2. CHEMISTRY

Scheme:
Max Marks: 150

	Duration (hrs.)	Max. Marks	Min. Pass Marks
Paper-I	3	33	
Paper-II	3	33	36
Paper-III	3	34	
Practical	5	50	18

Note: Ten (10) questions are to be set taking two (02) questions from each unit. Candidates have to answer any 5 questions selecting at least one question from each unit.

CH-201 Paper-I: Inorganic Chemistry
(2 hrs or 3 periods/week)

Unit-I

Chemistry of Elements of First Transition Series:
Characteristic properties of d-block elements. Properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation-states, coordination number and geometry.

Chemistry of Elements of Second and Third Transition Series:
General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

Unit-II

Coordination Compounds:
Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

Unit-III

Chemistry of Lanthanide and Actinide Elements:
Electronic structure, oxidation states, ionic radii and lanthanide contraction, complex formation, occurrence and isolation of lanthanide compounds.
General features of chemistry of separation of Np, Pu and Am from U, electronic configuration, oxidation states, magnetic properties, complexation behavior, comparison of Lanthanides and Actinides with d-block elements.

Unit IV

Oxidation and Reduction:
Use of Redox Potential data, analysis of stability of redox stability in water, Frost, Latimer and Pourbaix diagrams, Application of redox principles, extraction of elements.

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Unit-V

Acids and Bases:
Theories - Arrhenius, Bronsted-Lowry, Lux-Flood, Solvent system concept and Lewis concept of acids and bases.

Non-aqueous Solvents:
Physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2

CH-202 Paper-II: Organic Chemistry
(2 Hrs. or 3 periods/week)

Unit-I

Electromagnetic Spectrum: An Introduction

Absorption Spectroscopy
Ultraviolet (UV) spectroscopy - Absorption laws (Beer-Lambert Law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of solvents on transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones.

Infrared (IR) spectroscopy - Molecular vibrations, Hook's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristics absorption of various functional groups and interpretation of IR spectra of simple organic compounds.

Unit-II

Alcohols - Classification and nomenclature
Monohydric alcohols - Methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohol with mechanism.
Dihydric alcohols - methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement
Trihydric alcohols - methods of formation, chemical reactions of glycerol.

Phenols
Nomenclature, structure and bonding. Preparation of Phenols. Physical properties and acidic character. Comparative acidic strength of alcohols and phenols. Reactions of phenols- electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gattermann synthesis, Hauben-Hoesch reaction, Lederer Manasse reaction and Reimer-Tiemann reaction.

Ethers and Epoxides
Methods of formation, physical properties, Chemical reactions - cleavage and autooxidation, Zeisel's method.
Synthesis of epoxides, Acid and base catalysed ring opening of epoxides, orientation of epoxide

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reactions of Grignard and organolithium reagents with epoxides

Unit-III

Aldehydes and Ketones

Structure of the carbonyl group. Syntheses of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, syntheses of ketones from nitriles and from carboxylic acids. Physical properties.

Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones. Cannizzaro reaction, MPV (Meervein-Pondrof-Verley), Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones. Use of acetals and 1,3-dithiane as protecting group.

Unit-IV

Carboxylic Acids

Structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction. Reduction of carboxylic acids, mechanism of decarboxylation.

Methods of formation and chemical reactions of halo acids. Hydroxy acids - malic, tartaric and citric acids.

Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents (succinic, glutaric and adipic acids).

Carboxylic Acid Derivatives

Structure, nomenclature and synthesis of acid chlorides, esters, amides and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Preparation of carboxylic acid derivatives, chemical reactions, mechanisms of esterification and hydrolysis (acidic and basic).

Unit-V

Organic Compounds of Nitrogen

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid.

Amines: Structure, nomenclature and preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Physical properties, stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts. Gabriel phthalimide reaction and Hoffmann bromamide reaction with mechanism.

Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Diazotisation and mechanism. Synthetic transformations of aryl diazonium salts, azo coupling and its applications.

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CH-203 Paper III : Physical Chemistry

(2 Hrs. or 3 periods/week)

UNIT-I

Thermodynamics - I

Definition of Thermodynamic Terms: System, surroundings, etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process, concept of heat and work.

First Law of Thermodynamics : Statement, definition of internal energy and enthalpy, heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law. Joule-Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of Ideal gases under isothermal and adiabatic conditions for reversible process.

Thermochemistry : Standard state, standard enthalpy of formation, Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation.

UNIT-II

Thermodynamics –II

Second Law of Thermodynamics : Need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot-Theorem. Thermodynamic scale of temperature.

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

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

Chemical Equilibrium:

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle. Reaction Isotherm and reaction isochore. Clapeyron equation and Clausius-Clapeyron equation, applications.

UNIT-III

Phase Equilibrium: Statement and meaning of the terms' phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system - water, CO_2 and sulphur systems.

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

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

Liquid-Liquid mixtures - Ideal liquid mixtures, Raoult's and Henry's law. Non ideal systems, azeotropes - HCl-H_2O and ethanol-water systems. Partially miscible liquids, phenol-water, lower and upper consolute temperature, effect of impurity on consolute temperature. Nernst distribution law, thermodynamic derivation, applications.

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UNIT-IV

Electrochemistry – I

Electrical transport-conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution.

Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes. Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf 's method and moving boundary method.

Applications of conductivity measurements:

Determination of degree of dissociation, determination of K_a of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

UNIT-V

Electrochemistry –II

Types of reversible electrodes : Gas–metal- ion, metal-metal ion, metal-insoluble salt anion and redox electrodes, electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode, reference electrodes, standard electrode potential, sign conventions, electrochemical series and its significance.

Electrolytic and Galvanic cells - reversible and irreversible cells, conventional representation of electrochemical cells.

EMF of a cell and its measurements, Computation of cells EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K), polarization, over potential and hydrogen overvoltage.

Concentration cell with and without transport, liquid junction potential, application of concentration cells, Valency of ions, solubility product and activity coefficient, potentiometric titrations.

Definition of pH and pK_a, determination of pH using hydrogen quinhydrone and glass electrodes, by potentiometric methods.

Suggested Books:

1. Principles of Physical Chemistry, B. R. Puri, Sharma and M. S. Pathania.
2. A Text Book of Physical Chemistry, A. S. Negi and S. C. Anand.
3. A Text Book of Physical Chemistry, Kundu and Jain.
4. The elements of Physical Chemistry, P. W. Atkins, Oxford.
5. University General Chemistry, C. N. R. Rao, Mac Millan.

CH- 204 Chemistry Practical (Pass course), Laboratory Course-II

(4 hrs or 6 periods / week)

Inorganic Chemistry

(i) Preparation of Standard Solutions

Dilution 0.1 M to 0.001 M solutions

(ii) Volumetric Analysis

(a) Determination of acetic acid in commercial vinegar using NaOH

(b) Determination of alkali content in antacid tablet using HCl

(c) Estimation of calcium content in milk as calcium oxalate by permanganometry

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(d) Estimation of hardness of water by EDTA
(e) Estimation of ferrous and ferric by dichromate method
(f) Estimation of copper using thiosulphate

(iii) Gravimetric Analysis
(a) Cu as CuSCN
(b) Ni as Ni-dimethylglyoxime)

Organic Chemistry

(i) Laboratory Techniques

A. Thin Layer Chromatography

Determination of R_f values and identification of organic compounds.

(a) Separation of green leaf pigments (spinach leaves may be used).

(b) Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2-one and hexan-3-one using toluene and light petroleum (40-60) solvent system.

(c) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5 : 1.5)

B. Paper Chromatography: Ascending and Circular

Determination of R_f values and identification of organic compounds.

(a) Separation of mixture of phenylalanine and glycine, Alanine and aspartic acid, leucine and glutamic acid. Spray reagent – ninhydrin.

(b) Separation of a mixture of DL – alanine, glycine and L -Leucine using n-butanol: acetic acid: water (4:1:5). Spray reagent-ninhydrin.

(c) Separation of monosaccharides a mixture of D- galactose and D-Fructose Using n- butanol : acetone : water (4:5:1) Spray reagent -aniline hydrogen phthalate.

(ii) Qualitative Analysis

Identification of two organic compounds (one solid and one liquid) through the functional group analysis, determination of melting point, boiling point and preparation of suitable derivatives.

Physical Chemistry

(i) Transition Temperature

a) Determination of the transition temperature of the given substance by thermometric dilatometric method (e.g. $MnCl_2.4H_2O$ / $SrBr_2.2H_2O$).

(ii) Thermochemistry

a) To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.

b) To determine the enthalpy of neutralization of a weak acid / weak base versus strong base / strong acid and determine the enthalpy of ionization of the weak acid / weak base.

c) To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle.

(iii)Phase Equilibrium

a) To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system.

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a) To construct the phase diagram of two components (e.g. diphenylamine-benzophenone) system by cooling curve method.

(iv) Distribution law

a) To study the distribution of iodine between water and CCl_4.

b) To studs the distribution of benzoic acid between benzene and water.

(Instructions to the Examiner)
B.Sc. Part II
CH- 204 Chemistry Practical (Pass course)

Max. Marks: 50 Duration of Exam:5 hrs. Minimum Pass Marks:18

Inorganic Chemistry

Ex. 1 Volumetric Analysis
or
Gravimetric Analysis as mentioned in the syllabus 16

Organic Chemistry

Ex. 2 Identification of two organic compounds (one solid and one liquid) through the functional group analysis, determination of melting point, boiling point and preparation of suitable derivatives
or
Perform one experiment out of the experiments on thin layer and paper chromatography given in syllabus 12

Physical Chemistry

Ex. 3 Perform one of the physical chemistry experiments as mentioned in the syllabus. 12

Ex. 4 Viva-voce 5
Ex. 5 Record 5
50

Books Suggested (Theory Course)

1. Basic Inorganic Chemistry F.A. Cotton G. Wilkinson and P.L. Caus Wiley
2. Concise Inorganic Chemistry, J.D. Lee ELBS
3. Concepts of Models of Inorganic Chemistry B. Douglas, D. McDaniel and J. Alexander, John Wiley
4. Inorganic Chemistry, D.F. Shriver P.W. Atkins and C. H. Langford, Oxford
5. Inorganic Chemistry, W.W. Porterfield Addison Wesley
6. Inorganic Chemistry, A.G. Sharpe ELBS
7. Inorganic Chemistry, G.L. Miessler and D.A. Tarr, Prentice Hall
8. Organic Chemistry, Morrison and Boyd Prentice Hall
9. Organic Chemistry, L.G. Wade Jr. Prentice Hall
10. Fundamentals of Organic Chemistry, Solomons John Wiley

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11. Organic Chemistry Vol. I, II, III S.M. Mukherji, S.P. Singh and R.P. Kapoor. Wiley Eastern Ltd. (New Age International)
12. Organic Chemistry, F.A. Carey, McGraw Hill Inc.
13. Introduction to Organic Chemistry, Streitwieser Heathcock and Kosover, Macmillan
14. Physical Chemistry, G.M. Barrow, International Student Edition, McGraw Hill.
15. Basic Programming with Application, V.K. Jain, Tata McGraw Hill.
16. Computers and Common Sense, R. Hunt and Shelly, Prentice Hall.
17. University General Chemistry, C.N.R. Rao, Macmillan.
18. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
19. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
20. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.

Books Suggested (Laboratory Courses)

1. Vogel's Qualitative inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's Textbook of Quantitative Inorganic Analysis (revised), J. Bassett, R.C. Deney, G.H. Jeffery and J. Mendham, ELBS.
3. Standard Methods of Chemical Analysis, W.W. Scott, The Technical Press.
4. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge.
5. Handbook of preparative Inorganic Chemistry, Vol I & II, Braver, Academic Press.
6. Inorganic Synthesis, McGraw Hill.
7. Experimental Organic Vol I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill
8. Laboratory manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
9. Voge's Textbook of Practical Organic Chemistry, RS. Furniss, Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
10. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.
11. Experiments in Physical Chemistry, R.C.Das and B. Behra, Tata McGraw Hill
12. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.
13. Advanced Experimental Chemistry, Vol. 1-Physical, J.N. Gurtu and R. Kapoor, S. Chand & Co.
14. Selected Experiments in Physical Chemistry, N.G. Mukerjee, J.N. Ghjose& Sons.
15. Experiments in Physical Chemistry, J.C. Ghosh, Bharati Bhavan.

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