# B Sc. Pt -II 2018-19
# CHEMISTRY

Scheme:
Max Marks: 200

| | Duration (hrs.) | Max. Marks | Min. Pass Marks |
|---|---|---|---|
| Paper I | 3 | 50 | 18 |
| Paper-II | 3 | 50 | 18 |
| Paper-III | 3 | 50 | 18 |
| 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, chemistry of separation of Np, Pu and Am from U, electronic configuration, oxidation states, magnetic properties, complexation behavior, comparison of lanthanides and actinides, super heavy elements.

### Unit-IV

**Oxidation and Reduction:**
Uses of Redox Potential data, analysis of redox cycle, redox stability in water. Frost, Latimer and Pourbaix diagrams. Application of redox data in the extraction of elements.

16/3/18 16/3 16/3/18

Sunita 16/3/18

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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 slovents 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, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

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

16/3 16/3/18 16/3/18

16/3/18

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ring opening, 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 catalysis. 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.

16/3

16/3/18

16/3/18

16/3/18

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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. ($NaCl-H_2O$) System. Freezing mixtures acetone-dry ice.

**Liquid-Liquid mixtures:** Ideal liquid mixtures. Raoult's and Henry's law. Non ideal system – 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, application.

16/3/18 16/3/18 16/3

## 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 ($\Delta G$, $\Delta H$ 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.
6. Basic Inorganic Chemistry F.A. Cotton, G. Wilkinson and P.L. Caus. Wiley.
7. Concise Inorganic Chemistry, J.D. Lee. EI.BS
8. Concepts of Models of Inorganic Chemistry B. Douglas, D. McDaniel and J. Alexander, John Wiley.
9. Inorganic Chemistry, D.F. Shriver P.W. Atkins and C.H. Langford, Oxford.
10. Inorganic Chemistry, W.W. Porterfield Addison Wesley.
11. Inorganic Chemistry, A.G. Sharpe. EI BS
12. Inorganic Chemistry, G.L. Miessler and D.A. Tarr, Prentice Hall.
13. Organic Chemistry, Morrison and Boyd, Prentice Hall.
14. Organic Chemistry, L.G. Wade Jr. Prentice Hall.
15. Fundamentals of Organic Chemistry, Solomons, John Wiley.


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## CH-204 Chemistry Practical Labor tory Course- II
(4 hrs Or 6 Periods /week)

### Inorganic Chemistry

#### (i) Instrumentation

Colorimetry

(a) Job's method
(b) Mole- ratio method

Adulteration -Food stuffs

Effluent analysis, water analysis

**Solvent Extraction**

Separation and estimation of Mg (II) and Fe(II)

**Ion Exchange Method**

Separation and estimation of Mg (II) and Fe (II)

(ii) Separation and identification of Six radicals (3 cations and 3 anions) in the given inorganic mixture including special combinations and interfering radicals.

### 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 - Mixture of D- galactose and D- fructose using n-butanol : acetone : water (4:5:1) Spray reagent -aniline hydrogen phthalate.

**(ii) Synthesis of Organic Compunds**

(a) Acetylation of salicylic acid, aniline, glucose and hydroquinone,
Benzoylation of aniline and phenol
(b) Aliphatic elctrophilic substitution
Preparation of iodoform from ethanol and acetone
(c) Aromatic electrophilic substitution
Nitration
Preparation of M-dinitrobenzene
Preparation of p- nitroacetanilide
Halogenation
Preparation of P- bromoacetanilide
preparation of 2,4,6,- tribromophenol
(d) Diazotization/coupling
Preparation of methyl orange and methyl red
(e) Oxidation
Preparation of benzoic acid from tolueme.
(f) Reduction
Preparation of aniline from nitrobenzene
preparation of m-nitroaniline from m-dinitrobenzene.

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(iii) Qualitative Analysis

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

Physical Chemistry

(i) Transition Temperature

Determination of the transition temperature of the given substance by thermometric/dialometric 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 $\Delta H$ 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, Succine acid ) on the critical solution temperature of two partially miscible liquids (e.g. phenol- water system) and to determine the concentration of the solute in the given phenol water system.

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

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**(Instructions to the Examiner)**

**B.Sc. part II**

**CH-204 Chemistry Practical**

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

**Inorganic Chemistry**

Ex. 1 Mixture Analysis Or Solvent Extraction Or Ion exchange 16

**Organic Chemistry**

Ex. (i) Identification of one organic compounds through the functional group analysis, determination of melting point, boiling point and preparation of suitable derivatives. 07

Or

Perform one experiment out of the experiments on thin layer and paper chromatography given in the syllabus.

(ii) Synthesis of one of the six preparations 05

**Physical Chemistry**

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

Ex.4 Viva- voce 05

Ex. 5 Record 05

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Sunita 16/3/18

16/3/18

21/3/18 16/3

16/3/18