TRIPURA UNIVERSITY

(A Central University)
Suryamaninagar-799022

Syllabus

For

CHEMISTRY
(Major and General)

Semester I

Year 2014

Semester I
Chemistry
Paper – H1,
Marks: 100 (80+20)

Unit-I General Chemistry (Marks: 20) **30 Lectures**

A. **Atomic Structure: (10 Lectures):** Limitations of Bohr's atomic model; idea of the de Broglie matter waves, Heisenberg's uncertainty principle; Schrodinger's wave equation and its importance; quantum numbers; concept of wave function; physical concepts of Ψ and Ψ^2; radial and angular wave functions; shapes of s, p and d-orbitals, Aufbau principle, Pauli's Exclusion Principle, Hund's rule, Variation of orbital energies with atomic number and energy level diagram, electronic configurations of atoms, screening effect and effective nuclear charge, extra stability of half-filled and completely filled orbitals.

B. **Periodic properties: (10 Lectures):** Modern periodic table, classification of elements on the basis of electronic configuration; periodic variation in properties – atomic and ionic radii, oxidation states, ionization potential, electron affinity, electronegativity (Mulliken scale, Pauling's scale and Allred & Rochow scale); diagonal relationship.

C. **Statistical treatment of data analysis: (10 Lectures):** Accuracy and precision, classification of errors, detection and correction of determinant and indeterminant errors; the normal law of distribution of indetermination errors; the F and T tests, rejection of data, methods of least squares, propagation of errors in computation, significant figures.

Unit-II: Inorganic Chemistry (Marks: 20) **30 Lectures**

A. **Redox Reactions: (10 Lectures):** Ion electron method of balancing equations, calculation of equivalent weights of oxidants and reductants, standard electrode potential, formal potential, electrochemical series; redox potentials and its applications, choice of indicators in redox titrations.

B. **Chemical Bonding: (20 Lectures):** (i) **Ionic Bonding:** Types of ionic solids; radius ratio effect; limitation of radius ratio rule; concept of lattice energy, Bond-Lande equation; Born-Haber cycle; solvation energy and solubility of ionic solids; ionic potential, polarizing power; polarizability of ions and Fajan's rule.

(ii) **Covalent Bonding:** Basic idea of valence bond theory and its limitations; Concept of hybridization of orbitals; Bent's rule; valence shell electron pair repulsion (VSEPR) theory and its application to shapes of molecules and ions: BeF_2, BF_3, H_3O^+, NH_3, NH_4^+, ICl_2^-, H_2O, PCl_3, PCl_5, SF_4, SF_6, XeF_2, XeF_4, XeF_6, $XeOF_4$, ClF_3; formal charge, polarity of covalent bonds and dipole moment, percentage of ionic character of covalent bond, LCAO-MO theory and its application to homonuclear (H_2, N_2, O_2, O_2^{2-}, O_2^-, O^{2+}); heteronuclear diatomic molecules (CO, NO, HF) and polyatomic molecules (BeH_2, H_2O, NH_3).

(iii) **Bonding in Metals, Semiconductors and Hydrogen Bond:** Qualitative idea of free electron theory and band theory in solids; elementary ideas on semiconductors (n and p types); hydrogen bonding – concept and types of H-bonding – application to inorganic molecules, van der Waal's forces, π-π and C(H)-π interactions.

Unit-III: Organic Chemistry (Marks: 20)

30 Lectures

A. **Structure, Reactivity in Organic Molecules (10 lectures):** Hybridization (sp^n ,n= 1,2,3) of organic compounds, bond lengths, bond angles, bond energy, bond polarity, bond polarizability, formation of σ and π bonds, localized and delocalized chemical bonds, van der Waals interaction, resonance, tautomerism, steric inhibition of resonance, hyperconjugation, inductive and field effects, H-bonding, dipole moment- bond moment and group moment, physical properties (m.p., b.p., solubility) related to molecular structures. Activation energy and Transition state. Energy profile diagrams for reactions with single or multiple steps. Concepts of kinetic and thermodynamic control.

B. **Basic concept of organic reaction mechanism in aliphatic compounds: (10 lectures):** Synthesis of alkanes, alkenes, alkynes and alkadienes. Synthesis (preparation)of alcohols and ethers, aldehydes and ketones, carboxylic acids and their derivatives, nitro alkanes, nitriles, amines. Study of a) Electrophilic and free radical addition at C=C, b) Nucleophilic addition at the C=O group of aldehydes and ketones; c) Nucleophilic substitution reactions - S_N^1, S_N^2, S_N^i; d) Elimination reactions - α and β –eliminations, *syn* – and *anti*-elimination; E_1 and E_2- mechanism.

C. **Important reactions of aliphatic compounds with mechanism: (10 lectures):** Corey-House synthesis, dihydroxylation of alkenes, woodward-prevost hydroxylation, addition of hydrogen halides, ozonolysis, hydroboration-oxidation, oxymercuration-demercuration reaction, catalytic hydrogenation of alkenes. Alkadienes: conjugated addition; 1,2 vs 1,4- additions. **Alkynes:** acidity, use of Lindlar's catalyst, Birch reduction of alkynes; **Alcohols:** dehydration, oxidation, pinacol-pinacolone rearrangement; **Carbonyls:** Oppenauer oxidation, MPV reduction, Rosenmund reduction, Stephen's reaction, Sommelet reaction, Baeyer-Villiger oxidation, Wolff-Kishner reduction; Aldol, Claisen and Darzen-glycidic ester condensation; Cannizzaro and Tischenko reactions.

Unit-IV: Physical Chemistry (Marks: 20) 30 Lectures

A. **The Gaseous state: (12 Lectures):** Gas laws; postulates of kinetic theory of gases; derivation of the kinetic theory of gas equation- $PV = (1/3)\, mnc^2$; mean free path ; collision diameter; collision number; collision frequency; heat capacity of gases; viscosity of gases & effect of temperature. Real gases: Deviation from ideal behaviour – Regnault , Andrews and Amagat's experiments on gases; causes of deviation- van der Waals equation; critical phenomenon- critical constants, inter-relationships between critical constants and van der Waal's constants; law of corresponding states. Maxwell distribution of molecular velocities (no derivation) – most probable, average and root mean square velocities- their inter-relationship; Boltzmann equation (without derivation).

B. **Crystalline state: (10 Lectures):** Three laws of crystallography: Weiss and Miller indices; unit cell, seven crystal systems; 14 Bravais lattices; crystal packing; radius ratio - co-ordination number, X-ray diffraction (XRD) of crystals- derivation of Bragg's equation ; determination of crystal parameters of cubic systems- crystal structure of KCl, NaCl, CsCl, diamond, graphite, boron nitride and ice, defects in crystals- point defects- Schottky and Frenkel defects, colour center, semi- conductors.

C. **Fundamentals of computer: (8 Lectures):** History of development of computers, computer systems (mainframe, minis, micros and super computers); general awareness of computer hardware i.e. CPU and other peripheral devices (Input/Output and auxiliary storage devices); block diagram of computer; representation of characters, integers in computers (Bit, Byte, Word) and conversions – decimal to binary, decimal to hexadecimal; introduction to computer software (system & application); introduction to computer languages; introduction to computer programming; basic knowledge of computer programming in BASIC.

Physical Chemistry(Honours):

1. Physical Chemistry - P.C. Rakshit
2. Physical Chemistry - P.W. Atkins
3. Physical Chemistry - G. W. Castellan
4. Physical Chemistry - S. Glastone
5. Physical Chemistry - Marron & Pruton/ Marron & Lando
6. Molecular Spectroscopy - Barrow
7. Molecular Spectroscopy - Banwell
8. Introductory Quantum Chemistry – A.K. Chandra, TATA McGraw Hill.
9. Quantum Chemistry – D.A. Mcquarrie, Viva Books, Pvt. Ltd.
10. Atomic Structure and Chemical Bonds – Manas Chandtra
12. Programming in Basic –S. Gottfired
13. Programming in Basic –Balaguruswamy.
14. Statistical Methods – N.G. Das

Practical Chemistry(Honours):

1. Qualitative Inorganic Analysis – A.I.Vogel's Ed. G. Svehla
2. Quantitative Inorganic Analysis –A.I.Vogel
3. Advanced Experiments in Inorganic Chemistry -- G.N. Mukherjee
4. Hand Book of Organic Analysis-qualitative & quantitative-H.T. Clarke
5. Qualitative Analysis - V. Alexeyev
6. University Hand Book of Undergraduate Chemistry Experiments, University of Calcutta-G.N. Mukherjee (ed)
7. College Practical Chemistry-V.K. Ahluwalia, S. Dhingra & A. Gulati
8. Text Book of Practical Organic Chemistry-A.I. Vogel
9. Vogels Text Book of Practical Organic Chemistry

RECOMMENDED BOOKS

Organic Chemistry(Honours):

1. Organic Chemistry - I.L. Finar, Vol. I, 6th Edn. ELBS
2. Advanced Organic Chemistry - J. March
3. A guide to Organic Reaction Mechanism - P. Sykes, Orient Longman.
4. Organic Chemistry - R.T. Morrison & R.N. Boyd, Prentice – Hall.
5. Fundamentals of Organic Chemistry - Solomon
6. Organic Chemistry - Wade (Jr)
7. Stereochemistry of Carbon Compounds - E. Eliel.
8. Stereochemistry of Carbon Compounds - D. Nasipuri, John Wiley
9. Organic Spectroscopy - Y.R. Sharma
10. Organic Spectroscopy - W. Kemp
11. Organic Spectroscopy - P.S. Kalshi
12. Organic Reaction Mechanism - P.S. Kalsi
13. Organic Reaction mechanism - R.K. Bansal
14. Advanced Organic Organic hemistry - N.K. Visnoi
15. Advanced Practical Chemistry - R. Mukhopadhaya & P. Chatterjee.
16. Advanced Organic Chemistry – Miller
17. Organic Chemistry - Loudon

Inorganic Chemistry(Honours):

1. Basic Inorganic Chemistry - F.A. Cotton & G. Wilkinson & Gous
2. New concise Inorganic Chemistry - J.D. Lee
3. Inorganic Chemistry – Principles of Structure and Reactivity-Huhey,Keiter & Medhi
4. Selected topics in inorganic chemistry – Mallick, Tuli, Madan
5. Modern Inorganic Chemistry –W.L.Jolly
6. Inorganic Chemistry VolI&II - R.L.Dutta.
7. General and Inorganic Chemistry VoiII&II – R.P.Sarkar
8. Inorganic Chemistry - D.K.Chakrabarty
9. Essentials of Nuclear Chemistry -- H.J.Arnikar
10. Elements of Bioinorganic Chemistry - G.N. Nukherjee & A. Das
11. Fundamental Concepts of Inorganic Chemistry- Vol 1 &2 -A.K. Das
12. Bio inorganic Chemistry -Ashim. Kr.Das

Semester - I
Chemistry (General)

Paper – C1P1
Full Marks: 100 (80+20)

Unit-I General Chemistry (Marks: 20) **30 Lectures**

A. **Structure of atom (18 lectures):** Atomic spectra of hydrogen atom, Bohr's atomic model and its limitations (simple mathematical treatment of hydrogen atom), Sommerfield model, Black body radiation, Plank's Equation, Qualitative idea of Photoelectric effect and Compton effect, Wave-particle duality, de-Broglie matter wave, Heisenberg's uncertainty principle, Schrodinger's wave equation for one electron system (no mathematical derivation), wave functions and physical concept of ψ and ψ^2, shapes of s, p and d orbitals; quantum numbers and their significances, s, p, d, f orbitals, Pauli's exclusion principle, Hund's rule, , energy order of orbitals, Aufbau principle and its limitations, electronic configurations of atoms (up to $Z = 30$).

B. **Periodic properties of elements (12 lectures):** Modern periodic table, classification of elements on the basis of electronic configuration. Periodic properties: atomic radii, ionic radii, ionization potential, electron affinity, electronegativity, oxidation states, diagonal relationship; Pauling and Mulliken scale of electronegativity.

Unit-II Inorganic Chemistry (Marks:20) **30 Lectures**

A. **Redox Reactions (15 lectures):** Ion electron method of balancing equations, calculation of equivalent weights of oxidants and reductants, standard electrode potential, electrochemical series; redox potentials and its applications, choice of indicators in redox titrations.

B. **Nuclear Chemistry (15 lectures):** Stability of nucleus: neutron-proton ratio and its implications, binding energy, mass defects, Einstein's mass-energy relation, Natural and artificial radioactivity, measurement of radioactivity, radioactive disintegration and group displacement law, disintegration series, half-life period, radioactive equilibrium, types of nuclear reactions, artificial transmutation reactions, nuclear fission and nuclear fusion, Carbon-14 dating, nuclear forces: n-n, n-p, p-p.

Unit-III Organic Chemistry (Marks:20) **30 Lectures**

A. **Structure, Reactivity in Organic Molecules (10 lectures):** Hybridization(sp^n ,n= 1,2,3) of organic compounds, bond lengths , bond angles , bond energy , bond polarity , bond polarizability, formation of σ and π bonds, localized and delocalized chemical bonds , van der Waals interaction, resonance, tautomerism, steric inhibition of resonance, hyperconjugation , inductive and field effects, H-bonding, dipole moment- bond moment and group moment, physical properties(mp, bp, solubility) related to molecular structures.

B. **Organic reaction mechanism in aliphatic compounds** (10 lectures): Alkanes: Corey-House synthesis of alkanes ; Synthesis of alkenes, alkynes and alkadienes. synthesis (preparation)of alcohols and ethers, aldehydes and ketones, carboxylic acids and their derivatives, alkyl nitrates , nitro alkanes , nitriles , amines. Study of a) Electrophilic and free radical addition at C=C , b) Nucleophilic addition at the C=O group of aldehydes and ketones; c) Nucleophilic substitution reactions - S_N1, S_N2, S_Ni; d) Elimination reactions - α and β –eliminations, *syn* – and *anti*-elimination; E_1 and E_2- mechanism.

C. **Important reactions with mechanism of aliphatic compounds (10 lectures):** Alkane: free radical halogenations, Alkenes: halogenation, hydroxylation, hydrogen halides, ozonolysis, hydroboration-oxidation, catalytic hydrogenation of alkenes. Alkynes: acidity, use of Lindlar's catalyst, Birch reduction of alkynes; Alcohols: dehydration, oxidation, pinacol-pinacolone rearrangement; Carbonyls: Oppenauer oxidation, MPV reduction, Rosenmund reduction, Stephen's reaction, Baeyer-Villiger oxidation, Wolff-Kishner reduction; Aldol, Claisen condensation; Cannizzaro and Tischenko reactions.

Unit-IV Physical Chemistry (Marks:20) **30 Lectures**

A. **i)The Gaseous states (10 Lectures):** Gas laws, postulates of kinetic theory of gases, gas pressure, kinetic theory of gas equation PV = 1/3 mnc2 deduction of gas laws, average kinetic energy of molecules, mean free path, collision diameter, collision number, collision frequency, their dependence on temperature and pressure, heat capacity of gases, atomicity of molecule, viscosity of gases.

ii) Real gases: Deviation from ideal behavior, Regault, Andrews and Amagat experiments causes of such deviations, compressibility factor, vander Waals equation, critical phenomenon, critical constants, law of corresponding states. Maxwell distribution law of molecular, velocities (no derivation), most probable, average and root mean square velocities- their inter relationship, Boltzman equipartition energy (no derivation).

B. **The Liquid state (5 Lectures):** Physical properties of liquids including their experimental methods of determination, internal pressure, vapour pressure, surface tension and viscosity, effect of temperature on these properties.

C. **Thermodynamics (15 Lectures):** i) Thermodynamic apparatus, definations of various system, processes, functions, concept of heat and work. Zeroth law of thermodynamics. ii) First law- mathematical relation, internal energy, Joule's experiment, heat capacity of gases at constant volume and constant pressure, relationship between Cp and Cv, Kirchhoff's equation, calculation of change in thermodynamic parameters for expansion/compression of an ideal gas under various conditions for reversible/ irreversible processes, Jule-Thomson experiment, inversion temperature (elementary ideas only). **Second law of thermodynamics:** i)Need for second law, spontaneous process, reversible process, statements of second law, heat engine, Carnot cycle, Carnot engine and its efficiency, concept of entropy, entropy change in simple transformations, physical significance of entropy. ii) Gibb's free energy, Helmholtz free energy, Gibbs Helmholtz equation, criteria for thermodynamic equilibrium and spontaneity of a process.

RECOMMENDED BOOKS

Organic Chemistry(Pass):

1. Organic Chemistry - I.L. Finar, Vol. I, 6th Edn. ELBS
2. Advanced Organic Chemistry - B.S. Bahl & A. Bahl,
3. Advanced Organic Chemistry, Reactions & Mechanism – Mukherjee & Singh
4. Organic Chemistry - R.T. Morison & R.N. Boyed,
5. Stereochemistry of Carbon Compounds - D. Nashipuri,
6. Basic Stereochemistry of Organic Molecules - Subrata Sengupta,
7. Advanced Organic Chemistry - N.K. Visnoi
8. Jaiba Rasayan - Subrata Sengupta,

Inorganic Chemistry(Pass):

1. Inorganic Chemistry Vol. I & II - R.L. Datta
2. Advanced Inorganic Chemistry Vol. I & II - Prakash, Tuli, Basu and Madan,
3. Fundamental concepts of Inorganic Chemistry - A.K. Das
4. General and Inorganic Chemistry - Vol R. P. Sarkar
5. General and Inorganic Chemistry - S.N. Podder & S.P. Ghosh
6. Fundamental concepts of Inorganic Chemistry- Vol.1 & 2 – Ashim Kr. Das
7. Inorganic Chemistry – Puri, Sharma and Kalia
8. Inorganic Chemistry – J.D. Lee
9. General and Inorganic Chemistry (Part-I & II) R. Sarkar
10. Basic Inorganic Chemistry – Cotton and Wilkinson
11. Inorganic Chemistry – Principles of Structure and Reactivity-Huhey,Keiter & Medhi

Physical Chemistry(Pass):

1. Bhouta Rasayan - N.N.Kundu, Vol. I & II
2. Essentials of Physical Chemistry - Bahl & Tuli,
3. Bhouta Rasayan - P.C. Rakshit & P.R. Gupta,
4. Elementary Physical Chemistry - S.R. Palit,

Practical Chemistry(Pass):

1. A Manual of PracticalChemistry (Vol. I & II) - R.C. Bhattacharjee
2. University hand book of undergraduate chemistry experiments - G.N. Mukherjee, University of Calcutta.
3. College Practical Chemistry - Ahluwalia, Dingra & Gulati.
4. Bebaharic Rasayan, Podder & Ghosh