FACULTY OF SCIENCES

SYLLABUS of CHEMISTRY

FOR

B.Sc. (Hons.) Physics

(Semester I-IV)

Session: 2021-22

KHALSA COLLEGE AMRITSAR

(An Autonomous College)

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1. **Subject to change in the syllabi at any time. Please visit the College website time to time.**

BHP 104

Organic Chemistry-I

Time: 3 Hours **Total Marks:50**

(Max. Marks: 37+Internal Assessment: 13)

Total Lectures: 60 **Pass Marks: 35%**

Instructions for paper setters and students:

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.
III. Section I carries 9 marks and is compulsory consisting of eight short answer type questions of 1.5 marks each covering the whole syllabus. The candidate will have to attempt six questions in section I.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 7 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

UNIT-I 10Hrs

Stereochemistry: Molecular chirality, enantiomers/symmetry in achiaral structures, chiral centresin chiral molecules, properties of chiral molecules-optical activity, absolute and relative configuration, the Cahn-Ingold Perlog R-S notional system physical properties of enantiomers. Stereochemistry of chemical reactions that produce chiral centres, chemical reactions that produce stereoisomers, Resolution of enantiomers, chiral centres other than carbon.

UNIT-II 12Hrs

Chemistry alkanes and alkenes: Conformations of alkanes and cycloalkanes: conformationalanalysis of ethane, butane, cyclohexane, monosubstituted and disubstituted cyclohexane, conformation of small, medium and large ring cycloalkanes and of polycyclic ring systems.Stereochemistry of alkenes, naming stereo isometric alkenes by the E-Z system, mechanism of hydrogenation of alkenes, stereochemistry of hydrogenation of cycloalkenes, Dehydration of alcohols and regioselectivity of these reactions. Acid catalysed dehydration of alcohols with complete mechanistic discussion, Mechanism of dehydrohalogenation of alkylhalides (E mechanism), stereoselective and antielimination in E reactions, the E Mechanism, electrophilic addition of hydrogen halides to alkenes its regioselectivity explained on the basis of mechanism, free radical addition of hydrogen bromide to alkenes, acid catalysed hydration of alkene with mechanism stereochemistry of halogen addition to alkenes and its mechanistic explanation. Hypohalous acid addition to alkenes, epoxidation of alkenes.

Alkynes: Acidity of acetylene and terminal alkenes, metal ammonia reduction of alkyne,

addition ofhydrogen halides and water to alkynes, with detailed discussion of mechanism of these reactions, the diels Alder reaction, orbital symmetry and the diels Adler reaction.

UNIT-III **12Hrs**

Nucleophilic substitution and addition reaction:

(a) Functional group transformation by nucleophilic substituion, the biomolecular(SN), mechanismof nucleophilic substitution, stereochemistry of SN reactions, how SN reactions occur, steric effect in SN reactions, nucleophiles and nucleophilicity, the unimolecular (SN) mechanism of nucleophilic substitution, carbocation stability and the rate of substitution, by the SN mechanism stereochemistry of SN reactions, carbocation real arrangements in SN reactions, solvent effects, substitution and elimination as competing reactions. The SN -SN.

(b) Principles of nucleophillic addition to carbonyl groups : Hydration acetal formation, cyanohydrin formation ; reactions with primary and secondary amines, Whittig reaction, steroselective addition to carbonyl groups mechanism of halogenation, acid and base catalysed cholization, haloform reaction, aldol condensation, conjugate nucleophillic addition to unsaturated carbonyl compounds

UNIT-IV **11Hrs**

Spectroscopy: Principles of molecular spectroscopy, electromagnetic radiation, quantized energystates, NMR(H) Spectroscopy, nuclear shielding and Chemical shift measurements chemical shift and molecular structure, interpreting proton NMR spectra, spin- spin splitting in NMR spectroscopy, patterns of spin-spin splitting, proton NMR spectra of alcohols, NMR and conformations carbons- 13 nuclear magnetic resonance, the sensitivity problem, interpretation of spectra. Infrared spectroscopy, ultraviolet–visible (UV-VIS) spectroscopy and mass spectrometry.

Text and Reference Books:

1. R.T. Morison and R.N. Boyd, Organic Chemistry.
2. I.L. Finar, Organic Chemistry, Vol. I IV ed.
3. Advanced Organic Chemistry, Reactions Mechanisms and Structure by J. March.
4. Schaum's Outlines Series Theory and Problems of Organic Chemistry by Herbert Meislick and Jacob Sharefkin
5. Problems and their solution in Organic chemistry by I.L. Finar, Modern Organic Chemistry by J.D. Robbert and M.C. Caserio.
6. Organic Chemistry by D.J. Cram and G.S. Hammond.
7. J.E. Banks, Naming Organic Compounds – Programmed Introduction to Organic Chemistry.
8. E.L. Eliel, Stereochemistry of carbon compounds.
9. W. Camp, Organic Spectroscopy.
10. F.A. Carey, Organic Chemistry.

BHP 109

Organic Chemistry Practical

Max. Marks: 37+13(Internal Assessment) **Labs Hrs.: 60**

The preliminary examination of physical and chemical characteristics (physical state, colour, odor and ignition tests), elemental analysis (nitrogen, sulphur, chlorine, bromine, iodine), solubility tests including acid-base reactions, classification tests involving functional reactivityother than acid-base test, preparation of derivatives for given pure organic compounds.

The following categories of compounds should be analyzed.

-phenols, carboxylic acids

-carbonyl compounds - ketones, aldehydes

-carbohydrates

-aromatic amines

-aromatic hydrocarbons

Suggested Book:

Practical Organic Chemistry by F.G. Mann and B.C. Saunders

BHP 154 / BHMH-205
INORGANIC CHEMITRY –II

Time: 3 Hours **Total Marks:50**

(Max. Marks: 37+Internal Assessment: 13)

Total Lectures: 60 **Pass Marks: 35%**

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UNIT-I 12Hrs

Co-ordination Chemistry: Introduction, Werner's coordination theory, naming of co-ordinatecomplexes.Co-ordination numbers 1-12 and their stereo-chemistries.Factors affecting co-ordination numbers and stereo-chemistry

(a) Configurational Isomers

(b) Conformational isomerism, VSPER theory, molecular orbital theory applied to homoneuclear diatomic molecules and heteronuclear Diatomic molecules.

Bonding in metal complexes: Valence bond theory for co-ordinate complexes, inner and outerorbital complexes, Electro-neutrality and back bonding, limitations of V.B. theory.

Stability of coordination compounds: Introduction, Stability constant, stepwise stability constant,overall stability constant. Factors affecting the stability of metal ion complexes with general ligands, HSAB principle.

UNIT-II 12Hrs

Crystal field theory: Splitting of d-orbitals in octahedral, tetrahedral, cubic and square planer fieldsof ligands. Calculation of C.F.S.E. in high spin and low spin octahedral and High spin tetrahedral complexes, factors affecting the 10 Dq Value. Structural effects of crystal field splitting (Jahn-Teller distortion, variation of Ionic radii with increase in atomic number). Thermodynamics effects of C.F. splitting, variation in lattice energies, Hydration energies, Dissociation energies, Formation constants of hexammines. Site selection in spinels, Paramagnetism, diamagnetism, ferro and antiferromagnetism. Microstates and spectroscopic terms, a calculation of spectroscopic terms ford^1 electronic configurations, L S coupling, Hund's rule for finding the ground state terms,Electronic spectral properties of Ist transition series, Orgel Diagrams for d^1 - d^{10} systems, for weak field octahedral and tetrahedral complexes, limitations of C.F.T

UNIT-III **11Hrs**

Molecular Orbital Theory: Evidence for covalent character in Bonding, MOEL diagram for octahedral and tetrahedral complexes involving bonding, charge transfer transitions.

πAcid Ligands: Definition Carbon monoxide complexes, bonding in linear MCO groups,polynuclear metal carbonyls, vibrational spectra, Reactions, carbonyl hydrides and halides. Metal-metal bonding metal-metal multiple bonding , isolable analogies, Structure of high nuclearity carbonyl clusters, counting of electrons in carbonyl clusters.

UNIT-IV **10Hrs**

Alkali metal and alkaline earth metal chelators: Macrocyclic ligands, macrocyclic effect, crownethers and podands, coronands, cryptands, structure of 18 crown-6 complex with KNCS, ion cavity complex, effect of anion and cation type on complex structure, simultaneous complexation of metal ion and water or of two metal ions, sandwich formation, cryptands and their cation complexes, podands with aromatic donors and groups.

Text and Reference Books:

1. J.E. Huheey, Inorganic Chemistry, 3rd Ed.
2. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry.
3. B.E. Douglas and D.H. McDaniel, Concepts and Models of Inorganic Chemistry.
4. R. Hilgenfeld and W. Saengar, Topics in current chemistry Vol-II.

BHP 159
Inorganic Chemistry Practical

Max. Marks: 37+13(Internal Assesment) **Labs Hrs.: 60**

Identification of cations and anions in a mixture which may contain combinations of acid ions. These must contain interferring acid anions and one, the insoluble.

a) Special Tests for Mixture of Anions

(i) Carbonate in the presence of sulphate.
(ii) Nitrate in the presence of nitrite
(iii) Nitrate in the presence of bromide and iodide.
(iv) Nitrate in the presence of chlorate.
(v) Chloride in the presence of bromide and iodide.
(vi) Chloride in the presence of iodide.
(vii) Bromide and iodide in the presence of each other and of chloride.
(viii) Phosphate, arsenate and arsenite in the presence of each other.
(ix) Sulphide, sulphite, thiosulphate and sulphate in the presence of each other.
(x) Borate in the presence of copper and barium salts.
(xi) Oxalate in the presence of fluoride.

b) Separation and Identification of Cations in Mixtures

(i) Separation of cations in groups.
(ii) Separation and identification of Group I, Group II (Group IIA and IIB), Group III, Group IV, Group V and Group VI cations.

Book: Vogel's book on Inorganic Qualitative Analysis

BHP-204 / BHMH-304

Physical Chemistry-III

Time: 3 Hours **Total Marks: 50**

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UNIT I

1. Solutions and Colligative Properties **12Hrs.**

Ideal and non–ideal solutions, methods of expressing concentrations of solutions, Dilute solution, colligative properties, Raoult's law, relative lowering ofvapour pressure, molecular weight determination. Osmosis, law of osmotic pressure and itsmeasurement, determination of molecular weight from osmotic pressure, elevation of boilingpoint and depression of freezing point.

UNIT-II

2. Surface Chemistry **11 Hrs.**

Bulk phases and interfacial region,types of interfaces; Surface tension and interfacial tension.Thermodynamics of surfaces, plane interface, curved interface, Laplace and Kelvin equations, the contactangle, capillary rise and surface tension. Surface tension of solutions,Gibbs adsorption equation and itsderivation from thermodynamic considerations. Surfactants, Surface films on liquids. Criteria forspreading in liquid-liquid systems. (Wetting as contact angle and capitulary action Phenomenon solidliquidsystems).

UNIT-III

3. Chemical Kinetics **7 Hrs.**

Rate of reaction, rate constant and rate laws, the order of reaction, first, second & third and zero orderreactions, half-lives; determination of reaction order. Temperature dependence of reaction rates, reactionmechanism, rate-determining step approximation, steady-state approximation. Catalysis, homogeneous catalysis, autocatalysis, oscillation reactions.Enzyme catalysis, heterogeneous catalysis.

UNIT-IV

4. Liquid State **10 Hrs.**

Intermolecular forces, structure of liquids (a qualitative description). Structural differencesbetween solids, liquids and gases. Liquid crystals: Difference between liquids crystal, solid andliquid.Classification, structure of nematic and cholestric phases.Thermography and sevensegment cell.

5. Colloidal State **5 Hrs.**

Definition of colloids, classification of colloids. Solids in liquids (Sol): kinetic, optical andelectrical, properties, stability of colloids,protective action, Hardy Schulze law, gold number.Liquids in liquids (emulsions): Types of emulsions, preparation. Emulsifiers. Generalapplications of colloids.

Suggested Books

ESSENTIAL:

1. Physical Chemistry by P.W. Atkins, 8th Ed., Oxford University Press, 2006 (Indian Print).
2. Physical Chemistry by T. Engel & P. Reid, 1st ed., Pearson Education, 2006.
3. Physical Chemistry by Castellan, 3rd Ed., Addison Wisley/Narosa, 1985 (Indian Print)

FURTHER READING:

1. Physical Chemistry by G. M. Barrow, 6th Ed., New York, McGraw Hill, 1996.
2. Physical Chemistry by R. J. Silbey, R. A. Albert &Moungi G. Bawendi, 4th Ed., New York: John Wiley, 2005.

BHP-208

PHYSICAL CHEMISTRY LAB-III

Time: 3 Hours **Total Marks: 50**
(Max. Marks: 37 + Internal Assessment: 13)
6 Periods/week **Pass Marks: 35%**

Crystallisation:
Concept of indication of crystallisation. Phthalic acid from hot water (using fluted filter paper &stem less funnel)Acetanilide from boiling water, Naphthalene from Ethanol, Benzoic acid from water

Physical Chemistry
1. To determine the specific reaction rate of hydrolysis of ethyl acetate catalyzed by Hydrogen ions at room temperature.
2. To study the effect of acid strength on hydrolysis of an ester.

Viscosity, Surface Tension (Pure Liquids)
3. To study the viscosity and surface tension of glycerine solution in water.
4. To determine the solubility of benzoic acid at different temperatures and to determine H of the dissolution process.
5. 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.
6. To determine the enthalpy of dissolution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber cycle.

BHP-254 / BHMH-404

MOLECULAR SPECTROSCOPY-IV

Time: 3 Hours **Total Marks:50**

(Max. Marks: 37+Internal Assessment: 13)

Total Lectures: 60 **Pass Marks: 35%**

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UNIT – I

1. Energy and Electromagnetic Spectrum **5 Hrs**

Introduction, electromagnetic spectrum and Units, Regions of the spectrum, Basic features of different spectrometers, Statement of Born-Oppenheimer approximation, Degree of freedom, Frank Condon Principle, Fluorescence and Phosphorescence.

II. Ultraviolet and Visible Spectroscopy **6 Hrs**

The energy of electronic excitation, Measurement techniques, Beer-Lambert Law, Molar extinction coefficient. Different types of transition noticed in UV spectrum of organic functional groups and their relative energies. Chromophore, Auxochromes, Absorption and intensity shifts, Transition probability. Factors affecting λ_{max} , Effect of steric hindrance to coplanarity, Solvent effects.

UNIT – II

III. Infrared Spectroscopy **5 Hrs**

Vibrational energy levels, Selection rules, Force constant, Fundamental vibration frequencies, Factors influencing Vibrational Frequencies (Vibrational Coupling, Hydrogen Bonding, Electronic effect, Bond Angles, Field Effect) of different functional groups. Sampling techniques.

IV. Applications of UV and IR Spectroscopy **7 Hrs**

Applications of UV spectroscopy, Woodward Fieser rules for calculating λ_{max} of conjugated polyenes and α,ß -unsaturated carbonyl compounds. Applications of IR spectroscopy, Absorption of Common functional Groups, Interpretation of simple IR spectra, Finger print regions. Simple numerical problems based on UV and IR spectroscopy.

UNIT-III

V. Proton Magnetic Resonance spectroscopy (^{1}H NMR) 6 Hrs

The Nuclear spin, Larmor frequency, the NMR isotopes, Population of nuclear spin level, Spin and Spin lattice relaxation. Measurement techniques (CW & FT method), Solvent used. Chemical shift, Reference compounds, Shielding constant, Range of typical chemical Shifts, Simple application of chemical shifts, Anisotropic effect. Spin spin splitting, Coupling constant.

VI. Applications of NMR spectroscopy 5 Hrs

NMR spectra with various examples such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene, o-, m-, p- anisidine, o-, m-, p- nitrophenols, acetophenone. Simple numerical of structure elucidation of NMR spectroscopic data.

UNIT- IV

VII. Mass Spectrometery 5 Hrs

Basic Principles. Elementary theory. Molecular ions, isotope ions, Fragment ions of odd and even electron types, Nitrogen rule, Factors affecting cleavage patterns, Simple cleavage, Cleavages at a hetero atom, Multicentre fragmentations, Rearrangements, Diels – Alder fragmentation, Mc Lafferty rearrangement.

VIII. Applications of Mass Spectroscopy 6 Hrs

Cleavage associated with common functional groups , Aldehydes, Ketones, Cyclic and Acyclic Esters, Alcohols, Olefins, Aromatic compounds, Amines, Interpretation of the spectrum of unknown simple molecules.

Books Recommended:

1. Organic Spectroscopy By W. Kemp; Publisher- Palgrave, New York
2. D.H. Williams and I. Fleming. Spectroscopic Methods in Organic Chemistry.
3. Spectrometric Identification of Organic Compounds - R.M. Silverstein & F. X. Webster; Publisher: John Willey and Sons,Inc.
4. Introductory Problems in Spectroscopy- By R.C. Banks, E.R. Matjeha and G. Mercer; Publisher : The Benzamine / Cummings Publishing Company Inc.
5. Introduction to Spectroscopy – D. L. Pavia, G. M .Lampman, and G. S. Kriz Publisher: Brooks / Cole, a part of cengage learning

BHP-258

PHYSICAL CHEMISTRY LAB-IV

Time: 3 Hours **Total Marks: 50**

(Max. Marks: 37 + Internal Assessment: 13)

6 Periods/week **Pass Marks: 35%**

Note. The question paper will be set by the examiner based on the syllabus.

1. Refractometry: Determine refractive index of a given liquid as a criterion for its purity. (Benzene i.e. commercial) benzene + A.R. acetone).

2. Polarimetry: Determine the %age composition of an optically active solution.

3. Calorimetry:
   a) Determination of Heat of neutralization
      (i) Strong acid-strong base
      (ii) Weak acid-strong base.
   b) Determination of Heat of solution of KCl, NH_4Cl, KNO_3

4. Conductometry:
   a) Determination of cell constant.
   b) Determination of specific and equivalent conductance of electrolyte (NaCl andHCl).
   c) Precipitation titration of Na_2SO_4 vs. $BaCl_2$.
   d) Neutralization titrations NaOH vs. HCl and NaOH vs. CH_3COOH.

5. Determination of adsorption isotherm of oxalic acid on charcoal.