteries – Thermodynamics of batteries and fuel cells – half cell reactions in batteries – characteristic requirements of a battery system – components of batteries – porous electrodes – separators –evaluation of batteries – charge – discharge characteristics – primary batteries, lead acid batteries – Leclanche cells - lithium cells – Ni-Cd cells – High temperature batteries – sodium-sulphur system .

UNIT –V **(15 hrs)**

Corrosion and Corrosion Control – Thermodynamics of corrosion – Pourbaix diagrams – kinetics of corrosion – evans diagram – corrosion current and corrosion potential – Metal oxidation – atmospheric corrosion – crevice corrosion – bimetallic corrosion – stress corrosion – cracking – corrosion control and corrosion inhibitors – painting for corrosion control – cathodic protection – protection by sacrificial anodes.

REFERENCES

1. Bard and Faulkner, Electrochemical Methods;
2. Pletcher, Industrial Electrochemistry
3. Baizer, Organic Electrochemistry;
4. Lowenheim, Modern Electroplating
5. Bode, Lead Acid Batteries;

6. Vincent et al., Modern batteries – Introduction to Electrochemical Power Sources;
7. Bockris and Reddy, Modern Electrochemistry (Vol. II);
8. Narayanan, Introduction to Metallic Corrosion;
9. Fontana, Corrosion Engineering;
10. Banerjee, Introduction to the Science of Corrosion and its Inhibition

PRACTICAL SYLLABUS

For each of the papers:

Total Marks =100 (Internal = 40 & External = 60)

Distribution of internal Marks:

Continuous assessment (for minimum of ten experiments) = 20

Test + Model examination = 15

Record = 05

Distribution of External Marks:

Total = 60 (Record:10 & Experiment(s): 50)

PROJECT

Total Marks = 100 (Internal = 20 & External = 80)

Internal Marks, 20, to be awarded by the concerned Guide

Distribution of External Marks:

***Viva-voce* Examination = 20 & Project Report = 60**

(Jointly by both Internal & External examiners)

Semester: I & II **Credits: 03**
Subject code: 2P4 **Hours/week: 5**

Practical I : INORGANIC CHEMISTRY – I

Qualitative analysis, employing semimicro methods and spot tests of mixtures of common cations and ions of the following less familiar elements.

Thallium, Tungsten, Selenium, Tellurium, Molybdenum, Cerium, Thorium, Titanium, Zirconium, Vanadium, Beryllium, Uranium and Lithium.

About ten preparations involving different techniques selected from the following:

Lead tetra acetate, dipyridinium hexachloroplumbate, hydroxylamine hydrochloride, ortho- and para-hydroxy phenyl mercuric chloride, potassium cupric chloride, chrome alum, copper(I) chloride, trithio urea copper(I), potassium trioxalato-aluminato(III), potassium trioxalato chromate(III), potassium trioxalato ferrate(III), hexamine cobalt(III) chloride, chloro pentammine chromium(III), chloro aquo pentammine chromium(III) nitrate, tetrammine copper(II) sulphate, ammonium hexachloro stanate(IV).

Note: A minimum of five inorganic mixtures, each of two common and two rare elements should analysed by a student. A minimum of five preparations should be done by a student.

Colorimetric estimations (using Nessler technique and colorimeters) of copper, iron, nickel, manganese, chromium and zirconium (any four).

Distribution of Marks: **Total = 60 (Record:10 & Experiment(s): 50)**

Qualitative analysis = 25
Preparation = 10
Colorimetric estimation = 15

Refrerences:

1. V. V. Ramanujam, Semimicro Qualitative Inorganic Analysis.
2. J. Bassart, R. C. Denny, G.H. Jeffery Vogel and Mendham, Text book of Qualitative Inorganic Analysis, ELBS & longman.
3. V. Venkateswaran, R. Veeraswamy and A. R.. Kulandaivelu, Principles of Practical chemistry, sultan Chand & Sons.

Semester: I & II **Credits: 04**
Subject code: 2P5 **Hours/week: 5**

Practical II : ORGANIC CHEMISTRY – I

Analysis of two component mixtures - Separation and characterization of compounds.

About ten preparations involving single stage comprising of the following processes: nitration, acylation, halogenation, diazotisation, rearrangement, hydrolysis, reduction, alkylation and oxidation and preparations illustrating the following: Benzoin condensation, Cannizzaro reaction, Perkin reaction, Reimer-Tiemann reaction, Sandmeyer reaction, Fries rearrangement, Skraup synthesis – (recrystallisation of product, melting point determination and calculation of percentage yield)

Note: A minimum of six organic mixtures should be analysed by each student. A minimum of ten preparations should be done by each student

Distribution of Marks: **Total = 60 (Record:10 & Experiment(s): 50)**

Qualitative analysis = 40

Preparation = 10

References:

1. N. S.Gnanapragasam and G. Ramamurthy, Organic Chemistry Lab Manual, S. Viswanathan (printers & Publishers) Pvt. Ltd. (2010)

Semester: I & II **Credits: 03**
Subject code: 2P6 **Hours/week: 5**

Practical III : PHYSICAL CHEMISTRY – I

Thermodynamics:

a. Heat of solution from solubility

b. Heat of solution by calorimetry

Molecular weight determination by

i. Freezing point depression of solvents (benzene and water) by Beckmann method.

ii. By Rast micro methods

Distribution of activity and activity co-efficients by freezing point method.

Distribution co-efficient and determination of equilibrium constant.

Properties of matter

Variation of viscosity of liquids with temperature.

Determination of refractive index (Unknown composition of a mixture of liquids).

Heterogenecus equilibria

Thermal analysis of binary systems forming compounds with congruent melting points.

Three component systems (chloroform-acetic acid-water).

Electromotive force

Determination of standard potentials (Cu, Zn, Ag)

Evaluation of thermodynamic quantities from e. m. f. data (Daniel cell).

Determination of PH and Pka values using hydrogen and quinhydrone electrodes and glass electrode (PH meter), potentiometric acid-base titrations.

Determination of formal redox potential of a redox system, redox titrations.

Determination of instability constant (of silver ammonia complex) and its dependence on temperature.

Determination of solubility product of a sparingly soluble salt (concentration cell and chemical cell).

Determination of activity co-efficients from e. m. f. data.

Precipitation titration of a mixture of halides.

Distribution of Marks:
Total = 60 (Record:10 & Experiment(s): 50)

References:

1. Yadav, Practical Physical Chemistry
2. S.R. Palit and S. k. de, Practical Physical Chemistry, Science Book Agency, Calcutta
3. V. Venkateswaran, and A. R.. Kulandaivelu, Practical Physical Chemistry, sultan and & Sons.

Semester: III & IV **Credits: 04**
Subject code: 4P4 **Hours/week: 4**

Practical IV: INORGANIC CHEMISTRY – II

Industrial analysis: a. Analysis of two of the following alloys – brass, bronze, stainless steel, solder type metal. B. Analysis of any one of the following – cement, dolomite, glass.

Titrimetry: Oxidation using ceric and vanadium salts: Complexometric titrations involving estimation of calcium, magnesium, nickel, zinc and hardness of water.

Chromatography: Column, paper, thin layer and ion exchange.

Titrations in non-aqueous solvents.

Preparation, analysis and study of the properties of co-ordination complexes.

Note: Quantitative analysis (involving volumetric and gravimetric estimations) of at least five mixtures of cations should be done by a student. The volumetric procedure may also include EDTA titration for estimation of mixtures of cations.

Distribution of Marks: **Total = 60 (Record:10 & Experiment(s): 50)**

Volumetric analysis = 25

Gravimetric analysis = 25

Semester:III & IV **Credits: 03**
Subject code: 4P5 **Hours/week: 4**

Practical V: ORGANIC CHEMISTRY – II

Estimation of phenol, methyl ketone, glucose, nitro, amino and methoxy groups, unsaturation.

Analysis of oils (Reichart – Meisel value, Iodine value, Saponification value and acetyl value).

Extraction and estimation of active constituents:

a. Lactose from milk b. Caffeine from tea c. Nicotine from tobacco extract d. Citric acid or ascorbic acid from a tablet or from a natural source.

About five preparations from literature – (recrystallisation of product, melting point determination, TLC and calculation of percentage yield).

Purification of organic solvents using distillation (any two).

Distribution of Marks: **Total = 60 (Record:10 & Experiment(s): 50)**

Volumetric estimation = 30

Preparation = 20

References:

1. N. S.Gnanapragasam and G. Ramamurthy, Organic Chemistry Lab Manual, S. Viswanathan (printers & Publishers) Pvt. Ltd. (2010)

Semester:III & IV **Credits: 03**
Subject code: 4P6 **Hours/week: 4**

Practical VI: PHYSICAL CHEMISTRY – II

Conductivity experiments:

Determination of i) Equivalent conductance of a strong electrolyte and the verification of Debye-Huckel Onsagar law. ii) Verification of Ostwald dilution law and kohlrausch law for weak electrolytes.

Conductometric determination of Pka of a weak acid.

Hydrolysis constant of aniline hydrochloride.

Determination of the solubility of a sparingly soluble salt.

Conductometric titrations: Acid-base and precipitation titrations (including mixture of halides).

Colorimetric estimation using Beer-Lambert law (copper, nickel).

Dropping mercury cathodes – half-wave potentials and estimations by differential method of cadmium, copper, zinc and lead.

Chemical kinetics:

i. Evaluation of Arrhenious parameters using acid hydrolysis of an ester.

ii. Base catalysed hydrolysis of an ester conductometrically.

Rate of reaction between persulphate and iodide ions study of salt effects over the persulphate – iodide reaction.

Study of rate of polymerization of monomer solutions by viscosity.

Evaluation of i) Catalytic constant of a strong acid for the iodination of acetone or hydrolysis of an ester.

ii) Catalytic constants for weak acids and verification of Bronsted catalysis law.

Adsorption experiments: Adsorption of oxalic, acetic, formic acids on activated charcoal – Freundlish isotherm – surface are determination.

Distribution of Marks:

Total = 60 (Record:10 & Experiment(s): 50)

References:

1. Yadav, Practical Physical Chemistry
2. S.R. Palit and S. k. de, Practical Physical Chemistry, Science Book Agency, Calcutta
3. V. Venkateswaran, and A. R.. Kulandaivelu, Practical Physical Chemistry, sultan Chand & Sons.

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