KARNATAK UNIVERSITY

M. Sc. Chemistry

Choice Based Credit System

(CBCS)

Revised Syllabus

(w.e.f. 2019-20)

Basis for Internal Assessment:

Internal assessment marks in theory papers shall be based on tests. The tests may be conducted 8 to 12 weeks after the start of a semester. Internal assessment marks in practicals shall be based on tests. The practical test may be conducted 10 weeks after the start of a semester

Theory Question Paper Format for CBCS Semester Examinations:

Q: 1 (Compulsory)

Seven sub questions carry two marks each and one sub question to be answered of one mark (2 questions from each unit)

15 marks

Q: 2 to Q: 7

Six questions from four units will be given. Each question carries 15 marks. Any four questions are to be answered. There may be mixing of questions from different units.

15x4 = 60 marks

Total: 75 marks

The other general academic regulations will be same as laid by University

KARNATAK UNIVERSITY, DHARWAD
M.Sc. DEGREE PROGRAMME IN CHEMISTRY
(With effect from 2019-20)

(CBCS)
Course Structure and Scheme of Examination:

FIRST SEMESTER

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
CHGT–1.1: Inorganic Chemistry–I	4	4	3	25	75	100
CHGT–1.2: Organic Chemistry–I	4	4	3	25	75	100
CHGT–1.3: Physical Chemistry– I	4	4	3	25	75	100
CHGT–1.4: Analytical Chemistry	4	4	3	25	75	100
B. Practical						
CHG(Pr)–1.5: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
CHG(Pr) –1.6: Lab Course in Organic Chemistry	2	4	4	10	40	50
CHG(Pr) –1.7: Lab Course in Physical Chemistry	2	4	4	10	40	50
CHG(Pr) –1.8: Lab Course in Analytical Chemistry	2	4	4	10	40	50
Total	24	32	28	140	460	600

SECOND SEMESTER

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
CHGT–2.1: Inorganic Chemistry–II	4	4	3	25	75	100
CHGT–2.2: Organic Chemistry–II	4	4	3	25	75	100
CHGT–2.3: Physical Chemistry–II	4	4	3	25	75	100
B. Elective						
CHET-2.1: Applied Inorganic Chemistry						
C. Practical						
CHG(Pr) –2.4: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
CHG(Pr) –2.5: Lab Course in Organic Chemistry	2	4	4	10	40	50
CHG(Pr) –2.6: Lab Course in Physical Chemistry	2	4	4	10	40	50
Total	22	28	24	130	420	550

THIRD SEMESTER

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
Inorganic Chemistry						
CHGT–3.1: Inorganic Chemistry	4	4	3	25	75	100
CHGT–3.2: Organic Chemistry	4	4	3	25	75	100
CHGT–3.3: Physical Chemistry	4	4	3	25	75	100
B. Elective						
CHEOT-3.1: Applied Organic Chemistry OR CHEPT-3.1: Applied Physical Chemistry						
C. Practical						
CHG(Pr)–3.4: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
CHG(Pr)–3.5: Lab Course in Organic Chemistry	2	4	4	10	40	50
CHG(Pr)–3.6: Lab Course in Physical Chemistry	2	4	4	10	40	50
Total	22	28	24	130	420	550

FOURTH SEMESTER

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
Inorganic Chemistry						
CHGT–4.1: Inorganic Chemistry	4	4	3	25	75	100
CHGT–4.2: Organic Chemistry	4	4	3	25	75	100
CHGT–4.3: Physical Chemistry	4	4	3	25	75	100
CHGP–4.4: Project Work* Inorganic Chemistry/Organic Chemistry/Physical Chemistry	6	4	8	25	125**	150
Practical						
CHG(Pr)–4.5: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
CHG(Pr)–4.6: Lab Course in Organic Chemistry	2	4	4	10	40	50
CHG(Pr)–4.7: Lab Course in Physical Chemistry	2	4	4	10	40	50
Total	24	28	21	130	395	600

** Project Evaluation:

Dissertation – 75 Marks

Presentation/ Viva-Voce – 50 Marks

KARNATAK UNIVERSITY, DHARWAD
SYLLABUS FOR M.Sc. CHEMISTRY

CHOICE BASED CREDIT SYSTEM
(CBCS)
(With effect from 2019-20)

SEMESTER–I

CHGT–1.1: INORGANIC CHEMISTRY–I

UNIT–I

Structures and Energetics of Ionic Crystals and Covalent Bonds:

Ionic Bond: Properties of ionic compounds, crystal lattices, closed packed structures, coordination number of an ion, radius ratio rule, structures of crystal lattices- NaCl, CsCl, ZnS and rutile. Lattice energy: Born Lande equation, Born-Haber cycle, uses of Born-Haber type of calculations. Covalent character in ionic bonds, Fajan's rules, hydration energy and solubility of ionic solids.

Covalent Bond: Valence bond theory, resonance, hybridization and energetics of hybridization. VSEPR theory: Deduction of molecular shapes. MOT of homo and heteronuclear molecules and MO treatment for the molecules involving delocalized π-bonding (CO_3^{2-}, NO_3^- and CO_2).

Walsh diagrams and Bent's rule.

(**12 Hours)**

UNIT–II

Coordination Chemistry:

Coordination numbers 2–10 and their geometries. Crystal field theory of coordination compounds: octahedral, square planar, tetrahedral, trigonal bipyramidal and square pyramidal fields, measurement of 10 Dq and factors affecting it, CFSE, Spectrochemical series and Jahn–Teller effect.

Structural evidences for ligand field splitting: hydration, ligation and lattice energies. Evidences for covalency in M–L bonding. MO theory of coordination compounds: MO energy level diagrams for octahedral and tetrahedral complexes without and with pi-bonding.

Electronic Spectra: Spectroscopic ground terms, Orgel diagrams for transition metal complexes(T_d &O_h).

Magnetism: Types, spin moment, spin–orbit coupling.

(**12 Hours)**

UNIT–III

Stability of Metal Complexes, Concepts of Acids and Bases and Non-aqueous Solvents:

Stability of Complexes: Step–wise and overall formation constants, factors affecting stability of metal complexes, determination of stability constants of metal complexes by spectrophotometric and polarographic methods.

Concept of Acids and Bases: Theories of acids and bases, Bronsted and Lewis acids and bases, Lux–Flood theory, leveling effect of solvents, hardness and softness, HSAB concept and its applications.

Non-aqueous solvents: Classification of solvents, properties of non-aqueous solvents. Reactions in non-aqueous media: Liquid ammonia, anhydrous sulphuric acid, anhydrous HF, liquid sulphur dioxide. Super acids.

(12 Hours)

UNIT–IV

Solid State Chemistry:

Crystal lattice: Unit Cell, Miller indices and planes, X-ray diffraction method, molecular solids, hydrogen bonding, metallic, covalent and ionic solids; structural classification of binary and tertiary compounds, determination simple structure, spinel and perosvskite structures.

Band theory, conductors, semiconductors and insulators, energy bands, intrinsic and extrinsic semiconductors.

Perfect and imperfect crystals, intrinsic and extrinsic defects- point, line and plane defects. Vacancy, Schottky and Frenkel defects. Schottky and Frenkel defect formation, colour centres, non–stoichiometry.

(12 Hours)

Total 48 Hours

***Recommended Books**:*

1. Inorganic Chemistry–Principles of Structure and Reactivity, 4thEdn–J. E. Huheey, E.A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education (2009).
2. Shriver & Atkins' Inorganic Chemistry, 5th Edn–P. Atkins, Tina Overton, J. Rourke, Mark Weller and F. Armstrong.Oxford University Press (2010)

3. Inorganic Chemistry, 2nd Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall (2005)

4. Concise Inorganic Chemistry–J. D. Lee, 5th Edn, New Age International (1996).

5. Solid State Chemistry and its Applications–A. R. West, John–Wiley and sons.

6. Solid state Chemistry–N. B. Hannay, Prentice–Hall of India Pvt. Ltd. New Delhi.

CHG(Pr)–1.5: Lab Course in Inorganic Chemistry

1. Determination of iron in hematite ore using cerium(IV) solution (0.02M) as the titrant and gravimetric determination of insoluble residue.

2. Determination of calcium and magnesium carbonates in dolomite ore using EDTA titration and gravimetric analysis of insoluble residue.

3. Quantitative analysis of copper-nickel in alloy/mixture:
   i. Copper volumetrically using KIO_3
   ii. Nickel gravimetrically using DMG

4. Determination of lead and tin in a mixture: Analysis of solder using EDTA.

5. Determination of Cr(III) and Fe(III) in a mixture: Kinetic masking.

6. Quantitative determination of iron(III) gravimetrically and calcium(II) volumetrically in a mixture.

7. Determination of iron(II) and nickel (II) in a mixture:
   i. Iron(II) volumetrically using $K_2Cr_2O_7$ solution
   ii. Nickel gravimetrically using DMG solution

8. Quantitative analysis of chloride and iodide in a mixture:
   i. Iodide volumetrically using KIO_3
   ii. Total halide gravimetrically

9. Preparation of complexes:
   i) Tris (thiourea) copper(I)sulphate monohydrate and
   ii) Tris (oxalato) aluminate (III)

Scheme of Examination:

1. Duration of Examination : 4 hours
2. Experiment : 35 marks
3. Viva-voce and Journal : 05 marks
4. Internal assessment : 10 marks

Total : 50 marks

Recommended Books:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.

2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc, India.

3. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D

4. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.

5. Practical Inorganic Chemistry– G. Pass and H. Sutcliff, Chapman and Hall Ltd (1968)

CHGT–1.2: ORGANIC CHEMISTRY–I

UNIT–I

Bonding in Organic Molecules:

Localized chemical bonding: Bond distances, bond angles, bond energies, bond polarity, dipole moment and calculation of heat of reactions.

Delocalised chemical bonding: Conjugation, cross conjugation, steric inhibition of resonance, hyperconjugation, tautomerism, valence tautomerism. Bonding in fullerenes.

Structure and reactivity: Brönsted–Lowry concept of organic acids, conjugate acids and bases, pH, pKa values. Electronic, steric, and solvent effects on their strengths. General and specific acid base catalysis, running scale of acidity. Lewis acids and bases. HSAB concept.

(12 Hours)

UNIT-II

Organic Reaction Mechanisms:

Classification of organic reactions: Meaning and importance of reaction mechanism.

Non-kinetic methods of Detrmination of Reaction Mechanism: Product identification, cross over experiments, study of intermediates, isotopic labeling, kinetic isotope effects and stereochemical studies.

Nucleophilic substitutions (Aliphatic): Mechanisms of S_N2, S_N1 (rearrangements in S_N1 reactions) and S_Ni, $S_{RN}1$ pathways. Effects of structure, leaving groups and ambident nucleophiles.

Elimination Reactions: E_2, E_1, E_1CB pathways. Stereochemistry, product proportions in dehydration of alcohols, alkyl halides (chiral and achiral), Hoffmann and Saytzeff rules. Substitution v/s elimination and pyrolytic eliminations.

(12 Hours)

UNIT-III

Stereochemistry and Conformational Analysis:

Elements of symmetry and chirality, optical isomerism, optical activity, specific rotation. molecules with one asymmetric center. Fischer, Wedge and 3D representations, DL and RS systems indicating configuration. Ring compounds, molecules with two chiral centers: Fischer, Saw-Horse, Newmann projections and their transformations.

Enantiomers, diastereomers, epimers, racemization, resolution. Stereochemical correlation.

Geometrical isomerism: E–Z nomenclature, configuration of geometrical isomers and *syn*– & *anti*– isomers.

Conformational analysis: Conformational study of n-Butane, ethylene, glycol, chlorohydrin.

(12 Hours)

UNIT-IV

Aromaticity:

Aromaticity and Huckel's Rule: HMO theory, energy level diagrams, möbius systems, benzenoid and non-benzenoid aromatic compounds. Tropones, tropolones, borazine and azulene.

Heterocyclic Systems: Systems of the type pyrrole, pyridines, pyrilium cation, ferrocene. alternant and non-alternant hydrocarbons. Aromaticity of charged rings (3–8 membered), non aromatic, anti-aromatic and homo aromatic systems.

Ring current as criteria for aromaticity. Annulenes and heteroannulenes [10-18].

(12 Hours)

Total 48 Hours

Books Recommended:

1. Organic Chemistry–P. Y. Bruice, 7th Edition, Pearson Education Pvt. Ltd., New Delhi (2013).
2. Organic Chemistry –S. H. Pine, McGraw-Hill, London (1987).
3. Mechanism and Structure in Organic Chemistry–1965, by E.S. Gould.
4. Organic Chemistry–R. T. Morrison and R.T. Boyd, Prentice Hall, New Delhi (1994).
5. Organic Chemistry–T. W. Graham Solomons, 4th Edition, John Wiley and Sons (1988).
6. Organic Chemistry–G. M. Loudon, 4th Edition, Oxford University Press, New York (2002).

7. Organic Chemistry Volume–I, II–I. L. Finar, 6th Edition, ELBS London (2004).
8. Organic Chemistry–F.A. Carey, 4th Edition, McGraw Hill (2000).
9. Advanced Organic Chemistry, Reactions, Mechanism and Structure–J. March, 3rd Edition, Wiley Eastern Ltd. (2004).
10. Stereochemistry–Conformation and Mechanism–P. S. Kalsi, Wiley–Eastern Ltd, New Delhi (1992).
11. Guidebook to Mechanism in Organic Chemistry–P. Sykes. Orient Longman, London (2002).
12. Aromaticity–P. J. Garratt, McGraw Hill Book company (1971).

CHG(Pr)–1.6 : Lab Course In Organic Chemistry
Preparation of the following organic compounds:

1. Benzoic acid and benzyl alcohol from benzaldehyde (Cannizarro reaction).
2. Cyclohexanone from cyclohexanol.
3. Reduction of *p*-nitrobenzaldehyde to *p*-nitrobenzylalcohol.
4. 2,4-Dinitrophenol from chlorobezene.
5. Benzil from benzaldehyde.
6. m-Nitroaniline from nitrobenzene.
7. m-Nitro benzoic acid from ethyl benzoate.
8. Benzanilide from benzophenone (Beckmann rearrangement).
9. p-Bromoaniline from acetanilide.
10. p-Nitroaniline from acetanilide.

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry Revised–B.S.Furniss, A. J. Hannaford, P.W.G. Smith, A. R. Tatchell, 5th Edition, Addison Wesley Longman Limited, UK, 1997.
2. A Hand book of Organic Chemistry–by H. T. Clarke.
3. A Laboratory Manual of Organic Chemistry by B. B. Dey and M. V. Govindachari.
4. Lab Experiments in Organic Chemistry–by Arun Sethi, New Age International Ltd. New Delhi. 2006.

Scheme of Examination:

i.	Duration of examination	:	04 hours
ii.	Experiments	:	35 marks
iii.	Viva-Voce & Journal	:	05 marks
iv.	Internal assessment	:	10 marks
	Total	:	50 marks

CHGT-1.3: PHYSICAL CHEMISTRY–I

UNIT–I

Quantum Mechanics:

Review of classical mechanics: Equation of motion for a particle, Newtonian, Lagrangian and Hamiltonian equations of motion, elementary wave motion. Operators, eigen values and expectation values, commuting operators, linear operator and hermitian operators. Solutions of Schrödinger equations of a free particle, particle in a box problem: in one and three dimensions, degeneracy, reflection and penetration of a particle in a one dimensional box of semi-infinite barrier, a particle in a box of finite walls.

Rigid rotator, derivation of selection rules for transitions in rotating molecule, linear harmonic oscillator, Hermite polynomials. Equation for the hydrogen atom in spherical polar coordinates and an indication of the method of its solution, the quantum numbers and their significance**.**

Hydrogen-like atoms, properties of the H–atom wave functions. Electronic energy states of H–atom. Many electron systems and the self consistent field method. Electronic configurations in the periodic table. Pauli exclusion principle.

(12 Hours)

UNIT–II

Reaction Kinetics:

A critical account of collision and transition state theories.

Kinetics and mechanism: Steady state approximation and simple examples relating kinetics to mechanism. Theories of Unimolecular reactions: RRKM theory. Isomerisation of methyl isocyanide. Chain Reactions, examples of chain reactions, general aspects of chain reactions. Chain-length, chain transfer reactions, chain inhibition, kinetics of branching chain reactions and explosion limits.

(12 Hours)

UNIT–III

Thermodynamics:

Thermodynamic criteria for spontaneous chemical changes. Systems at (i) constant volume and temperature and (ii) constant pressure and temperature (derivation of $dA \leq 0$ & $dG \leq 0$). Dependence of free energy on pressure and temperature. Standard free energies and their

determination. Relation between free energy change and equilibrium constant. Gibbs–Helmholtz equation and their different forms. The pressure dependence of free energy of non–ideal gases and fugacity. Standard state for non-ideal gas. Equilibrium constant for system of non–ideal gases. Lewis and Randall rule. Temperature dependence of free energy and equilibrium constants.

Partial miscibility, activity and activity coefficients of components of solutions, partial molar quantities and their determinations. Gibbs–Duhem equation and the calculation of activity of a component in solutions. Duhem–Margules equation. Ternary systems and phase diagram of ternary systems.

(12 Hours)

UNIT–IV

Polymers:

Review on basic concepts of polymers and their classifications. Homopolymers, copolymers, terpolymers, addition polymers and condensation polymers with examples. Comparision between addition polymers and condensation polymers. Tacticity with examples of polystyrene and PMMA. Elastomers, difference between elastomer and thermoplastic, approaches to increase processability.

Techniques of free–radical polymerization: Bulk, solution, suspension, emulsion and precipitation polymerization.

Reactions of vinyl polymers**:** Functional group reactions, ring-forming reactions and block & graft copolymer formation. Crosslinking reactions: peroxide crosslinking, sulphur vulcanization, radiation crosslinking, photo crosslinking, electron beam crosslinking and miscellaneous crosslinking reactions. Polymer degradation: Chemical, thermal and radiation degradations.

(12 Hours)

Total: 48 Hours

Books Recommended:

1. Introduction to Quantum Chemistry by A. K. Chandra, Ed. 3, Tata McGraw Hill, New Delhi, 1988.
2. Quantum Chemistry by R. K. Prasad, New Age International Publications, New Delhi, 1997.
3. Quantum Chemistry by Eyring, Walter and Kimball, John-Wiley, New York.
4. Physical Chemistry by G. M. Barrow, McGraw Hill, New York, 1996.
5. Fundamentals of Physical Chemistry by Maron and Lando.
6. Physical Chemistry by P. W. Atkins, ELBS, London, 1990 (Ed. 4).
7. Physical Chemistry by K. Vamulapalli, Prentice Hall of India Pvt. Ltd., New Delhi,

1997.
8. Physical Chemistry by Daniels and Alberty, Wiley, New York.
9. Physical Chemistry Through Problems by S. K. Dogra and S Dogra, Wiley Eastern, New Delhi.
10. A Text Book of Physical Chemistry by Samuel Glasstone, McMillan, London.
11. Atomic Structure and Chemical Bonding by Manas Chanda, Tata McGraw Hill Publishing Co., New Delhi.
12. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi.
13. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York.
14. Polymer Chemistry: An Introduction, Malcolm P. Stevens, Oxford University Press, 1999.
15. Contemporary Polymer Chemistry, Harry R. Allcock and Frederick W. Lampe, Printice-Hall, 1981.
16. Principles of Polymer Chemistry, P. Bahadur and N. V. Shastri, Narosa Publisher, 2002
17. Polymer Chemistry: Properties and Applications, Andrew Peacock and Allison Calhoun, Hanser Publisher, 2006.
18. Text Book of Polymer Chemistry, Fred W. Billmeyer, Jr., Wiley Publisher, 1984.
19. Polymer Science, V. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, New Age International Publisher, 2001.

CHG(Pr)–1.7: LAB COURSE IN PHYSICAL CHEMISTRY

1. General Information and Chemical mathematics: Calibration of glasswares, concentration measures of solutions–concept of normality, molarity, molality and mole fraction, prepration of standard solution.
   Treatment of Experimental data–Errors, type of errors, Accuracy and precision. Mean deviation, standard deviation, significant figures, Methods of average and least squares.
2. Spectrophotometry: To obtain the absorption curve of $KMnO_4$ solution on a colorimeter and hence verify Beer–Lamberts law.
3. Potentiometery: Determination of the dissociation constant of dibasic acids (minimum two acids and titration with NaOH)
4. Conductance: Simultaneous estimation of $H_2C_2O_4$ and HCl in the mixture conductometrically by titrating with NaOH.
5. Distribution law: Studying the distribution of benzoic acid between water and benzene and hence determine the degree of association of benzoic acid in benzene.
6. Viscosity: Determination of viscosity average molecular weight of polystyrene in toluene by Ubbelohde Viscometer
7. Thermochemistry: Determine the relative strength of CH_3COOH and $ClCH_3COOH$ by calorimetric method.

8. Reaction Kinetics: Determination of activation parameters of the reaction of acid hydrolysis of methyl acetate at two different temperatures.
9. Cryoscopy: Determination of cryoscopic constant of benzene and nitrobenzene
10. Refractometry: Analysis of a binary mixture (glycerol and water) by refractive indices measurement.

Books Recommended:

1. Practical Physical Chemistry by A. M. James and F. E. Prichard, Longmans, London.
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill, New York.
3. Experiments in Physical Chemistry by Daniels, Alberty and Willams, McGraw Hill, New York.
4. Experimantal Physical Chemistry by W. G. Palmer, Cabridge University Press, London.
5. Advanced Physico-Chemical experiments by J. Rose. 6. Text Book of Physical Chemistry by S. Glasstone, , McGraw Hill,London.
6. Text book of Quantitative Analysis by A. I. Vogel, ELBS, Harlow.
7. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House.
8. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, New Age International Publishers.
9. Advanced Physical Chemistry Experiments by Gurtu and Gurtu, Pragati Prakashan Educational Publishers, 3rd Edition 2007.

Scheme of Examination:

i. Duration of examination: 04 hours
ii. Experiment : 35 marks
iii. Viva-Voce & Journal : 05 marks
iv. Internal assessment : 10 marks
Total : 50 marks

CHGT–1.4: ANALYTICAL CHEMISTRY

UNIT–I

Language of Analytical Chemistry, Data Treatment and Gravimetric Analysis:

Language of analytical chemistry: Definition of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Selection of an analytical method: Accuracy, precision, sensitivity, selectivity, robustness and ruggedness. Figures of merit of analytical methods: Sensitivity, detection limit and linear dynamic range.

Errors and Treatment of analytical Data: Limitations of analytical methods–Errors: determinate and indeterminate errors, minimization of errors. Statistical treatment of finite samples, measures

of central tendency and variability, mean, median, range, standard deviation and variance. Student's t-test, confidence interval of mean. Testing for significance and comparison of two means and two standard deviations. Comparison of an experimental mean and a true mean. Criteria for the rejection of an observation, Q–test. External standard calibration, the least squares methods, regression equation and correlation coefficient.

Gravimetric analysis**:** Mechansim of precipitation, factors influencing precipitation, coprecipitation, postprecipitation and organic reagents used in gravimetry (oxime and dmg).

(**12 Hours)**

UNIT–II

Titrimetric Methods:

Titrimetric Analysis: Principles of titrimetric analysis. Classification of reactions in titrimetry. Titrations based on acid-base reactions: Titration curves for strong acid and strong base, weak acid and strong base and weak base and strong acid titrations. Titration curves, quantitative applications, selecting and standardizing a titrant, inorganic analysis, alkalinity, acidity and ammonium salts.

Complexometric titrations: Indicators for EDTA titrations, theory of common indicators, titration methods employing EDTA, direct, back and displacement titrations, indirect determinations, titration of mixtures using masking and demasking agents.

Redox Titrations: Balancing redox equations, calculation of the equilibrium constant of redox reactions, titration curves, theory of redox indicators, calculation of standard potentials, determination of chemical oxygen demand (COD) in natural and waste waters.

Precipitation titrations: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the fajan's methods

(**12 Hours)**

UNIT–III

Separation Methods–I:

Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase and nature of adsorbents.

Column chromatography: Theories, plate theory, rate theory, band broadening-eddy diffusion, longitudinal diffusion and resistance to mass transfer, column efficiency, Van Deemter's equation and its modern version, interrelationships, capacity factor, selectivity factor, column resolution, distribution constant and applications of conventional column chromatography, advantages and limitations.

Thin layer chromatography (TLC): Definition, mechanism, efficiency of TLC plates, methodology, selection of stationary and mobile phases, development, spray reagents, identification and detection, reproducibility of R_f values, qualitative and quantitative analysis.

High performance liquid chromatography (HPLC): Instrumentation, pumps, column packing, characteristics of liquid chromatographic detectors, UV and fluorescence detectors, advantages and applications.

(12 Hours)

UNIT–IV

Separation methods-II

Gas chromatography (GC): Principle, instrumentation, columns, study of detectors, thermal conductivity, flame ionization and mass spectrometry, factors affecting separation, retention volume, retention time and applications.

Ion exchange chromatography (IEC): Definition, principle, requirements for ion-exchange resin, types of ion-exchange resins, resin properties-ion-exchange capacity and its determination, resin selectivity and factors affecting the selectivity, applications of IEC in purification and recovery processes.

Solvent extraction: Nernst partition law, efficiency and selectivity of extraction. Extraction systems: Extraction of covalent neutral molecules, extraction of uncharged metal chelates and synergic extraction, extraction of ion-association complexes-non chelated complexes and chelated complexes. Use of salting out agents. Methods of extraction–batch and continuous extractions. Applications (special emphasis on extraction of iron and copper).

(12 Hours)

Recommended Books:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
2. Analytical Chemistry, G.D. Christian, 6th edition, Wiley–India (2007).
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, PHI Learning Pvt Ltd. New Delhi(2009).
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd.(2007).
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California(1990).

CHG(Pr)–1.8: Lab Course in Analytical Chemistry

I. Organic Chemistry Practical

Quantitative analysis

1. Titrimetric Estimation of amino acids.
2. Estimation of glucose by Bertrand's method.
3. Estimation of keto group.
4. Iodine value of oil (Chloramine - T method)
5. Estimation of Nitro group by reduction using $SnCl_2$.

Qualitative Analysis

Separation of binary mixture of organic compounds using ether and identification of separated compounds by systematic qualitative organic analysis.

Please Note: 1) Individual organic compounds are to be given after the candidate reports the nature of the mixture. 2) Ether insoluble acids and ether insoluble Neutral organic compounds may be given. 3) Low boiling liquids and Amino acids need not be given.

The following mixtures may be given.

1. Acid + Base
2. Acid + Neutral
3. Base + Neutral
4. Phenol + Acid
5. Base + Phenol

II. Physical Chemistry Practicals

1. Determination of molecular radius of glycerol molecule by viscosity method.
2. Estimation of metal ions of ferric-thiocyante and cupric-ammonia complexes by spectrophotometrically.
3. Determination of relative strength of acids (HCl and H_2SO_4) by studying the hydrolysis of methyl actetate.
4. Determination of dissociation constants of weak monobasic acids potentiometrically by titrating against NaOH.
5. Comparison of strengths of chloroacetic acid and acetic acid using conductometric method.
6. Determine the dissociation constant of acetic acid pH-metrically by titrating against NaOH.

Books Recommended:

1. Practical Physical Chemistry by A. M. James and F. E. Prichard, Longmans, London.
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill, New York. Experiments in Physical Chemistry by Daniels, Alberty and Willams, McGraw Hill, New York.
3. Experimantal Physical Chemistry by W. G. Palmer, Cabridge University Press, London.
4. Advanced Physico-Chemical experiments by J. Rose. 6. Text Book of Physical Chemistry by S.
5. Glasstone, , McGraw Hill,London.
6. Text book of Quantitative Analysis by A. I. Vogel, ELBS, Harlow.
7. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House.
8. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, New Age International Publishers.
9. Advanced Physical Chemistry Experiments by Gurtu and Gurtu, Pragati Prakashan Educational Publishers, 3rd Edition 2007.

Scheme of Examination:

i. Duration of examination: 04 hours
ii. Experiment : 35 marks
iii. Viva-Voce & Journal : 05 marks
iv. Internal assessment : 10 marks
Total : 50 marks

SEMESTER II

CHGT–2.1: INORGANIC CHEMISTRY-II

UNIT–I

Chemistry of Non-Transition Elements:

Alkali and alkaline earth metal complexes of crown ethers, cryptands and calixarenes and their biological importance.

Synthesis, properties and structures of boron, carbon and silicon compounds: Chemistry of higher boranes, classification, structures and MO description of bonding, framework electron counting, Wade's rules, chemistry of B_5H_9, $B_{10}H_{14}$ and $B_nH_n^{2-}$, boron nitride, borazines, carboranes, metalloboranes, metallocarboranes; silicates, silicones, graphite, graphene, carbon nanotubes and zeolites.

Hydrogen bonding and its influence on properties.

(12 Hours)

UNIT–II

Chemistry of Main Group Elements:

Nitrogen, phosphorous and sulphur compounds: Hydrides, oxides and oxy acids of nitrogen, phosphorous, sulphur and halogens. Phosphazines, phosphazene polymers, sulphur–nitrogen compounds: Binary sulphur nitrides: S_4N_4, S_2N_2 and $(SN)_x$. P–O and P–S cage compounds.

Chemistry of halogens and xenon: Interhalogens, psuedohalogens, polyhalide ions, oxyhalogen species. Xenon oxides and fluorides.

(**12 Hours)**

UNIT–III

Symmetry and Group Theory:

Molecular symmetry, representation of symmetry operation as matrices. Definition of groups, set of symmetry operations of molecules satisfying the condition of point groups. Representation, basis of representation, reducible and irreducible representation. The great orthogonality theorem, character tables. The direct product. Applications of group theory: Molecular vibrations; molecular vibration in symmetrical AB_2. Hybridisation (tetrahedral and trigonal planar geometries)

(**12 Hours)**

UNIT–IV

Organometallic Chemistry:

Organometallic compounds: Introduction, classification of organometallic compounds by bond type, nomenclature, classification of ligands σ and π ligands, hapticity of ligands, 18 and 16 electron rules, electron counting schemes. Ferrocene and ruthenocene: Preparation, structure and bonding. Complexes containing alkene and alkyne ligands: Preparation, structure and bonding. Carbene (Fischer and Schrock type) complexes: Synthesis, structure and bonding. The isolobal principles.

Use of organometallic reagents in hydrogenation, hydroformylation, isomerisation and polymerization reactions.

(**12 Hours)**

Recommended Books:

1. Inorganic Chemistry–Principles of Structure and Reactivity, 4thEdn–J. E. Huheey, E.A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education (2009).
2. Shriver & Atkins' Inorganic Chemistry, 5th Edn–P. Atkins, Tina Overton, J. Rourke, Mark Weller and F.Armstrong.Oxford University Press (2010)

3. Inorganic Chemistry, 2nd Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall (2005)
4. Concise Inorganic Chemistry–J. D. Lee, 5th Edn, New Age International (1996).
5. Chemical Applications of Group Theory, 2nd Edn-F. A. Cotton, Wiley Eastern Ltd ( ).
6. Symmetry and Spectroscopy of Molecules–K. Veera Reddy, New Age International, (2011).
7. Group Theory in Chemistry–M. S. Gopinathanan and V. Ramakrishnan, Vishal Publishing Co. (2007)
8. Organometallic Chemistry–A unified Approach, R.C. Mehrotra and A. Singh, 2nd Edn. New Age International (2011).
9. F.A.Cotton and G.Wilkinson : Advanced Inorganic Chemistry, Wiley, 1991.
10. Basic Organometallic Chemistry– B D Gupta and A J Elias, Universities Press (2013)

CHG(Pr)–2.4: Lab Course in Inorganic Chemistry

1. Semimicro qualitative inorganic analysis of a mixture containing three cations (including one less common cation such as W, Mo, Ti, Zr, Ce, V and Li) and two anions (one of them may or may not be interfering anion such as PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^- and CH_3COO^-).

2. Separation and determination of Zn and Mg on an anion exchanger.

3. Demonstration experiment: Determination of iron as the 8–hydroxy quinolate by solvent extraction.

Scheme of Examination:

1.	Duration of Examination	: 4 hours
2.	Experiment	: 35 marks
3.	Viva-voce and Journal	: 05 marks
4.	Internal assessment	: 10 marks
	Total	: 50 marks

Recommended Books:

1. Vogel's Text Book of Quantitative Chemical Analysis(5th Ed), G.H.Jeffrey, J.Bassette, J.Mendham and R.C.Denny, Longman, 1999.
2. Vogel's Qualitative Inorganic Analysis(7th Ed), G.Svehla, Longman (2001)

CHGT–2.2: ORGANIC CHEMISTRY–II

UNIT–I

Reaction Mechanism:

Aliphatic electrophillic substitutions: S_E2, S_E1 and S_Ei mechanisms. Reactions involving double bond shifts, α-halogenation of carbonyl compounds, nitrosation at carbon bearing active hydrogen.

Aromatic electrophillic substitutions: Mechanisms of aromatic, nitration, sulphonation, halogenation, isotope effects, energy profile diagrams. Kinetic and thermodynamic control, sulphonation, Hammond's Postulate, o/p ratio, ipso–substitution, Vilsmeir Haack and Fries rearrangement.

Aromatic nucleophilic substitutions: S_NAr, S_N1 and aryne pathways. Meisenheimer complexes, mechanism and synthetic applications of vicarious nucleophilic substitution (VNS), Von-Richter, Goldberg, Bucherer, Shiemann reactions and Smiles rearrangement.

(12 Hours)

UNIT–II

Advanced Stereochemistry:

Prochirality: Homotopic, enantiotopic and diastereotopic atoms, groups and faces.

Stereochemical descriptors: Application to reduction of carbonyl compounds, cyanohydrin formation, addition of water to alkenes.

Optical activity due to molecular dissymmetry: Allenes, spiranes, biphenyls, atropisomerism, molecular crowding.

Conformational analysis of cyclohexane, mono substituted and disubstituted (1,2, 1,3, 1,4) cyclohexanes, Chirality of cyclohexanes.

(12 Hours)

UNIT–III

Carbohydrates:

Monosaccharides: Conformational representation of monosaccharides and their transformations. Determination of configuration of the monosaccharides, mechanism of mutarotation–base catalyzed isomerisation of aldoses and ketoses. Epimerisation, anomeric effect, glycosides, ether and ester derivatives of carbohydrates. Acetone, amino and deoxysugars. Oxidation and reduction reactions of carbohydrates.

Disaccharides: Structure elucidation of maltose, lactose, sucrose.

Polysaccharides: Structure and degradation of starch, cellulose and glycogen.

(**12 Hours)**

UNIT–IV

Chemistry of heterocycles: Nomenclature of heterocyclic compounds (including fused heterocycles).

Synthesis and chemical reactions of indole, quinoline, isoquinoline, thiazole, imidazole, benzimidazole, coumarin, flavones.

(**12 Hours)**

Total 48 Hours

Books Recommended:

1. Advanced Organic Chemistry part A and B–F. A. Carey and R. J. Sundberg, 4th Edition, Plenum Publishers (2000).
2. Advanced Organic Chemistry, Reactions, Mechanism and Structure–J March, 3rd Edition, Wiley Eastern Ltd. (2004).
3. Guide Book to Mechanism in Organic chemistry–Peter Sykes Oriant- Longman (1985).
4. Stereochemistry of Carbon Compounds–Eliel, Tata McGraw Hill, New Delhi (1976).
5. Stereochemistry of Organic Compounds, Principles and Applications – D. Nasipuri, Wiley Eastern Ltd (1992).
6. Organic Chemistry Vol–I, II, III–S. M. Mukherji, S. P. Singh and R. P. Kapoor, New Age International Ltd, New Delhi (2000).
7. Organic Chemistry Volume–I, II– I. L. Finar, 6th Edition, ELBS London (2004).
8. Chemistry of Carbohydrates–G. C. Percival.
9. Carbohydrates –Chemistry and Biochemistry –Pigman and Harton.
10. Heterocyclic Chemistry–T. L. Gilchrist, 3rd Edition, Pearson Education Delhi, (2005).
11. Heterocyclic Chemistry –J.A. Joule and G.F. Smith, 2nd Edition, Van Nostrand London (1978).
12. Heterocyclic Chemistry–R. K. Bansal, 3rd Edition, New–Age Interantional, New Delhi, 2004.
13. https://profiles.uonbi.ac.ke/sderese/files/upc_213nomenclature_of_heterocyclic_compounds_0.pdf

CHG(Pr) –2.5 : LAB COURSE IN ORGANIC CHEMISTRY

1. Quantitative Estimation of the following Organic compounds: (i) Acid (ii)Acid + Amide (iii) Acid + Ester (iv) Molecular weight determination by base hydrochloride method (v) Phenol (Bromometric method).
2. Preparations of derivatives of heterocycles like coumarins, quinolines, benzimidazoles, benzoxazines, pyrazoles by convention, microwave and by sonication.
3. Preparations based on functional group reactions of organic compounds like aldehydes, ketones, esters, phenols etc.

Note: Any two of the above experiments will be prescribed for the examination.

Scheme of Examination

i.	Duration of examination	:	04 hours
ii.	Experiments	:	35 marks
iii.	Viva-Voce & Journal	:	05 marks
iv.	Internal assessment	:	10 marks
	Total	:	50 marks

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry Revised–B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, 5th Edition, Addison Wesley Longman Limited, UK, 1997.
2. A Hand book of Organic Chemistry –H.T. Clarke.
3. A Laboratory Manual of Organic Chemistry–B. B. Dey and M.V. Govindachari.
4. Lab Experiments in Organic Chemistry –Arun. Sethi, New Age International Ltd. New Delhi. 2006.
5. Experimental Organic Chemistry–L. M. Harwood, and C. J. Moody, Blackwell Scientfic, London, 1989.
6. Practical Organic Chemistry–W. Kemp, McGraw Hill, London, 1967.

CHGT–2.3: PHYSICAL CHEMISTRY–II
UNIT–I

Microwave Spectroscopy and X–ray Diffraction:

Microwave spectroscopy: Gaseous microwave spectra and rotational transitions: Study of inversion of ammonia and hindered rotations in molecules. Instrumentation. Stark effect in molecular spectra, first and second order Stark effects.

X–ray diffraction: Origin and production of X–rays, interaction of X–rays with matter: Absorption, scattering and diffraction. Reciprocal lattice: Brag's law in reciprocal space. Instrumentation: Sources, filters, monochromatic detectors. Crystal structure: Unit cell, lattices, planes and miller indices. Debye-Scherrer powder methods and Weissenberg camera. Numerical problems.

(12 Hours)

UNIT –II

Reaction Kinetics:

Kinetics in Solution: Effect of solvent, pressure and ionic strength for ion-ion, ion-neutral molecule type reactions and cage effects.

Potential energy surfaces, methods employed in the construct of potential surfaces, calculating reactions.

Fast Reactions: Techniques for fast reactions, flow methods, stopped flow technique, relaxation methods and flash photolysis. Numerical problems.

(12 Hours)

UNIT –III

Electrochemistry:

Introduction to electrochemistry, Debye–Huckel and Bjerrum models and the corresponding theoretical expression for activity coefficient and Debye-Huckel-Onsagar theory of conductance of strong electrolytes.

Electrochemistry of Solution: Activity of ions in solution, solvation number and their determination, ion-solvent interactions, ion-ion interactions and free energy of ions in solution and triple ion formation, conductance minima and free energy of ions in solution. Born model for calculating the free energy of ion-solvent interaction and its modifications. The enthalpy and entropy of ion-solvent interaction. Electrical double layer: Electrocapilarity, Lippman equation (surface excess), theories of electrical double layer: Helmholtz–Perrin, Gouy-Chapman and Stern theories. Effect of ions on zeta potential. Over potentials, exchange current density, derivation of Butler-volmer equation and Tafel plot.

(12 Hours)

UNIT- IV

Polymer chemistry:

Transitions in polymers: Definition of glass transition temperature (T_g) and flow temperature (T_f) and melting temperature (T_m), thermal behaviour of amorphous and crystalline polymers, factors affecting the T_g. Plasticizers, properties and their effect on T_g of PVC and diethylhexylsuccinate, efficiency of plasticizers, comparison of T_g and T_m. T_g of copolymers and polymer blends, relation between T_g and T_m.

Polymer molecular weight: Number average and weight average molecular weights, polydispersity and molecular weight distribution in polymers. Numerical problems on determination of molecular weights.

Kinetics of polymerization: Kinetics of free-radical addition polymerization, cationic polymerization, anionic polymerization, copolymerization and determination of reactivity ratios.

Polymer synthesis: Ziegler-Natta polymerization (isotactic and syndiotactic) and its limitations. Metallocene catalysis polymerization (isotactic). Metathesis polymerization: Acyclic diene metathesis polymerization (ADMET) and ring opening metathesis polymerization (ROMP). Group transfer polymerization (GTP) and advantages of GTP.

(12 Hours)

Total 48 Hours

Books Recommended

1. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Tata McGraw Hill
1. Publishing Co., New Delhi.
2. An introduction to Molecular Spectroscopy by G. M. Barrow, McGraw Hill, New York.
3. Molecualr Spectra and Molecular Structure:I Spectra of Diatomic Molecules by G.
4. Herzberg, Van Nostrand, Princeton.
5. Physical Chemistry by P. W. Atkins, ELBS, London.
6. Physical Chemistry by G. M. Barrow, McGraw Hill, New York.
7. Atomic and Molecular Spectroscopy by M. C. Gupta, New Age International Publishers, New Delhi.
8. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi.
9. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York.
10. Chemical Kinetics by K. J. Laidler, McGraw Hill, 1950.
11. Kinetics and mechanism of chemical transformations by J. Rajaraman and J. Kuriacose, McMillan.
12. Theory of rate processes by S. Glasstone, K. J. Laidler and H. Eyring, McGraw- Hill, 1941.

13. Thoeries of Chemical recation Rates by K. J. Laidler, McGraw-Hill, 1969.
14. Techniques of Organic by Weissberger(ed.), Interscience, Vol.VIII, 1963,
15. Kinetics of Chemical Changes in Solution by E. S. Amis, MacMillan, 1948
16. The Foundations of Chemical Kinetics by S. W. Benson, MacGraw-Hill, 1960.
17. An Introduction to Electrochemistry by S. Glasstone, Van Nostrand, London
18. A Text book of Electrochemistry by G.F.A. Kortum and J.O.M. Bockris, Elsevier, New York.
19. Modern Electrochemistry by J.O.M. Bockris and A.K.N. Reddy Vol. I and Vol. II, Butterworths, London.
20. Polymer Chemistry: An Introduction, Malcolm P. Stevens, Oxford University Press, 1999.
21. Contemporary Polymer Chemistry, Harry R. Allcock and Frederick W. Lampe, Printice-Hall, 1981.
22. Principles of Polymer Chemistry, P. Bahadur and N. V. Shastri, Narosa Publisher, 2002
23. Polymer Chemistry: Properties and Applications, Andrew Peacock and Allison Calhoun, Hanser Publisher, 2006.
24. Text Book of Polymer Chemistry, Fred W. Billmeyer, Jr., Wiley Publisher, 1984.
25. Polymer Science, V. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, New Age International Publisher, 2001.

CHG(Pr)–2.6: LAB COURSE IN PHYSICAL CHEMISTRY

1. Solubility: Determine the heat of solution of a solute (e.g oxalic acid or benzoic acid) by solubility method.
2. Coulometric titration: Titration of I_2 against $Na_2S_2O_3$.
3. Cryoscopy: Determination of the degree of dissociation of a given strong electrolyte and the determination of the number of ions present in the solute using cryoscopy method.
4. Spectrophotometry: To obtain the absorption spectra of coloured complexes (Ferric-thiocyante and Cupric–ammonia complexes) and hence verify the Beer–Lambert's law and estimation of metal ions in solution by spectrophotometry.
5. Conductance: (i) Determination of equivalent conductance of a weak electrolyte at different concentrations and the applicability of Ostwald's law. (ii) Determination of equivalent conductance of a weak electrolyte from Kohlrausch's law.
6. Potentiometry: Potentiometric determination of formal redox potential of Fe^{2+}/Fe^{3+} and Ce^{4+}/ Ce^{3+} or Cr^{6+}/ Cr^{3+} couples by titrating Fe^{2+} solution with Ce^{4+} or Cr^{6+}.
7. Reaction Kinetics: Investigation of autocatalytic reaction between potassium permanganate and oxalic acid in the presence of H_2SO_4.
8. Viscosity: Determination of limiting viscosity number (Staudinger index) of polystyrene.
9. pH metry: Titration of acetic acid against NaOH and hence determine the acid dissociation constant (K_a).

Books Recommended:

1. Findlay's Practical Physical Chemistry, 9th edition, revised by B. P. Levitt, Longman, London.
2. Practical Physical Chemistry by A. M. James and F. E. Prichard, Longman, London.
3. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill, New York.
4. Experiments in Physical Chemistry by Daniels, Alberty and Willams McGraw Hill, New York.
5. Laboratory Physical Chemistry by Oelke/M.A.C.T.L.A.C.
6. Experimental Physical Chemistry by W. G. Palmer, C.U.P., London.
7. Advanced Physico-Chemical Experiments by J. Rose.
8. Text Book of Physical Chemistry by S. Glasstone, Macmillon and Co., London.
9. Text Book of Quantitative Analysis by A. I. Vogel, ELBS, Harlow.
10. Advanced Practical Physical Chemistry by J. B. Yadav. Goel Publishing House.
11. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, New Age International Publishers.
12. Advanced Physical Chemistry Experiments by Gurtu and Gurtu, Pragati Prakashan Educational Publishers, 3rd Edition, 2007.

Scheme of Examination:

i. Duration of examination: 04 hours
ii. Experiment : 35 marks
iii. Viva-Voce & Journal : 05 marks
iv. Internal assessment : 10 marks
Total : 50 marks

III SEMESTER
CHGT–3.1: INORGANIC CHEMISTRY
UNIT–I

Spectral and Magnetic properties of complexes:

Term symbols for d^n ions, spectroscopic ground states, selection rules, nature of spectral bands-band shapes, band intensities, band widths, effect of spin-orbit coupling, Orgel diagrams, Tanabe-Sugano diagrams, Racah parameters, interpretation of spectra of octahedral, distorted octahedral, tetrahedral and square planar complexes, calculation of nephelauxetic parameter, charge transfer bands, intervalence charge-transfer bands.

Type of magnetic behaviour, classical magnetism, orbital contribution, orbital contribution reduction factor, spin orbit coupling, measurement of magnetic susceptibility–Gouy and Faraday methods, diamagnetic corrections, magnetically non-dilute compounds- ferro, antiferro and ferri magnetic, spin cross-over systems, correlation of magnetic and structural properties

(12 Hours)

UNIT–II

Reaction Mechanisms in Transition Metal Complexes and Bioinorganic Chemistry:

Energy profile of a reaction, inert and labile complexes, kinetics of octahedral substitution and mechanistic aspects. Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism and evidences in its favour. Anation reactions, Substitution reactions in square planar complexes, trans effect, mechanisms of substitution. Electron transfer reactions-inner sphere and outer sphere reactions, complimentary and noncomplimentary reactions.

Bioinorganic Chemistry: Metal ions in biological systems-essential and trace metals, Transport and storage of dioxygen– haemoglobin, myoglobin, hemerythrin and hemocyanins, Electron transfer proteins- cytochromes, iron-sulphur proteins. Metalloproteins as enzymes–carboxy peptidase, catalases, peroxidases, cytochrome P–450, superoxide dismutase, copper oxidases, vitamin B_{12} coenzyme, chlorophyll and its role in photosynthesis, photosystems–I & II, nitrogen fixation and metal complexes in medicine.

(12 Hours)

UNIT–III

Applications of I.R. spectroscopy in Inorganic Compounds

Infrared spectra of simple molecules and coordination compounds, changes in infrared spectra of donor molecules upon coordination (N,N–dimethylacetamide, urea, DMSO, pyridine N–oxide, ammine, cyano, cyanato and thiocyanato complexes), mono and multinuclear carbonyl complexes, nitosyls, phosphine and arsine complexes. Change in spectra accompanying change in symmetry upon coordination (NO_3^-, SO_4^{2-}, NO_2^-, and ClO_4^-), hydrogen bonding, instrumentation including FTIR.

(12 Hours)

UNIT–IV

Electron Paramagnetic Resonance (EPR) Spectroscopy:

Basic principles, Selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin-orbit coupling, zerofield splitting and Kramer's degeneracy, rules for interpreting spectra, factros affecting the magnitude of values. Instrumentation. Applications to the study of free radicals, Coordination compounds, biological studies, rate of electron exchange reactions.

Mössbauer Spectroscopy:

Introduction, Principles, conditions for Mössbauer spectroscopy, parameters from Mossbauer spectra, isomer shifts, electric quadrupole interaction, magnetic interactions, Mossbauer spectrometer, applications, $Fe_3(CO)_{12}$, Prussion blue, oxyhemerythrin, hexacyanoferrates, nitropruside, tin halides.

Nuclear Quadrupole Resonance (NQR) Spectroscopy−Quadrupole nuclei, quadrapole movement, electric field gradient, the NQR experiment, structural information from NQR spectra.

(12 Hours)

Total :48 Hours

Books Recommended:

1. Electronic absorption Spectroscopy and Related Techniques–D. N. Satyanarayana, OUP, 2001.
2. Inorganic Reaction Mechanisms-F. Basolo and R. G. Pearson, Wiley Eastern, 1979.
3. W.W.Porterfield: Inorganic chemistry–A Unified Approach, Elsevier, 2005.
4. Elements of Magnetochemistry–R. L. Dutta and A Syamal : Affiliated East-West, 1993.
5. Inorganic Chemistry(4th edn) –J. E Huheey, R. L. Keiter and A. L. Keiter, Addison Wesley, 2000.
6. Inorganic Chemistry of Biological Processes, (2nd edn.) –M. N. Hughes, Wiley, 1988.
7. Bioinorganic Chemistry–I. Bertini. H. B. Gray, S. J. Lippard and J. S. Valentine:, Viva Books, 1998.
8. Bioinorganic Chemistry–A.K. Das, Books and Allied (P) Ltd, 2007
9. Principles of Bioniorganic Chemistry–S. J. Lippard and J. M. Berga. Panima Publishing Corporation.
10. Fundamentals of Molecular Spectroscopy–C. N. Banwell.
11. Physical Methods in Chemistry–R .S. Drago, Saunder college.
12. Structural Methods in Inorganic Chemistry–E. A. Ebsworth, D. W. H. Ranbin and S.Cradock, ELBS.
13. Infrared Spectra of Inorganic and Coordination Compounds, K. Nakamoto.
14. Infrared Spectroscopy–C.N.R. Rao.
15. Electron Absorption Spectroscopy and Selected Techniques–D. N. Satyanarayana, University Prof. India Ltd. Hyderabad.
16. Introduction to Spectroscopy-Pavia, Lampman and Kriz.

CHG(Pr)–3.5: Lab Course In Inorganic Chemistry

I. Preparation of the following complexes:

1. Copper-glycine complex : cis-and trans forms.
2. $Co(DMG)_2$ model for Vit-B_{12} and reaction
3. Potassium trisoxalatoferrate(III)
4. tris(acetylacetonate)manganese(III)
5. hexaammine/pentaammine chlorido cobalt (III) chloride.
6. nitro- and nitrito-complexes.(examples for linkage isomers)
7. Tris(thiourea) copper(I) sulphate monohydrate
8. Seperation of optical isomers of cis$[Co(en)_2Cl_2]Cl$.

II. Characterisation

1. Metal ion/anion determination in the above complexes
1. Interpretation of electronic, IR and NMR spectra

Scheme of Examination

i. Duration of examination	: 04 hours
ii. Interpretation of given spectra	:10 marks
iii. Analysis of a complex	: 25 marks
iv. Viva voce and Jounral	: 05 marks
v. Internal Assessment	:10 Marks
Total	: 50 marks

***Books recommended**:*

1. Vogel's Text Book of Quantitative Inorganic Analysis–J. Basett, R. C. Denney, H.
2. Jeffery and J. Mendham, Longmans, Green and company Ltd.
2. Practical Inorganic Chemistry–G. Pass and H. Sutcliff, Chapman and Hall Ltd.(1968)
3. General Chemistry Experiments-A. J. Elias, University Press.
4. Computers and their applications to Chemistry, Ramesh Kumari, Narosa

Scheme of Examination

1. Duration of Examination : 04 hours
2. Experiment : 35 marks
3. Viva-voce and Journal : 05 marks
4. Internal assessment : 10 marks

Total : 50 marks

CHGT–3.2: ORGANIC CHEMISTRY Paper II

UNIT–I

Reaction Mechanism: Nucleophilic substitution at allylic and trigonal carbon atom.

Neighbouring group participation, participation of σ, π, cyclopropane and aromatic rings in nucleophilic substitution reaction. Addition reactions: electrophilic addition across alkenes, *cis-trans* alkenes, dienes.

Stereochemistry: Stereoselectivity in organic synthesis, stereospecific and stereoselective reaction, principle of stereoselectivity, stereoselectivity in addition, elimination, substitution reaction. Asymmetric synthesis, enantioselective and diastereoselectivity in acyclic system, addition of nucleohphiles to carbonyl group, correalation of configuration, Crams rule and Prelogs rule for diastereselection.

(12 Hours)

UNIT–II

UV and IR Spectroscopy:

Electronic Spectroscopy: Introduction. Energy considerations. Experimental methods. Beer-Lambert's law. UV spectral study of unsaturated carbonyl and aromatic compounds. Steric effects, charge transfer bands.

Vibrational Spectroscopy: Introduction and Experimental methods. Units, Notation and Regions. Fundamental vibrations, overtones, Group frequencies, factors affecting group frequencies. Mechanical coupling, Fermi resonance, Applications of IR in the study of H–bonding, Alkanes, Alkenes, Alkynes, Aromatic compounds, Aldehydes, Ketones, Alcohols, Thiols, Acids, Acid chlorides, Amides, Amines, Esters, halides, nitro compounds, etc.

(12 Hours)

UNIT–III

Nuclear Magnetic Resonance:

^{1}H NMR: Magnetic properties of nuclei, shifts of different types of organic compounds empirical rules, spin-spin coupling, geminal–vicinal coupling–relative intensities, Long range coupling–spin decoupling, equivalence of protons–chemical and magnetic equivalence, spin–systems Karplus equation–curve, first order and second order patterns, lanthanide shift reagents, exchange phenomena. NOE.

^{13}C NMR: Broad band and off resonance coupling methods of detection. ^{13}C Chemical shifts of different classes of organic compounds–alkanes, alkyl halides, alkenes, alcohols, ethers, carbonyl compounds and aromatic compounds.

(12 Hours)

UNIT–IV

Mass Spectrometry and Composite Problems:

Instrumentation and theoretical principles, determination of empirical formula. Fragmentation: Principles, odd and EE ions, molecular ion and base peak, nitrogen rule, metastable ions. Isotope effects in chloro and bromo compounds. Stevenson rule. Fragmentation of: i) normal and branched alkanes. ii) alkenes. iii) benzene and its derivatives. iv) alcohols. v) aldehydes. vi) ketones. vii) acids. viii) esters. ix) ethers. x) amines. xi) nitro compounds. xii) halo compounds. McLafferty rearrangement.

Composite problems: Applications of UV, IR, NMR and Mass methods and chemical reactions in structure elucidation of organic compounds.

(12 Hours)

Total: 48 Hours

Books Recommended:

1. Stereochemistry of Organic compounds –Eliel, Tata McGraw Hill (2000).
2. Stereochemistry, Conformation and Mechanism –P.S. Kalsi, 6th Edition, New Age International Ltd. (2006).
3. Stereochemistry of Organic Compounds, Principles and Applications – D. Nasipuri, Wiley Eastern Ltd. (1992).
4. Advanced Organic Chemistry part A and B –F.A. Carey and R.J. Sundberg, 4th Edition, Plenum Publishers, (2000).
5. Advanced Organic Chemistry, Reactions, Mechanism and Structure – J March, 6th
6. Edition, Wiley Eastern Ltd. (2007).
7. Mechanism and Theory in Organic Chemistry –T.A.Lowry and K.S. Richardson, 3rd Edition, Addison-Wesley, UK (1998).

8. Organic Chemistry Volume-I, II and III –S.M.Mukherji, S.P.Singh and R.P. Kapoor, New Age International Ltd (2000).
9. Organic Reaction Mechanism – by R. K. Bansal, 3rd Edition, Tata McGraw Hill (2006).
10. Mechanism and Theory in Organic Chemicals –T.H. Lowry and K.S. Richardson, AWL, UK, 1998.
11. Advanced Organic Chemistry–R. Buckner, HAP Publishers, Sandiego, USA (2002).
12. Reactive Intermediates in Organic Chemistry – N. S. Isaacs, John Wiley and Sons, 1974.
13. Advanced Organic Chemistry part A and B –F.A. Carey and R.J. Sundberg, 4th Edition, Plenum Publishers, (2000).
14. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Tata McGraw Hill
15. Publishing Co., New Delhi.
16. An introduction to Molecular Spectroscopy by G. M. Barrow, McGraw Hill, New York.
17. Molecualr Spectra and Molecular Structure:I Spectra of Diatomic Molecules by G. Herzberg, Van Nostrand, Princeton.
18. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, and George S. Kriz, Cenage Learning, USA, (2015).

CHG(Pr)–3.6: Lab Course In Organic Chemistry

Identification of the Nature, Bulk separation, Purification and Qualitative analysis (using ether) of the Binary mixture of the following classes: Acids, Bases, Phenols and Neutral compounds (without derivatives).

Scheme of Examination

1. Duration of Examination : 04 hours
2. Experiment : 35 marks
3. Viva-voce and Journal : 05 marks
4. Internal assessment : 10 marks

Total : 50 marks

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry Revised by B.S. Furniss, A.J.
2. Hannaford, P.W.G. Smith, A.R. Tatchell, 5th Edition, Addison Wesley Longman

3. Limited, UK, 1997.
4. A Hand book of Organic Chemistry–by H.T.Clarke.
5. A Laboratory Manual of Organic Chemistry by B.B.Dey and M.V. Govindachari.
6. Lab Experiments in Organic Chemistry–by Arun. Sethi, New Age International
7. Ltd. New Delhi. 2006.

Scheme of Examination

Duration of examination	:	04 hours
Experiments	:	35 marks
Journal and Viva	:	05 marks
Internal Assessment	:	10 marks
Total	:	50 marks

CHGT–3.3: PHYSICAL CHEMISTRY:

UNIT–I

Quantum Mechanics:

Equation for hydrogen atom and its solutions, separation of variables, the phi, theta and radial equations, the problems of spherical symmetry.

Approximate methods in quantum mechanics: Variation method and variation theorem, linear variation functions, secular equations and secular determinants. Application of variation method to hydrogen molecule ion, hydrogen molecule and normal helium atom.

Perturbation theory (first order and non-degenerate), application of perturbation theory to the helium atom.

(12 Hours)

UNIT–II

Atomic Structure and Atomic Spectra:

A summary of the hydrogen spectrum. Alkali spectra and alkali like spectra, spark spectra and arc spectra. Moseley lines.

Helium and alkaline earth spectra. Multiplet structure of line spectra. Doublet structure of alkali spectra and compound doublets, triplets and singlets of alkaline earths and helium, prohibition of intercombinations. Multiplicities and term symbols.

Space quantization: Zeeman effect, normal and anomalous Zeeman effects, Paschen–Back effect, Stark effect.

(12 Hours)

UNIT–III

Symmetry Properties of Molecules and Group Theory:

Introduction to symmetry, molecular symmetry, symmetry elements, symmetry operations and matrix method in symmetry. Molecular point groups: point groups identification of point groups, construction of group multiplication tables, symmetry species and point group character tables.

Reducible and irreducible representations, properties of irreducible representation, Mulliken symbolism rules for irreducible representation, Structure of character tables, the standard reduction formula and the great orthogonality theorem. Normal mode analysis: number of normal modes of vibrational symmetry types, infrared and Raman activity, Rule of mutual exclusion.

(12 Hours)

UNIT–IV

Diffraction Studies:

X-ray diffraction: Reciprocal lattice, indexing of single crystal rotation photographs, determination of molecular parameters, the structure factor calculations, Fourier series and the phase problems. Refinements of Fourier procedures.

Neutron diffraction: Neutron diffraction and differences from X–ray diffraction.

Electron diffraction: Theoretical principles, structure analysis: Visual comparison of intensities, radial distribution function and its refinements. The rotating sector method.

(12 Hours)

Total 48 Hours

Books Recommended

1. Quantum Mechaincs–L.T.Schiff, Prentice–Hall.
2. Quantum Chemistry–H. Eyring, J. Walter and G. E. Kimball, John Wiley.
3. Quantum Mechanics–An Introduction–H. L. Strauss, Prentice Hall of India.
4. Quantum Mechanics–L. Pauling and E.B.Wilson, McGraw Hill.
5. Contemporary Quantum Chemistry–J. Goodisman, Plenum/Rosetta.
6. Quantum Chemistry–K. S. Pitzer, Prentice-Hall
7. Introductory Quantum Mechanics-Valdimir Rojanstry.
8. Quantum Chemistry–John P.Lowe.
9. Quantum Chemistry –Ira N. Levine, Prentice Hall of India Pvt. Ltd.
10. Quantum Chemistry–Donald A. McQuarrie, Viva Book Pvt. Ltd.
11. Physical Chemistry–P.W. Atkins, Clarendon Press, Oxford, 1970.
12. Molecular Quantum Mechanics–P.W.Atkins, Clarendon Press, Oxford, 1970.
13. Introduction to Quantum Chemistry–J. M. Anderson.

14. Introduction to Quantum Mechanics–R. H. Dicke, J. P. Wittke.
15. Indroductory Quantum Chemistry–A. K. Chandra, Tata McGraw Hill, New Delhi 1994.
16. Quantum Mechanics in Chemistry-M.W. Hanna.
17. Quantum Chemistry–R .K. Prasad, New Age International Publishers, New Delhi.
18. Atomic Spectra and Atomic structure–G. Herzberg, Van Nostrand
19. Chemical Applications of Group Theory–F.A.Cotton, Wiley Eastern, New Delhi
20. Molecular Symmetry–D.S.Schonlnd, Van Nostrand Comp.London,1965
21. Symmetry in Chemistry-Jeffe and Orchin, Wiley Inter Science, NewYork.
22. Symmetry, Orbitals and Spectra–Jeffe and Orchin, -Jeffe and Orchin, Wiley Inter Science, New York, 1971.
23. Electron Diffraction–T.B. Rymer, Methuen, London,1970
24. Neutron Diffraction–G.E.Becon
25. Symmetry in Molecules–J.M.Hollar
26. X-Ray Crystallography–Buerger
27. Diffraction Methods–Wernard
28. Chemical Crystallography–L.W.Bunn. N.Y.and Oxford,1945
29. Crystals and X–Rays K.landsdale, N.Y.1945
30. Crystal Structure Analysis–M.J.Berger, John Wiley and Sons, N.Y.1960
31. The Determination of Molecular Structure–P.J.Wheatley, Clarendon, Oxford,1960
32. Physical Chemistry–G.M.Barrow, McGraw Hill, New York, 1991
33. X-ray Diffraction–D.B.Cullity, Mass Addison, Wesley, 1978.

CHG(Pr)–3.4: Lab Course In Physical Chemistry

1. Viscosity: Determination of number average molecular weight by hydroxyl end group analysis.
2. Conductance: Verification of the Debye–Huckel-Onsagr equation for strong electrolytes.
3. Reaction Kinetics: Studying the acid catalysed kinetics of oxidation of glycene by chloramine–T (CAT) and hence determination of order of reaction w.r.t. CAT and glycene and hence overall order of the reaction.
4. Potentiometry: Potentiometric estimation of a mixture of a halides, (KCl, KBr and KI) by titrating against $AgNO_3$
5. Cryoscopy: Determination of the molecular weight of the given solute by the vacuum flask method.
6. pH metry: Determine the acid and base dissociation constant of an amino acid and hence find its isoelectric point
7. Refractometry: Analysis of a binary mixture (glycerol and water) by refractive indices measurement.
8. Spectrophotometry: Individual and simultaneous estimation of Fe(III) and Cu(II) spectrophotometrically by titrating against EDTA.

9. X-Ray diffraction: To determine the lattice constant and Bravais lattice using X-ray diffraction pattern.
10. Zeeman effect: Study the Zeeman effect and determine e/m ratio of electron.

Books Recommended:

1. Findlay`s Practical Physical Chemistry, 9th edition, revised by B.P.Levitt.
2. Practical Physical Chemistry by A.M.James and F.E.Prichard
3. Experiments in Physical Chemistry by Shoemaker and Garland 4. Experiments in Physical Chemistry by Daniels, Alberty and Williams et.al.
4. Laboratory Physical Chemistry by Oelke/ M.A.C.T.L.A.C.
5. Experimental Physical Chemistry by W.G. Palamer
6. Advanced Physico-chemical experiments by J.Rose
7. Experimental Physical Chemistry by V.D.Athwale and Paul Mathur, New Age International Publishers.
8. Text book of Physical Chemistry by S.Glasstone
9. Text book of quantitative analysis by A. I. Vogel
10. Advanced Practical Physical Chemistry by J. B. Yadhav, Goel Publishing house, Meerut.

Scheme of Examination:

i. Duration of examination: 04 hours
ii. Experiment : 35 marks
iii. Viva-Voce & Journal : 05 marks
iv. Internal assessment : 10 marks
Total : 50 marks

IV SEMESTER
CHGT–4.1: INORGANIC CHEMISTRY
UNIT–I

Organometallic Chemistry:

Chemistry of organometallic compounds with π–bonding ligands: Synthesis, structure, spectroscopy, reactions and bonding in metal–carbon π–bonded systems involving dihapto to hexahapto ligands Viz, olefins, acetylenes, allylic moieties, butadienes, cyclobutadienes, cyclo pentadienes and arenes.

(12 Hours)

UNIT–II

Organometallic Compound as Catalysts:

Fluxinol behaviour of organometallic compounds, homogeneous and heterogeneous catalysis involving metal complexes and organometallic complexes, oxidative additions, reductive elimination, insertion and deinsertion reactions, hydrogenation, hydroformylation, isomerisation, carboxylation, and polymerisation, water, gas shift reaction. Organometallic reagents in organic synthesis: organo iron, organo copper and organopalladium compounds.

(12 Hours)

UNIT–III

Instrumental Methods:

Thermogravimetric analysis (TGA): Factors affecting the results–Instrumentation and applications.
Differential thermal analysis (DTA): Theory–Instrumentation and applications.
Differential scanning calorimetry (DSC): Theory instrumentation and applications
Voltammetry: Fundamentals of voltammetry. Cyclic voltammetry: Principle and applications. Stripping voltammetry–basic principle and applications,
Atomic absorption spectrometry: Theory, instrumentation, different types of nebulizers, electrothermal vapouriser, cold vapour AAS determination of mercury, interferences, analytical applications of AAS.
Molecular luminescence spectroscopy: Theory, instrumentation, factors affecting fluorescence and its applications

(12 Hours)

UNIT–IV

Solid state chemistry

Electrical properties: survey of electrical properties and materials.

Super conductivity: Nature and properties of super conductivity material, Meinser effect, Type I and II super conductors, Theories, high temperature oxide super conductors, junction involving metal-super conductor. Applications.

Ionic conductivity: Alkali halides: Vacancy conduction. Silver chloride: interstitial conduction.

Solid electrolytes: β–Alumina, AgI and Ag+ ion solid electrolytes. Anion conductors, requirements for conductivity and Applications.

Magnetic properties: Mechanism of ferro and antiferro magnetic ordering ,seklescted examples of magnetic materials, their structure and properties; metal and alloys, transition metal oxides , spines garnets ,ilemenites, perovskites, magneto plumbites, applications, structure-property relation.

Optical properties: Luminescence and phosphorus, configurational coordinate model, some phosphor material, antistokes, phophores, lasers.

(12 Hours)

Total: 48 Hours

IV SEMESTER

CHG(Pr): 4.5: LAB COURSE IN INORGANIC CHEMISTRY

1. Use of cation resin
2. Use of anion resin
3. Determination of iron(II) using 1,10-phenanthroline by colorimetry
4. Determination of composition of iron(II)-1,10-phenanthroline complex by Job's and Mole ratio methods
5. Determination of titanium (IV) using H_2O_2 by colorimetry
6. Use of oxine and salicylaldoxime in the separation and estimation using volumetric/ gravimetric method
   i) Al + Mg and (ii) Cu + Ni

Books recommended:

1. A text Book of Quantitative Inorganic Analysis – A.I Vogel
2. Vogel's Text Book of Quantitative inorganic Analysis, Basset, Denney, Jeffery & Mendham
3. Colorimetric Determination of Traces of Metals – E.B Sandell.
4. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India

Scheme of Examination

1.	Duration of Examination	: 04 hours
2.	Experiment	: 35 marks
3.	Viva-voce and Journal	: 05 marks
4.	Internal assessment	: 10 marks
	Total	: 50 marks

Recommended Books:

1. Vogel's Text Book of Quantitative Inorganic Analysis-J. Bassett, R. C. Denney, G. H. Jaffery and J. Mandham, Longmans, Green and Company Ltd.

2. Chemical analysis of foods and food products-Morris B. Jacobs (3rd Edn.), D. Van Nostrand Company, inc.
3. Standard methods of chemical analysis–F. J. Welcher (6th Edn., Vol. 3 Part-B), D. Van Nostrand Company, Inc. Indian, United States and European Pharmacopea.
4. General Chemistry Experiments–A. J. Elias, University Press.

CHGT–4.2: ORGANIC CHEMISTRY:

UNIT–I

Heterocyclic Chemistry and Newer Reagents:

Heterocyclic Chemistry: Chemistry of three, four, and seven membered heterocycles with one Heteroatom.

Three membered: Oxiranes, aziridines and thiranes.

Four membered: Oxetanes, azetidines and thietanes.

Seven membered: Oxepines, azepines and thiepines.

Newer Reagents: Methods of preparations, mechanism of action and application of the following reagents in Organic synthesis:

DCC, 1, 3 Dithiane, LDA, DDQ, tributyl tinhydride, Wilkinson Catalyst, trimethyl silyl iodide, Gilman reagent.

(12 Hours)

UNIT–II

Organic Photochemistry and Pericyclic Reactions:

Organic Photochemistry: Principles of photochemistry, photochemical processes, energy transfer and photosensitization. Photochemical reactions: Photoreduction, Norrish type–I and II cleavages. Di-pi methane rearrangement, optical pumping. Photochemistry of cyclohexadienones, photo Fries rearrangement.

Pericyclic Reactions: Classification and features, Molecular orbital symmetry. Frontier orbitals of ethylene, 1,3–butadiene, 1,3,5–hexatriene and allyl systems.

Electrocyclic processes**:** Woodward Hoffmann rules for 4n– and (4n + 2)π systems.

Cycloaddition reactions: Diels–Alder reaction, [2+2] and [4+2] cycloaddition reactions, Supra facial and Antra facial addition.

Significance of Reactions**:** Sigmatropic rearrangement, supra and antra facial hydrogen shifts. Claisen, Cope, oxy Cope and aza Cope Rearrangements. Vitamin – D group isomerisations.

(12 Hours)

UNIT – III

Oxidations, Reductions and Newer Reactions:

Oxidations:

Oxidation of organic compounds using $KMnO_4$, PCC, OsO_4, CrO3, $K_2Cr_2O_7$, SeO_2,

$Pb(OAc)_4$, HIO_4, Oxygen, Oppaneur oxidation, Swern oxidation.

Hydroboraton – Isomerisation and oxidation.

Reductions:

Reduction of organic compounds using the following reagents: $LiAlH_4$, $NaBH_4$, DIBAL-H, Dissolving metal reduction, Birch Reduction, Wolf-Kishner Reduction.

Newer Reactions:

Mechanism and Synthetic applications of the following Named reactions: Suzuki coupling, Mitsunobu reaction, Pauson-Khand reaction, Heck arylation. Sonogashira reaction.

(12 Hours)

UNIT–IV

Medicinal Chemistry

Modern theories of drug action, concept of receptors, computer aided drug design, qualitative and quantitative SAR.
Sulfa Drugs: Sulfadiazines, sulfamethazines, sulfaguanidines, sulfa isoxozoles, sulfamerazine.
Analgesics: Classification of narcotic and non-narcotic analgesics.
Narcotic: Opium alkaloids, morphine, metopon**,** benzomorphan and phenazocine**.**
Non-narcotic: 4**–**Phenylpiperidines–Pethidine, diisopropylamines, methadone, pyrazolones, antipyrine.
Anti-fertility drugs: Steroidal and non-steroidal compounds norethindrone, mestranil, Norgestrol and non-steroidal antifertility drugs.

Structural features and uses of common antibiotic drugs: Norfloxacin, rifamycin and amoxycillin.

(12 Hours)
Total: 48 Hourss

Books Recommended:

1. An Introduction of the Chemistry of Heterocyclic Compounds - R. M. Acheson, 4th Edition, John Wiley and Sons.
2. Heterocyclic Chemistry –A.R. Katritzky and J. J. Logowskii.
3. Heterocyclic Chemistry –T. L. Gilchrist, 3rd Edition, Pearson Education Delhi (2005).
4. Modern Heterocyclic Chemistry –Joules and Smith.
5. Heterocyclic Chemistry –R.K.Bansal,3rd Edition, New Age International Publishers, (2002).
6. Medicinal Chemistry Volume I and II–A. Burger, Wiley-Interscience New York (1988).
7. Progress in Medicinal Chemistry Volume 1–8. Edited–G.P. Ellis and G. B. West. North Holland New York (1974).
7. Organic Chemistry volume I and II –I. L. Finar, 6th Edition, ELBS London (2004)
8. Principles of Organic Synthesis–R.O.C.Norman and J.M.Coxon, 3rd Edition, Nelson Thrones, UK (2003).
9. Organic Reaction Mechanism –R. K. Bansal, 3rd Edition, Tata McGraw Hill (2006).
10. Molecular rearrangements–I and II–P.de. Mayo.
11. Mechanisms of Molecular Migrations. Volume I and II–B.S. Thyagarajan, 1st Edition, Wiley Interscience, London (1979).
12. Molecular Transformations in Organic Chemistry–D.Ranganathan and
13. S. Ranganathan, 1st Edition, McMillan India, New Delhi (1975).
14. Biotransformations in Organic Chemistry–K. Faber, 4th Edition, Springer, Asian Books Ltd, (2002).

CHG(Pr)–4.6: Lab Course In Organic Chemistry

1. Multi-step preparation of organic compounds involving various reactions like addition, elimination, oxidation, hydrolysis etc. and purification methods like distillation and crystallization.
2. Identification of structure of the organic molecules based on spectra.

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry Revised–B.S. Furniss, A. J. Hannaford, P.W.G. Smith, A.R. Tatchell, 5th Edition, Addison Wesley Longman Limited, UK, 1997.

2. A Hand book of Organic Chemistry–H.T.Clarke.
3. A Laboratory Manual of Organic Chemistry–B. B. Dey and M.V. Govindachari.
4. Lab Experiments in Organic Chemistry –Arun Sethi, New Age International Ltd. New Delhi. 2006.

Scheme of Examination

Duration of examination :	04 hours
Experiments :	35 marks
Journal and Viva :	05 marks
Internal Assessment :	10 marks
	Total : 50 marks

CHGT–4.3: PHYSICAL CHEMISTRY

UNIT–I

Chemical Bonding-I:

Electronic structure of diatomic molecules. The Born–Oppenheimer approximatuion. Molecular orbital and valence bond theories of chemical bonding, comparison of the two, applications to hydrogen molecule and hydrogen molecule ion. Improvements in the Hitler-London wave functions. Bonding and antibonding molecular orbitals. Molecular orbital theory applied to homonuclear and heteronuclear diatomic molecules. Molecular electron configuration and calculation of bond order. Slater orbitals, Hartee-Fock self consistent field method for many electron atoms. Congfiguartion interaction and Roothaam equations.

(12 Hours)

UNIT–II

Homogeneous Catalysis:

Homogeneous catalysis: Introduction, General catalytic mechanism: Equilibrium treatment and steady-state treatment, activation energies for catalyzed reactions. Acid-Base catalysis: General acid-base catalysis, mechanism of acid-base catalysis, catalytic activity and acid-base strength, salt effects in acid-base catalysis and specific acid-base catalysis: Bronsted relation and linear free energy changes. Acidity functions: Zucker-Hammett hypothesis and Bunnett hypothesis. Enzyme Catalysis: influence of substrate concentration, pH, temperature and inhibitors, transient-phase kinetics. Mechanism of enzyme catalysis: Michaelis-Menten mechanism, Lineweaver-Burk plot.

. **(12 Hours)**

UNIT–III

Statistical Mechanics and Statistical Thermodynamics-I:

Microscopic and Macroscopic systems. Microstates and macrostates. Assemblies of independent localised and non–localised systems. Phase space or γ–space and μ–space. Ensembles.
Classical Statistics: Maxwell–Boltzmann distribution for ideal gases and mixture of gases. Determination of Lagrangian multipliers, alpha and beta. Equipartition of energies.
Heat Capacities of Solids: Einstein's theory of heat capacity of solids, Debye's theory. Characteristic temperature and use of Debye equation for the determination of heat capacity at low temperature.
Sackur–Tetrode equation: Entropies and heat capacities of ortho–, para-hydrogen systems, comparision of third law entropies with statistical entropies.

(12 Hours)

UNIT-IV

Rotation of Polyatomic Molecules and Rotational Spectra: Classification of molecules; momental ellipsoid, energy levels of linear, symmetric, spherical and asymmetric top molecules and their symmetry properties. Selection rules. Thermal distribution of rotational energy levels. Infrared rotational spectra and non rigid rotor treatment.

Vibration of Molecules: Molecule as harmonic oscillator: vibrational eigen functions and eigen values. Hermite polynomials; calculation of transition of probabilities and selection rules. The anharmonic oscillator, energy levels, selection rules and IR spectra. Anhormonicity and Morse equations.

Rotation–Vibration Spectra of Polyatomic Molecules: Rotation - vibration spectra, shapes of absorption bands in case of (i) linear, (ii) symmetric top, (iii) spherical top and (iv) asymmetric top, molecules. Isotopic effects. Applications of IR spectroscopy. Numerical problems on IR spectroscopy.

(12 Hours)

Total 48 Hours

Books Recommended:

1. Quantum Mechaincs -L.T.Schiff, Prentice-Hall.
2. Quantum Chemistry- H. Eyring, J. Walter and G. E. Kimball, John Wiley.
3. Quantum Mechanics-An Introduction- H. L. Strauss, Prentice Hall of India.
4. Quantum Mechanics-L. Pauling and E.B.Wilson, McGraw Hill.
5. Contemporary Quantum Chemistry-J. Goodisman, Plenum/Rosetta.
6. Quantum Chemistry- K. S. Pitzer, Prentice-Hall
7. Introductory Quantum Mechanics-Valdimir Rojanstry.
8. Quantum Chemistry- John P.Lowe.
9. Quantum Chemistry –Ira N. Levine, Prentice Hall of India Pvt. Ltd.

10. Quantum Chemistry-Donald A. McQuarrie, Viva Book Pvt. Ltd.
11. Physical Chemistry- P.W. Atkins, Clarendon Press, Oxford, 1970.
12. Molecular Quantum Mechanics-P.W.Atkins, Clarendon Press, Oxford, 1970.
13. Introduction to Quantum Chemistry-J. M. Anderson.
14. Introduction to Quantum Mechanics-R. H. Dicke, J. P. Wittke.
15. Indroductory Quantum Chemistry- A. K. Chandra, Tata McGraw Hill, New Delhi 1994.
16. Quantum Mechanics in Chemistry-M.W. Hanna.
17. Quantum Chemistry- R .K. Prasad, New Age International Publishers, New Delhi.
18. Physical Chemistry by G. M. Barrow, McGraw Hill, New York, 1996.
19. Fundamentals of Physical Chemistry by Maron and Lando.
20. Physical Chemistry by P. W. Atkins, ELBS, London, 1990 (Ed. 4).
21. Physical Chemistry by K. Vamulapalli, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
22. Physical Chemistry by Daniels and Alberty, Wiley, New York.
23. Physical Chemistry Through Problems by S. K. Dogra and S Dogra, Wiley Eastern, New Delhi.
24. A Text Book of Physical Chemistry by Samuel Glasstone, McMillan, London.
25. Atomic Structure and Chemical Bonding by Manas Chanda, Tata McGraw Hill Publishing Co., New Delhi.
26. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi.
27. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York.
28. Statistical Mechanics-N. Davidson, McGraw-Hill, 1962
29. Introduction to Statistical Thermodynamics-M. Dole, Prentice Hill. 1954
30. Statistical Thermodynamics-R. H. Fowler and E. A. Guggenheim, Cambridge University Press, 1939.
31. An Introduction to Statistical Mechanics-T. L. Hall, Addison Wesley, 1960.
32. Introduction to Statistical Mechanics-G. S. Rushbrook, Oxford University Press, 1949.
33. Statistical Mechanics-J. E. Mayer and M. G. Mayer, John Willey, 1940.
34. Textbook of Physical Chemistry by A. Singh and R. Singh, Campus Books International, New Delhi
35. Introduction to Molecular Spectroscopy-G.M.Barrow, McGraw Hill
36. Physical Methods in Inorganic Chemistry-R. S. Drago East-West Press, New Delhi.
37. Molecular Spectroscopy-J D. Graybeal. McGraw Hill
38. Spectroscopy, Volume I,II,III Ed-B.P. Straughan and S. Walker Chapman Gall, 1976.
39. Molecular Magnetic Resonance Spectroscopy-R.M.L.Bell and R.K. Harris
40. Spectra of Diatomic Molecules, G. Hertzberg-D. Van Norstrand Co. Inc. Prenceton N.J. 1950
41. Infrared and Raman Spectra of Polyatomic molecules-G.Hertzberg, D. Van Norstrand Co.Inc. Prenceton N.J. 1950
42. Absorption Spectroscopy-R.P.Bauman.
43. Molecular' Structure : A Physical Approach-J.C.D. Brand and J.C. Speakaman, Edward Arnold Ltd., London.
44. Microwave Spectroscopy-J.M. Sugden and C.N. Kenny.

45. Fundamentals of Molecular Spectroscopy-C. N.Banwell, Tata- Mcgraw Hill, New Delhi, 1975.
46. Molecular Vibrations-E.B.Wilson, J.C. Decius and P.G.Cross.

CHG(Pr)–4.7: Lab Course In Physical Chemistry

1. Viscosity: Viscosity of air by Rankine`s method.
2. Solubility: Variation of solubility of $Ca(OH)_2$ in NaOH solution and hence determination of the solubility product of $Ca(OH)_2$.
3. Thermochemistry: Heat of reaction (precipitation/formation) of $BaSO_4$. c) Heat of transition of Glauber's salt ($Na_2SO_4.10H_2O$)
4. Surface Tension: Critical micelle concentration of a soap molecule. (e.g., Potassium laureate).
5. Potentiometry: Determination of degree of hydrolysis and K_h of aniline hydrochloride
6. Polarimetry: Kinetics of inversion of sucrose and determination of catalytic coefficient.
7. Cryoscopy: Determination of activities of electrolytes and non-electrolytes using cryoscopy method.
8. Spectrophometry: Investigation of complex formation between Fe^{+3} and Salicyclic acid: formula, stability, ΔG value calculation and pH effects.
9. Glass transition temperature: Determination of glass transition temperature by dilatometer.
10. Solid state: To determine the electron-phonon coupling constant of copper

Books Recommended:

1) Findlay's Practical Physical chemistry, 9th edition, revised by B.P. Levitt.
2) Practical Physical Chemistry by A.M.James and F.E.Prichard
3) Experiments in Physical Chemistry by Shoemaker and garland
4) Experiments in Physical Chemistry by Daniels, Alberty and Williams et.al.
5) Laboratory Physical Chemistry by Oelke / M.A.C.T.L.A.C.
6) Experiments in Physical Chemistry by W.G.Palmer
7) Advanced Physico-Chemical experiments by J.Rose
8) Experimental Physical Chemistry by V.D.Athwale and Paul Mathur , New Age International Publishers.
9) Text Book of Physical Chemistry by S.Glasstone
10) Text Books of quantitative analysis by A.I.Vogel
11) Advanced Practical Physical Chemistry by J.B.Yadhav, Goel Publishing House, Meerut.
12) Computers and their applications to Chemistry, Ramesh Kumari, Narosa.
13) A Lab Manual of Polymers, S. M. Ashraf, Sharif Ahmed, Ufana Riaz, I.K. International New Delhi.

Scheme of Examination:

i. Duration of examination: 04 hours
ii. Experiment : 35 marks

iii. Viva-Voce & Journal : 05 marks
iv. Internal assessment : 10 marks
Total : 50 marks

CHGP-4.4: Project Work

The project work may include implant training in Industries/short term work in the Department/other educational institutions/R&D organizations/Data mining/Review of current literature/ Theoretical methods/computer applications. Experimental work may involve studies on synthesis/measurements/study of properties/characterization by physical methods/activities for reported/unreported research or any suitable combination thereof

In case of the students who would work outside the campus, the supervising staff member may visit to the work place at least once during the period and may be eligible for TA-DA as per the University ruless