Course Module for Semester 1 and Semester 2
Department of Chemistry

Core Course for Chemistry Honours, (CC1 Organic Chemistry)

1. Factors affecting properties of Organic Compounds

(i) Localized and delocalized bonds, different effects like inductive effects, field effects, resonance effect, hyperconjugation, steric effect etc.. 10 Lectures
(ii) Tautomerism. 2 Lectures
(iii) Aromaticity, nonaromaticity and antiaromaticity, Huckels rule. 4 Lectures

2 Factors influencing chemical properties

(i) Polarity of bond in organic compounds. 2 Lectures
(ii) Dipole moment and its application. 2 Lectures
(iii) Explanation of different properties like acidity, basicity. 2 Lectures

3 Stereochemistry of Organic compounds

(i) Concept of constitution, and different shape and cause of stereochemistry in organic compounds. 4 Lectures
(ii) Optical properties and concept of element of symmetry. 2 Lectures
(iii) CIP rule, D/L, Threo and Erythreo nomenclatures 2 Lectures
(iv) Racemisation, resolution and stereoselctive reaction 2 Lectures

Course for Chemistry Honours, Semester 1, CC1 - Practical

(i) Separation of individual compound from a mixture of compounds by the use of simple chemicals like acid, base or sodium bicarbonate and determining their melting points. 6 Lectures
(ii) Characterisation and identification of few solid and liquid compounds by chemical reactions. 20 Lectures
(iii)Determining boiling points of some liquid. 6 Lectures

Course Module for B.Sc. Chemistry General Course (GE1)

First part
(i) IUPAC Nomenclature, nature of bonding, hybridization, isomerism 4 Lectures
(ii) Acidity, Basicity, polarity and factors affecting them 4 Lectures

Second Part
(i)Reactions and preparation of organic compound, interconversion 6 Lectures
(ii)Stereochemistry 2 Lectures
(iii)CIP rule 1 Lecture

Course Module for B.Sc. Chemistry Pass Course (CC1)

First part

(i)IUPAC Nomenclature, nature of bonding, hybridization, isomerism 4 Lectures

(ii)Acidity, Basicity, polarity and factors affecting them 4 Lectures

Second Part

(i)Reactions and preparation of organic compound, interconversion 6 Lectures

(ii)Stereochemistry 2 Lectures

(iii)CIP rule

Course code: cc-1

Course Title:Organic Chemistry-I(Theo):Basics of Organic Chemistry

Bonding and physical properties: 4 lecture

1.Valence Bond Theory:Concept of hybridisation, shapes of molecules,resonance(including hyperconjugation); Calculation of formal charges and double bond equivalent(DBE);orbital pictures of bonding(sp3,sp2,sp:C-C, C-N,&C-O systems and s-cis and s-trans geometry for suitable cases)

2.Physical properties: influences of hybridisation on bond properties :bond dissociation energy(BDE) and bond energy,bond distances, bond angles, concept of bond angle strain(Baeyer's strain theory); melting point/ boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces :polarity of molecules and dipole moments ,relative stabilities isomeric hydrocarbons in terms of heat of hydrogenations and heat of combustion and heat of formation 5 lecture

2. Reactive intermediates: carbocations(carbenium and carbonium ions),carbanions, carbon radicals,carbenes generation and stability, structure using orbital picture and electrophilic/nucleophilic behaviour of reactive intermediates(elementary idea) 5 lecture

Core Course (Hons.): CC2

1. ***Kinetic theory& the gaseous state***

2. Coordinates,Gamma function & their applications 3 Lectures
3. Maxwell's speed distribution functions, energydistribution. 6 Lectures
4. functions different types of velocities. 2Lectures
5. Different collisions and their effects. 3 Lectures
6. van der Waal's gas equation & related discussion. 4Lectures
7. Discussion on critical states. 2Lectures
8. Dieterici gas equation & its features. 2Lectures
9. Reduced equation of state, vapour density, limiting density 3Lectures
10. Equipartition principle, Molar heat capacity. 2Lectures

2. **Thermodynamics**

1.(i) Basic formalism concept of thermal equilibrium, heat and work. 2 Lectures
(ii) Reversible and irreversible processes and their mathematical derivations and different processes like isothermal and adiabatic etc. 5Lectures

(iii) Derivatives, exact differentials, state and path functions. 4 Lectures
(iv) Cyclic rule, zeroth law, first law of thermodynamics and their mathematical implications. 3 Lectures
(v) Different functions like H,U, C_p, $C_v$and their relations, Joule's experiment. 4 Lectures
(vi) Thermochemistry, Kirchoff's equation, heat changes etc. 2 Lectures

2.(i) Second law of thermodynamics and its need, Kelvin, Planck and Clausius statements and their equivalence, Carnot cycle, Carnot's theorem, Thermodynamic scale of temperature. 6 Lectures

(ii) Physical concept of entropy, Clausius inequality, entropy change of system and surrounding for various processes and during isothermal mixing of ideal gases 5Lectures
(iii) Auxiliary state functions (G and A) and their variations with T, P and V, criteria of spontaneity and equilibrium, Maxwell relations, Thermodynamic equation of state, Gibb's-Helmholtz equation 4 lectures .

(iv) Joule-Thomson (J-T) experiment, inversion temperature, J-T coefficient For a Van der Waals gas, general heat capacity relations. 3Lectures

3. Chemical Kinetics 1

1 Introduction, reaction rate, order&molecularity. 3 Lectures
2 Rate expression of different order reactions. 4 Lectures
3 Arrhenius equation and activation energy and explanation. 3 Lectures
4 Rate expressions of different reactions of different mechanism. 4Lectures
5 Concept of steady state and H_2 -Br_2&H_2 -O_2chain reaction. 3 Lectures

6. Collision theory of bimolecular reactions 3Lectures
7. Transition state theory 3Lectures
8.Free energy of activation & entropy 2Lectures
9. Pressure dependence of rate constant 2Lectures
10. Primary kinetic salt effect 3Lectures
11. Lindemann mechanism &unimolecular reaction 2Lectures

12. Homogeneous catalysis 2Lectures

13. Autocatalysis: Periodic Reactions2Lectures

CC-2 (Prac.)
Physical Chemistry(prac) 30 lectures

1.Determination of pH of unknown solution (buffer), by colour matching method.
2. Determination of the reaction rate constant of hydrolysisofethylacetate in the presence of an equal quantity of sodium hydroxide.
3. Determination of solubility product of a sparingly soluble salt(PbI_2)by titrimetric method
4. Kinetic study of acid catalyzed hydrolysis of methyl acetate.
5. Kinetic study of H_2O_2 decomposition with KI catalyst

B.Sc. General Course in Chemistry

Course code: CC1 (General Theo)
1.Fumdamental of Organic Chemistry 5 lecture
Electronic displacements : inductive effect, resonance,andhyperconjugation; cleavage of bonds: Homolytic and heterolytic; structure of organic molecules on the basis of VBT; nucleophies and electrophiles; reactive intermediates :carbocations, carbanions and free radicals
2.Alkenes(up to 5carbons) 5lectures
Preparation: elimination reactions:dehydration of alcohols and dehydrohalogenation of alkyl halides:cis alkenes and trans alkenes(Birch reduction),Reactions:
Cis addition(alkaline KMnO4) and trans addition(bromine) with mechanism ;addition of HX(Markonikoff's with mechanismand anti markonikoff'saddition),hydration,ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction
3.Nucleophilic substitution and Elimination reactions 5 lectures
Nucleophilic substitutions: SNI and SN2 reactions;eliminations: E1 and E2 reactions (elementary mechanistic aspects); and Hofmann eliminations; elimination Vs substitutions
4. Alkanes(up to5 carbons) 4 lecture
Preparation: catalytic hydrogenations, wurtz reaction,
Kolbe's synthesis, from Grignard reagent, reactions:
Mechanish for free radical substitutions: halogenation

CC1(General prac)
Organic Chemistry 30 lecture
Qualitative Analysis of single solid organic compounds
1.Detection of special elements(N,Cl and S) in organic compounds
2.Solubility and Classification(solvents:water, dil.HCl,dilNaOH)
3.detection of functional groups:(Aromatic –NO2 and NH2,-COOH,carbonyl,-OH(phenolic) in solid organic
Compounds
Experiments 1 to 3 with unknown(at least 6) solid samples

Inorganic Chemistry 24 lectures

1.Estimation of sodium carbonate and sodium hydrogen carbonate present ina mixture.
2.Estimation of oxalic acid by titrating it with $KMnO_4$
3.Estimation of water of crystallization in mohr's salt by titrating with $KMnO_4$.
4.Estimation of Fe(II)ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5.Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$.

GE1/CC1 (Inorganic and Organic Chemistry)

1. **Atomic structure (IP,)**

(I) Bohr's theory for hydrogen atom, Bohr s model	2 Lectures
Atomic spectra of Hydrogen	1 lecture
Sommerfield model, quantum numbers and significance	3 lectures
Pauli s exclusion Principle, Hunds rule	2 lectures
Aufbau principle and its limitations	1 lectures
Electronic configuration of many electron atoms	1 lectures

2. Chemical periodicity (IP)

(ii) Explanation, periodic table and classification of elements	2 Lectures
Characteristics of s, p, d, f-block elements	2 Lectures
Atomic and ionic radii	2 lectures
Ionization potential and eLectron affinity	1 lectures
Electronegativity and position of H and noble gases	2 lectures
Periodicity and properties of s, p elements	1 lecture

3. **Acids and bases (SG)**

Bronsted-Lowry concept, conjugate acid-base, relative strengths	3 lectures
Differentiating and levelling solvents, effect of solv and substituents	1 lecture
Lewis acid base concept and their classification	2 lectures
Lux Flood concept and solvent system concept `	2 lectures
HSAB concept and its applicatons	2 lectures

4. **Redox (IP)**

Balancing of equations by ion electron method And by oxidation no. method	1 lecture
Oxidimetry and reductimetry	1 lecture

Course Module for Semester 2

CC-3(Inorganic) **64 lectures**

1. Atomic structure

(I) Bohr's theory for hydrogen atom, Bohr s model

Atomic spectra of Hydrogen

Sommerfield model,Wave Mechanics: de Broglie equation,Heisenberg's Uncertainty Principle,

Schrodinger's wave equation, Significance of Ψ and Ψ^2, quantum numbers and significance

Radial and angular wave functions for H-atom.

Shapes of s,p,d and f orbitals.

Pauli s exclusion Principle, Hunds rule and multiplicity

Aufbau principle and its limitations

Ground state Term symbols of atoms and ions for atomic number upto 30.

2. Chemical periodicity

(ii) Explanation, Modern IUPAC periodic table

Effective nuclear charge, Slater's rule

Atomic and ionic radii, Covalent radii

Lanthanide contraction,

Ionization potential and electron affinity

Electronegativity(Pauling's, Mulliken's and Allred-Rochow's scales)

Group trends and periodic trends in these properties

in respect of s, p and d block elements

Secondary periodicity, Relativistic effect and Inert pair effect.

5. Acids and bases

Acid Base concept: Arrhenius concept, Theory of solvent system

Bronsted-Lowry concept, conjugate acid-base, relative strengths

Pauling's rules, Lux-Flood concept, Lewis concept Group characteristics.

Differentiating and levelling solvents, effect of solv and substituents

Thermodynamic Acidity parameter, Drago-Wayland equation

Super acids, Gas phase acidity and proton affinity,

HSAB concept and its applicatons

Acid-base equilibria in aqueous solution, pH, buffer

Acid-base neutralisation curves, indicator, choice of indicators

6. Redox Reactions and precipitation reactions

Balancing of equations of redox reaction by ion electron method

Standard redox potentials with sign conventions, Nernst equation(without derivation)

Influence of complex formation, precipitation and change of pH on redox potentials; formal potential

Feasibility of a redox titration, redox potential at the equivalence point, redox indicators.

Latimer and Frost diagram of common elements and applications.

Disproportionation and comproportionation reactions

Solubility product , common ion effect, application to the precipitation

Separation of common metallic ions as hydroxides, sulphides, phosphates, carbonates, sulphates and halides.

CC-3 practical **32 lectures**
Inorganic Chemistry-1(Prac)

Acid and Base Titrations

1. Estimation of carbonate and hydroxide present together in mixture .
2. Estimation of carbonate and bicarbonate present together in mixture
3. Estimation of free alkali present in different soaps/detergents.

Oxidation- Reduction Titrimetric

1. Estimation of Fe(11) using standardized KMnO4 solution.
2. Estimation of oxalic acid and sodium oxalate in a given mixture.
3. Estimation of Fe(11) and Fe(111) in given mixture using K2Cr2O7 solution.
4. Estimation of Fe(111) and Mn(11) in a mixture using standardized KMnO4 solution
5. Estimation of Fe(111) and Cu(11) in a mixture using K2Cr2O7.
6. Estimation of Fe(111) and Cr(111) ina mixture using K2Cr2O7.

CC-4(Organic) 64 lectures

Course for Chemistry Honours, Semester2 (CC4 Organic Chemistry)

4. Chirality arisng out of stereoaxis

(i) Stereoisomerism of cumilene, allene
(ii) Spiro compound, biphenyl, and other
(iii) Configuration, descriptor, raccemisation, buttressing effect.

4 Concept of prostereoisomerism

(i) Pro –R/pro-S/proZ/pro-E ets.

5 Conformation of Organic compounds

(i) Nomentaclature, different effects, Klyne-Prelog terminology.
(ii) Energy barrier, concept of steric strain, stability of conformer.
(iii) Butan Gauch ineraction, steric effect, H-bonding
(iv) Conformation of ethane, propane, n-butane

6 Conformation of halohydrin, conjugated stsem, haloalkene, 2,3-dimethyl butane, 2-methylbutane

7 Reaction thermodynamics
(i)Free energy and equilibrium, enthalpy and entropy
(ii)Intermolecular and intramolecular reaction

6. Concept of organic base and acid
(i)Effect of structure, solvent etc on acidity
(ii)HsSAB theory, nucleophilicity and basisity

7. Tautomerism.

8 Reaction kinetics
(i)Rate constant and free energy of activation, energy profile diagram
(ii) Order, molecurality, catalyst, kinetically and thermodynamically controlled reaction

9 Substitution and elimination reactions
(i)Free radical substitution
(ii)Nucleophilic substitution reaction, SN1, SN2, SNi reaction
Effect of NGP, Stereochemistry of substitution reaction
(iii)E1, E2, E1cb, Ei (Syl elimination)
(iii)Selectivity of elimination, Saytzeff/Hoffman elimination

Course for Chemistry Honours, Semester 1, CC4 – Practical **32 lectures**

(iv)Preparation of organic compound by , nitration, brimination, esterfication, amide formation, condensation, hydrolysis, aromatic side chain modification, condensation
Finding melting point, purification of the product formed by crystallization

GE-2 and CC-II Theory

Physical Chemistry 34 lectures

1. Kinetic theory& the gaseous state

(a) Concept of pressure and temperature; collision of gas molecules; Collision diameter,number, and mean free pat; binary collisions, rate of effusion

(b) Nature of distribution of velocities, Maxwell's speed distribution , energy distribution. Average velocity, root mean square velocity and most probable velocity;
Equipartition principle, Molar heat capacity

(c) Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waal's gas equation, its derivation & related discussion. Discussion on critical states, Critical constants in terms of van der waal's constants. Law of corresponding states

(d) Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitatively)

2. Properties of liquids

(i) General features of fluid flow, Reynolds number, viscous drag, streamline motion, Newton's equation, viscosity coefficient, kinetic theory of gas viscosity, viscosity of gas vs liquid., Poiseuilles' equation and its derivation,temperature dependence of viscosity,determination of viscosity coefficient of liquids.

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(ii) Vapour pressure, Surface energy and surface tension and it's dependence on temperature and concentration, excess pressure, capillary rise, condition of wetting, determination of surface tension, concept of liquid crystal and superfluid.

3. Properties of solids

(a) Forms of solids, crystal systems, Unit cell, Bravais lattice types; Symmetry elements, laws of crystallography, Law of constancy of interfacial angles, law of rational indices; Miller indices of different planes and interplaner distance, Bragg's law; structure of NaCl, KCl, and CsCl (qualitatively); defects in crystals; glasses and liquid crystals.

4. Chemical Kinetics

(a)Introduction, reaction rate, order&molecularity, rate constants;
Rates of different order reactions(first order, second order and n-th order)
Their differential and integrated forms (with derivation); Pseudo first order reaction;
determination of order of a reaction, opposing reactions and parallel reactions.
(b) Arrhenius equation and activation energy and explanation
Rate expressions of different reactions of different mechanism.
Collision theory of bimolecular reactions, Lindemann mechanism &unimolecular reaction
Outline of transition state theory (classical treatment)

Inorganic chemistry

1. Chemical Bonding of Inorganic compounds 30 lectures

(a)Ionic bonds: General characteristics of ionic bonding, energy considerations , lattice energy and salvation energy and their importance in terms of stability. Solubility of ionic compounds, Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

b. Covalent bonding: VB Approach: shape of some inorganic molecules and ions on the basis of VSEPR and hybridizations with suitable example of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

c. Concept of resonance and resonating structures in various inorganic and organic compounds .

d. MO Approach: Rules for the LACO method ,bonding and antibonding MOs and their characteristics for s-s,s-p, and p-p combinations of atomic orbitals, nonbonding combination of orbitals. MO treatment of homonuclear diatomic molecules of 1^{st} and 2^{nd} periods. And heteronuclear diatomic molecules such as CO,NO and NO+. comparison of VB and MO approach

2.Comparative study of p –block elements
a. Group trends in electronic configuration. Modification of pure elements, common oxidation states , inert pair effect , and importance

1.B-Al –Ga –In –Tl
2. C –Si –Ge –Sn –Pb
3. N –P –As –Sb – Bi
4. O –S –Se –Te –Po
5. F-Cl – Br- I

GE -2 and CC-II(General) Practical

Physical chemistry 18 lectures

1. Determination of Surface tension of unknown liquid at different concentration

2. Determination of viscosity of unknown liquid solution at different concentration

Inorganic practical 24 lectures

Qualitative analysis of mixtures containing three radicals.