DEBRAJ ROY COLLEGE (AUTONOMOUS)
FOUR YEARS UNDERGRADUATE PROGRAMME (FYUGP) 2020

SYLLABUS OF BSC in Chemistry
(NEP)

Approved in the BOS (held on 28th June 2024)
Department of Chemistry
Debraj Roy College
(An Autonomous College under Dibrugarh University)
Circuit House Road, Golaghat-785621, Assam

Debraj Roy College (Autonomous), Golaghat

FYUGP Structure as per UGC Credit Framework of December, 2022

Semester	Course	Title of the Course	Total Credit
I	CHM-101T	Chemistry-I	3
	CHM-101P	Chemistry Experimental-I	1
	CHMIN-101T	Fundamentals of Chemistry-I	3
	CHMIN-101P	Minor Experimental-I	1
	CHGEC-101	Chemistry in Daily Life -I	3
	CHSEC-101T	Basic Analytical Chemistry	2
	CHSEC-101P	SEC Experimental-I	1
	AEC-101	MIL	4
	VAC-101	Understanding India	2
	Total Credits		**20**
II	CHM-201T	Chemistry-II	3
	CHM-201P	Chemistry Experimental-II	1
	CHMIN-201T	Fundamentals of Chemistry-II	3
	CHMIN-201P	Minor Experimental-II	1
	CHGEC-201	Chemistry in Daily Life- II	3
	CHSEC-201T	Fuel Chemistry	2
	CHSEC-201P	SEC Experimental-II	1
	AEC-201	English Language & Communication Skills	4
	VAC-201	Environmental Science	2
	Total Credits		**20**
III	CHM-301T	Chemistry-III	3
	CHM-301P	Chemistry Experimental-III	1
	CHM-302T	Chemistry-IV	3
	CHM-302P	Chemistry Experimental-IV	1
	CHMIN-301T	Fundamentals of Chemistry-III	3
	CHMIN-301P	Minor Experimental-III	1
	CHGEC-301	Chemistry in Daily Life-III	3
	CHSEC-301T	Inorganic Materials for Industrial Importance	2
	CHSEC-301P	SEC Experimental-III	1
	VAC-301	Yoga Education	2
	Total Credits		**20**

B. SC. IN CHEMISTRY PROGRAM (NEP)
Detailed Syllabus of 1st Semester
Title of the course: Chemistry-1
(Inorganic, Physical & Organic Chemistry)
Course Code: CHM-101 (T+P)
Nature of the Course: Chemistry Major
Total Credits: 4

Distribution of Marks: 60 (End Sem) (45T+15P) + 40 (In-Sem)

COURSE OBJECTIVES: To give idea about the basic knowledge of chemistry in different field of specializations (viz. inorganic, organic and physical chemistry)

Section I: Inorganic Chemistry

Periodic properties: Lecture: 06, Marks: 07
Effective nuclear charge-screening effect and variations, Slater rules, Atomic radii, ionic and covalent radii, Ionization enthalpy, electron gain enthalpy, electronegativity (Pauling, Mulliken's, Allred-Rochow and Mulliken Jaffe's Scales), Variation of electronegativity with bond order, Partial charge, hybridization and group electronegativity.

Bonding and structure: Lecture: 09, Marks: 08
Ionic Bonding: Energy consideration in ionic bonding, lattice Energy. Born-Lande Equation and its application, Madelung Constant. Born - Haber cycle and its application, polarizing power and polarizability, Fajan's rule, Bond moment, dipole moment and percentage ionic character. Hydrogen Bonding. Covalent Bonding: VB Approach-Concept of hybridization (sp, sp2, sp3, sp^3d, sp^3d^2 and dsp^2). VSEPR Theory. Resonance and Resonance energy: Study of some inorganic and organic compounds (O_3, NO_3^- , CO_3^{2-}, SO_4^{2-}, C_6H_6). Co-ordinate or Dative Bond. Bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals non-bonding combination of orbitals, MO treatment of homonuclear diatomic molecules (N_2, O_2, F_2) and heteronuclear diatomic molecules (CO, NO and NO^+)

Section II: Physical Chemistry

Gas: Lecture: 10, Marks:10
kinetic gas equation, Maxwell distribution of molecular speed, different types of speeds (average, root mean square and most probable).
co-efficient of compressibility and thermal expansion.
Collision parameters: collision frequency, collision diameter. Mean free path.
Viscosity of gases.
Law of equipartition of energy, degrees of freedom and average energy of a molecule, molecular basis of heat capacity.
Real gases: Deviation from ideal behavior,
compressibility factor (Z), Van der Waals equation of state and its derivation, Boyle's Temperature, Virial equation of state.

Critical state, Continuity of states, Isotherms of real gases, Andrew's Isotherm for CO_2, Relationships between critical constants and Van der Waals constants, Critical compressibility factor Reduced equation of state, The principle of corresponding states.

Liquid: Lecture: 05, Marks: 05

Qualitative treatment of the structure of liquids, Molecular interactions in liquids, physical properties of liquids (vapor pressure, surface tension, viscosity)

Explanation of cleansing action of detergents, Capillary action, Effect of temperature on surface tension and coefficient of viscosity, Experimental methods for determination of surface tension and coefficient of viscosity, Newtonian and non-Newtonian liquids, Liquid crystals

Section III: Organic Chemistry

Basics of Organic Chemistry: Lecture: 07, Marks: 08

Electronic Effects in Organic Molecules:

Cleavage of bonds: Homolytic and heterolytic fission, Electron displacement effects: Inductive, Electrometric, Mesomeric, Resonance, Hyperconjugation, Steric effects and application. Tautomerism.

Study of reaction intermediates: carbocation, carbanion, free radical, carbene, nitrene and benzyne. Energy profile diagrams of one step, two steps and three steps reactions, Rate limiting steps. Activation Energy.

Concept of Electrophile, Nucleophile and their relative strength.

Organic Lewis acids and bases-(relative strength & factors affecting it); substituents effect upon Ka & pKa.

Stereochemistry - 1: Lecture: 08, Marks: 07

Fischer, Flying wedge, sawhorse and Newman projection formulae – and interconversion. D & L nomenclature, Cahn-Ingold- Prelog rules, R & S nomenclature for compounds with one and two asymmetric carbon atoms, Erythro- and Threo- representations.

Study of Configuration isomers – elements of symmetry, Concept of Chirality, Enantiomer, Diastereoisomer & Geometrical isomers, Optical isomerism, optical and specific rotations. Meso Compound, Optical activity in compounds not containing asymmetric carbon atoms namely biphenyls, allenes, Racemisation. Resolution & Asymmetric Synthesis.

Geometrical Isomerism – E&Z Nomenclature and interconversion.

Section IV: Experimental Work:

Oxidation-Reduction Titrimetry (any one): Practical classes: 30, Marks: 15

(i) Estimation of Fe(II) using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid using standardized $KMnO_4$ solution.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using diphenylamine as internal indicator
(iv) Estimation of oxalic acid using $K_2Cr_2O_7$ solution.

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examinations - 20 Marks
- Others - 20 Marks

(i) Attendance/ Home Assignment
(ii) Seminar presentation on any of the relevant topics
(iii) Group Discussion

Suggested Text Books:

1. Inorganic Chemistry – J.D. Lee
2. Basic Inorganic chemistry – Cotton and Wilkinson
3. Inorganic Chemistry – J.E.Huheey
4. Organic Chemistry – I.L. Finar, Vol. I & II, ELBS
5. Organic Chemistry, R.I. Morrison & R.N. Boyd, S.K. Bhattacharjee
6. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
7. P.W. Atkins, Physical Chemistry, Oxford University Press.
8. Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal

Suggested Reference Books:

1. General and Inorganic Chemistry (Part-I & II) R. Sarkar
2. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
3. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
4. Inorganic Chemistry – Puri, Sharma and Kalia
5. Physical Chemistry- G.W. Castellan, Narosa Publishing House, New Delhi.
6. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi
7. Nagin, S. Chand & Co.
8. Physical Chemistry – D.S. Pahari (Vol. I & II).
9. Physical Chemistry – Levine
10. Organic Reactions and their Mechanisms (New Age International Private Limited) - P.S.Kalsi.
11. Organic Chemistry – M.K. Jain, S. Chand & Co.
12. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
13. Organic Chemistry – Vol. I & II, Mukherjee and Kapoor
14. Advanced General Organic Chemistry (Part I and Part II) - S. C.Ghosh
15. Organic Chemistry (Oxford) - Clayden,Warren, Greeves and Wothers.

B. Sc. In Chemistry Program (NEP)
Detailed Syllabus of 1st Semester
Title of the course: Fundamentals of Chemistry - I
Course Code: CHMIN-101 (T+P)
Nature of the Course: Chemistry Minor
Total Credits: 4

Distribution of Marks : 60 (End Sem) (45T+15P) + 40 (In Sem)

COURSE OBJECTIVES: To develop the basic knowledge of chemistry in relation to atomic structure, bonding, emphasize on different states of matter & their mechanical treatment, preliminary knowledge in basic organic chemistry & aliphatic hydrocarbons analysis.

Section I: Inorganic Chemistry

Atomic Structure: Lecture: 09, Marks: 09

Recapitulation of Bohr's Theory, de Broglie, Heisenberg Uncertainty Principle, Time independent Schrödinger wave equation (H=E).Significance of ψ and ψ^2 Schrodinger equation for Hydrogen atom (qualitative treatment only). Quantum numbers, Electronic configuration of elements based upon electronic configuration in the periodic table, periodic properties-effective nuclear charge, ionization energy, electron affinity, electronegativity (Pauling, Mulliken's and Allred-Rochow scales). Redox potential.

Chemical Bonding and Molecular Structure-1: Lecture: 06, Marks: 06

Ionic Bonding: Energy consideration in ionic bonding, Lattice Energy and Solvation Energy and their importance in the context of Stability and Solubility of ionic compounds. Polarizing power and polarizability. Fajan's rule, dipole moment and percentage ionic character. Hydrogen Bonding.

Section II: Physical Chemistry

Gas: Lecture: 10, Marks: 10

Kinetics of gas: Kinetic gas equation, Maxwell distribution of molecular speed, different types of speeds (average, root mean square and most probable).
Collision parameters: collision frequency, collision diameter. Mean free path,
Transport properties: Viscosity of gases and its temperature and pressure dependence,
Law of equipartition of energy, degrees of freedom and average energy of a molecule, molecular basis of heat capacity.
Real gases: Deviation from ideal behavior,
compressibility factor (Z), van der Waals equation of state and its derivation, Boyle's Temperature. Critical state, Continuity of states, Isotherms of real gases, Relationships between critical constants and Van der Waals constants, Reduced equation of state, The principle of corresponding states.

Liquid: Lecture: 05, Marks: 05

Qualitative treatment of structure of liquids, Molecular interactions in liquids, Physical properties of liquids (vapor pressure, surface tension, viscosity)
Explanation of cleansing action of detergents, Capillary action, Effect of temperature on surface tension and coefficient of viscosity, Experimental methods for determination of surface tension and coefficient of viscosity, Newtonian and non-Newtonian liquids.

Section III: Organic Chemistry

Lecture: 08, Marks: 08

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: Carbocations, Carbanions and free radicals, nitrene.
Concepts of aromatic, anti-aromatic and non-aromatic compounds (including examples of Benzenoid, cyclic carbocations and carbanions); Hückel's rule.

Aliphatic Hydrocarbon – 1:

Alkanes: Lecture: 07, Marks: 07

Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent, Corey House synthesis. Reactions: Free radical Substitution: Halogenation

Section IV: Experimental Work:

Any one experiment either from expt. List No 1 or 2: Practical classes: 30, Marks: 15

1. (i) Determine the surface tension of various liquids by drop number method.
   (ii) Determination of viscosity of aqueous solutions at room temperature.

2. pH -metry and (Any one experiment)
   - (i) pH- metric titration;
     - (a) Hydrochloric acid vs. Sodium Hydroxide
     - (b) Acetic acid vs. Sodium Hydroxide
   - (ii) Preparation of buffer solutions of different pH
     - (a) sodium acetate-acetic acid
     - (b) ammonium chloride-ammonium hydroxide

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examinations - 20 Marks
- Others - 20 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics

Suggested Text Books:

1. Inorganic Chemistry – Puri, Sharma and Kalia
2. A Text Book of Physical Chemistry – Negi & S.C. Anand, Wiley Eastern
3. Principles of Physical Chemistry, Puri, Sharma, Pathania, Shoban Lal, (S. Chand & Co.)
4. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
5. General and Inorganic Chemistry (Part-I & II) R. Sarkar

Suggested Reference Books:

1 Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Organic Chemistry – M.K. Jain, S. Chand& Co.
3. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
4. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi
5. P.W. Atkins, Physical Chemistry, Oxford University Press.

B. SC. IN CHEMISTRY PROGRAM (NEP)
Detailed Syllabus of 1st Semester
Title of the course: Chemistry in Daily Life-I
Course Code: CHGEC-101
Nature of the Course: Natural Science
Total Credits: 3

Distribution of Marks: 45 (End Sem) + 30 (In-Sem)

COURSE OBJECTIVES: To introduce the students with the fascinating chemistry of some food products and to introduce the concept of food packaging, processing and preservation.

Unit I: Dairy Products: Lecture: 16, Marks: 14
Composition of milk and milk products. Principles of dairy safety; Milk processing. Qualitative analysis of fat content, minerals in milk and butter.
Qualitative analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy.

Unit II: Food additives: Lecture: 08, Marks: 10
Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate.
Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate.

Unit III: Food adulterants, and contaminants: Lecture:10, Marks: 09
Food processing and packaging; Food adulteration: definition and its importance, adulterants present in coffee, tea, milk, spices, grains and food colour.
Difference between food adulteration and Contamination.

Unit IV: Artificial food colorants: Lecture:11, Marks: 12
Natural and synthetic colors, fake colors, inorganic pigments, application of colors in the food industry, flavoring agents, Coal tar dyes and non-permitted colors and metallic salts. Utility of coal tar dyes in food and cosmetics and its harmful effect.

MODES OF IN-SEMESTER ASSESSMENT: **30 Marks**
- Two Internal Examinations - 20 Marks
- Others - 10 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics

Suggested Books:

1. Food Science & Quality Control by SMT. B. Poornima - Centrum Press First edition 2014.
2. Post-Harvest Management of Horticultural crops - S. Saraswathy, T.L. Preethi AGROBIOS (India) 2013.

3. A Handbook of Agn. Food processing and marketing by S.C. Gaur, Agro Bios (India) 2012.
4. Quality Control for value edition in Food processing – by Dev Raj, Rakesh Sharma & V.K. Joshi New India Publishing Agency, 2011.
5. Food processing and preservation – Subbulakshmi, G. Shobha, A. Udipi, New Age International (P) Ltd., 2006.

B. SC. IN CHEMISTRY PROGRAM (NEP)
Detailed Syllabus of 1st Semester
Title of the course: Basic Analytical Chemistry
Course Code: CHSEC-101 (T+P)
Nature of the Course: Skill Enhancement Course
Total Credits: 3

Distribution of Marks: 45 (End Sem) (30T+15P) + 30 (In-Sem)

COURSE OBJECTIVES: To provide a basic understanding of chemical analysis of soil, water, food products, cosmetics and separation techniques.

Unit I: Lecture: 08, Marks: 08

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.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators
a) Determination of pH of soil samples.
b) Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Unit II: Lecture: 10, Marks: 10

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.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservatives and adulteration.

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

Unit III: Lecture:12, Marks: 12

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.
a) Paper chromatographic separation of mixture of metal ions ($Fe^{3+}$and A^{l3+}).
b) To compare paint samples by TLC method.
Ion-exchange: Column, ion-exchange chromatography etc.
Determination of ion exchange capacity of anion/ cation exchange resin (using batch procedure if use of column is not feasible).
Analysis of cosmetics: Major and minor constituents and their function.
a) Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b) Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Unit IV: Experimental Work:

Any one experiment: Practical classes: 30, Marks: 15

(i) Determination of dissolved oxygen in water. (DO)
(ii) Determination of Chemical Oxygen Demand (COD)
(iii) Determination of Biological Oxygen Demand (BOD)
(iv) Determination of hardness of water by complexometric titration (using EDTA)
(v) Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry
(vi) Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
(vii) Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks

MODES OF IN-SEMESTER ASSESSMENT: **30 Marks**

- Two Internal Examinations - 20 Marks
- Others - 10 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics
  - (iii) Group Discussion

Suggested Text Books:

1. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996.
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009
3. Cooper, T.G. The Tools of Biochemistry, John Wiley & Sons, N.Y. USA. 16 (1977).
4. Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.

Suggested Reference Books:

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA,1988.
2. Skoog, D.A., Holler, F.J. & Crouch, S. Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Analytical Chemistry: An Introduction 6th Ed., Saunders College Publishing, Fort Worth, Philadelphia (1994).
4. Harris, D. C. Quantitative Chemical Analysis, 9th ed. Macmillan Education, 2016.
5. Dean, J. A. Analytical Chemistry Handbook, McGraw Hill, 2004.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India, 1992.
7. Freifelder, D.M. Physical Biochemistry 2nd Ed., W.H. Freeman & Co., N.Y. USA (1982).
8. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., NewYork (1995).
9. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004
10. Higson, S. P.J. (2003), Analytical Chemistry, Oxford University Press.

B. SC. IN CHEMISTRY PROGRAM (NEP)

Detailed Syllabus of 2nd Semester

Title of the course: Chemistry-II

(Inorganic, Physical & Organic Chemistry)

Course Code: CHM-201 (T+P)

Nature of the Course: Chemistry Major

Total Credits: 4

Distribution of Marks: 60 (End Sem) (45T+15P) + 40 (In-Sem)

COURSE OBJECTIVES: To give concept about the chemistry of non-transition elements, metallurgy, 1st law of thermodynamics, solid state chemistry and chemistry of aliphatic & aromatic hydrocarbons.

Section I: Inorganic Chemistry

Non Transition elements: Lecture: 09, Marks:09

a) Noble Gas: Compounds of Xenon only

b) Boron: wade's rule, nomenclature of closo, nido and arachno boranes, structure of boron hydrides, carboranes, metallo boranes and metallo carboranes. borazine, c) Carbon: Fullerenes (C60)

d) Silicon: classifications and structure of silicates, silicones, Zeolites, use of Zeolites as catalyst and molecular sieve, aluminosilicates.

e) Nitrogen: Hydrazine, hydroxylamine and hydrazoic acid.

f) Phosphorus: Phosphines, oxy acids of phosphorus, organophosphorus compounds, phosphazine, $(SN)_x$: Preparation, structure and uses.

Metal and metallurgy: Lecture: 06, Marks: 06

Theory of reduction (Thermodynamic approach), role of carbon and other reducing agents, electrolytic reduction, roasting and calcinations. Method of purification and refining of metals including modern methods like zone refining, vacuum arc process, ion exchange, solvent extraction and electrolytic method, Van- Arkel process and hydrometallurgy.

Study of potassium dichromate, potassium chromate, manganese dioxide, potassium permanganate, ammonium molybdate, sodium cobaltinitrite, cobalt nitrate, Ni-DMG, vanadium pentoxide).

Section II: Physical Chemistry

Chemical Thermodynamics-I: Lecture: 08, Marks: 08

Extensive and Intensive properties, Path function and State function, isolated, open and closed systems.

Zeroth Law of thermodynamics, thermodynamic scale of temperature.

First law of thermodynamics-Internal energy, enthalpy, molar heat capacities, relation between Cp and Cv, calculations of heat, work, internal energy and enthalpy for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Relation between P, V, T. Variation in internal energy and enthalpy with temperature, Joule Thomson effect, calculation of Joule Thomson co-efficient for ideal and Van der Waal's gas.

Thermochemistry- Standard states, Enthalpy of formation, Heat of reaction.

Hess's law, Kirchhoff's law relation of reaction enthalpy with internal energy, Bond energy and Bond dissociation energy.

Solids: Lecture: 07, Marks:07

Nature of the solid state and types of solid.

Elementary ideas of symmetry, symmetry elements and symmetry operations. Qualitative idea of point and space groups, Space lattice and Unit cell.

Seven Crystal Systems and fourteen Bravais Lattices.

Law of constancy of interfacial angles.

Law of rational indices, Weiss indices, Miller indices, Interplanar spacings in a crystal system.

X-ray diffraction, Bragg's law, Powder and Single crystal X-ray diffraction.

Crystal structure of NaCl, KCl, CsCl and ZnS (Zinc Blende) (qualitative treatment only).

Packing of crystals, Crystal defects (point defects), Concept of Conductors, Semiconductors and Insulators from Band theory.

Section III: Organic Chemistry

Stereochemistry – II Lecture: 04, Marks: 07

Study of conformational isomerism - conformations analysis of ethane & butane**.** Stabilty of cycloalkanes and Baeyer Strain theory. Conformation of Cyclohexane and their relative stability. Conformation of mono substituted cyclohexane.

Cycloalkanes: Preparation using Wurtz reaction, Dieckmann's ring closure and reduction of aromatic hydrocarbons.

Chemistry of Alkanes: Lecture: 04, Marks: 03

Nomenclature & Classification, Preparation by Wurtz reaction, Kolbe method and Corey-House synthesis. Reactions: Mechanism of halogenation, free radical substitution, sulphonation, nitration, oxidation. Reactivity & Selectivity.

Aromatic Hydrocarbons: Lecture: 07, Marks:05

Huckel Rule - Aromaticity, antiaromaticity and non-aromaticity.

Benzene: Industrial and laboratory preparations, purification. Properties: Electrophilic substitution reactions: nitration, sulphonation, halogenation, Friedel Crafts alkylation and acylation with mechanisms. Orientation and reactivity of disubstitution reactions: nitration and halogenations. Activation/deactivation of aromatic ring and directing effects of groups. Partial rate factor (O/P ratio). Orientation and reactivity of disubstitution reactions: nitration and halogenations.

Polynuclear aromatic hydrocarbons: Preparation and properties of naphthalene, anthracene and phenanthrene.

Section IV: Experimental Work:

Any two experiments: Practical classes: 30, Marks: 15

(i) Purification of organic compounds by crystallization using the following solvents:
   a. Water b. Alcohol c. Alcohol-water solution

(ii) Determination of the melting points of organic compound (Electrically heated melting point apparatus)

(iii) Effect of impurities on the melting point – mixed melting point of two unknown organic compounds (Electrically heated melting point apparatus)

(iv) Separation of a mixture of o- and p-nitrophenol or o- and p-aminophenol by thin layer chromatography (TLC)

(v) Separation of a mixture of two amino acids by paper chromatography

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examinations - 20 Marks
- Others - 20 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics
  - (iii) Group Discussion

Suggested Text Books:

1. Inorganic Chemistry – J.D. Lee
2. Basic Inorganic chemistry – Cotton and Wilkinson
3. Inorganic Chemistry – J.E.Huheey
4. Organic Chemistry – I.L. Finar, Vol. I & II, ELBS
5. Organic Chemistry, R.I. Morrison & R.N. Boyd, S.K. Bhattacharjee
6. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
7. P.W. Atkins, Physical Chemistry, Oxford University Press.

8. Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal

Suggested Reference Books:

1. General and Inorganic Chemistry (Part-I & II) R. Sarkar
2. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
3. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
4. Inorganic Chemistry – Puri, Sharma and Kalia
5. Physical Chemistry- G.W. Castellan, Narosa Publishing House, New Delhi.
6. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi
7. Nagin, S. Chand & Co.
8. Physical Chemistry – D.S. Pahari (Vol. I & II).
9. Physical Chemistry – Levine
10. Organic Reactions and their Mechanisms (New Age International Private Limited) - P.S.Kalsi.
11. Organic Chemistry – M.K. Jain, S. Chand & Co.
12. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
13. Organic Chemistry – Vol. I & II, Mukherjee and Kapoor
14. Advanced General Organic Chemistry (Part I and Part II) - S. C.Ghosh
15. Organic Chemistry (Oxford) - Clayden,Warren, Greeves and Wothers.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course: Fundamentals of Chemistry - II

Course Code: CHMIN-201 (T+P)

Nature of the Course: MINOR COURSE 1

Total Credits: 4

Distribution of Marks: 60 (End Sem) (45T+15P) + 40 (In-Sem)

COURSE OBJECTIVES: To develop the basic knowledge of chemistry in relation to Coordination chemistry, covalent bonding, emphasize on different states of matter & their mechanical treatment, preliminary knowledge in basic organic chemistry, hydrocarbons, stereochemistry & conformational analysis.

Section I: Inorganic Chemistry

Coordination Chemistry: Lecture: 07, Marks : 07

Review of Werner's theory. Types of ligands, monodentate, bidentate ambidentate and polydentate ligands (including Acceptor and macrocyelic ligands. IUPAC Nomenclature of Co-ordination compounds. Isomerism of 4-and 6- coordinate compounds. Introduction to Valence Bond and Crystal Field theory. Application of dimethyl glyoxime, EDTA, 8-hydroxy quinoline, 2,2-bipyridyl, and ethylene diamine in analysis.

Chemical Bonding and Molecular Structure-2 Lecture:08, Marks: 08

Covalent Bonding:
VB Approach-Concept of hybridization, sp, sp^2 , sp^3 , sp^3d, sp^3d^2 and dsp^2 VSEPR Theory. Resonance and Resonance energy: Study of some inorganic and organic compounds (O_3,NO_3^-, CO_3^{2-} , SO_4^{2-}, C_6H_6). Molecular Orbital Approach: LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non-bonding combination of orbitals, MO treatment of homonuclear diatomic molecules and heteronucear diatomic molecules such as CO, NO and NO+

Section II: Physical Chemistry

Solids: Lecture: 08, Marks: 09
Nature of the solid state and types of solid. Elementary ideas of symmetry, symmetry elements and symmetry operations. Space lattice and Unit cell. Seven Crystal Systems and Fourteen Bravais Lattices. Law of constancy of interfacial angles. Law of rational indices, Miller indices, Interplanarspacings in a crystal system. X-ray diffraction, Bragg's law, Crystal structure of NaCl, KCl, CsCl (qualitative treatment only). Crystal defects (point defects). Liquid crystals.

Ionic Equilibria: Lecture: 07, Marks : 06
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis: Hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions: Buffer capacity, buffer range, pH (Henderson equation).Solubility and solubility product of sparingly soluble salts, applications of solubility product principle.

Section III: Organic Chemistry

Stereochemistry: Lecture: 06, Marks: 07
Representation of organic molecules in 2D and 3D (Flying wedge, Fischer, Sawhorse and Newman projection formulae and their interconversions); concept of chirality (enantiomers and diastereomers); CIP rules – R, S nomenclature. Geometrical isomerism (cis-trans, syn-anti, E/Z notations); Conformational analysis (ethane, butane, cyclohexane)

Aliphatic Hydrocarbon – 2: Lecture: 08, Marks 08
Alkene: Formation by elimination reactions- E1, E2, E1cB reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition). Study of Syn Hydroxylation ($KMnO_4$ oxidation), Ozonolysis, Hydration, Hydroboration – Oxidation reaction
Alkyne: Formation by elimination reaction, Acidity of terminal alkyne and formation of metal salt, Conversion to higher alkynes, Ozonolysis and electrophilic addition reaction.

Section IV: Experimental Work:

Practical classes: 30, Marks: 15
Inorganic qualitative analysis of salt mixtures containing 4 radicals including interfering radicals PO_4^{3-}, BO_3^{3-} and F^-

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examinations - 20 Marks
- Others - 20 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics

Suggested Text Books:

1. Inorganic Chemistry – Puri, Sharma and Kalia
2. A Text Book of Physical Chemistry – Negi & S.C. Anand, Wiley Eastern
3. Principles of Physical Chemistry, Puri, Sharma, Pathania, Shoban Lal, (S. Chand & Co.)
4. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
5. General and Inorganic Chemistry (Part-I & II) R. Sarkar

Suggested Reference Books:

1 Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Organic Chemistry – M.K. Jain, S. Chand& Co.
3. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
4. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi
5. P.W. Atkins, Physical Chemistry, Oxford University Press.

B. SC. IN CHEMISTRY PROGRAM (NEP)
Detailed Syllabus of 2nd Semester
Title of the course: Chemistry in Daily Life-II
Course Code: CHGEC-201
Nature of the Course: Natural Science
Total Credits: 3

Distribution of Marks: 45 (End Sem) + 30 (In-Sem)

COURSE OBJECTIVES: To introduce the chemistry of some biomolecules and to familiarize with vitamins and their importance in human body

Unit I: Vitamins: Lecture: 12, Marks: 12

Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A, Vitamin B, Vitamin C, Vitamin D, Vitamin E & Vitamin K.

Unit II: Oils and fats: Lecture: 10, Marks: 12

Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Soaps & Detergents: Definition, classification, manufacturing of soaps and detergents, composition and uses.

Unit III: Proteins: Lecture:13, Marks: 14

Sources, Composition and Biological values of protein, Elementary ideas of proteins and amino acids, Essential and Non-essential amino acids. Peptide bonds, Polypeptides, Qualitative ideas of structure of proteins (Primary, secondary, Tertiary and Quaternary structure), Denaturation and coagulation of proteins.

Unit IV: Nucleic Acids: Lecture:10, Marks: 07

Nucleic acids: Chemical composition, classifications & functions.

MODES OF IN-SEMESTER ASSESSMENT: **30 Marks**

- Two Internal Examinations - 20 Marks
- Others - 10 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics

Suggested Books:

1. Berg, J.M.; Tymoczko, J.L.; Stryer, L. (2006), Biochemistry. W.H. Freeman and Co.
2. Nelson, D.L.; Cox, M.M.; Lehninger, A.L.(2009),Principles of Biochemistry. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A.; Rodwell, V.W.(2009),Harper's Illustrated Biochemistry. Lange Medical Books/McGraw-Hill.
4. Brown,T.A. (2018) Biochemistry, (First Indian addition 2018) Viva Books.
5. Kumar, A.; Garg, S.; Garg, N. (2012), Biochemical Tests: Principles and Protocols. Viva Books.
6. Finar, I. L. (2008), Organic Chemistry, Volume 2, 5th Edition, Pearson Education.

B. SC. IN CHEMISTRY PROGRAM (NEP)
Detailed Syllabus of 2nd Semester
Title of the course: Fuel Chemistry
Course Code: CHSEC-201 (T+P)
Nature of the Course: Skill Enhancement Course
Total Credits: 3

Distribution of Marks: 45 (End Sem) (30T+15P) + 30 (In-Sem)

COURSE OBJECTIVES: To provide a basic scientific and technical understanding of the production, behaviour and handling of hydrocarbon fuels, petrochemicals and lubricants. This will enable the students to be industry ready to contribute effectively in the field of petroleum chemistry and technology.

Unit I: Lecture: 09, Marks: 10

Review of energy sources: Renewable and nonrenewable energy sources . Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas composition and uses. Fractionation of coal tar, uses of coal tar based chemicals.

Unit II: Lecture: 15, Marks: 15

Petroleum and Petrochemical Industry: Composition of crude petroleum; Different types of petroleum products and their applications. Principle and process of fractional distillation, Cracking - Thermal and catalytic cracking; Qualitative treatment of non petroleum fuels -LPG, CNG, LNG, bio-gas, fuels derived from biomass, fuel from waste; synthetic fuels -gaseous and liquids.

Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Unit III: Lecture: 06, Marks: 05

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting),Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants – viscosity index, cloud point, pore point.

Unit IV: Experimental Work:

Any one experiment: Practical Classes: 30 Marks: 15

(i) To determine the aniline point of a given lubricating oil.
(ii) To determine the acid value of a given oil
(iii) To prepare biodiesel from vegetable oil
(iv) To determine the enthalpy of combustion of liquid fuels using spirit / alcohol burners.
(v) To determine the calorific value of fuel

MODES OF IN-SEMESTER ASSESSMENT: **30 Marks**

- Two Internal Examinations - 20 Marks
- Others - 10 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics
  - (iii) Group Discussion

Suggested Text Books:

1. B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

Suggested Reference Books:

1. E. Stocchi (1990) Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
2. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course: Chemistry-III

(Inorganic, Physical & Organic Chemistry)

Course Code: CHM-301 (T+P)

Nature of the Course: Chemistry Major

Total Credits: 4

Distribution of Marks: 60 (End Sem) (45T+15P) + 40 (In-Sem)

COURSE OBJECTIVES: To develop the basic knowledge of chemistry in relation to d and f block elements, coordination compounds, chemical thermodynamics, ionic equilibrium, alkenes, alkynes and chemistry of halogenated hydrocarbons.

Section I: Inorganic Chemistry

d and f block elements: Lecture: 06, Marks: 06

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Electronic configuration, oxidation states, colour, spectral and magnetic properties of lanthanides and actinides. Lanthanide contraction, separation of lanthanides (ion-exchange method only).

Coordination compounds: Lecture: 09, Marks: 09

Types of ligands: monodentate, bidentate, ambidntate, polydentate and macro cyclic ligand. Effective atomic number rule, VB, crystal field, MO and introduction to ligand field theories and their applications. Spectroscopic terms, RS coupling, Mullikan's symbol (A, B, E, T). Spectrochemical and naphelauxetic series, Electronic spectra of simple Td and Oh complexes, selection rules and Orgel diagram (d1 to d9 system). Magnetic properties: Paramagnetism, diamagnetism, magnetic properties of octahedral complexes, Antiferromagnetism.

Section II: Physical Chemistry

Chemical Thermodynamics II Lecture: 07, Marks: 07

Second law of thermodynamics, Carnot's theorem, Carnot cycle, efficiency of heat engines.

concept of entropy, entropy change in a cyclic, reversible, irreversible process, calculation of entropy changes of an ideal gas with change in P,V,T, entropy change in physical transformation, statistical interpretation of entropy.
Helmholtz free energy (A) and Gibb's free energy (G), Variation of A and G with P,V,T, criteria for spontaneity and equilibrium, Maxwell's relationship,
Gibb's–Helmholtz equation. Nernst heat theorem.
Third law of thermodynamics, concept of residual and absolute entropy.

Ionic Equilibria: Lecture: 08, Marks: 08

Strong and weak electrolytes, degree of ionization, factors affecting degree of ionization, levelling effect of water ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect..

Salt hydrolysis: Hydrolysis constant, degree of hydrolysis and pH for different salts.

Buffer solutions, buffer capacity pH of buffer solution (Henderson equation), applications of buffer (analytical chemistry and biochemical processes in the human body.)

Solubility and solubility product of sparingly soluble salts.

Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

Section III: Organic Chemistry

Alkenes: (up to 5 carbons): Lecture: 05, Marks: 04
Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule).Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti Markownikoff's addition), Hydration, Ozonolysis.

Alkynes: (up to 5 carbons): Lecture: 03, Marks: 04
Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4.

Chemistry of Halogenated Hydrocarbons: Lecture: 07, Marks: 07
Alkyl halides: Methods of preparation including Hunsdiecker reaction from silver or lead (IV) salts of carboxylic Acid). Nucleophilic substitution reactions: SN1, SN2, and SNi Mechanisms with stereochemical aspects and effect of solvent. Nucleophilic substitution vs elimination. Haloform reaction. Aryl halides: Preparation from diazonium salts. Nucleophilic Aromatic Substitution SNAr, Benzyne intermediates. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Section IV: Experimental Work:

Any one experiment: Practical classes: 30, Marks: 15
(i) Determination of surface tension of various liquids by drop number method.

(ii) Determination of viscosity of aqueous solutions at room temperature.
(iii) pH- metric titration;
    (a) Hydrochloric acid vs. sodium hydroxide
    (b) Acetic acid vs. sodium hydroxide
(iv) Preparation of buffer solutions of different pH
    (a) sodium acetate-acetic acid
    (b) ammonium chloride-ammonium hydroxide
(v) Determination of heat capacity of a calorimeter

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examinations - 20 Marks
- Others - 20 Marks
    (i) Attendance/ Home Assignment
    (ii) Seminar presentation on any of the relevant topics
    (iii) Group Discussion

Suggested Text Books:

1. Inorganic Chemistry – J.D. Lee
2. Basic Inorganic chemistry – Cotton and Wilkinson
3. Inorganic Chemistry – J.E.Huheey
4. Organic Chemistry – I.L. Finar, Vol. I & II, ELBS
5. Organic Chemistry, R.I. Morrison & R.N. Boyd, S.K. Bhattacharjee
6. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
7. P.W. Atkins, Physical Chemistry, Oxford University Press.
8. Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal

Suggested Reference Books:

1. General and Inorganic Chemistry (Part-I & II) R. Sarkar
2. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
3. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
4. Inorganic Chemistry – Puri, Sharma and Kalia
5. Physical Chemistry- G.W. Castellan, Narosa Publishing House, New Delhi.
6. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi
7. Nagin, S. Chand & Co.
8. Physical Chemistry – D.S. Pahari (Vol. I & II).
9. Physical Chemistry – Levine
10. Organic Reactions and their Mechanisms (New Age International Private Limited) - P.S.Kalsi.
11. Organic Chemistry – M.K. Jain, S. Chand & Co.
12. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
13. Organic Chemistry – Vol. I & II, Mukherjee and Kapoor
14. Advanced General Organic Chemistry (Part I and Part II) - S. C.Ghosh
15. Organic Chemistry (Oxford) - Clayden,Warren, Greeves and Wothers.

B. SC. IN CHEMISTRY PROGRAM (NEP)
DETAILED SYLLABUS OF 3rd SEMESTER
Title of the Course: Chemistry-IV
(Inorganic, Physical & Organic Chemistry)
Course Code: CHM-302 (T+P)
Nature of the Course: Chemistry Major
Total Credits: 4

Distribution of Marks: 60 (End Sem) (45T+15P) + 40 (In-Sem)

COURSE OBJECTIVES: To understand the concepts of acids and bases including Brönsted-Lowry and Lewis theories, application of HSAB principles, the inorganic reaction mechanisms, chemical kinetics, catalysis, the chemistry of C-O bonds in alcohols, phenols, ethers, and epoxides,

Section I: Inorganic Chemistry

Acids and Bases: Lecture: 06, Marks: 06
Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB Principle

Inorganic reaction mechanism: Lecture: 09, Marks: 09
Introduction to inorganic reaction mechanism, inert and labile complexes, association, dissociation and concerted paths. Acid and base hydrolysis (with reference to cobalt complexes only). Substitution reaction in octahedral and square planar complexes. Trans effect, Irving-William series.

Section II: Physical Chemistry

Chemical Kinetics: Lecture: 10, Marks: 10

Order and molecularity of a reaction, Rate law, Integrated form of rate expressions up to second order reactions, experimental methods of the determination of order of reaction,

Kinetics of Complex reactions : (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates (qualitative treatment only), Lindemann theory of unimolecular reaction.

Catalysis: Lecture: 05, Marks: 05
Criteria of catalysis, homogeneous and heterogeneous catalysis, introduction to acid base catalysis. Mechanisms of catalyzed reactions at solid surfaces, effect of temperature on surface reactions, nanoparticles as catalysts, autocatalysis, catalytic poison, Enzyme catalysis, Michaelis-Menten equation.

Section III: Organic Chemistry

Chemistry of C-O Bond: Lecture: 15, Marks: 15

Alcohols: Preparation and properties of Glycol: Oxidation by OsO_4, alkaline $KMnO_4$, periodic acid and lead tetracetate, Jones oxidation. Pinacol Pinacolone rearrangement with mechanism.
Trihydric alcohol: Glycerol: preparation & properties**.**
Phenols: Preparation and properties:- acidity comparison with alcohol. Substitution reaction, Reimer- Tiemann and Kolbe-Schmidt reaction, Fries rearrangement with mechanism.
Other aromatic Hydroxy compounds: Cresol, nitrophenols, picric acid, benzyl alcohol, dihydric phenols.
Ethers: Preparation and properties: Williamson's synthesis. Reaction with acids.
Epoxides: Preparation and properties: ring opening reactions of epoxides.

Section IV: Experimental Work:

Inorganic Preparation (Any one): Practical classes: 30, Marks: 15

i. Potash alum
ii. Chrome alum
iii. Potassium trioxalatochromate
iv. Potassium trioxalatoferrate
v. Pentaaminenitrocobalt(III)chloride
vi. Pentaaminenitritocobalt(III)chloride

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examinations - 20 Marks
- Others - 20 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics
  - (iii) Group Discussion

Suggested Text Books:

1. Inorganic Chemistry – J.D. Lee
2. Basic Inorganic chemistry – Cotton and Wilkinson
3. Inorganic Chemistry – J.E.Huheey
4. Organic Chemistry – I.L. Finar, Vol. I & II, ELBS
5. Organic Chemistry, R.I. Morrison & R.N. Boyd, S.K. Bhattacharjee
6. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
7. P.W. Atkins, Physical Chemistry, Oxford University Press.
8. Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal

Suggested Reference Books:

1. General and Inorganic Chemistry (Part-I & II) R. Sarkar
2. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)

3. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
4. Inorganic Chemistry – Puri, Sharma and Kalia
5. Physical Chemistry- G.W. Castellan, Narosa Publishing House, New Delhi.
6. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi
7. Nagin, S. Chand & Co.
8. Physical Chemistry – D.S. Pahari (Vol. I & II).
9. Physical Chemistry – Levine
10. Organic Reactions and their Mechanisms (New Age International Private Limited) - P.S.Kalsi.
11. Organic Chemistry – M.K. Jain, S. Chand & Co.
12. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
13. Organic Chemistry – Vol. I & II, Mukherjee and Kapoor
14. Advanced General Organic Chemistry (Part I and Part II) - S. C.Ghosh
15. Organic Chemistry (Oxford) - Clayden,Warren, Greeves and Wothers.

B. SC. IN CHEMISTRY PROGRAM (NEP)
DETAILED SYLLABUS OF 3rd SEMESTER
Title of the Course: Fundamentals of Chemistry - III
Course Code: CHMIN-301 (T+P)
Nature of the Course: MINOR COURSE 1
Total Credits: 4

Distribution of Marks: 60 (End Sem) (45T+15P) + 40 (In-Sem)

COURSE OBJECTIVES: To give the concept of physico-chemical methods involved in metallurgy; first and second law thermodynamics; aromatic hydrocarbons and alkyl, aryl halides.

Section I: Inorganic Chemistry

Chemistry of non-metals: Lecture: 08, Marks: 08

a. Boron: Preparation, structure and bonding of diborane
b. Silicon: Structure, properties and use of silicon carbide and silicon polymers (linear).
c. Nitrogen: Hydroxylamine, Hydrazine, Hydrazoic acid; preparation, properties, uses and electronic structure.
d. Rare gases: Xenon compounds.
e. Phosphorous: Structures of oxides and oxyacids.

General principles of metallurgy: Lecture: 07, Marks: 07

Physico-Chemical methods involved in metallurgy(concentration, calcinations, reduction, roasting, zone refining, solvent extraction, hydrometallurgy and electrochemical methods) with reference to gold, nickel, thorium uranium and manganese (whichever is applicable).

Section II: Physical Chemistry

Chemical Thermodynamics Lecture: 15, Marks: 15

Thermodynamic systems, Extensive and Intensive properties of a systems, Path function and State function,

Zeroth Law of thermodynamics, First law of thermodynamics-Internal energy, enthalpy, molar heat capacities, relation between Cp and Cv, calculations of heat, work, internal energy and enthalpy for reversible, irreversible and free expansion of ideal gases under isothermal and adiabatic conditions. Relation between P, V, T. Variation in internal energy and enthalpy with temperature, Joule Thomson effect,

Thermochemistry- Standard states, Enthalpy of formation, Heat of reaction. Hess's law, Kirchhoff's law relation of reaction enthalpy with internal energy, Bond energy and Bond dissociation energy.

Second law of thermodynamics

Spontaneous and Non-Spontaneous processes, Carnot cycle, Concept of entropy, Entropy change of an ideal gas with change in P,V,T, concept of work function and free energy.

Section I: Organic Chemistry

Aromatic Hydrocarbons: Lecture: 05, Marks: 06

Preparation (only benzene) from phenol by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions- Electrophitic substitution in benzene: nitration, halogenations, sulphonation, Fridel-Craft alkylation and acylation with mechanism

Alkyl and Aryl halides: Lecture: 09, Marks: 09

Alkyl halides:

Nucleophilic Substitution Reactions (SN2, SN1, & SNi) Preparation: from alkenes and alcohols Reactions: Hydrolysis, nitrite and nitro formation, nitrile and isonitrile formation. Williamson's Synthesis: elimination vs Substitution

Aryl halides:

Preparation (chloro, bromo, iodo benzene only): From phenol, Sandmeyer & Gattermann reaction. Reactions (chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH) and effect of nitro substituent. Reactivity and relative strength of carbon-halogen bond in alkyl, allyl, benzyl and vinyl and Aryl halide.

Section IV: Experimental Work:

Organic Qualitative Analysis : Practical classes: 30, Marks 15

Detection of elements (nitrogen, sulphur and halogens) and functional groups of organic compound containing one functional group.

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examinations - 20 Marks
- Others - 20 Marks
  - (i) Attendance/ Home Assignment

(ii) Seminar presentation on any of the relevant topics

Suggested Text Books:

1. Inorganic Chemistry – Puri, Sharma and Kalia
2. A Text Book of Physical Chemistry – Negi & S.C. Anand, Wiley Eastern
3. Principles of Physical Chemistry, Puri, Sharma, Pathania, Shoban Lal, (S. Chand & Co.)
4. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
5. General and Inorganic Chemistry (Part-I & II) R. Sarkar

Suggested Reference Books:

1 Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Organic Chemistry – M.K. Jain, S. Chand& Co.
3. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
4. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi
5. P.W. Atkins, Physical Chemistry, Oxford University Press.

B. SC. IN CHEMISTRY PROGRAM (NEP)
Detailed Syllabus of 3rd Semester
Title of the course: Chemistry in Daily Life-III
Course Code: CHGEC-301
Nature of the Course: Natural Science
Total Credits: 3

Distribution of Marks: 45 (End Sem) + 30 (In-Sem)

COURSE OBJECTIVES: To understand about the applications of polymers, fertilizers, cosmetics and perfumes in everyday life.

Unit I: Chemical and Renewable Energy Sources: Lecture: 12, Marks: 10

Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy store.

Unit II: Polymers: Lecture: 11, Marks: 12

Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronic, automobile components, medical fields, and aerospace

materials. Problems of plastic waste management. Strategies for the development of environment friendly polymers.

Unit III: Chemistry of Cosmetics & Perfumes: Lecture: 12, Marks: 12

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Unit IV: Fertilizers: Lecture: 11, Marks: 11

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

MODES OF IN-SEMESTER ASSESSMENT: **30 Marks**

- Two Internal Examinations - 20 Marks
- Others - 10 Marks
  - (i) Attendance/ Home Assignment
  - (ii) Seminar presentation on any of the relevant topics

Suggested Books:

1. Barel, A.O.; Paye, M.; Maibach, H.I.(2014),Handbook of Cosmetic Science and Technology, CRC Press. 2. Garud, A.; Sharma, P.K.; Garud, N. (2012), Text Book of Cosmetics, Pragati Prakashan.
3. Gupta, P.K.; Gupta, S.K.(2011),Pharmaceutics and Cosmetics, Pragati Prakashan
4. Butler, H. (2000), Poucher's Perfumes, Cosmetic and Soap, Springer.
5. Kumari, R. (2018), Chemistry of Cosmetics, Prestige Publisher.
6. Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), Engineering Chemistry, Vikas Publications.
7. Sharma, B. K. Engineering Chemistry, Goel Publishing House, Meerut, 2006
8. Carraher,C. E. Jr. (2013), Seymour's Polymer Chemistry, Marcel Dekker, Inc.
9. Ghosh, P. (2001), Polymer Science & Technology, Tata Mcgraw-Hill.

B. SC. IN CHEMISTRY PROGRAM (NEP)
Detailed Syllabus of 3rd Semester
Title of the course: Inorganic Materials of Industrial Importance
Course Code: CHSEC-301 (T+P)
Nature of the Course: Skill Enhancement Course

Total Credits: 3

Distribution of Marks: 45 (End Sem) (30T+15P) + 30 (In-Sem)

COURSE OBJECTIVES: To introduce the diverse roles of inorganic materials in the industry. It gives an insight into how these raw materials are converted into products used in day-to-day life. Students learn about silicates, fertilizers and surface coatings. The course helps develop the interest of students in the frontier areas of inorganic and material chemistry

Unit I: Silicon Materials, Silicones & Cements: Lecture: 12, Marks: 14

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Silicones

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Unit II: Fertilizers: Lecture: 06, Marks: 06

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Unit III: Lecture: 12, Marks: 10

Surface Coatings: Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings, metal spraying and anodizing.

Unit IV: Any one experiment: Practical classes: 30, Marks: 15

(i) Estimation of free phosphoric acid in superphosphate fertilizers.
(ii) Estimation of CaO in cement.
(iii) Laboratory synthesis of the following pigments:
    (a) Prussian blue,

(b) Malachite green,
(c) Chrome yellow.

MODES OF IN-SEMESTER ASSESSMENT: **30 Marks**

- Two Internal Examinations - 20 Marks
- Others - 10 Marks

(iv) Attendance/ Home Assignment
(v) Seminar presentation on any of the relevant topics
(vi) Group Discussion

Suggested Text Books:

1. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut

Suggested Reference Books:

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.