NOWGONG COLLEGE

(Autonomous)

SYLLABUS

Department of Chemistry

Learning Outcome-based Curriculum Framework (LOCF) of Four Year Undergraduate Programme Choice-based Credit System with flexibility

Effective from Academic Year 2023-24

Syllabus is approved in Academic Council, Nowgong College (Autonomous)

Dated: 30th June, 2023

Course and Credit Structure

Semester	Major (Maj)	Minor (Min)	Inter-Disciplinary	AEC	SEC	VAC (Any Two)	Summer Internship	Research Project/Dissertation	Total
I	CHEM- MAJ-1014 (Fundamentals of Chemistry-I)	CHEM-MIN-1014 (Fundamentals of Chemistry-I)	CHEM -IDC-1014 (Fundamentals of Chemistry-I)	ASSA/HIND/BENG-AEC-1012 Jugajogmulok Axomiya/ Vyakaran Evam Vyavaharik Hindi/Byowoharic Bangla – I	CHEM - SEC-1014 (Basic Analytical Chemistry)	UNIN-VAC-1012 (Understanding India) ENSC-VAC-1012 (Environmental Science) NASS-VAC-1012 (National Service Scheme)	---	---	22
II	CHEM - MAJ-2014 (Fundamentals of Chemistry-II)	CHEM-MIN-2014 (Fundamentals of Chemistry-II)	CHEM -IDC-2014 (Fundamentals of Chemistry-II)	ASSA/HIND/BENG -AEC-2012 Byowoharic Axomiya/ Karyalayi Hindi /Byowoharic Bangla – II	CHEM - SEC-2014 (Pesticide Chemistry)	DITS-VAC-2012 (Digital Technological Solutions) YOMH-VAC-2012 (Yoga and Mental Health) NACC-VAC-2012 (National Cadet Corps)	---	---	22
Certificate after 1 year									

III	CHEM - MAJ-3014 (Physical Chemistry-I) CHEM - MAJ-3024 (Organic Chemistry-I)	CHEM -MIN-3014 (Chemical Energetics, Equilibria & Functional Organic Chemistry-I)	CHEM -IDC-3014 (Analytical Clinical Biochemistry)	ENGL-AEC-3012 (English and Mass Communication)	CHEM - SEC-3014 (Fuel Chemistry)	------	----	--------	22
IV	CHEM - MAJ-4014 (Physical Chemistry-II) CHEM - MAJ-4024 (Organic Chemistry-II) CHEM - MAJ-4034 (Inorganic Chemistry-I) CHEM-MAJ-4044 (Quantum Chemistry and Group Theory)	CHEM-MIN-4014 (Solutions, Phase Equilibrium, Conductance, Electrochemistry & Carboxylia Acids, Amino Acids and Carbohydrates)	-------	ENGL-AEC-4012 (Academic Writing)	------	----	---------	------	22
Diploma after 2 years									
	CHEM - MAJ-5014 (Physical Chemistry-III)	CHEM -MIN-5014 (Analytical	-------	------	-------	-------	CHM-INTE-5012 (Internship)	-------	

V	CHEM - MAJ-5024 (Organic Chemistry-III) CHEM - MAJ-5034 (Inorganic Chemistry-III) CHEM - MAJ-5044 (Quantum and Spectroscopy-I)	Methods in Chemistry)					(Polymer Science & Technology)		22
VI	CHEM - MAJ-6014 (Physical Chemistry-V) CHEM - MAJ-6024 (Organic Chemistry-IV) CHEM - MAJ-6034 (Inorganic Chemistry-IV) CHEM - MAJ-6044 (Molecular Spectroscopy) CHEM-MAJ-6052 (Project /Dissertation)	CHEM -MIN-6014 (Industrial Chemicals and Environment)	-------	----	-----	---------	----	------	22
Degree after 3 years (with Major/Minor)									

VII	CHEM - MAJ-7014 (Physical Chemistry-VI) CHEM - MAJ-7024 (Organic Chemistry-VI) CHEM - MAJ-7034 (Inorganic Chemistry-VII)	CHEM-MIN-7014 (Polymer Chemistry)	------ ---	------ --	------- --	----------	REET-VAC-7012 (Research Ethics)	REME - MAJ-7044 (Research Methodology)	22
VIII	CHEM - MAJ-8014 (Analytical Methods in Chemistry)	CHEM -MIN-8014 (Green Chemistry)				---------	INPR-VAC-8012 (Intellectual Property Right)	CHEM -DISS-80112 (Dissertation) (Those who are undertaking Research Project or Dissertation) OR CHEM-MAJ-8024 (Physical Chemistry) CHEM-MAJ-8034 (Foundation of Organic Synthesis) CHEM-MAJ-8044 (Biochemistry) (Those who are not undertaking Research Project or Dissertation)	22
Degree after 4 years (with Honours/by Research)									176

N.B.: 1. 4 credit papers = 100 marks (60T+20IA+20P)

2. 2 credit papers = 50 marks (30T+10IA+10P) & AEC: 50 marks (40T+10IA)

Question Pattern:

- For 100 marks papers [1 marks x 7 (no option) , 2 marks x 4(no option) , 5 marks x 3 (5 options), 10 marks x 3 (5 options)]
- For 50 marks papers [1marks x 4 (no option), 2 marks x 3 (no option), 5 marks x 2 (4 options), 10 marks x 1 (2 options)]
- For AEC 50 marks papers [1 marks x 4 (no options) , 2 marks x 3 (no options), 5 marks x 2 (4 options), 10 marks x 2 (4 options)]

Semester I
Major Course
Course Code: CHEM-MAJ-1014
Course Paper: Fundamentals of Chemistry-I
Credit-4 (3T+1P)
Total no. of Lectures: 45L+15P Total Marks: 100 (T60+IA20+P20)

Objective: This course may be divided into two broad parts-inorganic and organic chemistry. In inorganic chemistry part the students will be taught atomic structure, chemical bonding and molecular structure. The organic chemistry part contains fundamentals oforganic chemistry, stereochemistry and aliphatic hydrocarbons.

Learning Outcome: After completion of this course the students will learn the atomic structure through the basic concepts of quantum mechanics. They will understand the chemical bonding through VB and MO approaches. In organic part, students are expected to learn basic ideas that effect properties of organic compounds and about aliphatic hydrocarbon such as alkanes, alkenes.

CONTENTS
THEORY

UNIT 1: INORGANIC CHEMISTRY

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes andtheir significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbitalangular momentum and quantum numbers *ml* and *ms*. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantumnumber (*ms*).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

(10 Lectures)

UNIT 2: CHEMICAL BONDING AND MOLECULAR STRUCTURE

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stabilityand solubility of ionic compounds. Statement of Born-Landé equation for calculation oflattice energy, Born-Haber cycle and its applications, polarizing power and polarizability.Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment andpercentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods

(including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and $NO^{+.}$ Comparison of VB and MO approaches.

(15 Lectures)

UNIT 3: FUNDAMENTALS OF ORGANIC CHEMISTRY

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonanceand Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.
Reactive Intermediates in Organic Reactions :
Formation, structure and stability of reactive intermediates: Carbocations, Carbanions, Radicals, Carbenes, Nitrenes, Benzyne (Brief mechanistic perspective using concepts of Substitution, Addition, Elimination and Rearrangements reactions)
Strength of organic acids and bases: Comparative study with emphasis on factors affectingpKa values. Aromaticity: Benzenoids and Hückel's rule.
Stereochemistry of organic molecules
Representation of organic molecules in 2D and 3D (Fischer, Newman and Sawhorse Projection formulae and their interconversions); Geometrical isomerism (cis-trans, syn-anti, E/Z, R/S notations); Concept of chirality (enantiomers and diastereomers); Configuration and Conformation, Barriers to rotation, Conformational Analysis (ethane, butane, cyclohexane)

(10 Lectures)

UNIT 4: ALIPHATIC HYDROCARBONS

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe'ssynthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes anddehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$)and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff'saddition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

(10 Lectures)

Suggested Readings:

1. J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
2. F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
3. Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*,John Wiley.
4. James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principlesof Structure and Reactivity*, Pearson Publication.
5. T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
6. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
7. E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
8. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand

PRACTICAL: CHEMISTRY1

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of oxalic acid by titrating it with $KMnO_4$.
2. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
3. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
4. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) anddistillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yieldsto be done.

(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols
(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Suggested Readings:

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

SEMESTER-II
Major Course
Course Code: CHEM-MAJ-2014
Course Paper: Fundamentals of Chemistry-II
Credit-4 (3T+1P)
Total no. of Lectures: 45L+15P Total Marks: 100 (T60+IA20+P20)

Objective: This course may be divided into two broad parts-inorganic and physical chemistry. Three units-main group elements, transition elements and co-ordination chemistry will be taught in the inorganic chemistry part. The physical chemistry part contains thermodynamics and states of matter.

Learning Outcome: After completion of this course the students will learn periodic properties in main group elements, transition metals (3d series). They will also learn the crystal field theory in coordination chemistry unit. In physical chemistry part, the students are expected to learn kinetic theory of gases, ideal gas and real gases, surface tension, viscosity, basic solid state chemistry and thermodynamics.

CONTENTS
THEORY

UNIT 1: INORGANIC CHEMISTRY

s-and *p*-Block Elements

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first memberof each group.

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of variousoxidation states (Latimer diagrams) for Mn, Fe and Cu.

(15Lectures)

UNIT 2: COORDINATION CHEMISTRY

Coordination compounds, types of ligands, Werner's theory, IUPAC nomenclature and isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers.

(5 Lectures)

UNIT 3: PHYSICAL CHEMISTRY

Gases and Liquids

Gases:
Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation ofreal gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2.
Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.
Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).
Liquids:
Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

(10 Lectures)

UNIT 4: CHEMICAL THERMODYNAMICS-I

Intensive and extensive variables; state and path functions; isolated, closed and open systems;zeroth law of thermodynamics.

First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible,irreversible and free expansion of gases (ideal and van der Waals) under isothermal andadiabatic conditions. Law of equipartition of energy, degrees of freedom and molecular basisof heat capacities.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules andions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

(15 Lectures)

Suggested Readings:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage LearningIndia Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York(1985).
6. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.
7. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.

8. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
9. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd.,2008.

PRACTICAL: CHEMISTRY2

s- AND *p*-BLOCK ELEMENTS, TRANSITION ELEMENTS, COORDINATION CHEMISTRY STATES OF MATTER & CHEMICALKINETICS

SECTION A: INORGANIC CHEMISTRY

Semi-micro qualitative analysis using H_2S of mixtures - not more than four ionic species (twoanions and two cations and excluding insoluble salts) out of the following:

CO_3^{2-} , NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+},, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+}, Mg^{2+}

(Spot tests should be carried out wherever feasible)

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/ $CuSO_4$) and estimate the concentration of the same in a given solution.
3. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
4. Estimation of total hardness of a given sample of water by complexometric titration.

SECTION B: PHYSICAL CHEMISTRY

(I) Surface tension measurement (use of organic solvents excluded).

a) Determination of the surface tension of a liquid or a dilute solution using astalagmometer.

b) Study of the variation of surface tension of a detergent solution with concentration.

(II) Chemical Kinetics

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis ofmethyl acetate

Suggested Readings:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R.Chand & Co.: New Delhi (2011).

MINOR COURSE SYLLABUS

Semester I
Minor Course
Course Code: CHEM-MIN-1014
Credit-4 (3T+1P)
Total no. of Lectures: 45L+15P **Total Marks: 100 (T60+IA20+P20)**

Objective: This course may be divided into two broad parts-inorganic and organic chemistry. In inorganic chemistry part the students will be taught atomic structure, chemical bonding and molecular structure. The organic chemistry part contains fundamentals oforganic chemistry, stereochemistry and aliphatic hydrocarbons.

Learning Outcome: After completion of this course the students will learn the atomic structure through the basic concepts of quantum mechanics. They will understand the chemical bonding through VB and MO approaches. In organic part, students are expected to learn basic ideas that effect properties of organic compounds and about aliphatic hydrocarbon such as alkanes, alkenes.

CONTENTS
THEORY

UNIT 1: INORGANIC CHEMISTRY

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes andtheir significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbitalangular momentum and quantum numbers *ml* and *ms*. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantumnumber (*ms*).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

(10 Lectures)

UNIT 2: CHEMICAL BONDING AND MOLECULAR STRUCTURE

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stabilityand solubility of ionic compounds. Statement of Born-Landé equation for

calculation oflattice energy, Born-Haber cycle and its applications, polarizing power and polarizability.Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment andpercentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods

(including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and $NO^{+.}$ Comparison of VB and MO approaches.

(15 Lectures)

UNIT 3: FUNDAMENTALS OF ORGANIC CHEMISTRY

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.
Reactive Intermediates in Organic Reactions :
Formation, structure and stability of reactive intermediates: Carbocations, Carbanions, Radicals, Carbenes, Nitrenes, Benzyne (Brief mechanistic perspective using concepts of Substitution, Addition, Elimination and Rearrangements reactions)
Strength of organic acids and bases: Comparative study with emphasis on factors affectingpKa values. Aromaticity: Benzenoids and Hückel's rule.
Stereochemistry of organic molecules
Representation of organic molecules in 2D and 3D (Fischer, Newman and Sawhorse Projection formulae and their interconversions); Geometrical isomerism (cis-trans, syn-anti, E/Z, R/S notations); Concept of chirality (enantiomers and diastereomers); Configuration and Conformation, Barriers to rotation, Conformational Analysis (ethane, butane, cyclohexane)

(10 Lectures)

UNIT 4: ALIPHATIC HYDROCARBONS

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe'ssynthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes anddehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$)and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff'saddition), Hydration, Ozonolysis, oxymecuration-demercuration,

Hydroboration-oxidation.

(10 Lectures)

Suggested Readings:

1. J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
2. F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
3. Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*,John Wiley.
4. James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principlesof Structure and Reactivity*, Pearson Publication.
5. T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
6. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
7. E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
8. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand

PRACTICAL: CHEMISTRY1

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of oxalic acid by titrating it with $KMnO_4$.
2. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
3. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
4. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

SECTION B: ORGANIC CHEMISTRY

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yieldsto be done.
   (d) Bromination of Phenol/Aniline
   (e) Benzoylation of amines/phenols
   (f) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Suggested Readings:

a) Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
b) Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
c) Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
d) Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960

Semester II
Minor Course
Course Code: CHEM-MIN-2014
Course Paper: Fundamentals of Chemistry-II
Credit-4 (3T+1P)
Total no. of Lectures: 45L+15P **Total Marks: 100 (T60+IA20+P20)**

Objective: This course may be divided into two broad parts-inorganic and physical chemistry. Three units-main group elements, transition elements and co-ordination chemistry will be taught in the inorganic chemistry part. The physical chemistry part contains thermodynamics and states of matter.

Learning Outcome: After completion of this course the students will learn periodic properties in main group elements, transition metals (3d series). They will also learn the crystal field theory in coordination chemistry unit. In physical chemistry part, the students are expected to learn kinetic theory of gases, ideal gas and real gases, surface tension, viscosity, basic solid state chemistry and thermodynamics.

CONTENTS
THEORY

UNIT 1: INORGANIC CHEMISTRY

s-and *p*-Block Elements

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first memberof each group.

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of variousoxidation states (Latimer diagrams) for Mn, Fe and Cu.

(15Lectures)

UNIT 2: COORDINATION CHEMISTRY

Coordination compounds, types of ligands, Werner's theory, IUPAC nomenclature and isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers.

(5 Lectures)

UNIT 3: PHYSICAL CHEMISTRY

Gases and Liquids

Gases:
Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation ofreal gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2.
Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.
Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).
Liquids:
Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

(10 Lectures)

UNIT 4: CHEMICAL THERMODYNAMICS-I

Intensive and extensive variables; state and path functions; isolated, closed and open systems;zeroth law of thermodynamics.

First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible,irreversible and free expansion of gases (ideal and van der Waals) under isothermal andadiabatic conditions. Law of equipartition of energy, degrees of freedom and molecular basisof heat capacities.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules andions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

(15 Lectures)

Suggested Readings:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.
7. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.

8. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
9. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd.,2008.

PRACTICAL: CHEMISTRY2

s- AND *p*-BLOCK ELEMENTS, TRANSITION ELEMENTS, COORDINATION CHEMISTRY STATES OF MATTER & CHEMICALKINETICS

SECTION A: INORGANIC CHEMISTRY

Semi-micro qualitative analysis using H_2S of mixtures - not more than four ionic species (twoanions and two cations and excluding insoluble salts) out of the following:

CO_3^{2-} , NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+},, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+}, Mg^{2+}

(Spot tests should be carried out wherever feasible)

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/ $CuSO_4$) and estimate the concentration of the same in a given solution.
3. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
4. Estimation of total hardness of a given sample of water by complexometric titration.

Section B: Physical Chemistry

(III) Surface tension measurement (use of organic solvents excluded).
- a) Determination of the surface tension of a liquid or a dilute solution using astalagmometer.
- b) Study of the variation of surface tension of a detergent solution with concentration.

(IV) Chemical Kinetics

Study the kinetics of the following reactions.

3. Initial rate method: Iodide-persulphate reaction
4. Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.
c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis ofmethyl acetate

Suggested Readings:

a) Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
b) Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
c) Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

INTERDISCIPLINARY COURSE SYLLABUS

Semester I
Course Code: CHEM-IDC-1014
Course Paper: Fundamentals of Chemistry-I
Credit-4 (3T+1P)
Total no. of Lectures: 45L+15P Total Marks: 100 (T60+IA20+P20)

Objective: This course may be divided into two broad parts-inorganic and organic chemistry. In inorganic chemistry part the students will be taught atomic structure, chemical bonding and molecular structure. The organic chemistry part contains fundamentals oforganic chemistry, stereochemistry and aliphatic hydrocarbons.

Learning Outcome: After completion of this course the students will learn the atomic structure through the basic concepts of quantum mechanics. They will understand the chemical bonding through VB and MO approaches. In organic part, students are expected to learn basic ideas that effect properties of organic compounds and about aliphatic hydrocarbon such as alkanes, alkenes.

CONTENTS
THEORY

UNIT 1: INORGANIC CHEMISTRY

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes andtheir significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbitalangular momentum and quantum numbers *ml* and *ms*. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantumnumber (*ms*).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

(10 Lectures)

UNIT 2: CHEMICAL BONDING AND MOLECULAR STRUCTURE

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of

stabilityand solubility of ionic compounds. Statement of Born-Landé equation for calculation oflattice energy, Born-Haber cycle and its applications, polarizing power and polarizability.Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment andpercentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods

(including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and $NO^{+.}$ Comparison of VB and MO approaches.

(15 Lectures)

UNIT 3: FUNDAMENTALS OF ORGANIC CHEMISTRY

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonanceand Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.
Reactive Intermediates in Organic Reactions :
Formation, structure and stability of reactive intermediates: Carbocations, Carbanions, Radicals, Carbenes, Nitrenes, Benzyne (Brief mechanistic perspective using concepts of Substitution, Addition, Elimination and Rearrangements reactions)
Strength of organic acids and bases: Comparative study with emphasis on factors affectingpKa values. Aromaticity: Benzenoids and Hückel's rule.
Stereochemistry of organic molecules
Representation of organic molecules in 2D and 3D (Fischer, Newman and Sawhorse Projection formulae and their interconversions); Geometrical isomerism (cis-trans, syn-anti, E/Z, R/S notations); Concept of chirality (enantiomers and diastereomers); Configuration and Conformation, Barriers to rotation, Conformational Analysis (ethane, butane, cyclohexane)

(10 Lectures)

UNIT 4: ALIPHATIC HYDROCARBONS

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe'ssynthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes anddehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk.

$KMnO_4$)and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff'saddition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

(10 Lectures)

Suggested Readings:

1. J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
2. F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
3. Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*,John Wiley.
4. James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principlesof Structure and Reactivity*, Pearson Publication.
5. T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
6. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
7. E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
8. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand

PRACTICAL: CHEMISTRY1

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of oxalic acid by titrating it with $KMnO_4$.
2. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
3. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
4. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yieldsto be done.
    a) Bromination of Phenol/Aniline
    b) Benzoylation of amines/phenols
    c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Suggested Readings:

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

SEMESTER-II
Interdisciplinary Course
Course Code: CHEM-IDC-2014
Course Paper: Fundamentals of Chemistry-II
Credit-4 (3T+1P)
Total no. of Lectures: 45L+15P Total Marks: 100 (T60+IA20+P20)

Objective: This course may be divided into two broad parts-inorganic and physical chemistry. Three units-main group elements, transition elements and co-ordination chemistry will be taught in the inorganic chemistry part. The physical chemistry part contains thermodynamics and states of matter.

Learning Outcome: After completion of this course the students will learn periodic properties in main group elements, transition metals (3d series). They will also learn the crystal field theory in coordination chemistry unit. In physical chemistry part, the students are expected to learn kinetic theory of gases, ideal gas and real gases, surface tension, viscosity, basic solid state chemistry and thermodynamics.

CONTENTS
THEORY

UNIT 1: INORGANIC CHEMISTRY

s-and *p*-Block Elements

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first memberof each group.

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of variousoxidation states (Latimer diagrams) for Mn, Fe and Cu.

(15Lectures)

UNIT 2: COORDINATION CHEMISTRY

Coordination compounds, types of ligands, Werner's theory, IUPAC nomenclature and isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers.

(5 Lectures)

UNIT 3: PHYSICAL CHEMISTRY

Gases and Liquids

Gases:
Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation ofreal gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2.
Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.
Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).
Liquids:
Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

(10 Lectures)

UNIT 4: CHEMICAL THERMODYNAMICS-I

Intensive and extensive variables; state and path functions; isolated, closed and open systems;zeroth law of thermodynamics.

First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible,irreversible and free expansion of gases (ideal and van der Waals) under isothermal andadiabatic conditions. Law of equipartition of energy, degrees of freedom and molecular basisof heat capacities.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules andions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

(15 Lectures)

Suggested Readings:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).

5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.
7. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
8. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
9. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd.,2008.

PRACTICAL: CHEMISTRY2

s- AND *p*-BLOCK ELEMENTS, TRANSITION ELEMENTS, COORDINATION CHEMISTRY STATES OF MATTER & CHEMICALKINETICS

SECTION A: INORGANIC CHEMISTRY

Semi-micro qualitative analysis using H_2S of mixtures - not more than four ionic species (twoanions and two cations and excluding insoluble salts) out of the following:

CO_3^{2-} , NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+},, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+}, Mg^{2+}

(Spot tests should be carried out wherever feasible)

5. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
6. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/ $CuSO_4$) and estimate the concentration of the same in a given solution.
7. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
8. Estimation of total hardness of a given sample of water by complexometric titration.

Section B: Physical Chemistry

(V) Surface tension measurement (use of organic solvents excluded).
- a) Determination of the surface tension of a liquid or a dilute solution using astalagmometer.
- b) Study of the variation of surface tension of a detergent solution with concentration.

(VI) Chemical Kinetics

Study the kinetics of the following reactions.

5. Initial rate method: Iodide-persulphate reaction
6. Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.
c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis ofmethyl acetate

Suggested Readings:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

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SKILL ENHANCEMENT SYLLABUS

Semester I
Skill Enhancement Course
Course Code CHEM-SEC-1014
Course Paper: Basic Analytical Chemistry
Credit-4 (3T+1P)
Total no. of Lectures: 45L+15P **Total Marks: 100 (T60+IA20+P20)**

Objective: To familiarize students with different micro and semimicro analytical techniques and help develop the ability to use modern instrumental methods for chemical analysis of food, soil, air and water.

Learning Outcome: Upon completion of this course, students shall be able to explain the basic principles of chemical analysis, design/implement microscale and semimicro experiments, record, interpret and analyze data following scientific methodology.

CONTENTS
THEORY

UNIT 1: INTRODUCTION: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

UNIT 2: ANALYSIS OF SOIL AND WATER
Composition of soil, Concept of pH and pH measurement, Complexometrictitrations, Chelation, Chelating agents, use of indicators
a. Determination of pH of soil samples.
b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometrictitration.

ANALYSIS OF WATER: Definition of pure water, sources responsible for contaminating water,water sampling methods, water purification methods.
a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.

UNIT 3: ANALYSIS OF FOOD PRODUCTS: Nutritional value of foods, idea about food processing and foodpreservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida,chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

UNIT 4: CHROMATOGRAPHY: Definition, general introduction on principles of chromatography, paperchromatography, TLC etc.
a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).

b. To compare paint samples by TLC method.

Practical/ Presentation:

Suggested Applications (Any one):

a. To study the use of phenolphthalein in traps cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.

Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples byflame photometry.
b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid inSoft Drink.

Suggested Readings:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, NewYork.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.,* Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.,* W.H. Freeman and Co., N.Y. USA(1982).
8. Cooper, T.G. *The Tools of Biochemistry,* John Wiley and Sons, N.Y. USA. 16(1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.,* Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.,* Marcel Dekker, Inc., NewYork (1995).

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Semester II
Skill Enhancement Course
Course Code: CHEM-SEC-2014
Course Code: Pesticide Chemistry
Credit-4 (3T+1P)

Total no. of Lectures: 45L+15P **Total Marks: 100 (T60+IA20+P20)**

Course Objective: This is a brief and introductory course on pesticides, through which the students will be introduced to various classes of pesticides, their synthesis, applications and possible hazards of their uses.

Learning Outcome: Students will be able to explain or describe and critically examine different types of pesticides, their activity/toxicity and their applications and the need for the search of an alternative based on natural products.

CONTENTS

THEORY

Unit 1:

Definition of pesticides, general introduction to pesticides (natural and synthetic),

Unit 2:

Benefits and adverse effects of pesticides.

Unit 3:

Classification, mode of action, toxicity and methods of pesticides residue analysis.

Unit 4:

Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene); organophosphate (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor)

Practical/ Presentation

1. To calculate acidity/alkalinity in given sample of pesticides formulations as per BISspecifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates.

Suggested Readings:

1. R. Cremlyn: Pesticides, Preparation and Mode of Action, John Wiley & Sons, NewYork, 1978
2. RPBateman, Pesticide Applications, AAB Press, 2004
3. Principles of Pesticide chemistry: S K Handa, Ed. by Agrobios (India), 2008
4. Pesticide Science & Biotechnology: R Greenhalgh and T R Robers, IUPAC, Blackwell Scientific Publications, 1987
5. The Chemical Process Industries: D N Shreve
6. Pesticide Chemistry : G Matolesy, M. Nadasy, V. Andriska, Elsevier Sc. Publisher,USA, 1988

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