01 May 2019

Syllabus

for

B.Sc. (Honours) Course in

CHEMISTRY

Choice Based Credit System

Effective from the Session 2016-17

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SEMESTER – I (Total Marks 100, Credit 12)

Inorganic Chemistry – I (Core-I) **Marks 50, Credit 6**

Unit-I: Atomic Structure and Nuclear Chemistry **(16 L)**

Nuclear Stability: neutron-proton ratio and Segre's chart, modes of decay and neutron proton-ratio, packing fraction, mass defect and nuclear binding energy, magic number; Radioactive decay, units of radioactivity, different modes of decay, half-life and average life of radioelements, radioactive equilibrium, natural radioactive disintegration series, principles of determination of age of rocks and minerals, radio carbon dating, disintegration series (Naturally occurring), group displacement law, artificial radioactivity, nuclear fission, fusion reaction and spallation, nuclear energy and power generation, application of radioactivity in analytical chemistry

Bohr's theory and its limitation, Sommerfeld theory (no derivation) and hyperfine splitting of spectral lines, Bohr's correspondence principle, de Broglie matter waves, penetration and quantum defects of atomic orbitals, concept of atomic orbitals: shapes, radial and angular wavefunction (qualitative idea), radial distribution probability function of s, p, d and f orbitals (qualitative idea); significance of different quantum numbers, many electron atoms and ions: Pauli's exclusion principle, Hund's rule, Aufbau principle; energy level of atomic orbitals and writing of the electron configuration of atoms, term symbols of atoms and ions (some illustrative examples)

Unit-II: Periodic Table and Periodic properties **(15 L)**

Modern version of the periodic table and extended periodic table, connection among valency/oxidation number, electron distribution, position of the elements
Periodicity of properties: atomic radii, ionic radii, covalent radii, Vander Waals radii, ionization energy, ionic potential, electron affinity, electronegativity, Pauling's, Mulliken's, Jaffe-Hinzes' and Allred-Rochow's scales; electronegativity equalization principle, controlling factors, applications, Effective nuclear charge (Slater's rule, elementary calculations), catenation, metallic and non-metallic character
Properties of boarder line elements, secondary periodicity, relativistic effects, exchange energy, inert pair effect, diagonal relationship, peculiarity of the first and second row elements

Unit-III: Chemical Bonding in Covalent Compounds (Preliminary Concept) **(15 L)**

Concept of hybridization: directional character of covalent bonds, equivalent and non-equivalent hybrid orbitals, Bent's rule, resonance effects and resonance energy, covalent bond energy and bond length, Controlling factors; Valence Shell Electron Pair Repulsion theory (VSEPR): Shape of the molecular species, stereochemically active lone pairs, VSEPR in the light of electron domain theory

Covalent radii (tetrahedral and octahedral); partial ionic character in covalent bonds, Pi-bonding: p - p , p -d and d -d interaction, importance in controlling different molecular properties (C vs Si, N vs P, O vs S etc); -bonding in boron compounds, -bonding and properties of oxyacids of different nonmentals, electron deficient Covalent bonds (Qualitative approach): 2c-1e, 2c-3e, 3c-2e (H-bridge bond), banana bonds, odd electron molecules

Unit-IV: Molecular Orbital Theory of Covalent Compounds and Some Aspects of Covalent Bonding **(14 L)**

Molecular orbital theory (MOT): LCAO approach, shape and symmetry of the bonding and antibonding molecular orbitals, symmetry elements of the sigma, pi and delta molecular orbitals, bond orders, bond lengths

Molecular orbital models for homonuclear diatomic species, interaction of hybride atomic orbitals, symmetry interaction among the Mos, conditions of LCAO, bond order, molecular orbital models for heteronuclear diatomic species: CO, NO, HCl, etc and polyatomic species (e.g. H_2O, BeH_2 CO_2, BF_3 etc.), MOT of Inert gas compounds (3c-4e bond)

Organic Chemistry – I (Core-II) **Marks 50, Credit 6**

Unit-I: Classification and nomenclature **(3 L)**

Classification of organic compounds; Nomenclature with special reference to polycyclic, bridge-head, aromatic, heterearomatic and heterocyclic compounds.

Unit-II: Structure, bonding and properties of Organic molecules; Organic acid-bases (11 L)

Hybridisation of atomic orbitals; orbital picture of ethane, ethene, ethyne, allene and benzyne; state of hybridisation and bonding properties; delocalised bonds, resonance, steric inhibition of resonance, hyperconjugation, tautomerism, aromaticity, non-aromaticity and anti-aromaticity; Inductive and field effect; Dipole moment; Intermolecular forces of attraction; Solute-Solvent interaction; Acid base principles; Relation between structure and acidity & basicity; Effect of solvent on acids and bases; Molecular orbitals of ethylene, butadiene and hexatriene; HOMO and LUMO concept.

Unit-III: Organic reaction mechanism : An Introduction **(14 L)**

Homolysis and heterolysis of bonds; Thermodynamics and kinetics of organic reactions, Transition state theory and Hammond's postulate with energy profile; principle of microscopic reversibility, kinetically and thermodynamically controlled reactions; Primary and Secondary kinetic isotope effects; cross over experiments; Study of Reactive intermediates : Generation, shape, stability and reactions of carbocations, carbanions, free radicals, arynes, ylides, carbenes and nitrenes; classification of organic reactions, nucleophiles and electrophiles.

Unit-IV: Aliphatic and aromatic nucleophilic substitutions **(12 L)**

Free radical and nucleophilic substitutions at sp_3 Carbon; S_{N1}, S_{N2}, S_{Ni}, $S_{N1'}$, $S_{N2'}$ reactions; NGP phase transfer catalysis; use of crown ether; functional group transformations using S_{N2} reactions, nucleophilic substitutions at sp_2 carbon.
Aromatic S_N processes : Addition – elimination mechanism, ArS_{N1} mechanism, elimination – addition mechanism, orientation and reactivity.

Unit-V : Static stereochemistry-I **(20 L)**

Concept of constitution, configuration and conformation of organic molecules; elements of symmetry, symmetry operations, chirality and chiral centre(s), optical activity and optical isomerism, optical rotation, optical purity, enantiomeric excess, racemisation, resolution of racemic acids, bases and alcohols, configurational nomenclature : D/L, R/S, *erythro/threo* ; stereochemical representation. Fischer, Newman, Sawhorse, Flying wedge and their interconversions; Axial chirality of allenes, biphenyls and their *R/S* descriptions. Geometrical isomerism : *cis/trans* and *E/Z* nomenclature; conformational isomerism : eclipsed, staggered, gauche arrangements; synperiplaner, synclinal, anticlinal, antiperiplaner conformations, conformational analysis of ethane *n*-butane, 1, 2 dihaloethane and ethylene glycol.

SEMESTER – II (Total Marks 100, Credit 12)

Physical Chemistry – I (Core-III) **Marks 50, Credit 4**

Unit – I: Properties of Gas **(16 L)**

Idea of distribution functions, properties of gamma functions, Maxwell's speed and energy distributions in one-, two- and three- dimensions, distribution curves, different types of speeds and their significance, principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases

Collision of gas molecules, collision diameter, collision number and mean free path, frequency of binary collision in same and different molecules, wall collision and rate of effusion

Andrew's and Amagat's plots, compressibility factor, van der Waals equation and its features, critical constants and critical state, law of corresponding states, virial equation; significance of second virial coefficient, Boyle temperature, Dieterici equation and its features

Unit – II: Thermodynamics I **(12 L)**

Basic formalism, concept of thermal equilibrium and zeroth law of thermodynamics, state and path functions, partial derivatives and cyclic rule, concept of heat and work, reversible and irreversible processes, graphical representation of work done

First law, U and H as state functions, concept of C_P and C_V and their relations, Joule's experiment and its consequence, isothermal and adiabatic processes

Thermochemistry: Kirchoff's equation, heat changes during physicochemical processes at constant P/V, bond dissociation energies, Born-Haber's cycle

Unit – V: Properties of Fluids **(10 L)**

General features of fluid flow (streamline and turbulent flows) Reynolds number, nature of viscous drag for streamline motion, Newton's equation, viscosity coefficient, kinetic theory of gas viscosity, viscosity of gases vs liquids, Poiseuille's equation and its derivation, temperature dependence of viscosity, intrinsic viscosity, principle of determination of viscosity coefficients of liquids by Ostwald viscometer and falling sphere methods

Nature of the liquid state, vapour pressure, surface tension, surface energy, excess pressure, capillary rise and measurement of surface tension, condition of wetting, vapour pressure over a curved surface, temperature-dependence of surface tension, principle of determination of surface tension, concept of liquid crystals and superfluids

Physical Chemistry-I Lab **Marks 50, Credit 2**

1. Surface tension of a liquid/solution by drop-number method.

2. Viscosity coefficient of a liquid/solution by Ostwald viscometer.

Organic Chemistry-II (Core-IV) **Marks 50, Credit 6** 4

Unit-I: Static Stereochemistry-II **(8 L)**

Prochirality, topicity of ligands and faces (*Pro – R*, *Pro – S* and *Re/Si*; designation). Asymmetric synthesis; Cram's rule. Conformational analysis of cyclohexane and its mono and di-subsituted derivatives with chair, boat and twist boat forms and their symmetry properties, and their chiroptic properties.

Unit-II : Elimination Reactions **(6 L)**

E1, E2 and $E1_CB$ mechanisms, their mechanistic spectrum, orientation, stereoselectivity; elimination vs substitution; *syn*-elimination : Pyrolysis of ester, Xanthate, *tert* – N oxide.

Unit-III : Electrophilic and radical addition to C – C multiple bonds **(8 L)**

Halogenation, hydrohalogenation, hydration, hydrogenation, epoxidation, hydroxylation, ozonolysis, hydroboration, 1, 3 dipolar addition, electrophilic addition to conjugated dienes and allenes, radical addition of HBr; reduction of alkynes and benzenoid aromatics, Diels – Alder reaction.

Unit-IV : Nucleophilic addition to carbonyl group **(10 L)**

Reaction with water, alcohols, amines, thiols, HCN, bisulfite; Wittig reaction, MPV reduction, reduction with lithium aluminium hydride and sodium borohydride, Wolf-Kishner reduction, Clemensen reduction, Bouveault-Blanc reduction, addition of organometallics, addition of diazomethane; Cannizaro reaction, aldol condensation including directed aldol reaction, Claisen condensation, Knoevenagel reaction, Stobbe reaction, Reformatsky reaction, Mannich reaction, Darzen's glycidic ester synthesis, Perkin reaction, Benzoin condensation, nucleophilic addition (Michael addition) to , unsaturated carbonyl system.

Organic Chemistry-II Lab **Marks 50, Credit 2**

Qualitative analysis of organic compound :

A. Study on Physical Properties : Physical State, Colour, odour, acid-base character, ignition, solubility and melting point.

B. Detection of special elements (N, S, Cl) by Lassaigne's test.

C. Detection of functional group : – COOH, – OH (Phenolic), – COOR, Carbonyl group (aldelydic and ketonic) , >C=C< (unsaturation), $-NH_2$, $-NO_2$, $-CONH_2$ and CONHAr (anilido)

D. Preparation of a suitable derivative of one functional group present in the sample.

SEMESTER – III (Total Marks 150, Credit 18)

Inorganic Chemistry – II (Core-V) **Marks 50, Credit 4**

Unit-I: Chemistry of s and p Block Elements **(14 L)**

General properties of s- and p-block elements, Comparative account of physical and chemical properties of the s and p-block elements, the diagonal relationship, variation of electronic configuration, elemental forms, metallic nature, magnetic properties (if any), catenation properties (if any), hydrides, halides, oxides, oxy-acids (if any), inert pair effect (if any), complex chemistry (if any) in respect of the following elements

(i) S-block elements: Li-Na-K, Be-Mg-Ca-Sr-Ba.
(ii) P-block elements: B-Al-Ga-In-Tl, C-Si-Ge-Sn-Pb, N-P-As-Sb-Bi, O-S-Se-Te, F-Cl-Br-I, He-Ne-Ar-Kr-Xe

Properties and reactions of important compounds
(i) Structure, bonding and reactivity of B_2H_6; $(SN)_x$ with x = 2, 4; phosphazines; interhalogens. (ii) Structure of borates, silicates, polyphosphates, borazole, boron nitride, silicones, thionic acids. (iii) Reactivity of polyhalides, pseudo halides, fluorocarbons, freons and NOx with environmental effects. (iv) Chemistry of hydrazine, hydroxylamine, N_3-, thio- and per-sulphates

Compounds of Noble Gases: structure, preparation and reactivity

Unit-II: Acids and Bases and Ionic Equilibria **(15 L)**

Brönsted Lowry's concept, cosolvating agents, differentiating and leveling effect, Theory of solvent system, Lux-Flood concept, Lewis concept- Stability of the adduct (Drago-Wayland equation), change of bond length parameter in adduct formation, -acidity of the ligands, synergistic effect, Usanovich's concept

Strength of hydracids and oxyacids, different factors in determining acid-base strength: inductive effect and hyperconjugation, steric effects (B- and F-strain), salvation, H-bonding

Hard and Soft acid base (HSAB) principle: classification and characteristic, hardness and frontier molecular orbital (FMO), electronegativity and hardness and softness, symbiosis, theoretical back ground, application of the concept; acid-base equilibria in solution: hydrolysis of salts, P_H calculation, buffer, acid-base neutralization curves and selection of indicator

Inorganic Chemistry – II Lab **Marks 50, Credit 2**

Qualitative analysis
Qualitative analysis of mixtures containing not more than four radicals from among the following:
BASIC RADICALS: Silver, lead, mercury, bismuth, copper, cadmium, arsenic, antimony, tin, iron, aluminium, manganese, chromium, nickel, cobalt, zinc, calcium, strontium, barium, sodium, potassium
ACID RADICALS: Chloride, bromide, iodide, bromate, iodate, silicate, fluoride, arsenite, arsenate, phosphate, nitrite, nitrate, sulphide, sulphite, thiosulphate, suplhate, borate, ferro/ferri-cyanide, chromate, dichromate
Insoluble Materials: Al_2O_3, Fe_2O_3, Cr_2O_3, SnO_2, $SrSO_4$, $BaSO_4$, CaF_2.

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Organic Chemistry – III (Core-VI) **Marks 50, Credit 4**

Unit-I: Molecular rearrangements and Named reactions **(10 L)**

Wagner-Meerwein, Pinacol-Pinacolones, Dakin, Bayer-Villiger, Beckmann, Favorsky, Hoffmann, Lossen, Schmidt, Curtius, Benzil – benzilic acid, dienone-phenol, Wolf, Claisen, Fries, Photo Fries, Orton, Demjanov, Benzidine Semidine.
Birch, Von Richter, Houben-Hoesch, Arndt-Eistert homologation, HVZ, Hunsdiecker, Oppenaur, Sandmeyer, Stephen, Williamson ether synthesis.

Unit-II: Aromatic electrophilic substitutions **(8 L)**

Mechanism, orientation and reactivity; nitration, nitrosation sulfonation, halogenation Friedel-Crafts, Haworth Synthesis, Gatterman – Koch, Gatterman, Hoesch, Vilsmeier – Haack, Reimer – Tiemann, Kolbe – Schmidt, Chloromethylation, Manasse, Kolbe.

Unit-III: Synthesis, physical properties and reactions **(10 L)**

(i) Aliaphatic and aromatic nitrogen compounds : amines, nitro compounds, nitro alkanes, alkyl nitrites, aromatic diazonium compounds, dilzomethane; (ii) nitrophenols, amionophenols, nitro anilines, amino carboxylic acids.

Organic Chemistry – III Lab **Marks 50, Credit 2**

Quantitative analysis of organic compound :

Estimation of : 1. Glucose by Fehling's solution, 2. Acetone, 3. Aniline

Physical Chemistry – II (Core-VII) **Marks 50, Credit 4**

Unit – I: Thermodynamics II & Application **(20 L)**

Second law of thermodynamics and its need, Kelvin, Planck and Clausius statements and their equivalence, Carnot cycle and refrigerator, Carnot's theorem, thermodynamic scale of temperature
Physical concept of entropy, Clausius inequality, entropy change of system and surroundings for various processes and transformations, entropy change during isothermal mixing of ideal gases, entropy and unavailable work, auxiliary state functions (G and A) and their variations with T, P and V, criteria of spontaneity and equilibrium
Thermodynamic relations, Maxwell relations, thermodynamic equation of state, Gibbs-Helmholtz equation and its consequence, Joule-Thomson (J-T) experiment inversion temperature, J-T coefficient for a van der Waals gas, general heat capacity relations
Additivity rule, partial molar quantities, chemical potential and its variation with T and P, Gibbs-Duhem equation, fugacity of gases and fugacity coefficient

Unit – II: Statistical Thermodynamics & Third Law **(8 L)**

Thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation), application to barometric distribution, partition function and thermodynamic properties (U, H & P), Einstein's theory of heat capacity of solids and its limitations
Nernst heat theorem and its implications, approach to zero Kelvin, Planck's formulation of third law and absolute entropies

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Unit – III: Chemical Kinetics –I **(10 L)**

Introduction, reaction rate and extent of reaction, order and molecularity; kinetics of zero, first, second, fractional and pseudo-first order reactions; determination of order of reaction, opposing, consecutive and parallel reactions (first order), concept of steady state and rate determining step, chain reaction: elementary idea, illustrations with H_2-Br_2 and H_2-O_2 reactions
Temperature dependence of reaction rate, Arrhenius equation

Unit – IV: Ionic Equilibria **(6 L)**

Ostwald's dilution law, pH, buffer solution and buffer capacity, Henderson equation, hydrolysis and hydrolysis constant of salts, indicators: acid-base and its function, Hammett acidity function

Unit - V. Properties of Solid **(6 L)**

Unit cell, Bravais lattice, crystal system, packing in cubic crystals, Miller indices, Bragg's equation and its applications, crystal structures of NaCl and KCl, Crystal defects

Physical Chemistry – II Lab **Marks 50, Credit 2**

1. Kinetics of decomposition of H_2O_2 by potassium iodide.

2. Solubility/solubility product of Mg-carbonate in presence/absence of common ions and/or neutral electrolytes.

Industrial Chemistry (SEC) **Marks 50, Credit 2**

Water **(3 L)**

Types of water, analysis of water (different types of hardness), for municipal and industrial use

Electrochemical and Electro-thermal Industries **(3 L)**

Preparation and use of Potassium permanganate, hydrogen peroxide, synthetic graphite, calcium carbide, carborundum, alloy steels

Ceramics **(4 L)**

Refractories, pottery, porcelain, glass, fibre glass

Rusting of Iron and Steel **(3 L)**

Cause and prevention of corrosion

Industrial Safety and Fire Protection **(4 L)**

Flash point, fire extinguishers – foam, carbon dioxide, sprinkler system, inert gases.

Pollution **(3 L)**

Types of wastes – industrial, domestic, electronic; their causes and control

Pharmaceutical Chemistry (SEC) **Marks 50, Credit 2**

Drugs & Pharmaceuticals **(15 L)**

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation **(5 L)**

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

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SEMESTER – IV (Total Marks 150, Credit 18)

Inorganic Chemistry – III (Core-VIII) **Marks 50, Credit 4**

Unit-I: Chemistry of d and f Block Elements **(15 L)**

d-Block elements: general comparison of 3d, 4d and 5d elements with special reference to electronic configuration, variable valency, ability to form coordination complexes, spectral magnetic catalytic properties

f-Block Elements: comparison of the general properties (e.g. electronic configuration, oxidation state, variation in atomic and ionic (3+) radii, complex formation, magnetic and spectral properties) of lanthanides and actinides, f-contraction, similarities between the later actinides and the later lanthanides, spectral properties (in comparison with the d-block elements), isolation and occurrence, use of the metals, principle of separation of lanthanides, chemistry of separation of Np, Pu and Am from U

Chemistry of some representative compounds: $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, $K_2[Ni(CN)_4]$, H_2PtCl_6, $Na_2[Fe(CN)_5NO]$

Unit-II: Coordination Chemistry-I: Bonding in Coordination Compounds (Preliminary Concept) and Properties of Coordination Compounds **(16 L)**

Werner's Coordination theory, different types of ligands, metal chalates, IUPAC nomenclature of coordination compounds, electronic theory of complex compounds, effective atomic number (EAN) and its limitations, Valence bond theory in coordination compounds: different geometry, outer and inner orbital complexes, magnetic criterion of bond type, Principle of electroneutrality of atoms, limitations of VBT

Stereochemistry, Coordination number, factors favouring low and high coordination numbers, isomerism (ionization, hydrate, ligand, linkage, coordination, geometrical and optical etc.) in coordination compounds, concept of Stability constant (stepwise and overall), chelate effect, macrocyclic effect and macropolycyclic effect, labile and inert complexes, substitution reaction on square planer complexes, trans-effect (preliminary concept) in square planar complexes, application of coordination complexes in chemical analysis, elucidation of structure of coordination compounds, metal complexes in biosphere

Inorganic Chemistry – III Lab **Marks 50, Credit 2**

Preparation
Chrome alum, Mohr's salt, Cuprommonium sulphate, sodium nitroprusside, hexamine cobalt(III) chloride, tris (ethane 1,2-ammine) nickel(III) chloride

Organic Chemistry – IV (Core-IX) **Marks 50, Credit 4**

Unit-I: Heterocyclic compounds **(6 L)**

Syntheses, properties and uses of furan, pyrrole, thiophene, pyridine, quinoline, isoquinoline and indole

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Unit-II: Alicylic compounds **(3 L)**

Structure of simple alicyclic compounds up to six-membered ring; strain theory in classical and modern theoretical approach, effect of strain on reaction, ring synthesis-principles controlling ring closure reactions, rules for ring closure (Baldwin's rule), ring expansion and contraction process.

Unit-III: Amino acids and Proteins **(6 L)**

Essential and non-essential amino acids, isoelectric point, ninhydrin reaction, synthesis of glycine, alanine and tryptophan; classification of proteins, geometry of peptide linkage, elementary idea about primary and secondary structures of proteins; C-terminal, N-terminal and their determination; peptide synthesis, Merrifield synthesis

Unit-IV: Carbohydrate chemistry **(8 L)**

Chemistry of monosaccharides and disaccharides including structures and configurations: D-glucose, fructose, and sucrose; stepping-up and stepping-down of monosaccharides, conversion of aldose to ketose and vice versa; mutarotation, epimerization, anomeric effect, reducing sugars, elementary idea about starch and cellulose

Unit-V: Alkaloids and Terpenenoids **(6L)**

Introductory discussion on terpenenoids and alkaloids; biosynthesis of squalene; determination of structures of *citral*, α-*terpineol*, piperine, ephedrine and coniine

Organic Chemistry – IV Lab **Marks 50, Credit 2**

Identification with general reaction and tests of the following compounds:
a) Methyl alcohol, b) Ethyl alcohol, c) Acetone, d) Formic acid, e) Acetic acid, f) aniline, g) Nitro benzene, h) Tartaric acid, i) Succinic acid, j) Salicylic acid, k) Glucose l) Resorcinol

Physical Chemistry – III (Core-X) **Marks 50, Credit 4**

Unit – I: Chemical Equilibrium **(6 L)**

Thermodynamic condition of equilibrium, degree of advancement and Le Chatelier's principle, Van't Hoff isotherm, isobar and isochore

Unit – II: Electrochemistry **(20 L)**

Conductance and its measurement, cell constant, specific and equivalent conductances, their variations with dilution for strong and weak electrolytes, molar conductance, transport number and determination by Hittorf methods, Kohlrausch's law, Walden's rule, ion conductance and ionic mobility, application of conductance measurement (determination of solubility product and ionic product of water), conductometric titrations
Ion atmosphere, asymmetry and electrophoretic effects, Wien effect and Debye-Falkenhagen effect, Activity and activity coefficients of electrolyte/ion in solution, Debye-Hückel theory, Debye-Hückel limiting law (with derivation), solubility equilibrium and influence of common and indifferent ions
Electrochemical cells, half cells/electrodes with types and examples, cell reactions and thermodynamics of cell reactions, Nernst equation, standard cells, calomel, Ag/AgCl, quinhydrone and glass electrodes: features and applications, potentiometric titrations (acid base and redox), concentration cells, liquid junction potential

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Unit – III: Chemical kinetics –II **(6 L)**

Collision theory of bimolecular reactions, unimolecular reactions, Lindemann theory, transition state theory, free energy and entropy of activation, pressure-dependence of rate constant, primary kinetic salt effect

Homogeneous catalysis, with reference to acid base and enzyme catalyses, heterogeneous catalysis

Unit – IV: Interface & Dielectrics **(12 L)**

Special feature of interfaces, physical and chemical adsorptions, Langmuir and Freundlich adsorption isotherms, surface excess and Gibbs adsorption isotherms, heterogeneous catalysis (single reactant)

Electrical double layers, zeta potential, overvoltage, Stern double layer (qualitative idea), Tyndall effect, electrokinetic phenomena (qualitative idea), colloids and electrolytes, micelle and reverse micelle, critical micelle constant (CMC)

Electrical properties of molecules, polarizability, induced and orientation polarization, Debye and Clausius-Mossotti equations (without derivation) and their applications

Origin and types of intermolecular forces, different types of potential and their diagrams

Physical Chemistry – III Lab **Marks 50, Credit 2**

1. Equilibrium constant of the reaction $KI + I_2 = KI_3$ by partition method.

2. Conductometric titrations of an acid or a base (acid may be monobasic/dibasic, and similarly for the base)

3. Potentiometric titrations of an acid or a base (acid may be monobasic/dibasic, and similarly for the base)

Chemistry of Cosmetics & Perfumes (SEC) **Marks 50, Credit 2**

Preparation and Use of Cosmetics & Perfumes **(20 L)**

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.

Fuel Chemistry (SEC) **Marks 50, Credit 2**

Energy Sources **(6 L)**

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

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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 bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry **(10 L)**

Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants **(4 L)**

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

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SEMESTER – V (Total Marks 200, Credit 24)

Organic Chemistry – V (Core-XI) **Marks 50, Credit 4**

Unit-I: Methodology in organic synthesis **(8 L)**

Disconnection approach, synthons, synthetic equivalents, umpolung, one-group disconnection of alcohols, olefins and ketones; synthesis involving enolates and enamines with special reference to diethyl malonate and ethyl acetoacetate; Robinson annelation; synthesis through protection of functional groups

Unit-II: Pericyclic reactions **(8 L)**

FMO approach, definition, classification, electrocyclic reactions (including Woodward-Hofmann selection rules): [4+2] cycloaddition with special reference to Diels-Alder reaction, alder ene reaction, [2+2] cycloaddition; sigmatropic reactions: [1,j] and [i,j] shifts, [1,3] and[1,5] H-shifts, [3,3] sigmatropic shifts with reference to Cope and Claisen rearrangements

Unit- III: Spectroscopy **(15 L)**

UV: Electronic transitions with reference to σ-σ^*, n-σ^*, π-π^*, n-π^* transitions; absorption maximum and absorption intensity, effect of solvent; Woodward-Fischer rule with reference to conjugated system like dienes, trienes and α,β-unsaturated carbonyls including cyclic systems

IR: Hooke's law, stretching and bending vibrations, characteristic and diagnostic stretching frequencies, factors affecting stretching frequencies (H-bonding, electronic factor, ring size), finger-print region, diagnostic bending frequencies for benzene and its *o*-, *m*- and *p*-isomers

1H NMR: Principle, nuclear spin, NMR-active nuclei, chemically equivalent and nonequivalent protons; chemical shift, upfield and downfield shifts; shielding/deshielding of protons in systems involving C-C, C=O, C=C, benzene, cyclohexane; spin-spin splitting with reference to CH_3CH_2Br, CH_3CH_2OH, Br_2CHCH_2Br; characteristic ^1H NMR signals for simple molecules.

Application of the above spectroscopic methods in structure elucidation of simple organic molecules

Organic Chemistry – V Lab **Marks 50, Credit 2**

Preparation -

1. Condensation : *preparation of phthalimide*
2. Nitration : *nitration of nitro benzene and acetanilide*
3. Oxidation : *Oxidisation of benzyl alcohol*
4. Hydrolysis : *hydrolysis of amide*
5. Rearrangement reaction : *Benzil-benzilic acid rearrangement*

Inorganic Chemistry – IV (Core-XII) **Marks 50, Credit 4**

Unit-I: Redox Potential and Redox Equilibria **(12 L)**

Some basic aspects of redox reactions, equivalent weights of oxidants and reductants, ion-electron method of balancing redox ractions, complimentary and noncomplimentary redox reactions,

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disproportionation and comproportionation reactions, overpotential, electron and atom transfer in redox reactions

Standard redox potentials, sign convention, Nernst equation, electrochemical series, formal potential and its importance in analytical chemistry; Redox potential: effect of complex formation, effect of precipitation, effect of P_H change, chemistry of aqua regia and mixed acids

EMF Diagram (Latimer, Frost and Pourbaix), thermodynamic aspects of disproportionation and comproportionation reactions, redox potential and equilibrium constants, clock reaction, redox titration and redox indicators, function of Zimmermann Reinhardt (ZR) solution

Unit-II: Bioinorganic Chemistry **(12 L)**

Essential metals: role of metal ions in biological systems (specially Na_+, K_+, Mg_{2+}, Ca_{2+}, $Fe_{3+/2+}$, $Cu_{2+/+}$, and Zn_{2+}) and in different metalloproteins and metalloenzymes, metal ion transport across biological membrane, Na_+- ion pump, ionophores, biological functions of hemoglobin and myoglobin, cytochromes and ferredoxins, carbonate bicarbonate buffering system and carbonicanhydrase, biological nitrogen fixation, photosynthesis: photosystem-I and photosystem-II, metal dependent disease, detoxification by chelation therapy for Pb and As poisoning

Important metal complexes in medicines (Examples only), antimicrobial activity, antiarthritic gold complexes, anticancer compounds (Pt-complexes and metallocenes), lithium therapy in psychiatric mind disorder

Unit-III: Organometallic Compounds **(13 L)**

Definition, a brief history, nomenclature, classification, importance of organometallic compounds as reagents, additives and catalysts, effective atomic number rule (18 electron rule), counting of electrons
preparation, properties and bonding in - carbonyl, nitrosyl and cyanide complexes; IR-results as diagnostic tools in the identification of nature of bonding in such -acid complexes, metal-olefin complexes: Zeise's salt (preparation, structure and bonding), ferrocene (preparation, structure and reactions), heptacity of organometallic ligands and their examples, different types of reaction (elementary idea): oxidative addition, reductive elimination, insertion

Inorganic Chemistry – IV Lab **Marks 50, Credit 2**

Volumetric analysis:
Redox titrations- permanganometry, dichromatometry, iodometry and iodimetry
Volumetric analysis of mixtures involving not more than two different estimations:
Fe +Cu, Fe + Cr, Fe + Ca, Ca + Ba, Ca + Mg etc.

Green Chemistry (DSE) **Marks 50, Credit 6**

Unit - I: Introduction to Green Chemistry **(8 L)**

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Unit – II: Principles of Green Chemistry and Designing a Chemical synthesis **(34 L)**

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

Prevention/ minimization of hazardous/ toxic products reducing toxicity. risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents.
Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.

Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

Unit – III: Examples of Green Synthesis/ Reactions and some real world cases **(18 L)**

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)

Environmental Chemistry (DSE) **Marks 50, Credit 6**

Unit-I: The Atmosphere **(15 L)**

Composition and structure of the atmosphere: troposphere, stratosphere, mesosphere and thermosphere, ozone layer and its role; major air pollutants : CO, SO_2, NO and particulate matters – their origins and harmful effects, problems of ozone layer depletion, green house effect, acid rain and photochemical smog, air pollution episodes, air quality standard, air pollution control measures: cyclone collector, electrostatic precipitator, catalytic converter, detection, collection and principles of estimation of CO, NO_x, SO_2, H_2S and SPM in air samples

Unit-II: Aspects of Environmental Inorganic Chemistry **(15 L)**

Atmospheric stability and temperature inversion, greenhouse effect, global warming and cooling, ozone depletion and involved chemical reactions, the *disaster* of *endosulfan* in *kasargod in kerala,* smog formation, acid rain, eutrophication in natural water bodies, Minamata disease, Bhopal disaster, hazard of nuclear disaster (Chernobyl and Fukushima Daiichi), nuclear disaster management

Unit-III: The Hydrosphere **(15 L)**

Water pollutants: action of soaps and detergents, phosphates, industrial effluents, agricultural runoff, domestic wastes; thermal pollution radioactive pollution and their effects on animal and plant life, water pollution episodes, waste water treatment: chemical treatment and microbial treatment; water quality standards: DO, BOD, COD, TDS and hardness parameters, desalination of sea water: reverse osmosis, electro dialysis, detection and estimation of As, Hg, Cd, Pb, Cr, NH_4 and F , NO_3 , NO_2 in water sample

Unit-IV: The Lithosphere and Pollution control **(15 L)**

Soil pollution and control measures, biochemical effects of As, Pb, Cd, Hg, Cr, and their chemical speciation, monitoring and remedial measures; noise pollution, agricultural and industrial pollution, green solution to various environmental hazards

Solid State Chemistry (DSE) **Marks 50, Credit 6**

Unit-I: Basic Concepts and selected structure **(14 L)**

Some basic crystal geometries: simples cube (sc), body centred cube (bcc), face centred cube (fcc), diamond cube (dc), close packing models: hexagonal close packing (hcp) (ABAB… type), cubic close packing (ccp) (ABCABC… type), tetrahedral and octahedral holes, packing efficiency

Structural inferences (Simple) from crystallochemical parameters; Structure of Ionic Crystals: AB-type (i.e NaCl, CsCl and {ZnS, (sphelarite and wurtzite)}, AB_2 type (CaF_2, SiO_2 and TiO_2), Ilmenite and perovskite (ABO_3), spinel (AB_2O_4)

Unit-II: Crystallographic Basics **(14 L)**

Crystal, Steno's Law, Hauy's Law (law of rational intercepts), law of constancy of symmetry, Weiss indices, Miller's indices, Unit cell, Bravis Lattice, Crystal systems, crystal class, Bragg's equation with derivation, methods of crystal analysis, application of Bragg's equation, crystal structure of sodium chloride and potassium chloride, Lattice vector and reciprocal lattice vector, Brillouin zone

Unit-III: Chemical Bonding in Solids **(14 L)**

Energetics of ionic bond formation and concept of lattice energy (thermodynamic basis), Born-Lande equation, Kapustinski equation, controlling factors of lattice energy.

Ionic radii (Pauling's crystal and univalent radii, Shannon's crystal radii), Pauling's rules for ionic crystals, general properties of metals: free electron theory of metallic bonding (qualitative treatment), band theory and electrical properties of solids (qualitative idea), intrinsic and extrinsic semiconductor with examples from main group elements, alloys and intermetallic compounds: Hume-Rothery rules, electron compounds

Unit-IV: Properties of Solids **(18 L)**

Crystal defects: thermodynamics aspect of defects, stoichiometric and nonstoichiometric, point defects, Schottky and Frenkel, colour centres, dislocations, conductor, semiconductor, insulator in the light of band theory, n–type, p–type, semiconductors, transistor, semiconductor Hall effect and Hall co-efficient; superconductivity in solids, ferroelectricity.

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SEMESTER – VI (Total Marks 200, Credit 24)

Inorganic Chemistry – V (Core-XIII) **Marks 50, Credit 4**

Unit-I: Coordination Chemistry-II: Crystal Field Theory; Magnetochemistry: Origin of Colours in Transition Metal Compounds **(13 L)**

Crystal field theory: Splitting of d-orbitals in different geometries (octahedral, tetrahedral and square planar), crystal field stabilization energy (CFSE), Jahn-Teller distortion, spectrochemical series, low-spin and high-spin complexes, pairing energy, factors affecting 10Dq value, critical 10 Dq value.
Origin of colour in coordination complexes: L-S coupling, ground state terms, selection rules, Orgel diagrams, charge transfer spectra (preliminary idea)

Magnetochemistry: differnet types (dia-, para-, ferro and antiferromagnetic), orbital and spin magnetic moment, spin only moments of d_n ions, superexchange and antiferromagnetic ineractions (simple examples); stabilization of unusual oxidation states of metal centres, linkage isomerism: HSAB concept and -bonding effect.

Unit-II: Introduction to Analytical Chemistry **(10 L)**

Errors in chemical analysis: accuracy, precision, determinate, indeterminate, systematic and random errors; source, effect and detection of systematic errors; distribution of random errors; standard deviation of calculated results- sum or difference, product or quotient, significant figures, rounding and expressing results of chemical computations.
Solvent extraction, distribution ratio, principle of solvent extraction, extraction equilibrium and effect of P_H; Complexometric titration, masking and demasking agents, metal indicators, Inner-metallic complexes, application in analytical chemistry.

Inorganic Chemistry – IV Lab **Marks 50, Credit 2**

1. Complexometric Titration:
$CaCO_3$ and $MgCO_3$ in mixture; Mg_{2+} and Zn_{2+} in mixture.
2. Gravimetric Analysis:
(i) Estimation of nickel (II) using Dimethylglyoxime as the precipitant.
(ii) Estimation of copper as CuSCN.
(iii) Estimation of iron as Fe_2O_3 after precipitating iron as $Fe(OH)_3$ and Heating at elevated temperature etc
3. Ion-exchanger: Cation content of a sample by cation exchanger
4. Solvent extraction

Physical Chemistry – IV (Core-XIV) **Marks 50, Credit 4**

Unit – I: Phase Equilibria & Colligative Properties **(18 L)**

Definition of phase, component and degree of freedom, phase rule and its derivation, phase diagram, phase equilibria for one-component system: water and carbon dioxide, first order phase transition and Clapeyron equation, Clausius-Clapeyron equation: derivation and applications
Liquid-vapour equilibrium for two-component systems, Duhem-Margules equation, Henry's law, Konowaloff's rule, deviation from ideal behavior, azeotropic solution, liquid-liquid phase diagrams for phenol-water, triethylamine-water and nicotine-water systems, solid-liquid phase diagram, eutectic mixture, Nernst distribution law, solvent extraction

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ΔG, ΔS, ΔH and ΔV of mixing for binary solutions, vapour pressure of solution, ideal solutions, colligative properties, Raoult's law; ebullioscopy, cryoscopy and osmosis (thermodynamic treatment only): inter relationships and abnormal behavior in solution, van't Hoff *i*-factor

Unit – II: Symmetry & Group Theory **(5 L)**
Introduction, symmetry elements and operations with illustrations, symmetry elements and physical properties, group and symmetry group, group multiplication table, point group

Unit – III: Quantum Chemistry **(15 L)**
Black body radiation, Planck's radiation law, photoelectric effect, Wilson-Sommerfeld quantization rule, application to Bohr atom, harmonic oscillator, rigid rotator and particle in 1-d box, de Broglie relation and energy quantization in Bohr atom and box, Heisenberg uncertainty principle, Bohr's correspondence principle and its applications to Bohr atom and particle in 1-d box

Elementary concept of operators, eigenfunctions and eigenvalues, linear operators, commutation of operators, expectation value, hermitian operator, properties, Schrödinger's time independent equation, acceptability of wave function, probability interpretation of wave function
Particle in a box, setting up of Schrödinger's equation of 1-d box, its solution and application, degeneracy

Unit – IV: Photochemistry & Spectroscopy **(10 L)**
Primary photophysical processes, potential energy diagram, Franck-Condon principle and vibrational structure of electronic spectra, bond dissociation, decay of excited state by radiative and nonradiative paths, fluorescence and phosphorescence, Jablonsky diagram, laws of photochemistry, quantum yield, photochemical equilibrium, photosensitized reactions, kinetics of HI decomposition
Alkali metal spectra, multiplicity of spectral lines, idea of spin quantum number, physical idea of spin orbit coupling
Rotational spectroscopy of diatomic molecules, rigid rotator model, characteristic features (spacing and intensity)
Vibrational spectroscopy of diatomic molecules, Simple Harmonic Oscillator (SHO) model

Physical Chemistry – IV Lab **Marks 50, Credit 2**

1. Kinetics of saponification of ester by conductometric method.

2. Conductometric verification of Ostwald dilution law

3. Colorimetric determination of pK_{in} of methyl red

Chemistry of Nanomaterials (DSE) **Marks 50, Credit 6**

Unit-I: Basic Concepts on Nanomaterials **(14 L)**
The scope and challenges of nanomaterials chemistry, the nanoscale and colloidal systems, fundamentals of surface and interfacial chemistry, chemical potential and surface curvature, surface energy and stabilization of nanoscale materials, electrostatic stabilization, interaction between two particles (DLVO theory), steric stabilization

Unit-II: Synthesis and Fabrication of Nanomaterials **(14 L)**

Top down and bottom up techniques, zero-dimensional nanomaterials: nanoparticles, synthesis of metallic, semiconducting and oxide nanoparticles, one-dimensional nanostructures: nanowire and

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nanorods, fundamentals of VLS and SLS growth, two-dimensional nanostructures: thin films, physical and chemical vapor deposition (PVD and CVD), Diamond films, sol-gel films

Unit-III: Special Nanomaterials **(16 L)**

Graphene, Carbon fullerenes (detailed on bonding and structure), carbon nanotubes: classification and physical characteristics, porous materials: micro and mesoporous materials, core-shell structures, quantum dot, metal-polymer structures, organic-inorganic hybrids, Metal-Organic framework (MOF), intercalation compounds, nanocomposites

Unit-IV: Characterization, Properties and Applications of Nanomaterials **(16 L)**

X-ray Diffraction (XRD), Scherrer's Formula, scanning and tunneling electron Microscopy (preliminary idea), size dependent properties: Electrical, optical, catalytic and magnetic; melting point and lattice constants, nanobots, nanocatalysis, catalysis by gold nanoparticles, biological applications of nanoparticles

Dynamic Stereochemistry (DSE) **Marks 50, Credit 6**

Unit-I: General Introduction **(8 L)**

Regioselective, regio specific and chemoselective reactions; stereo-selectivity and stereospecificity; Stereoseleactive reactions : Classification, terminology and principles;

Unit-II: Synthetic Approach **(12 L)**

Asymmetric synthesis and Asymmetric Induction; Diastereo selective synthesis : Asymmetric synthesis with chiral substrates, cram's rule – its application and deviation, Felkin-Anh Model Prelog's rule, Enantio Selective synthesis.

Unit-III: Stereochemical Aspects of a few Organic Reactions **(20 L)**

Polar addition reactions to alkene, Prevost and woodward Hydroxylation, Hydroxylation by OsO_4 followed by reductive cleavage, Catalytic reductions of alkenes and alkynes, Nucleophilic substitution on saturated carbon, E_1 and E_2 reaction, stereoconvergent Elimination, stereochemical aspects of a few Molecular rearrangement – Pinacol rearrangement, Beckmann rearrangement, Claisen rearrangement and Cope rearrangement.

Unit-IV: Alicyclic system **(20 L)**

Conformation and Reactivity in cyclohexanes; Steric effect and steroelectronic effect; Neighbouring group effects, effects of conformation on rearrangement and transannular reactions in alicyclic system; Diastereo selection in cyclic system. Reactions of cyclohexane derivatives; Hydrolysis of ester of cyclohexane carboxylic acids, Esterification Reaction of cyclohexane carboxylic acids, S_{N1}, S_{N2}, E_1, E_2, NGP, reactions. Hydride reduction of cyclohexanones to cyclohexanols, oxidation of cyclohexanols with Chromic acid, Merged substitution – elimination reaction, Reaction of 2-Aminocyclohexanol by Nitrous acid, Pinacol-pinacolone rearrangement in cyclohexanediols.

Quantum Chemistry & Spectroscopy (DSE) **Marks 50, Credit 6**

Unit – I: Quantum Mechanics **(18 L)**

Summarization of the results of some experiments black-body radiation, photoelectric effect, Davison and Germer experiment, Franck-Hertz experiment, identification of classical and quantum systems, Bohr's correspondence principle with examples; postulates of quantum mechanics, properties of wave functions, operators and related theorems

Degeneracy; Schrödinger equation, energy-eigenvalue equation, expectation value, eigenvalue and spread of observation, definition of uncertainty;
Free particle system – position, momentum, energy and uncertainity relation, motion of three dimension, degeneracy, potential barrier, tunnelling
Vibrational motion of a particle, classical mechanical treatment, quantum mechanical treatment and their comparison
Rotational motion of a particle – Schrodinger equation and wave function, spherical angular coordinates, complete wave function (spherical harmonics) Physical interpretation Elementary discussion of the H-atom solution

Unit – II: Atomic Spectra **(12 L)**

Quantum numbers, orbital and spin angular momenta of electrons, Stern-Gerlach experiment, vector atom model, term symbols (one and two optical electron systems), normal and anomalous Zeeman effect, Paschenback effect

Unit – III: Molecular Spectroscopy **(30 L)**

Electromagnetic spectrum and molecular processes associated with the regions
Rotational spectra: classification of molecules into spherical, symmetric and asymmetric tops; diatomic molecules as rigid rotors energy levels, selection rules and spectral features, isotope effect, intensity distribution, effect of non-rigidity on spectral features
Vibrational spectra of diatomics: potential energy of an oscillator, Harmonic Oscillator approximation, energy levels and selection rules, anharmonicity and its effect on energy levels and spectral features: overtones and hot bands, vibration-rotation spectra of diatomics: origin; selection rules; P, Q and R branches
Raman spectra: origin, selection rules, rotational and vibrational Raman spectra of diatomics
NMR spectra: theory, relaxation process, instrumentation, chemical shift and shielding, factors contributing to magnitude of shielding, spin interactions its origin, equivalent protons, qualitative idea of energy levels of AX and A2 systems, a few representative examples Mossbauer Spectra: Origin, Chemical shift, Quadruple effect

GENERIC ELECTIVE

GE – I - Basics in Organic and Inorganic Chemistry (Core) **Marks 50, Credit 6**

[N.B.: GE – I for Honours Course (Except Chemistry Honours)]

Unit – I: Atomic Structure **(12 L)**

Bohr's theory: energy and radius calculations for H-like atoms, dual nature of matter and light, de Broglie's relationship, Heisenberg's uncertainty principle (qualitative), quantum numbers, Pauli exclusion principle, qualitative introduction of orbitals, shapes of orbitals, electron distribution of elements - Aufbau principle and Hund's rule.

Unit – II: Radioactivity **(8 L)**

Theory of disintegration, rate constant, half life period (their interrelationship – deduction) idea of disintegration series, artificial transmutation and artificial radioactivity, uses and abuses of radioactivity. Stability of atomic nucleus, n/p ratio, mass defect, binding energy.

Unit – III: Periodic Table and Periodic Properties **(10 L)**

Periodic law, Periodic classification of elements on the basis of electron distribution, s-, p- and d-block elements, connection among valencies, electron distribution and positions of the elements in the long form of the periodic table. Periodic properties: atomic radii, ionic radii, covalent radii, ionisation energy, electron affinity, electronegativity and its different scales.

Unit – IV: Functional Nature of Organic Compounds **(3 L)**

Classification of organic compounds in termsof functional groups, their IUPAC nomenclature and valence bond structures.

Unit – V: Electron Displacement in Molecules **(7 L)**

Concept of Inductive effect, Electromeric effect, Hyperconjugation, Resonance, Steric Inhibition of ResonanceAromaticity and Tautomerism.

Unit – VI: Introduction to Organic Reaction Mechanism **(20 L)**

Homolytic and heterolytic bond cleavage; Reaction intermediates: carbocation, carbanion, free radical (generation, shape, stability and reaction)

Classification of organic reactions (substitution, elimination, addition and rearrangement) and reagent types (electrophiles, nucleophiles, acids and bases), Ideas of organic reaction mechanism (SN1, SN2, E1 and E2) Aromatic electrophilic substitution mechanism, orientation and reactivity, bromine and HBr addition to alkenes mechanism

GE – II - Elementary Physical Chemistry & Organic Chemistry Marks 50, Credit 4

[N.B.: GE – II for Honours Course (Except Chemistry Honours)]

Unit – I: Kinetic Theory of Gases **(8 L)**

Ideal gas equation, derivation of gas laws, Maxwell's speed and energy distributions (derivation excluded); distribution curves; different types of speeds and their significance, concept of equipartition principle, van der Waals equation, Virial equation, continuity of state, Boyle temperature, critical constants, specific heats and specific ratios, laws of partial pressure, vapour density and density method of determination of molecular weights, limiting density, abnormal vapour density, frequency of binary collisions; mean free path

Unit – II: Thermodynamics **(12 L)**

Thermal equilibrium and zeroth law, First law, reversible and irreversible work, criteria of perfect gas, isothermal and adiabatic expansions, Joule-Thomson effect (derivation excluded); Thermochemistry: Hess's law and its application

Second law and its elementary interpretation, Carnot's cycle and theorems, Clausius inequality, criteria of spontaneity, free energy and entropy

Unit – III: Stereochemistry **(20 L)**

Concept of constitution, configuration and conformation, chirality and chiral centre , optical activity , optical rotation, specific rotation, optical purity enantiomerism and diastereomerism, optical isomerism of lactic acid and tartaric acid, D, L and R, S nomenclature;

Geometrical isomerism with reference to fumaric acid and maleic acid; cis-trans and E, Z nomenclature.

Conformational analysis of ethane.

Organic Qualitative Practical (Lab) **Marks 50, Credit 2**

Detection of elements (N, S, Cl) and any one of the following groups in organic compounds (solid only): $-NH_2$, $-NO_2$, $-CONH_2$, -OH, >C=O, -CHO, -COOH

GE – III- Physical Chemistry & Inorganic Chemistry **Marks 50, Credit 4**

[N.B.: GE – III for Honours Course (Except Chemistry Honours)]

Unit – I: Phase Equilibria and Colligative Properties **(10 L)**

Phase rule equation (derivation excluded); phase diagram of water system, Miscibility (phenol-water) and distillation of completely miscible binary liquid mixtures; azeotropes, Steam distillation

Graphical approach of Raoult's law of vapour pressure and colligative properties: osmosis, lowering of freezing point, elevation of boiling point, experimental methods of determination of molecular weights of substances in dilute solutions, van't Hoff 'i' factor and abnormal behaviour of electrolytic solutions

Unit – II: Electrochemistry **(10 L)**

Electrolytic conduction, transport number (experimental determination excluded), velocity of ions: specific, equivalent and molar conductances, determination of equivalent conductivity of solutions, Kohlrausch's law, strong and weak electrolytes, Ion atmosphere; electrophoretic and relaxation effects, Debye-Huckel theory (qualitative) and the limiting law.

Electrochemical cells, half-cells (with types and examples), Nernst equation and standard electrode potentials, standard cells

Unit – III: Chemical Kinetics **(10 L)**

Order and molecularity of reactions, integrated rate laws (first and second order), average life period, concept of Arrhenius activation energy

Catalysis, autocatalysis, enzyme catalyst, catalyst poisons, promoters, elementary treatment of mechanism of catalysis

Unit – III: Chemical and Ionic Equilibrium **(10 L)**

Conditions of spontaneity and equilibrium, degree of advancement and Le Chatelier principle; Van't Hoff isotherm, isobar and isochore

Ostwald dilution law, Henderson equation, neutralization and acid-base indicators, buffers, common ion effect, solubility product (application in analytical chemistry)

Inorganic Qualitative Practical (Lab) **Marks 50, Credit 2**

Detection of three radicals by analysis of mixture containing not more than three radicals from the following list (insoluble salts excluded)

Silver, lead, mercury, bismuth, copper, cadmium, arsenic, antimony, tin, iron, aluminium, chromium, zinc, manganese, cobalt, nickel, calcium, strontium, barium, magnesium, sodium, potassium, ammonium and their oxides, hydroxides, chlorides, bromides, iodides, sulphates, sulphites, sulphides, thiosulphates, chromates, phosphates, nitrites, nitrates and borates.

GE – IV- Inorganic Chemistry & Organic Chemistry **Marks 50, Credit 4**

[N.B.: GE – IV for Honours Course (Except Chemistry Honours)]

Unit – I: Chemical Forces and Molecular Structure **(12L)**

Ionic bond, covalent bond (octet rule and expanded octet), dative bond, deformation of ions and Fajan's rules, Born-Haber cycle, hydrogen bond: intra- and intermolecular, bond polarity and dipole moment. Bond lengths, bond angles and qualitative description of shapes of some simple molecules like CO_2, SO_2, H_2O, $BeCl_2$, BF_3, NH_3, CH_4, C_2H_4, C_2H_2, C_6H_6.

Unit – II: Acids, Bases and Buffers **(6 L)**

Different concept of acids and bases, ionic product of water, salt hydrolysis, pH and its colorimetric determination, Strengths of strong and weak acids and bases.

Unit – III: Oxidation and Reduction **(10 L)**

Electronic concepts, oxidation number, ion-electron method of balancing equations, application of redox reactions, idea of standard potential and formal potential. Derivation of thermodynamic quantities of cell reactions (ΔG, ΔH and ΔS).

Unit – IV: Organic Synthesis **(12 L)**

Preparation and synthetic uses of diethyl malonate, ethylacetoacetateand Grignard reagents

Preparation of TNT phenyl acetic acid,, salicylic acid, cinnamic acid, sulphanilic acid, phenyl hydrazine, nitrophenols,nitroanilines, picric acid glycerol, allyl alcohol, citric acid.

Inorganic Quantitative (Lab) **Marks 50, Credit 2**

a. Titration of Na_2CO_3 + $NaHCO_3$ mixture vs HCl using phenolphthalein and methyl orange indicators
b. To find the total hardness of water by EDTA titration
c. Titration of ferrous iron by $KMnO_4/K_2Cr_2O_7$
d. Titration of ferric iron by $KMnO_4/K_2Cr_2O_7$ using $SnCl_2$ reduction

Recommended Books

Inorganic Chemistry

R. L. Dutta and G. S. De, Inorganic Chemistry, Pt – I, 7th Edn, 2013, The New Book Stall, 2013.

R. L. Dutta, Inorganic Chemistry, Pt –II, 5th Edn, 2013, The New Book Stall, 2006.

R. Sarkar, General and Inorganic Chemistry, Pt- I, II, 2nd Edn, Books & Allied (P) Ltd, 2009.

A. K. Das, Fundamental Concepts of Inorganic Chemistry, (Vol. 1-3), 2nd Edn, CBS Publisher, 2012.

A. K. Das, Fundamental Concepts of Inorganic Chemistry, (Vol. 4-7), CBS Publisher, 2014.

G. Wulfsberg, Inorganic Chemistry, Viva Books Private Ltd., New Delhi, 2001.

D. F. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, Oxford University Press, New York, 1990.

B. Douglas, D. McDaniel and J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edn, John Wiley and Sons, Inc., New York, 2001.

J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edn, Pearson Education, India, 2006.

A. Das and G. N. Mukherjee, Elements of Bioinorganic Chemistry, 2nd Edn, U. N. Dhur and Sons, Kolkata, 2002.

S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, 1st Edn, Panima Publishing, 1995.

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R. H. Crabtree, The Organometallic Chemistry of Transition Metals, 2nd Edn., John Wiley, 1994.

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J. W. Steed and J. L. Atwood, Supramolecula Chemistry, 22nd Edn, Wiley, 2009.

A. K. Das, Bioinorganic Chemistry, 2nd Edn, Books & Allied (P) Ltd, Kolkata, 2004.

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I. M. Kolthoff, P. J. Elving and E. B. Sandell, Treatise on Anlytical Chemistry, Pt-I, II, III, The Interscience Encyclopedia, Inc., New York. 1959.

D. Harvey, Modern Analytical Chemistry, McGraw-Hill, New York, 2000.

D. A. Skoog, Principle of Instrumental Analysis, 3rd Edn, Saunders College Publishing, New York, 1985.

G. D. Christian, Analytical Chemistry, 5th Edn. John Wiley, New York, 1994.

H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edn Reprint, New Age International (P) Ltd Publications, New Delhi, 2001.

D. A. Skoog, D. M. West and F. J. Holley, Fundamentals in Analytical Chemistry, 5th Edn, Saunders, Philadelphia, 1988.

S. Lindsay and J. Barnes, High Performance Liquid Chromatography, John Wiley, New York, 1992.

D. G. Peters, J. M. Hayes and G. M. Hieftje, Chemical Separations and Measurements: Theory and Practice of Analytical Chemistry, Saunders, Wiley Interscience, New York, 1974.

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Organic Chemistry

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E.L. Eliel, S.H. Wilen and L.N. Mander, Stereochemistry of Organic Compounds, John Wiley & Sons, New York, 1994.

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P. Sykes: A Guide to Mechanism in Organic Chemistry.

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R. T. Morrison and R. N. Boyd: Organic Chemistry

R. O. C. Norman and J. M. Coxon: Principle of organic synthesis

I. L. Finar, Organic Chemistry, Vol I, 6th Edn., Addison Wesley Longmann, London, 1998.

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G. K. Vemulapally, Physical Chemistry, Prentice-Hall of India Pvt. Ltd., New Delhi, 2006.

S. Glasstone, Text Book of Physical Chemistry, Macmillan and Company Ltd., London, 1951.

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S. N. Mukherjee, Introduction to Physical Chemistry, Art Union, Calcutta.

R.G. Mortimer, Physical Chemistry, Third Edition, Elsevier Academic Press.

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K.L. Kapoor, A Text Book of Physical Chemistry (Vol. 1 – 5), Macmillan India Limited, New Delhi.

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Berry, Rice & Ross, Physical Chemistry, Oxford University Press.

K. L. Chugh & S. L. Agnish, A Text Book of Physical Chemistry (Vol 1 – 3), Kalyani Publishers.

K. J. Laidler, Chemical Kinetics, Pearson, New Delhi, 2014.

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A. Ghoshal, Numerical Problems on Physical Chemistry, Books and Allied (P) Ltd.

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R. K. Prasad, Quantum Chemistry, New Age International (P) Limited, Publishers.

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B. K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers

A. K. Chandra, Introductory Quantum Chemistry, Tata McGraw Hill Publishing Company Limited. S. C. Rakshit, Molecular Symmetry Group and Chemistry, Sarat Book House

F. A. Cotton, Chemical Applications of Group Theory, Wiely-India, New Delhi, 2003.

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R. Ameta, Symmetry and Group Theory in Chemistry, New Age International Publishers, Kolkata, 2013.

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Ghoshal, Mahapatra & Nad , An Advanced Course in Practical Chemistry, New Central Book Agency (P) Ltd.

S. K. Maity and N. K. Ghosh, Physical Chemistry Practical, New Central Book Agency (P) Ltd.

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G. Svehla, Vogels Qualitative Inorganic Analysis, 7th Edn, Dorling Kindersley (RS) 2006.

A. K. Nad, B. Mahapatra & A. Ghosal, An Advanced Course in Practical Chemistry, New Central, 2007.

Vogel's Text Book of Practical Organic Chemistry (5th Edn).

Mann and Saunders, Practical Organic Chemistry.

Skill Enhancement Course

G. L. Patrick, Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.

H. Singh & V.K. Kapoor, Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.

E.Stocchi, Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK 1990.

Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.

B.K. Sharma & H.Gaur, Industrial Chemistry, Goel Publishing House, Meerut 1996.

B.K. Sharma & H. Gaur, Industrial Chemistry, Goel Publishing House, Meerut 1996.

[N.B.: Digital analytical balance (accuracy up to third/fourth decimal) must be used for experiments on inorganic, analytical and physical chemistry.]

Syllabus

for

B.Sc. Course with

CHEMISTRY

Choice Based Credit System

Effective from the Session 2016-17

KAZI NAZRUL UNIVERSITY
Asansol
West Bengal

SEMESTER – I (Total Marks 50, Credit 6)

Basics in Organic and Inorganic Chemistry (Core) **Marks 50, Credit 6**

[N.B.: Core – I for B.Sc. Course with Chemistry & GE – I for Honours Course (Except Chemistry Honours)]

Unit – I: Atomic Structure **(12 L)**

Bohr's theory: energy and radius calculations for H-like atoms, dual nature of matter and light, de Broglie's relationship, Heisenberg's uncertainty principle (qualitative), quantum numbers, Pauli exclusion principle, qualitative introduction of orbitals, shapes of orbitals, electron distribution of elements - Aufbau principle and Hund's rule.

Unit – II: Radioactivity **(8 L)**

Theory of disintegration, rate constant, half life period (their interrelationship – deduction) idea of disintegration series, artificial transmutation and artificial radioactivity, uses and abuses of radioactivity. Stability of atomic nucleus, n/p ratio, mass defect, binding energy.

Unit – III: Periodic Table and Periodic Properties **(10 L)**

Periodic law, Periodic classification of elements on the basis of electron distribution, s-, p- and d-block elements, connection among valencies, electron distribution and positions of the elements in the long form of the periodic table. Periodic properties: atomic radii, ionic radii, covalent radii, ionisation energy, electron affinity, electronegativity and its different scales.

Unit – IV: Functional Nature of Organic Compounds **(3 L)**

Classification of organic compounds in termsof functional groups, their IUPAC nomenclature and valence bond structures.

Unit – V: Electron Displacement in Molecules **(7 L)**

Concept of Inductive effect, Electromeric effect, Hyperconjugation, Resonance, Steric Inhibition of ResonanceAromaticity and Tautomerism.

Unit – VI: Introduction to Organic Reaction Mechanism **(20 L)**

Homolytic and heterolytic bond cleavage; Reaction intermediates: carbocation, carbanion, free radical (generation, shape, stability and reaction)

Classification of organic reactions (substitution, elimination, addition and rearrangement) and reagent types (electrophiles, nucleophiles, acids and bases), Ideas of organic reaction mechanism (SN1, SN2, E1 and E2) Aromatic electrophilic substitution mechanism, orientation and reactivity, bromine and HBr addition to alkenes mechanism

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SEMESTER – II (Total Marks 50, Credit 6)

Elementary Physical Chemistry & Organic Chemistry (Core)

Marks 50, Credit 4

[N.B.: Core – II for B.Sc. Course with Chemistry & GE – II for Honours Course (Except Chemistry Honours)]

Unit – I: Kinetic Theory of Gases **(8 L)**

Ideal gas equation, derivation of gas laws, Maxwell's speed and energy distributions (derivation excluded); distribution curves; different types of speeds and their significance, concept of equipartition principle, van der Waals equation, Virial equation, continuity of state, Boyle temperature, critical constants, specific heats and specific ratios, laws of partial pressure, vapour density and density method of determination of molecular weights, limiting density, abnormal vapour density, frequency of binary collisions; mean free path

Unit – II: Thermodynamics **(12 L)**

Thermal equilibrium and zeroth law, First law, reversible and irreversible work, criteria of perfect gas, isothermal and adiabatic expansions, Joule-Thomson effect (derivation excluded); Thermochemistry: Hess's law and its application

Second law and its elementary interpretation, Carnot's cycle and theorems, Clausius inequality, criteria of spontaneity, free energy and entropy

Unit – III: Stereochemistry **(20 L)**

Concept of constitution, configuration and conformation, chirality and chiral centre , optical activity , optical rotation, specific rotation, optical purity enantiomerism and diastereomerism, optical isomerism of lactic acid and tartaric acid, D, L and R, S nomenclature;

Geometrical isomerism with reference to fumaric acid and maleic acid; cis-trans and E, Z nomenclature.

Conformational analysis of ethane.

Organic Qualitative Practical (Lab) **Marks 50, Credit 2**

Detection of elements (N, S, Cl) and any one of the following groups in organic compounds (solid only): $-NH_2$, $-NO_2$, $-CONH_2$, -OH, >C=O, -CHO, -COOH

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SEMESTER – III (Total Marks 50, Credit 6)

Physical Chemistry & Inorganic Chemistry (Core) **Marks 50, Credit 4**

[N.B.: Core – III for B.Sc. Course with Chemistry & GE – III for Honours Course (Except Chemistry Honours)]

Unit – I: Phase Equilibria and Colligative Properties **(10 L)**

Phase rule equation (derivation excluded); phase diagram of water system, Miscibility (phenol-water) and distillation of completely miscible binary liquid mixtures; azeotropes, Steam distillation

Graphical approach of Raoult's law of vapour pressure and colligative properties: osmosis, lowering of freezing point, elevation of boiling point, experimental methods of determination of molecular weights of substances in dilute solutions, van't Hoff 'i' factor and abnormal behaviour of electrolytic solutions

Unit – II: Electrochemistry **(10 L)**

Electrolytic conduction, transport number (experimental determination excluded), velocity of ions: specific, equivalent and molar conductances, determination of equivalent conductivity of solutions, Kohlrausch's law, strong and weak electrolytes, Ion atmosphere; electrophoretic and relaxation effects, Debye-Huckel theory (qualitative) and the limiting law.

Electrochemical cells, half-cells (with types and examples), Nernst equation and standard electrode potentials, standard cells

Unit – III: Chemical Kinetics **(10 L)**

Order and molecularity of reactions, integrated rate laws (first and second order), average life period, concept of Arrhenius activation energy

Catalysis, autocatalysis, enzyme catalyst, catalyst poisons, promoters, elementary treatment of mechanism of catalysis

Unit – III: Chemical and Ionic Equilibrium **(10 L)**

Conditions of spontaneity and equilibrium, degree of advancement and Le Chatelier principle; Van't Hoff isotherm, isobar and isochore

Ostwald dilution law, Henderson equation, neutralization and acid-base indicators, buffers, common ion effect, solubility product (application in analytical chemistry)

Inorganic Qualitative Practical (Lab) **Marks 50, Credit 2**

Detection of three radicals by analysis of mixture containing not more than three radicals from the following list (insoluble salts excluded)
Silver, lead, mercury, bismuth, copper, cadmium, arsenic, antimony, tin, iron, aluminium, chromium, zinc, manganese, cobalt, nickel, calcium, strontium, barium, magnesium, sodium, potassium, ammonium and their oxides, hydroxides, chlorides, bromides, iodides, sulphates, sulphites, sulphides, thiosulphates, chromates, phosphates, nitrites, nitrates and borates.

Industrial Chemistry (SEC) (Optional) **Marks 50, Credit 2**

Water **(3 L)**

Types of water, analysis of water (different types of hardness), for municipal and industrial use

Electrochemical and Electro-thermal Industries **(3 L)**

Preparation and use of Potassium permanganate, hydrogen peroxide, synthetic graphite, calcium carbide, carborundum, alloy steels

Ceramics **(4 L)**

Refractories, pottery, porcelain, glass, fibre glass

Rusting of Iron and Steel **(3 L)**

Cause and prevention of corrosion

Industrial Safety and Fire Protection **(4 L)**

Flash point, fire extinguishers – foam, carbon dioxide, sprinkler system, inert gases.

Pollution **(3 L)**

Types of wastes – industrial, domestic, electronic; their causes and control

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SEMESTER – IV (Total Marks 50, Credit 6)

Inorganic Chemistry & Organic Chemistry (Core) **Marks 50, Credit 4**

[N.B.: Core – IV for B.Sc. Course with Chemistry & GE – IV for Honours Course (Except Chemistry Honours)]

Unit – I: Chemical Forces and Molecular Structure **(12L)**

Ionic bond, covalent bond (octet rule and expanded octet), dative bond, deformation of ions and Fajan's rules, Born-Haber cycle, hydrogen bond: intra- and intermolecular, bond polarity and dipole moment. Bond lengths, bond angles and qualitative description of shapes of some simple molecules like CO_2, SO_2, H_2O, $BeCl_2$, BF_3, NH_3, CH_4, C_2H_4, C_2H_2, C_6H_6.

Unit – II: Acids, Bases and Buffers **(6 L)**

Different concept of acids and bases, ionic product of water, salt hydrolysis, pH and its colorimetric determination, Strengths of strong and weak acids and bases.

Unit – III: Oxidation and Reduction **(10 L)**

Electronic concepts, oxidation number, ion-electron method of balancing equations, application of redox reactions, idea of standard potential and formal potential. Derivation of thermodynamic quantities of cell reactions (ΔG, ΔH and ΔS).

Unit – IV: Organic Synthesis **(12 L)**

Preparation and synthetic uses of diethyl malonate, ethylacetoacetateand Grignard reagents

Preparation of TNT phenyl acetic acid,, salicylic acid, cinnamic acid, sulphanilic acid, phenyl hydrazine, nitrophenols,nitroanilines, picric acid glycerol, allyl alcohol, citric acid.

Inorganic Quantitative (Lab) **Marks 50, Credit 2**

a. Titration of Na_2CO_3 + $NaHCO_3$ mixture vs HCl using phenolphthalein and methyl orange indicators
b. To find the total hardness of water by EDTA titration
c. Titration of ferrous iron by $KMnO_4/K_2Cr_2O_7$
d. Titration of ferric iron by $KMnO_4/K_2Cr_2O_7$ using $SnCl_2$ reduction

Chemistry of Cosmetics & Perfumes (SEC) (Optional) **Marks 50, Credit 2**

Preparation and Use of Cosmetics & Perfumes **(20 L)**

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.

SEMESTER – V (Total Marks 50, Credit 6)

Applied Chemistry (Elective) **Marks 50, Credit 6**

[N.B.: Discipline Specific Elective (DSE) for B.Sc. Course with Chemistry]

Unit – I: Analytical Chemistry **(18 L)**

(a) Accuracy and precision in analysis, types of errors, data analysis and curve fitting (linear Y = mX + C type), numerical problems, mean, mode and variant

(b) Principles of acid-base titration, use of indicators and indicator constant, titration of Na_2CO_3 + $NaHCO_3$ mixture vs HCl using different indicators, estimation of mixture of strong and weak acids, qualitative discussion of salt hydrolysis (no derivation)

(c) Single electrode potential and emf of a chemical cell, principles of redox titration, use of redox potentials, iodometry, iodimetry, use of $K_2Cr_2O_7$ and $KMnO_4$ as oxidant (acid, neutral and alkaline media)

Unit – II: Basic Principles of Green Chemistry **(12 L)**

Tools of green chemistry including the use of alternative feed stocks or starting materials, reagents, solvents, target molecules, and catalysts (homogeneous, heterogeneous and biocatalysis), green chemistry as the alternative chemistry for protection of environment.

Unit – III: Colloidal State **(12 L)**

General classification, general methods of preparation of lyophobic colloids and general properties of colloids, ideas of coagulation, peptization, protective colloids, dialysis, gold number, isoelectric point, Brownian motion

Unit – IV: Macromolecular Chemistry **(18 L)**

Introduction, definition of macromolecules, natural and synthetic polymers, monomers, polymers, degree of polymerization, simple idea of polymer structure: homopolymer (linear, branched, cross-linked) and copolymer (random, block, graft), polymerization reaction step (growth, addition, ring opening), importance of polymers both natural and synthetic

Number and weight average molecular weights of polymers – significance, structure and use of natural rubber, synthetic rubber (neoprene), synthetic fibres (Nylon 66, poly ester), plastics like polyethylene and PVC, macromolecules and environment.

Quantum Chemistry, Spectroscopy & Photochemistry (Elective) **Marks 50, Credit 6**

[N.B.: Discipline Specific Elective (DSE) for B.Sc. Course with Chemistry]

Unit – I: Quantum Chemistry **(25 L)**

Black body radiation, Planck's radiation law, photoelectric effect, Wilson-Sommerfeld quantization rule, application to Bohr atom, harmonic oscillator, rigid rotator and particle in 1-d box, de Broglie

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relation and energy quantization in Bohr atom and box, Heisenberg uncertainty principle, Bohr's correspondence principle and its applications to Bohr atom and particle in 1-d box

Elementary concept of operators, eigenfunctions and eigenvalues, linear operators, commutation of operators, expectation value, hermitian operator, properties, Schrödinger's time independent equation, acceptability of wave function, probability interpretation of wave function

Particle in a box, setting up of Schrödinger's equation of 1-d box, its solution and application, degeneracy

Stationary Schrödinger equation for the H-atom in polar coordinates, separation of radial and angular parts

Unit – II: Photochemistry **(15 L)**

Absorption, Lambert-Beer's law, photochemical laws, primary photophysical processes, potential energy diagram, Franck-Condon principle, fluorescence and phosphorescence, Jablonsky diagram, Laws of photochemistry, quantum yield, kinetics of HI decomposition, H_2-Br_2 reactions

Unit – III: Spectroscopy **(20 L)**

Alkali metal spectra, multiplicity of spectral lines

Rotational spectroscopy of diatomic molecules, rigid rotator model, characteristic features (spacing and intensity), applications

Vibrational spectroscopy of diatomic molecules, Simple Harmonic Oscillator (SHO) model; vibration rotation spectra, applications

NMR spectra, nuclear spin, Larmour precision, chemical shift, spin-spin interaction

Pharmaceutical Chemistry (SEC) (Optional) **Marks 50, Credit 2**

Drugs & Pharmaceuticals **(15 L)**

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation **(5 L)**

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

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SEMESTER – VI (Total Marks 50, Credit 6)

Chemistry of Biomolecules & Chemotherapy (Elective) **Marks 50, Credit 6**

[N.B.: Discipline Specific Elective (DSE) for B.Sc. Course with Chemistry]

Unit – I: Carbohydrate Chemistry **(15 L)**

Classification, Structure and configuration of D- arabinose, D – ribose, D- glucose, D – fructose and Sucrose (Fischer and Haworth projection) : Structure determination of D- glucose : Epimers and Anomers ;MutarotationOsazone formation, Oxidation and reduction of D – glucose ; Stepping up and stepping down of monosaccharides ; Conversion of aldose to ketose and vice – versa ; Elementary idea about starch and cellulose.

Unit - II: Amino acids and Protein **(15 L)**

Essential and non-essential amino acid ; Synthesis of glycine and alanine ; Isoelectric point ; Detection of amino acid (Ninhydrin reaction) Classification of Protein , Geometry of peptide Linkage elementary idea about primary and secondary structure of protein ; Denaturation of proteins .

Unit – III: Heterocyclic Compound and Nucleic acids **(15 L)**

Structures of furan, pyrrole, thiophene, Pyridine, Pyrimidine, Pyrimidine derivatives like uracil, thymine andcytosine, purine and purine derivatives like adenine, guanine & uric acid ; Reactivity and basicity comparison between pyrrole and pyridine, Synthesis of uric acid from barbituric acid .

Nucleosides, nucleotides, Nucleic acid, Structural component of RNA and DNA ; Secondary structure of DNA (Watson and Crick Model) .

Unit - IV: Enzymes and Biochemical Process **(8 L)**

Definition of terms : enzymes, Cofactors, Coenzymes, Prosthetic groups Metalloenzymes, Metabolism (Catabolism and Anabolism) ; Nomenclature and Classification of enzymes ; Characteristics of enzymes ; Biochemical process : i) Conversion of pyruvate to acetyl CoA ; ii) glycolytic degradation of D – glucose into lactic acid.

Unit - V: Chemotherapy **(7 L)**

Meaning of Chemotherapy, definition of drug, side effects, secondary effects and toxic effects of drugs ; preparation and uses of the drugs : Paracetamol, Aspirin, Sulphadiazine, Phenobarbitol and Metronidiazole.

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Advanced Inorganic Chemistry (Elective) **Marks 50, Credit 6**

[N.B.: Discipline Specific Elective (DSE) for B.Sc. Course with Chemistry]

Unit – I: Coordination Chemistry **(15 L)**

Double and complex salts, Werner's theory, ligands, coordination number, inner metallic complexes, chelate effect, different types of isomerism, IUPAC nomenclature.

Unit – II: Chemistry of Main Group Elements **(30 L)**

A comparative study of the elements belonging to a particular group to be made in brief on the basis of their electron distribution and position in the periodic table. Structures (excluding stereochemistry) and properties of important compounds mentioned to be explained.

Group 1: Hydrogen – isotopes and binary hydrides, lithium and its similarities and differences from other alkali metals, diagonal relationship with magnesium, lithium aluminium hydride,

Group 2: Calcium, stroncium and barium, hydrolith, calcium cyanamide, gypsum and plaster of paris.

Group 12: Zinc, cadmium and mercury. Nesslar's reagent, Millon's base.

Group 13: Diborane, boron trifluoride, sodium borohydride, inorganic benzene.

Group 14: Carbon, silicon, tin and lead, carbide, silicon carbide, silica, sodium silicate. Silica gel, hydrofluorosilicic acid, silicon tetra chloride, glass, fullerene.

Group 15: Nitrogen, phosphorus, arsenic, antimony and bismuth, hydrazine, hydrazoic acid, hydroxyl amine, hyponitrous acid, phosphorus oxyacids (H_3PO_2, H_3PO_3, H_3PO_4, $H_4P_2O_7$ and HPO_3), sodium bismuthate.

Group 16: Oxygen and sulphur, composition and structure of ozone, oxyacids of sulphur (H_2SO_3, H_2SO_4, $H_2S_2O_3$, $H_2S_2O_8$), persulphate

Group 17: Fluorine, chlorine, bromine and iodine, oxides and oxyacids of chlorine, isolation of fluorine.

Group 18: Rare gases (isolation and uses) with special reference to general fluorides (structure)

Unit – III: Transition Metals **(15 L)**

Groups 6 and 7: Chromium, manganese, K_2CrO_4, $K_2Cr_2O_7$, CrO_2Cl_2, $KMnO_4$, chrome alum.

Groups 8, 9 and 10: Iron, cobalt and nickel, principles of isolation of Ni (excluding details), composition and uses of alloys, steels, rusting of iron, galvanization and tin plating.

Group 11: Cu, Ag, Au, principles of Ag and Au isolation

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Fuel Chemistry (SEC) (Optional) **Marks 50, Credit 2**

Energy Sources **(6 L)**

Review of energy sources (renewable and non-renewable). 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 bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry **(10 L)**

Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants **(4 L)**

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

Secretary
College Councils
Kazi Nazrul University
Asansol- 713340

01/05/19
Dean
Faculty of Science
Kazi Nazrul University
Asansol - 713340

Ujjalkanti Roy
01.05.19
Head
Department of Chemistry
Kazi Nazrul University
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Recommended Books

A. Sangal, Advanced Organic Chemistry, Vol. 1, Krishna Prakashan Media (P) Ltd, Meerut, India, 2012.
S. R. Palit, Elementary Physical Chemistry; Book Syndicate Private Limited.

P. C. Rakshit, Physical Chemistry; Sarat Book Distributers.

Dr. A. K. Mondal, Degree Bhouto O Sadharan Rasayan; Sarat Book Distributers.

A. Ghoshal, Sadharan O Bhouto Rasayan;: Books and Allied (P) Ltd.

S. Ekambaram, General Chemistry; Pearson.

G. K. Mukherjee & J. Das, Ajaibo Rasayan, Books & Allied Pvt. Ltd.

R. L. Dutta and G. S. De, Inorganic Chemistry, Part – I, The New Book Stall, 7th Edn, 2013.
R. L. Dutta, Inorganic Chemistry, Part –II, The New Book Stall, 5th Edn, 2006.
P. K. Dutt, General and Inorganic Chemistry, (Vol- I & II).
S. N. Poddar & S. Ghosh, General & Inorganic Chemistry (Vol I & II) , Book Syndicate Pvt Ltd.
S. Sengupta, Organic Chemistry.
Bahl and Bahl, Organic Chemistry, S. Chand Publications.
R. K. Bansal, Organic Chemistry.
A. K. Das, Environmental Chemistry With Green Chemistry.
A. Kar, Medicinal Chemistry
Sriram & Yogeswari, Medicinal Chemistry.
G. A. Ozin and A. C. Arsenult, Nanochemistry: A Chemical Approach to Nanomaterials.
C. N. R. Rao, A. Muller and A. K. Cheetham, Nanomaterial Chemistry: Recent Development and New Directions.
G. L. Patrick, Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
H. Singh & V.K. Kapoor, Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
E.Stocchi, Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK 1990.
Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
B.K. Sharma & H.Gaur, Industrial Chemistry, Goel Publishing House, Meerut 1996.
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