SYLLABUS FOR B.Sc. COURSE

SUBJECT: CHEMISTRY

(Honours & Pass)

FOR

Nagaland University

(Approved minor modification as per 25th Academic Council No.AC:258:1)

B.Sc. Course Structure
Subject : Chemistry

Semester		Course Number	Course Name	Credits	Total Credits
I	Pass	CHEM-101	Inorganic (Theory)	4	8
		CHEM-102	Inorganic (Practical)	1	
	Honours	CHEM-103	Inorganic (Theory)	2	
		CHEM-104	Inorganic (Practical)	1	
II	Pass	CHEM-201	Organic (Theory)	4	8
		CHEM-202	Organic (Practical)	1	
	Honours	CHEM-203	Organic (Theory)	2	
		CHEM-204	Organic (Practical)	1	
III	Pass	CHEM-301	Physical (Theory)	4	8
		CHEM-302	Physical (Practical)	1	
	Honours	CHEM-303	Physical (Theory)	2	
		CHEM-304	Physical (Practical)	1	
IV	Pass	CHEM-401	Inorganic (Theory)	4	8
		CHEM-402	Inorganic (Practical)	1	
	Honours	CHEM-403	Quantum Chemistry & Molecular Spectroscopy	2	
		CHEM-404	Advanced Practical-1 (Physical, Inorganic and Organic)	1	
V	Pass	CHEM-501	Organic (Theory)	4	8
		CHEM-502	Organic (Practical)	1	
	Honours	CHEM-503	Analytical Chem & Applications of Spectroscopy.	2	
		CHEM-504	Advanced Practical-II (Physical, Inorganic and Organic)	1	
VI	Pass	CHEM-601	Physical (Theory)	4	10
		CHEM-602	Physical (Practical)	1	
	Honours	CHEM-603	Choice Based Credit Paper a. Biological Chemistry b. Nano Chemistry c. Medicinal Chemistry d. Environmental and Green Chemistry	3	
		CHEM-604	Project Work	2	

*** Choice based credit paper will be offered depending on the availability of specialized teacher in the respective colleges**

Salient Features of the Syllabus

1. For all theory papers, there will be five units irrespective of the credit of the paper. The total numbers of lectures/ contact hours against the credits are as follows:

Total credit	Total credit hours	Total no. of lectures	Total no. of units	No. of lectures per unit
4	60	80	5	16
2	30	40	5	8

* considering that one semester has around 15 working weeks, total credit hours are calculated. Since the class lectures are of 45 minutes, accordingly contact hours is converted into number of class lectures

2. The possible combinations for Chemistry Honours are as follows:

CHEMISTRY	BOTANY	ZOOLOGY
CHEMISTRY	PHYSICS	MATHEMATICS
CHEMISTRY	MATHEMATICS	COMPUTER SCIENCE
CHEMISTRY	GEOGRAPHY	ZOOLOGY
CHEMISTRY	GEOGRAPHY	BOTANY
CHEMISTRY	GEOLOGY	GEOGRAPHY
CHEMISTRY	ANTHROPOLOGY	BOTANY
CHEMISTRY	ANTHROPOLOGY	ZOOLOGY

*First two subject combinations are the preferred one

3 Students without Mathematics can also take admission into Honours Course in Chemistry, provided they have studied and cleared the subject Mathematics up to 12th standard.

4 The Choice Based Credit Course paper in the sixth semester needs to be selected by the respective Department, subject to availability of specialized Teacher.

5 The Practical Examination will be internal

6 All the theory papers are of 100 marks and out of that 30% is internal

SEMESTER-I

CHEM-101: Inorganic Chemistry
(Pass Course - Theory)

Total Credits: 4

Unit- 1 **(16 L)**

a) Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodingerwave equation, significance of Ψ and Ψ^2, quantum numbers, radial and angular wave functionsand probability distribution curves, shapes of s, p, and d orbitals. Aufbau and Pauli's exclusionprinciples, Hund's multiplicity rules. Electronic configurations of the elements, effective nuclearcharge and shielding or screening effect.

b) Chemical periodicity

Periodic classification of elements, salient characteristics of s, p, d and f- block elements.Periodic trends of atomic radii, ionic radii, ionization potential, electron affinity andElectronegativity in the periodic table, variation of metallic and non-metallic properties indifferent periods and groups, and diagonal relationship.

Unit- II

Chemical bonding **(16 L)**

(i) Covalent bonding

Basic idea of valence bond theory and its limitations; LCAO-MO theory and its application tohomonuclear diatomic molecules (H_2, N_2, O_2, O_2^{-2}, O_2^- , O_2^+), concept of hybridization oforbitals; valence shell electron pair repulsion (VSEPR) theory and shapes of molecules and ions:BeF_2, BF_3, H_3O^+, NH_3, H_2O, H_2S, O_3, CO_2, BO_3^{3-}, PCl_3, PCl_5, SF_4, SF_6.

(ii) Ionic Bonding: Ionic structures; radius ratio effect; limitation of radius ratio rule; concept oflattice energy and Born-Haber cycle; polarizing power; polarizability of ions and Fajan's rule,results of polarization on melting and boiling points.

Unit- III

a) s and p Block Elements **(16 L)**

Oxidation states, variation of acidic and basic properties of their oxides andoxy-acids, inert pair effect and catenation. Preparation, important reactions, structure and use of following compounds: Boric acid, borates, boron nitride, diborane and oxyacids of nitrogen,phosphorous, sulphur and chlorine. Basic properties of halogens and interhalogens, pseudohalides.

b)Chemistry of Noble Gases

Position in the periodic table, separation and isolation of helium, neon and argon from liquid air,study of the following compounds (preparation, structure and properties of XeF_2, XeF_4, andXeO_3 and $XeOF_4$.

Unit -IV

Nuclear Chemistry-I **(16 L)**

(a) Fundamental particles (electron, proton, neutron, positron, neutrino and mesons); nuclear bindingenergy, mass defect and packing fraction; half-life and average life period; importantapplications of radioactive isotopes;

(b) Unit of radioactivity; group displacement law; balancing ofnuclear reactions; artificial radioactivity; elementary ideas of fission, fusion, controlled fissionreactions , atomic energy & Nuclear reactors.

Unit –V

a) Acid-Base Concepts **(16 L)**

Arrhenius concept; Bronsted-Lowry concept, the solvent-system (Franklin) concept and itslimitations; Lewis concept; effect of substituent's and solvent on strengths of acids and bases – leveling effect; Relative strengths of acids and bases (pK_a , pK_b, and pH concepts). Hard and SoftAcid and Bases (HSAB): Classification of acids and bases as hard and soft, Pearson's HSABprinciple and its applications, symbiosis, basis of hard-hard and soft-soft interactions.

b) Principles of Qualitative and Quantitative Analysis-I

Solubility product and its applications in the Group separations of cations, Volumetric analysis - standard solutions, primary standards, expressing concentrations of standard solutions, redoxtitrations (potassium permanganate, potassium dichromate, sodium thiosulphate and iodine),iodometric and iodimetric titrations, acid-base indicators and its theory.

Recommended Books

1. Comphrensive Inorganic Chemistry Vol – I & II: **Sulekh Chandra** (New Age Publication, New Delhi
2. Advanced Inorganic Chemistry Vol I & II: **Satya Prakash, G.D.Tuli, R.D.Madan& S.K Basu**, S.Chand& Co.New Delhi
3. Selected topics in Inorganic Chemistry: **U.Malik, G.D.Tuli, R.D.Madan,** S.Chand& Co. New Delhi
4. Principles of Inorganic Chemistry: **Puri, Sharma &Kalia**, Vishal Publications, Jalandhar
5. Modern Inorganic Chemistry: **R.C. Aggarwal,** KitabMahal
6. Advanced Inorganic Chemistry Vol. I, II: **Gurdeep Raj**, Goel Publishing House, Meerut
7. Essentials of Nuclear Chemistry: **H.J. Arnikar**, New Age Publication New Delhi
8. Basic Inorganic Chemistry: **Cotton, Wilkinson &Gaus**, Wiley
9. Concise Inorganic Chemistry: **J.D.Lee**(Blackwell Science)
10. Inorganic Chemistry: **Sharpe** (Pearson Education)
11. Inorganic Chemistry: Shiver & Atkins (Oxford University Press)
12. Inorganic Chemistry: **J.E. Huheey, E.A. Keiter& R.L Keiter**
13. Inorganic Chemistry: **R.Gopalan**, *Universities Press (India) Pvt. Ltd. Hyderabad (A.P.)*

CHEM-102: Inorganic Chemistry
(Pass Course- Practical)

Total Credit: 1

Part I Qualitative Analysis

Inorganic mixtures containing five radicals/ions to be prepared from the following list:

Ag^{+},Pb^{2+}, Hg_2^{2+}, Hg^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+}, Fe^{3+}, Al^{3+}, Ba^{2+}, Cr^{3+}, Zn^{2+}, Mn^{2+},Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+} , Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}, SO_3^{2-}, S^{2-}, CrO_4^{2-}, PO_4^{3-}, NO_3^{-}, NO_2^{-}, BO_3^{3-},AsO_4^{3-}.

Every mixture contains at least one interfering radical. Presence of Na^{+}, NH_4^{+}, K^{+}, CO_3^{2-}, mustbe ignored and not to be reported. At least 5 salt mixtures have to be done by each student in thepractical classes keeping records carefully.

Part 2: Volumetric Analysis

(a) Estimation of ferrous ion by $KMnO_4$method
(b) Estimation of ferric ion by $K_2Cr_2O_7$ method.
(c) Estimation of copper by iodometric method.
(d) Determination of Acetic acid in Commercial Vinegar using NaOH.
(e) Determination of alkali content – Antacid tablet using HCl.

(Standardization of solution will have to be done by each candidate by using hisprepared standard solution and he will have to report the result)

Note: Experiments may be added/deleted subject to availability of time and facilities

CHEM-103: Inorganic Chemistry
(Honours Course - Theory)

Total Credit: 2

Unit I

(a) Chemical Bonding-II **(8 L)**

LCAO-MO theory and its application to heteronuclear diatomic molecules (CO,NO,NO^+, NO^{2+},NO^- ,CN,CN^-,HF) conditions for combination of atomic orbitals; pictorial representation ofvarious molecular orbitals; multi-center bonding in electron deficient molecules with reference tohydrides of boron (3c-2e bond); resonance and its application in NO^{3-}, SO_4^{-2}, ClO_4^-, CO_3^{-2} and SO_3^{-2}.

(b) Industrial Chemistry

Water – Industrial purification of drinking water and water analysis.Fertilizers – Nitrogen fertilizers-manufacture of ammonia, and urea. Phosphatic fertilizers -calcium superphosphate, NPK fertilizers.Glass – raw materials used for preparation; different types (varieties) of glass and theircomposition, optical and coloured glass, properties. Cement-constituents, manufacture and setting process, role of gypsum.Paints and pigments: constituents of paints; classification of pigments on the basis of theircolour with examples.

Unit II

(a) Molecular Symmetry: **(8 L)**

Symmetry elements and symmetry operations: symmetry planes and reflections, inversion center,proper axis and proper rotations, improper axis and improper rotations; molecular point groups;classification of molecules into point groups of H_2O, NH_3, BCl_3 H_2O_2 $BeCl_2$, and R_2NH;symmetry of tetrahedron, and square planar complexes.

(b) Analyses of Experimental Data

Accuracy and precision; Methods for their expression; classification of errors; sources of errors,minimization of errors, the Normal Law of Distribution of indeterminate errors, propagation oferrors, mean and standard deviations, significant figures, rejection of data- the F-test, T-test, andQ-test, the method of least-squares, correlation coefficient.

Unit III

(a) Bioinorganic Chemistry **(8 L)**

Essential and trace elements in biological systems, Metalloporphyrins, chlorophyll, hemeproteins (hemoglobin, myoglobin); role of cobalt in vitamin B_{12}; Enzymes; Metalloenzymes (Zn)and their characteristics and functions; Non-complexingcations in biochemical processes(Na andK), Role of metals and non-metals in metabolism; metal and non-metal deficiency and toxicity.Biological role of alkali and alkaline earth metal ions with special reference to Ca^+. Nitrogenfixation.

(b) Nanomaterials

General introduction to Nanomaterials and emergence of nanotechnology, Types of nanomaterials, Synthesis of nanoparticles of gold, platinum and silver; properties of nanoparticles;important applications of nano-particles.

Unit IV

(a) Crystal Field Theory **(8 L)**

d-orbital by electrostatic field (octahedral, tetrahedral and square planar geometry), and magneticproperties (high spin and low spin complexes); factors affecting crystal field splitting energy (10Dq value) and spectrochemical series; Structural and thermodynamic effects of d-orbitalsplitting,(variation of ionic radii, Jahn-Teller effect, hydration and lattice energies of first rowtransition metal ions),octahedral vs. tetrahedral coordination.

(b) Magnetochemistry

Explanations of diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, originof paramagnetic moment: electron spin moment, and orbital angular moment, magneticsusceptibility, Curie law, Curie-Weiss law, Bohr Magneton, magnetic susceptibilitymeasurement using Gouy and Faraday methods explanation of magnetic behaviours of thefollowing: $K_4[Fe(CN)_6]$, $K_3[Fe(CN)_6]$, $[Co(NH_3)_6]Cl_3$, $K_2[Ni(CN)_4]$, $K_3[CoF_6]$, $K_3[MnF_6]$,$Ni(CO)_4$.

Unit V **(8 L)**

(a) Organometallic Chemistry: Synthesis, structure, bonding and reactivity of transition metalcomplexes with Olefins, Cyclopantadienyl, Cyclopentadiene, Benzenoid, π-allyl and Enylsystems. Transition metal-carbon π-bond: metal-alkyls, metal-carbenes and metal-carbynes.

(b) Metal – Ligand Equilibria in Solution: Stepwise and overall formation constants: trends instep wise formation constants: determination of binary formation constant by spectrophotometry:factors affecting stability of metal complexes and chelate effect.

Recommended Books

1 .Advanced Inorganic Chemistry Vol I & II: **Satya Prakash, G.D.Tuli, R.D.Madan& S.K Basu**, S.Chand& Co.New Delhi
2. Selected topics in Inorganic Chemistry: **U.Malik, G.D.Tuli, R.D.Madan,** S.Chand& Co. New Delhi
3. Principles of Inorganic Chemistry: **Puri, Sharma &Kalia**, Vishal Publications, Jalandhar
5. Modern Inorganic Chemistry: **R.C. Aggarwal,** KitabMahal
6. Advanced Inorganic Chemistry Vol. I, II: **Gurdeep Raj**, Goel Publishing House, Meerut
8. Basic Inorganic Chemistry: **Cotton, Wilkinson &Gaus**, Wiley
9. Concise Inorganic Chemistry: **J.D.Lee**(Blackwell Science)
10. Inorganic Chemistry: **Sharpe** (Pearson Education)
11.Inorganic Chemistry: **Shiver & Atkins** (Oxford University Press)
12. Inorganic Chemistry: **J.E. Huheey, E.A. Keiter& R.L Keiter**
13. Analytical Chemistry: **G.L. David Krupadanam, D. Vijaya Prasad, K.Varaprasad Rao, K.L.N. Reddy and C. Sudhakar.** *Universities Press (India).*
14.Bioinorganic Chemistry: PragatiPrakashan, Meerut

CHEM-104: Inorganic Chemistry
(Honours Course - Practical)

Total Credit: 1

Part I: Qualitative Analysis

Inorganic mixtures containing four radicals/ions to be prepared from the following list:

Ag^{+}, Pb^{2+}, Hg_2^{2+}, Hg^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+}, Fe^{3+}, Al^{3+}, Ba^{2+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+} , Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}, SO_3^{2-}, S^{2-}, CrO_4^{2-}, PO_4^{3-}, NO_3^{-}, NO_2^{-}, BO_3^{3-}, AsO_4^{3-}.

Every mixture must contain at least one interfering radical. Presence of Na^{+}, K^{+}, CO_3^{2-}, must beignored and not to be reported. At least 5 salt mixtures have tobe done by each student in the practical classes keeping records carefully.

The preparation of this type of combination must be avoided while preparing a mixture.

(a) Cl^{-}, Br^{-}& I^{-} (b) NO^{3-}& NO^{2-} (c) NO^{3-} Br^{-}& I^{-}, (d) PO_4^{3-}, AsO_4^{3-}& AsO_3^{2-}(e) CO_3^{2-}& SO_3^{2-} SO_4^{2-} (f) Cl^{-}, Br^{-} or I^{-} (g) S^{2-}, SO_3^{2-}, SO_4^{2-}, $S_2O_3^{2-}$.

Part II: Gravimetric analysis

a) Analysis of Cu as CuSCN
b) Ni as Ni(DMG)
c) Zn as ZnO
d) Cr as Cr_2O_3
e) Fe as Fe_2O_3

Note: Experiments may be added/deleted subject to availability of time and facilities

SEMESTER-II

CHEM-201: Organic Chemistry
(Pass Course - Theory)

Total Credit: 4

Unit- I

a) Bondings and Shapes of Organic Molecules (16 L)

Hybridizations of orbitals, implications of hybridization on the concept of bond length, bondenergy, bond angles, shape of the molecules with the examples of molecules given below:(i) CH_4, H_3O^+, $-CH_3$, RNH_2 (ii) C_2H_4, $^+CH_3$, carbonyl compounds and (iii) C_2H_2, R-CN, allene,ketene.Nature of covalent bond and its orbital representation in molecules listed above.Conjugation, resonance, hyper-conjugation (propene and toluene), homolytic and heterolyticbond cleavage. Types of reagents – electrophiles and nucleophiles. Reactive intermediates – carbocations, carbanions, free radicals, carbenes and their stability and shape (with examples).

b) Organic Stereochemistry-I

Concepts of types of isomerism—Configuration and conformation isomerism. Fischer, Newmanand Sawhorse projection formula with suitable examples ; geometrical isomerism, configurationof geometrical isomers, E and Z nomenclature, geometric iomers of oximes; configuration – optical activity, chiral carbon atom, relative and absolute configuration, optical isomerism oflactic and tartaric acids, enantiomerism and diastereoisomerism; meso compounds.

Unit-II

(a) Alkanes (16 L)

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification ofcarbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (with specialreference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation ofcarboxylic acids), physical properties and chemical reaction of alkanes. Mechanism of freeradical halogenation of alkanes: orientation, reactivity and selectivity.

(b) Alkenes and Alkynes

Nomenclature of alkenes, methods of formation. The Saytzeff's rule, Hofmann elimination,physical properties and stabilities of alkenes. Chemical reaction of alkenes-mechanisms involvedin hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroborationoxidation.Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$Polymerization of alkenes.Nomenclature, Structure and bonding in alkynes, methods of formation, chemical reactivity,electrophilic addition reactions (halogenations, hydration, HX, HOX), ozonolysis, compare acidity of ethane, ethene and ethyne.

Unit-III

(a) Arenes and Aromaticity **(16 L)**

Nomenclature of benzene derivatives. Aromatic nucleus and side chain. Structure of benzene:Molecular formula and Kekule's structure. Stability and carbon-carbon bond lengths ofbenzene, resonance structure, MO picture. Aromaticity: Huckel rule, aromatic ions, Aromaticelectrophilic substitution -Mechanism of nitration, halogenation, sulphonation, Friedel-Craftreaction. Effect of substituent groups (activating and deactivating substituents, directiveinfluence).

(b) Organic Reaction Mechanisms

Nucleophile, ambident nucleophile, SN1, SN2, factors affecting substitution reactions (structureof substrate, nature of nucleophile, solvent, role of leaving group), Mechanisms of nucleophilicsubstitution reactions of alkyl halides, SN2 and SN1 reactions, difference between nucleophilesand bases.Elimination reactions (E1, E2), orientation in elimination reactions (Saytzeff's and Hoffmann'srule).

Unit-IV

(a) Alkyl and Aryl Halides **(16 L)**

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions(hydrogenolysis, aqueous and alcoholic KOH, NH_3, KCN, AgCN, KNO_2, $AgNO_2$, RCOOAg,RONa, Mg, Li, Na.Polyhalogen compounds: chloroform, carbon tetrachloride.Methods of formation of aryl halides, nuclear and side chain reaction. The addition-eliminationand the elimination-addition mechanisms of nucleophilic aromatic substitution reactions.

(b) Alcohols and Phenols

Classification and nomenclature: Monohydric alcohols – nomenclature, methods of preparationby reduction of Aldehydes, Ketones, carboxylic acids and esters (including hydroboration andmercuration). Hydrogen bonding. Acidic nature. Reactions of alcohols distinction betweenprimary, secondary and tertiary alcohols (Victor Meyer's test) methods of formation, chemicalreactions of ethylene glycol and glycerol.Nomenclature, preparation of phenols, physical properties and acidic character. Comparativeacidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion, reactions ofphenols – electrophilic aromatic substitution, acylation and carboxylation, Gatterman synthesis,Reimer-Tiemann reaction.

Unit-V

(a) Aldehydes and Ketones **(16 L)**

Nomenclature and structure of the carbonyl group. Synthesis of Aldehydes and Ketones withparticular reference to the synthesis of Aldehydes from acid chlorides, synthesis of ketones fromnitriles and from carboxylic acids. Chemical reactivity of carbonyl group, general mechanism ofnucleophilic additions and addition-elimination reactions. Reactions with HCN, $NaSO_3H$,NH_2OH, NH_2NH_2, $C_6H_5NHNH_2$, $NH_2CONHNH_2$,) and Cannizzaro reaction; acidity of of α-hydrogen in carbonyl compounds and formation of enolates, Benzoin, Aldol, Perkincondensation., condensation with ammonia Oxidation of Aldehydes, oxidation of Ketones,.Clemmensen, Wolf-Kishner reductions.

(b)Ether

Nomenclature of ethers and methods of their formation, Physicalproperties. Chemical reactions, cleavage and auto-oxidation. Ziesel's method.

Recommended Books

1. Organic Chemistry: **Morrison and Boyd**, Prentice Hall of India Pvt. Ltd. New Delhi
2. Organic Chemistry, ArunBahl&B.S.Bahl, S.Chand& Co. New Delhi
3. Reactions, Rearrangements and Reagents: **S.N.Sanyal**, *BharatiBhawan Publishers and Distributers, Patna*
4. Stereochemistry: **P.S.Kalsi**, New Age International Publishers, New Delhi
5. Organic Reactions and their Mechanism: **P.S.Kalsi**, New Age International Publishers, New
6. Modern Organic Chemistry: **M.K.Jain and S.C.Sharma**: *Vishal Publishing Company, Jalandhar*
7. Undergraduate Organic Chemistry: **Jagdamba Singh &L.D.S.Yadav**Vol-I, II, III, *PragatiPrakashan, Meerut*
8. Advanced Organic Chemistry: **Jagdamba Singh &L.D.S.Yadav**, *PragatiPrakashan, Meerut*
9. Reaction Mechanism in Organic Chemistry, **S.M.Mukherji&S.P.Singh**, Macmillan India Ltd. Delhi
10. Stereochemistry of Carbon Compounds: **Ernest L. Eliel**, Tata McGraw-Hill Pub. Co. Ltd. New Delhi

CHEM-202: Organic Chemistry
(Pass Course - Practical)

Total Credit: 1

Qualitative Analysis

Systematic qualitative analysis of organic compounds containing one functional groups.

(a) Detection of elements (N,Cl,Br,I,S)

(b) Detection of the following functional groups (with systematic reporting)carbonyl, carboxyl, phenolic, amino, nitro, sulphonic, and amide group

(c) Determination of the melting point/boiling point

(d) Separation of organic compounds by sublimation method.

Note: Experiments may be added/deleted subject to availability of time and facilities

CHEM-203: Organic Chemistry
(Honours Course - Theory)

Total Credit: 2

Unit- I

(a) Introduction to Organic Synthesis **(8L)**

Formation of carbon-carbon bond, electrophilic and nucleophilic carbon species, acid-assistedreaction base-assisted condensations (Knoevenagel, Michael, Wittig reaction, Reformatskyreaction, Claisen reaction, Claisen-Schmidt reaction, Mannich reaction) Formation and acidassisted cleavage of acetals and ketals, mechanisms of formation and hydrolysis of esters andamides (acylic and cylic).Use of inorganic reagents in organic synthesis: $LiAlH_4$, $NaBH_4$, B_2H_6, Na/liq NH_3, Aluminiumisopropoxide, $KMnO_4$, HIO_4, Lead tetra acetate.

Unit-II

(a) Introduction to Dienes **(8 L)**

Conjugated, isolated and cumulated dienes (allenes). Structures. Preparation and reactions ofconjugated dienes (1,3-butadiene and isoprene).

b) Polynuclear Aromatic Hydrocarbons

Introduction; molecular orbital structure of naphthalene; resonance; reactions, mechanism andorientation of electrophilic substitution. Preparations and reactions of α- and β-naphthols (azocoupling,reactions with HNO_2 and $FeCl_3$. Preparation and reactions of anthracene.

c) Organosulphur Compounds

Nomenclature, structural features, methods of formation and chemical reactions of Thiols,Thioethers, sulphonic acids, sulphonamides and sulphaguanidine.

Unit-III

a) Synthetic Polymers **(8L)**

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinylpolymerization, Ziegler-Natta polymerization and vinyl polymers.Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyderesins, urea formaldehyde resins, epoxy resins and polyurethanes.Natural and synthetic rubbers.

b) Pericyclic Reactions

Definition of Pericyclic reactions, molecular orbitals and Pericyclic reactions(i) Electrocyclic reactions: Introduction, stereochemistry of Electrocyclic reaction, conrotatorydisrotatoryring closure and ring opening (with simple examples like 1,4-(2E,4E)-hexatriene,(2E,4Z)-hexatriene; (2E,4Z,6Z)-Octatriene, (2E,4Z,6E)-Octatriene Woodward-Hofmann's rulefor Electrocyclic reactions, Frontier Molecular Orbital Theory (no correlation diagram required)(ii) Cycloaddition reactions: Definition of dienes and dienophiles, Supra-supra, Antara-Antaramodes of cycloadditions [4+2] Diels-Alder reaction and [2+2] cycloaddition reaction by takingexamples of simple dienes and dienophiles.

Unit-IV **(8L)**

a) Heterocyclic Compounds- I

Introduction: Molecular orbital picture and aromatic characteristics of Pyrrole, furan, thiopheneand pyridine. Methods of synthesis and chemical reactions with particular emphasis on themechanism of

electrophilic substitution. Mechanism of nucleohilic substitution reactions inpyridine derivatives. Comparison of basicity of pyridine, piperidine and Pyrrole.

b) Heterocyclic Compounds-II

Introduction to condensed five and six- membered heterocycles. Preparation and reactions ofIndole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraupsynthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactionsof indole, quinoline and isoquinoline.

Unit-V **(8L)**

a) Organic Photochemistry:

Molecular energy and photochemical energy, excitation of molecules, Franck-Condon Principle,dissipation of energy and Jablonski diagram and singlet-triplet states, photosensitization andquenching, quantum yield. Introduction to the photochemical reactions of carbonyl compounds,Patterno-Buchi reaction, Norrish Type I and Type II cleavages, photo reduction

b) Molecular Rearrangements

Carbonium ion rearrangement (Pinacol-Pinacolone; Wagner-Meerwein and dienone-phenolrearrangements, Beckmann, Wolff, Hofmann, Curtius, Benzil-Benzilic acid, Fries rearrangement

Recommended Books

1. Organic Chemistry: Mukherji, Singh and Kapoor. Vol : I, II and III, New Age Publications
2. Heterocyclic Chemistry: Raj K. Bansal: New Age International Publishers, New Delhi
3. Polymer Science: V.R.Gowariker, N.V.Vishwanathan, JayadevSreedhar, New Age International Publishers.
4. Organic Chemistry: Morrison and Boyd, Prentice Hall of India Pvt. Ltd. New Delhi
5. Reactions, Rearrangements and Reagents: S.N.Sanyal, BharatiBhawan Publishers
6. Advanced Organic Chemistry: Jagdamba Singh &L.D.S.Yadav, PragatiPrakashan.Meerut
7. Reaction Mechanism in Organic Chemistry, S.M.Mukherji&S.P.Singh, Macmillan India Ltd. Delhi
8. Organic Chemistry, Paula Y. Bruice, Prentice Hall.
9. Reactive Intermediates, Christopher J Moody and Gordon H. Whitham, Oxford University Press.

CHEM-204: Organic Chemistry
(Honours Course - Practical)

Total Credit: 1

Qualitative Analysis

Systematic qualitative analysis of organic compounds containing two functionalGroups.

(a) Detection of elements (N,Cl,Br,I,S)

(b) Detection of the following functional groups (with systematic reporting)Carbonyl, carboxyl, phenolic, amino, nitro, sulphonic, and amide group

(c) Determination of the melting point/boiling point

(d) Identification of the compound with the help of a reference book.

(e) Preparation of the derivative and determination of its melting point.

Note: Experiments may be added/deleted subject to availability of time and facilities.

SEMESTER-III

CHEM-301: Physical Chemistry
(Pass Course - Theory)

Total Credit: 4

Unit-I

a) Thermodynamics-I **(16L)**

Types of systems, Thermodynamic process. First Law of thermodynamics Heat capacity, heatcapacities at constant volume and pressure and their relationship. Joule Thomson Effect andcoefficient, inversion temperature. Thermochemistry: Standard state, standard enthalpy offormation - Hess's Law of heat summation and its applications. Enthalpy of neutralization. Bonddissociation energy and its calculation from thermo-chemical data, temperature dependence ofenthalpy: Kirchhoff's equation (derivation and application). (Numerical problem based on the topic).

Unit-II **(16L)**

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 (statement and its derivation). Concept of Entropy: entropy as a state function, entropy as a function of V &T, Entropy as a function of P & T, entropy change for a spontaneous process in a physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium, Entropy change in ideal gases and mixing of gases.

Unit-III

a)Gaseous state-I: **(16L)**

Postulates of kinetic theory of gases, deviation of real gases from ideal behaviour, van der Waals andVirial equation of state, critical phenomena, principle of corresponding states, equation for reducedstate. Liquefaction of gases, Maxwell-Boltzmann distribution of molecular speeds, collisions between molecules in a gas: -collision diameter, collision number, collision frequency, mean free path.

b) Liquid state-I

Intermolecular forces: - dipole-dipole forces, dipole-induced dipole force, London forces, hydrogenbonding (inter, and intra bonding), structure of liquids (a qualitative description). Liquid crystals: -classification, structure and properties of smectic, nematic and cholestric liquid crystals,Thermography,

Unit-IV **(16L)**

(a) Phase rule and its application

Definition of the following terms:- phase, component, degrees of freedom, derivation of thephase rule, phase equilibrium and metastable equilibrium phase diagram involving onecomponent system (water and sulphur).Phase euilibra of two component systems, solid-liquid equilibra, simple eutectic Pb-Ag systemsand desilverization of lead.

(b) Electrochemistry-I

Electrical transport- conduction in metals and in solutions; specific conductance and equivalentconductance, measurement of equivalent conductance, variation of specific and equivalentconductance with dilution and Kohlrausch law, Migrations of ions, Transport number.Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes,Ostwald's dilution law its uses and limitations,

Unit-V

(a)Chemical kinetics-I (16L)

Rate of reaction and rate constant, moleculatiry and order of reaction, zero order reaction,differential and integrated forms of first and second order reactions, pseudo-unimolecularreactions, experimental determination of order of reaction:- differential method, integral method,method of half- life and isolation method, effect of temperature on reaction rates and activationenergy, effect of catalyst. Temperature dependence on rate constant - The Arrhenius equation,Radioactive decay as a first order phenomenon

(b) Macromolecules:

Characteristic of macromolecules, concept of number average and mass average molecularweight. Determination of molecular weight of macromolecules by: Osmotic pressure method, Viscosity method, Light scattering method.

Recommended Books

1. Principles of Physical Chemistry: **Puri, Sharma and Pathania**, Vishal Publishing Co.
2. Advanced Physical Chemistry: **D.N. Bajpai**, S.Chand& company Ltd, New Delhi.
3. An Introduction to Chemical Thermodynamics: **R.P. Rastogi and R.R. Misra**, Vikas Publications, New Delhi.
4. Chemical Kinetics: **Laidler, Harper and Row**.
5. Physical Chemistry, **T.W. Atkins**, Oxford University Press

CHEM-302: Physical Chemistry
(Pass Course - Practical)

Total Credit: 1

List of Experiments:

(1) Determination of the heat of neutralization of a strong acid by a strong base.

(2) Determination of the molecular weight by Rast's method.

(3) Study of the heat of dilution of H_2SO_4 and then to determine the strength of an unknownacid.

(4) Determination of the velocity constant of the reaction between hydrogen peroxide andpotassium permanganate, using ferric chloride as catalyst.

(5) Determination of the solubility of a salt ($BaCl_2$/ Benzoic acid) at two differenttemperatures and to determine the heat of solution.

(6) Study of the adsorption of oxalic acid on charcoal and verification of Freundlich'sadsorption isotherm.

(7) Verification of Hardy-Schulze law: Preparation and coagulation of arsenic sulphide(As_2S_3) sol using NaCl, $BaCl_2$ and $AlCl_3$ solutions.

(Only one experiment will be selected from the list by a candidate by lot during theexamination.)

Note: Experiments may be added/deleted subject to availability of time and facilities

CHEM-303: Physical Chemistry
(Honours Course -Theory)

Total Credit: 2

Unit-I

Electrochemistry-II **(8 L)**

Galvanic cells, reversible cells and reversible electrodes (Hydrogen electrode, Calomel electrode and Oxidation-reduction electrodes). Single electrode potential and sign conventions. Free energy change in cells. The Nernst equation of electrolyte concentration on electrode potential. Standard electrode potential and electrochemical series. Concept of activity and activity coefficient of an electrolyte. Determination of ionic activities by EMF method. Concentration cells (with and without transference), derivation of expressions for their EMFs. Liquid Junction Potential, Fuel Cells: Hydrogen-Oxygen fuel cells and Coal-fired fuel cells. Application of EMF measurements: Determination of pH by using hydrogen electrode and quinhydrone electrode.

Unit-II **(8L)**

Phase Equilibria-II

Ideal liquid mixtures, azeotropes (ethanol – water systems.) Partially miscible liquids-Lowerand upper critical solution temperature (Phenol-water, trimethylamine-water systems), steamdistillation (aniline-water system). Solid solutions – compound formation with congruent meltingpoint (Mg-Zn) and incongruent melting point, ($FeCl_3$-H_2O) and ($CuSO_4$-H_2O) system, freezingmixture, acetone-dry ice. Nernst distribution law – thermodynamic derivation, applications.

Unit-III **(8L)**

(a) Physical properties and Molecular structure

Optical activity polarization- Clausius-Mossatti equation, orientation of dipoles in electric field,dipole moment, induced dipole moment, measurement of dipole moment-Temperature andrefractivity method, Dipole moment and structure of molecules, Magnetic properties –paramagnetism,diamagnetism, and ferromagnetism.

(b) Solid state

Space lattice, Laws of crystallography - Law of constancy of interfacial,angles, Law of rationality of indices, Millers and weises indices, Laws of symmetry. Symmetryelements in crystals. X-ray diffraction by crystals. Derivation of Bragg's equation. Measurementof diffraction angle by powder method.

Unit-IV **(8L)**

Chemical Kinetics-II

Kinetic equations for complex reactions: Chain, parallel, opposing and consecutivereactions; Experimental methods of chemical kinetics-Potentiometric, Spectrophotometric andoptical methods. Rate constant for simple bimolecular reactions; Collision theory; Activatedcomplex theory Reactions in solutions: Diffusion controlled & activation controlledreactions; Thermodynamic formulation of rate constant, expression for rate constant based onequilibrium constant.

Unit-V **(8L)**

Statistical Thermodynamics

Limitation of classical thermodynamics, concepts of distribution of energy, thermodynamicprobability , Boltzmann distribution law , partition function and thermodynamic parameters;relation between molecular and molar partition functions, translational partition function,rotational partition function for linear and non-linear molecules; vibrational partition function,electronic partition function, reference state of zero energy for evaluating partition function,equilibrium constant in terms of partition function.

Recommended Books

1. Principles of Physical Chemistry: **Puri, Sharma and Pathania**, Vishal Publishing Co.
2. Advanced Physical Chemistry: **D.N. Bajpai**, S.Chand& company Ltd, New Delhi.
3. An Introduction to Chemical Thermodynamics: **R.P. Rastogi and R.R. Misra**, Vikas Publications, New Delhi.
4. Chemical Kinetics: **Laidler, Harper and Row**.
5. Physical Chemistry, **T.W. Atkins**, Oxford University Press

CHEM-304: Physical Chemistry
(Honours Course - Practical)

Total Credit: 1

(a) Determination of surface tension of a liquid/solution by drop-weight method.

(b) Determination of viscosity – composition (v/v) curve of ethanol-water system and todetermine the composition (v/v) of a given mixture.

(c) Determination of partition coefficient of a solute between two immiscible solvents (e.g.iodine in water/organic solvent; benzoic acid in water/benzene).

(d) Determination of the velocity constant of the hydrolysis of methyl acetate catalysed by anacid.

(e) Conductometric titrations of an acid by a base. Acid-base titration using potentiometer.

(d) Determination of the heat of solution of solid calcium chloride by the Born-Haber cycle.

(e) Determination of the critical solution temperature of the phenol-water system.

(f) Study on the kinetics of the reaction between potassium persulfate and potassium iodide attwo temperatures.

Note: Experiments may be added/deleted subject to availability of time and facilities

SEMESTER-IV

CHEM-401: Inorganic Chemistry
(Pass Course - Theory)

Total Credits: 4

Unit- 1 **(16 L)**

(a) Comparative study of d-Block Elements (Group 3-12)

Group discussion of transition elements with respect to position in the periodic table, electronicconfiguration, density, melting and boiling points, atomic volume, atomic and ionic radii,ionization potentials, electron affinity, Electronegativity, oxidation states, complexes and therelative stability of their oxidation states, oxides halides, hydrides and catalytic properties.Difference between first, second and third transition series.Preparation, important reactions, structures and uses of potassium dichromate, potassiumpermanganate.

b) Nuclear Chemistry-II

Detection and measurement of radioactivity (G.M. Counter method); Decay kinetics-first orderrate equation for radioactive disintegration; Theory of Radioactive disintegration; Radioactiveseries-Uranium; magic number concept; uses of radioactive and non-radioactive isotopes; purity and strength of radio isotopes, Radio chemical principle in theuse of Tracers. Size of Nucleus; nuclear forces; the possible forcesbetween n-n, p-p, and n-p; nuclear reactions spallation. Atomic energy and Q values of nuclear reactions (MeV).

Unit- II **(16 L)**

a) Coordination Compounds

Werner's Coordination theory, coordination number, ligands and their classification, chelation,applications of chelate formation; nomenclature of coordination compounds, effective atomicnumber rule, Isomerism in coordination compounds, geometrical and optical isomerism in 4- and6-coordinate complexes; Sedgwick's effective atomic number rule; stereochemistry ofcomplexes with coordination numbers 4 and 6. Bonding in transition metal complexes: ValenceBond Theory and elementary idea of Crystal Field Theory for octahedral and tetrahedralcomplexes, their role in nature and medicine.

b) Environmental Chemistry

Composition of the atmosphere, photochemical reactions in the atmosphere, acid rain, carbonmonoxide and its effects, -- suspended particulate matter – size and effects on health, dual role ofozone in the atmosphere tropospheric ozone and stratospheric ozone, ozone hole, carbon dioxideand other gases responsible for global warming. Measures to control air pollution. Quality ofwater drinking and other purposes. Permissible limits. Common water pollutants-organic andinorganic. Heavy metals and their toxic effects. Pollution of water through use of chemicalfertilizers. Fluoride contamination and fluorosis. Pollution due to mining. Measures taken tocontrol water pollution.

Unit- III **(16 L)**

(a) Chemistry of Lanthanide and Actinide Elements

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complexformation, occurrence and isolation, lanthanide compounds. General features and chemistry ofActinides, chemistry of separation of Np, Pu and Am from U, similarities between the lateractinides and the later lanthanides. Preparation, reactions, structure and uses of uraniumhexafluoride.

b) Separation Methods

Solvent extraction: Principles and process of solvent extraction; distribution law and partitioncoefficient; Batch extraction, continuous extraction and counter-current distribution.Chromatography: Classification of chromatographic methods; principles of differentialmigration; adsorption phenomenon; nature of the adsorbents; solvent systems and R_f values.

Unit- IV **(16 L)**

a) Study of the following.

Active nitrogen, activated charcoal, allotropy, isomorphism, alloy and amalgams, principles ofIodometry and Iodimetry, resins-cationic and anionic resins, molecular sieves, Carborandum.

b) Inorganic Polymers.

Types of inorganic polymers: Comparison with organic polymers: Important synthesis,structural aspects and application of silicones. Phosphazenes: Uses, structure and bonding inTri- and Tetra- Phosphonitrilic halides.

Unit- V **(16 L)**

a) Metal carbonyls

Preparation, properties, structure and bonding of mono nuclear carbonyls, π-acceptor behavior ofcarbon monoxide, synergic effect (MO diagram of CO be refer for synergic effect refer to IRfrequencies) Carbonylate anions, Ferrocene and its Reactions.

b) Non – Aqueous solvents

Physical properties of a solvent for functioning as an effective reaction medium, types ofsolvents and their general characteristics. Liquid NH_3 as a non – aqueous solvent.

Recommended Books

1. Advanced Inorganic Chemistry Vol I & II: **Satya Prakash, G.D.Tuli, R.D.Madan& S.K Basu**, S.Chand& Co.
2. Selected topics in Inorganic Chemistry: **U.Malik, G.D.Tuli, R.D.Madan,** S.Chand& Co. New Delhi
3. Principles of Inorganic Chemistry: **Puri, Sharma &Kalia**, Vishal Publications, Jalandhar
4. Advanced Inorganic Chemistry Vol. I, II: **Gurdeep Raj**, Goel Publishing House, Meerut
5. Essentials of Nuclear Chemistry: **H.J. Arnikar**, New Age Publication New Delhi
6. Basic Inorganic Chemistry: **Cotton, Wilkinson &Gaus**, Wiley
7. Concise Inorganic Chemistry: **J.D.Lee**(Blackwell Science)
8. Inorganic Chemistry: **Sharpe,** Pearson Education
9. Inorganic Chemistry: **Shiver & Atkins,** Oxford University Press
10. Inorganic Chemistry: **J.E. Huheey, E.A. Keiter& R.L Keiter**
11. Separation Chemistry: **R.P.Budhiraja**; New Age international (P) Ltd. Publishers.

CHEM-402: Inorganic Chemistry
(Pass Course - Practical)

Total Credit: 1

Part I: Volumetric Analysis

(a) Estimation of Ca^{2+} by $KMnO_4$ method and by $K_2Cr_2O_7$ method

(b) CI^- by Mohr's and Volhard's method

(c) Cu^{2+} and CI^- from $CuCI_2$

(d) Zn^{2+} and CI^- from $ZnCI_2$

(e) To determine volumetrically the number of molecules of water of crystallization of $BaCl_2$crystals.

(f)To determine volumetrically the percentage purity of a sample of Potassium Chloride

(g) To estimate Copper as Cupric Oxide in a solution of $CuSO_4$

Part II: Oxidation - Reduction Titrations

a. To estimate the amount of Zinc present in the whole of the given $ZnSO_4$ solution being provideddecinormal Potassium ferrocyanide solution of $ZnSO_4$ crystals.

b. To estimate H_2O_2 by Iodometric method.

Part III: Gravimetric Estimations of Two Constituents

a. To estimate Copper and Zinc in the given solution.

b. To estimate Silver and Zinc in the given solution.

c. To estimate Copper and Magnesium in the given solution.

Note: Experiments may be added/deleted subject to availability of time and facilities

CHEM-403: Quantum Chemistry and Molecular Spectroscopy
(Honours Course - Theory)

Total Credit: 2

Unit –I **(8L)**

Quantum Mechanics-I

Operators: Addition and subtraction of operators, Multiplication of operators, Linear and Non-linear operators, Eigen value and eigen function equations.Construction of Hamilton (H) operator, Schrodinger wave equation and solution of $H\Psi=E\Psi$ forparticle in 1-D box, normalization and orthogonality of Ψ, Postulates of quantum mechanics,nodes in excited state and calculation of average value $\langle x \rangle$, $\langle x^2 \rangle$, $\langle p \rangle$ and $\langle p^2 \rangle$. Schrodingerwave equation for H-atom, Hydrogen like wave function, radial wave function, angular wavefunction.

Unit-II **(8L)**

Quantum Mechanics – II

Molecular orbital theory, basic ideas- criteria for forming M.O from A.O, construction of M.O'sby LCAO- H_2^+ ion, calculation of energy levels from wave functions, physical picture ofbonding and antibonding wave functions, concept of σ, σ^*, π, π^* orbitals and theircharacteristics. Hybrid orbitals-sp, sp^2, sp^3 calculation of coefficients of A.O's used in thesehybrid orbitals. Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

Unit-III **(8L)**

Introduction to Spectroscopy

Introduction: electromagnetic radiation, region of the spectrum, basic features of differentspectrometer, statement of Born-Oppenheimer approximation, degrees of freedom. Rotational(rigid rotor model) and Vibrational (harmonic oscillator model) spectra of diatomic molecules,frequency expressions, selections rules, spectral intensity, determination of bond length, isotopeeffect.

Unit-IV **(8L)**

Vibrational spectrum

Infrared spectrum: energy level of simple harmonic oscillator, selection rules, pure Vibrationalspectrum, intensity, determination of force constant and qualitative relation of force constant andbond energies, effect of an harmonic motion and isotope on the spectrum, idea of Vibrationalfrequencies of different functional groups.

Unit-V **(8L)**

Rotational spectroscopy

Diatomic molecules, energy levels of a rigid rotator (semi-classical principles) selection rules,spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution)qualitative description of non-rigid rotator.

Recommended Books

1. Principles of Physical Chemistry: **Puri, Sharma and Pathania**, Vishal Publishing Co.

2. Physical Chemistry, **T.W. Atkins**, Oxford University Press

3. Introductory Quantum Chemistry, **A.K. Chandra**, Tata McGraw Hill

4. Quantum Chemistry, **I. Levine**, Tata McGraw Hill

5. Fundamental of Molecular Spectroscopy, **Collin N. Banwell and Elaine M. Mccash**, Tata McGraw Hill

6. Quantum Chemistry: **R.K.Prasad**, New Age International Publishers, New Delhi

CHEM-404: Advance Practical-1
(Honours Course - Practical)

Total Credit: 1

On the basis of the result of the draw of lot before the practical examination, a student will haveto perform two experiments among the following three sections.

Part I: Physical

(a) Determination of the strength of a given ferrous sulfate solution potentiometrically.
(b) Verification of Beer-Lambert's law using copper sulfate or $K_2Cr_2O_7$ solution colorimetricallyand determination of the concentration of the above solution.
(c) Decomposition of hydrogen peroxide using ferric chloride as catalyst and to determine theactivation energy.

Part II: Organic

(i) Preparation of acetanilide from aniline (ii) Preparation of aspirin from Salicylic acid (iii)Preparation of benzanilide from aniline (iv) Preparation of 2,4,6- tribromophenol from Phenol.(v) Preparation of Methyl orange

Yield and quality of the compoundRecrystallisation and melting point

Part III: Inorganic

A. Inorganic Preparations

Preparation of the following
(a) TetrammineCu(II) sulphate
(b) HexammineNi(II) chloride
(c)Potassium trioxalato ferrate (III)
(d) Poatssiumtrioxalato chromate (III)
(e) Cu (Thiourea) complex
(f) Ammonium ferric sulphate
(g)Nitro pentamminecobalt(III)chloride
(h)Reineck Salt (i)Potassiumtrioxalato chromate (III)
(j)Potassium chlorochromate

Characterization of the compound prepared, students should recrystallize the product and verifythe presence of anion and cations by qualitative analysis.
Yield and quality of the compound.
Detection of anion and cations.

Note: Experiments may be added/deleted subject to availability of time and facilities

SEMESTER-V

CHEM-501: Organic Chemistry
(Pass Course - Theory)

Total Credit: 4

Unit-I **(16L)**

a) Carboxylic Acids and its derivatives

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects ofsubstituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids.Hell-Volhard-Zelinsky reaction. Reduction of carboxylic acids. Mechanism of decarboxylation.Structure, nomenclature and preparation of esters, amides (urea), acid anhydride. Physicalproperties and chemical properties of esters, amides acid anhydrides.

b) Active methylene compounds

Tautomerism (keto-enol), difference between tautomerism and resonance, synthetic applicationof Diethyl malonate, Ethyl acetoacetate, Ethyl cyanoacetate.

Unit-II **(16L)**

a) Nitro compounds

General methods of preparation, chemical reactions of nitroalkanes, reductions in acidic, neutraland alkaline media, hydrolysis, reaction with nitrous acid, acidic nature, Picric acid.

b) Amines

Structure and nomenclature of amines, Preparation of amines, physical properties, Structuralfeatures effecting basicity of amines, Preparation of alkyl and aryl amines (reduction of nitrocompounds nitriles), reductive amination of aldehydic and ketonic compounds. Chemicalreactivity, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrousacid. Gabriel-Phthalimide reaction, Hofmann bromide reaction. Distinction between primary,secondary and tertiary amines and their separation.

Unit-III **(16L)**

a) Organometallic Compounds

Organomagnesium compounds: Formation of Grignard Reagent, synthesis of alkanes, alcohols,carboxylic acids, aldehydes, ketones, amines with Grignard Reagent.Organolithium compounds: Preparation and synthetic use of alkyl Lithium.

b) Amino Acids, Peptides and Proteins

Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectricpoint and electrophoresis. Preparation and reactions of ά-amino acids. Structure andnomenclature of peptides and proteins. Classification of proteins.

Unit-IV **(16L)**

a) Carbohydrates-I

Classification and nomenclature. Monosaccharides. Mechanism of osazone formation,interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses.Configuration of monosaccharides. Erythro and threodiastereomers. Conversion of glucose intomannose. Formation of glycosides, ethers and esters. Cyclic structure of D(+)- glucose.Mechanism of mutarotation.

Unit-V

(a) Synthetic Dyes **(16L)**

Colour and constitution (electronic concept). Classification of dyes. Chemistry and synthesis ofMethyl orange, Congo red, Malachite green, crystal violet, Phenolphthalein, Fluorescein,Alizarin and indigo

(b) Diazo compounds

Preparation and stability of diazo compounds (aliphatic and aromatic). Reactions of benzenediazonium chloride. Preparation and reaction of diazomethane

Recommended Books

1. Organic Chemistry: **Morrison and Boyd**, Prentice Hall of India Pvt. Ltd. New Delhi
2. Organic Chemistry: Mukherji, Singh and Kapoor. Vol: 1, II and III, New Age Publications
3. Organic Chemistry: Jagdamba Singh &L.D.S.YadavVol-I, II, III, PragatiPrakashan, Meerut.
4. A Text Book of Organic Chemistry, A. Bahl and B.S. Bahl, S. Chand & Co. New Delhi
5. Organic Chemistry, Paula Y. Bruice, Prentice Hall.
6. Organic Chemistry, S.H. Pine, Mc-Graw Hill

CHEM-502: Organic Chemistry
(Pass Course - practical)

Total Credit: 1

a) Identification of the compound with the help of a reference book.

b) Determination of pH of given aerated drinks, fruit juices,shampoos and soaps.

Note: Experiments may be added/deleted subject to availability of time and facilities

CHEM-503: Analytical Chemistry & Application of Spectroscopy
(Honours Course -Theory)

Total Credit: 2

Part-I: Analytical Chemistry

Unit-1 **(8L)**

a) Thermal method of analysis: Theory of thermogravimetry(TG), basic principle ofinstrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

b) Precipitation: Desirable properties of gravimetric precipitates. Formation of gravimetricprecipitates. Conditions for quantitative precipitation. Contamination in precipitates. Methods forremoving impurities in precipitates. Organic precipitants (oxine, dithiozone, α-nitroso, β-naphthol, cupeferron, dimethyl glyoxime) in chemical analysis.

Unit-II **(8 L)**

a) Electro analytical methods: Classification of electro analytical methods, basic principle of pHmetric, potentiometric and conductometric titrations. Techniques used for the determination ofequivalence point. Techniques used for the determination of pK_a values.

b) Development of chromatograms: Frontal, elution and displacement methods. Qualitative andquantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Unit-III **(8L)**

Spectrophotometry: Beer's law and its limitations, nomenclature and units. Generalinstrumentation for spectrophotometry, spectrophotometric determination of one component(iron, chromium, manganese, nickel, titanium and phosphorus) and two components(overlapping and non-overlapping) systems, spectrophotometric determinations of dissociationconstants of an indicator, photometric errors and RINGBOM-AYRES plots.

Part-II: Application of Spectroscopy

Unit-IV **(8L)**

Organic spectroscopy

IR Spectrometry: General Principles, IR Spectroscopy: Fundamental and Non-fundamentalmolecular vibrations; IR absorption positions of O, N and S containing functionalgroups; Effect of H- bonding on IR absorptions; Fingerprint region and its significance;application in functional group analysis.

UV Spectroscopy: Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic Shifts, Intensity ofAbsorption; Application of Woodward Rules for calculation of λ_{max} for the following systems:α, β-unsaturated Aldehydes, Ketones, carboxylic acids and esters; Conjugated dienes: alicyclic,homoannular and heteroannular; Extended conjugated systems (Aldehydes, ketones and dienes);*Cis*and *trans* isomers.

Unit-V **(8L)**

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, Chemical Shift andfactors influencing it; Spin-Spin Coupling and Coupling constant; Anisotropic Effects inAlkene, alkyne, Cycloalkane, Carbonyl compounds and benzene; Study of AX, AX_2, AX_3,A_2X_3 and AMX Patterns of NMR spectra. Applications of IR, NMR and UV in StructuralIdentification of Simple Organic Molecules.

Recommended Books

1. Instrumental Methods of Analysis, **H.H. Willard, L.L.Meritt, J.A.Dean, F.A.Settle.** CBS Publications
2. Vogel's Text Book of Quantitative Chemical Analysis, **J.Mendham, R.C. Denney, J.D.Barnes andM.J.Thomas**. Pearson Education
3. Essentials of Nuclear Chemistry, **H.J.Arnikar**, Wiley Eastern
4. Basic Concept of Analytical Chemistry, **S.M. Khopkar**, New Age International Publishers
5. Spectroscopy of Organic Compounds, **P.S.Kalsi**, New Age International Publishers
6. Elementary Organic Spectroscopy, **Y.R. Sharma**, S. Chand & Co. New Delhi
7. Separation Chemistry: **R.P.Budhiraja**, New Age Publications, New Delhi

CHEM-504: Advance Practical -II
(Honours Course - Practical)

Total Credit: 1

On the basis of the result of the draw of lot before the practical examination, a student will haveto perform two experiments among the following three sections.

Part I: Inorganic

Quantitative Analysis
Gravimetric Estimation of (a) Ag^{+} (b) Zn^{2+} (c) Ba^{2+}
Estimation (volumetrically or gravimetrically) of the following constituents from the mixturesof:
(a) Iron-Calcium (b) Iron-Copper (c) Copper-Zinc
(d) Calcium-Barium (e) Copper-Nickel .
Complexometric titration using EDTA for estimation of (i) Mg^{2+} and (ii) Zn^{2+}.

(Only one experiment will be selected from each part by a candidate by drawing lot during theexamination.)

Part II: Organic

Chromatography
a) Separation of mixtures.
b) Separate and identify the monosaccharide's present in the given mixture (glucose andfructose) by paper chromatography. Report the $R_f$values
c) Chromatographic separation of the active ingredients of plant, flower and juices by TLC.

Part III: Physical
a) Determination of order of reaction, rate constant and energy of activation forsaponific-ation of an ester by NaOH, conductometrically.
b) Determination of strength of strong and weak acids in a mixture, conductometrically.
c) Determination of critical micellar concentration (CMC) of sodium lauryl sulphate fromthe measurement of conductivities at different concentrations.
d) Determination of strengths of halides in a mixture, potentiometrically.

Note: Experiments may be added/deleted subject to availability of time and facilities

SEMESTER-VI

CHEM-601: Physical Chemistry
(Pass Course- Theory)

Total Credit:4

Unit-1 **(16L)**

a) Colloids

Definition, classification of colloids, solid in liquid colloids (sols), preparation of sols, properties-Kinetic, optical and electrical properties, stability of colloids, protective actions, Hardy-Schulze rule, gold number. Liquids in liquids (Emulsions)- classification and properties, gel, surfactants and micelles, inhibition, general application of colloids.

b) Adsorption and Catalysis,

Theories of adsorption- Freundlich and Langmuir adsorption isotherm (derivation and limiting cases), Ion-exchange adsorption and its applications. Catalysis: characteristic of catalyzed reactions, types of catalysis with examples, Theories of catalysis, Acid-Base catalysis, mechanism of enzyme catalysed reaction- MichaelisMenten equation.

Unit-II **(16L)**

Gaseous state –II

Real gases- deviation from ideality, compressibility factor, Maxwell's distribution law ofmolecular speeds, molecular speeds and energy distribution as a function of temperature,calculation of most probable velocity, root mean square velocity, average velocity fromMaxwell's distribution law. Maxwell-Boltzmann law of distribution of molecular velocities,degrees of motion, principle of equipartition of energy, viscosity of gases, Boyle temperature,critical phenomena-critical constants, p-v isotherm of CO_2, continuity of state, law ofcorresponding states and reduced equation of state, methods of liquefaction of gases.

Unit-III **(16L)**

(a) Chemical equilibria

Law of mass action, equilibrium constant (K_c) from thermodynamic derivation of law of massaction, temperature and pressure dependence of equilibrium constant (K_p and K_c)- van't Hoff equation,relation between K_p and K_c, equilibria in homogeneous and heterogeneous system, le Chatelier'sprinciple, Clausius-Clapeyron equation and its applications.

(b) Ionic Equilibria

Dissociation equilibria of weak electrolytes, dissociation constant of weak acids (K_a), ionicproduct of water (K_w), hydrogen ion concentration and pH scale, Common ion effects, Buffersolution and buffer activity, calculation of pH values of buffer's mixtures. Henderson-Hasselbalch equation, hydrolysis constant of a base (K_b), relation between K_a, K_w and K_b.Derivation of hydrolysis constant for salts of :- i) strong acids and weak base, ii) weak acids andstrong base and iii) weak acids and weak bases. Solubility product and its application.

Unit-IV **(16L)**

Liquid State –II

Qualitative description of the structure of liquids, physical properties of liquids-vapour pressure,surface tension, viscosity, refractive index (definitions and descriptions), determination of surfacetension, viscosity and refractive index of liquids. Physical properties and chemical constitution- additiveand constitutive properties, molar volume, parachor, specific and molar refraction. Polarand non-polar liquids, dielectric constant, dipole moment, structure of molecules, polarization,Clausius-Mossotti equation

Unit-V **(16L)**

Photochemistry

Introduction, difference between thermal and photochemical process, Beer-Lambert law, Laws of photochemistry- Grothus- Draper's law, Stark-Einstein law, Quantum efficiency and quantum yield, Jablonski diagram depicting various process occurring in the excited state, Fluorescence, Phosphorescence, non-radiative processes (internal conversion, intersystem crossing), Photosensitized reactions- energy transferred processes (simple examples).

Recommended Books

1. .Principles of Physical Chemistry: **Puri, Sharma and Pathania**, Vishal Publishing Co.
2. Advanced Physical Chemistry: **D.N. Bajpai**, S.Chand& company Ltd, New Delhi.
3. An Introduction to Chemical Thermodynamics: **R.P. Rastogi and R.R. Misra**, Vikas Publications, New Delhi.
4. Chemical Kinetics: **Laidler, Harper and Row**.
5. Physical Chemistry, **T.W. Atkins**, Oxford University Press
6. An Introduction to Chemical Thermodynamics: **R.P. Rastogi and R.R. Misra**, Vikas Publications, New Delhi.

CHEM-602: Physical Chemistry
(Pass Course - Practical)

Total Credit: 1

List of Experiments:

1) To study the kinetics of iodination of acetone.

2) To study the kinetics of a second order reaction (saponification of ethyl acetate).

3) Determination of critical solution temperature and composition of the phenol-water systemand to study the effect of impurities on it.

4) Determination of enthalpy of hydration of copper sulphate.

5) pH metric titrations of

   i) Strong acid and strong base

   ii) Weak acid and strong base

Note: Experiments may be added/deleted subject to availability of time and facilities

CHEM -603 Choice Based Credit Paper
(Honours Course –Theory)

The Elective papers selected are:

1. Biological Chemistry
2. Nano Chemistry
3. Environmental and Green Chemistry
4. Medicinal Chemistry