Chemistry
(Honours)
(Choice Based Credit System)
(Effective from the Academic Session 2017-2018)

Second Semester

MAHARAJA BIR BIKRAM UNIVERSITY
AGARTALA, TRIPURA: 799004
### PROGRAMME STRUCTURE

Structure of Proposed CBCS Syllabus B.A/B.Sc/B.Com Honours.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Core Course (14) Honours</th>
<th>Ability Enhancement Compulsory Course (AECC) (2)</th>
<th>Skill Enhancement Course (SEC) (2)</th>
<th>Discipline Specific Elective (DSE) (4)</th>
<th>Generic Elective (GE) (4)</th>
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<tbody>
<tr>
<td>1</td>
<td>C1 C2</td>
<td>AECC1: Environmental Science</td>
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<td>GE1</td>
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<td>(Paper-I of selected subject other than Hons subject)</td>
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<td>2</td>
<td>C3 C4</td>
<td>AECC2: (English/MIL Communication)</td>
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<td>(Paper-II of selected subject other than Hons subject)</td>
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<td>3</td>
<td>C5 C6 C7</td>
<td>SEC1</td>
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<td>(Paper-III of selected subject other than Hons subject)</td>
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<td>4</td>
<td>C8 C9 C10</td>
<td>SEC2</td>
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<td>DSE1 DSE2</td>
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<td>6</td>
<td>C13 C14</td>
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<td>DSE3 DSE4</td>
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SEMESTER- I  
CORE COURSE – Paper I  
INORGANIC CHEMISTRY-I  

TOTAL MARKS – 100  
(Theory – 70, Practical-30)

Unit-I ATOMIC STRUCTURE:  

(14 Lectures)

Unit-II  
PERIODICITY OF ELEMENTS  
Periodicity of Elements: s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g) Electronegativity, Pauling’s/ Mulliken’s/ Allred Rachow’s/ and Mulliken-Jaffé’s electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson’s electron density ratio.  

(16 Lectures)

Unit-III  
CHEMICAL BONDING-I  

(16 Lectures)
Unit-IV
CHEMICAL BONDING:-II

(i) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
(ii) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

(iii) OXIDATION-REDUCTION:
Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

16 Lectures

14 Lectures

Reference Books:

CHEMISTRY LAB- C- I

(A) Titrimetric Analysis
(i) Calibration and use of apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants (B) Acid-Base Titrations
(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture. (iii) Estimation of free alkali present in different soaps/detergents
(C) Oxidation-Reduction Titrimetry
(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution. (ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
Estimation of Fe(II) with K₂Cr₂O₇ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:
1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
Unit-I
GASEOUS STATE

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of $\sigma$ from $\eta$; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, $Z$, and its variation with pressure for different gases. Causes of deviation from ideal behaviour, van 12 der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

(16 Lectures)

Unit-II
LIQUID STATE
(i) Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

IONIC EQUILIBRIA- I
(ii) Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and triprotic acids (exact treatment).

(14 Lectures)

Unit- III
SOLID STATE
Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg’s law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

(16 Lectures)
Unit-IV
Ionic equilibria - II:

(14 Lectures)

Reference Books:

CHEMISTRY LAB-(C-II LAB)

1. Surface tension measurements.
a. Determine the surface tension by (i) drop number (ii) drop weight method.
b. Study the variation of surface tension of detergent solutions with concentration. 2. Viscosity measurement using Ostwald’s viscometer.
a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
b. Study the variation of viscosity of sucrose solution with the concentration of solute. 3. pH metry
a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
b. Preparation of buffer solutions of different pH i. Sodium acetate-acetic acid ii. Ammonium chloride-ammonium hydroxide
c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base. d. Determination of dissociation constant of a weak acid.

Reference Books
Unit -I
BASICS OF ORGANIC CHEMISTRY:
Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.
Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.
Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.
CARBON-CARBON SIGMA BONDS
Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, C o t e y H o u s e S y n t h e s i s, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.
(14 lectures)

Unit-II
STEREOCHEMISTRY
Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.
(16 Lectures)

Unit – III
CHEMISTRY OF ALIPHATIC HYDROCARBONS
A. Carbon-Carbon pi bonds:
Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.
Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. 15 Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alklylation of terminal alkynes.
(14 Lectures)
Unit-IV

A. Cycloalkanes and Conformational Analysis
Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

B. AROMATIC HYDROCARBONS
Aromaticity: Hückel’s rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitrination, sulphonation and Friedel-Craft’s alkylation/acylation with their mechanism. Directing effects of the groups.

(16 Lectures)

Reference Books:
• Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
• Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

CHEMISTRY LAB-C III
1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents: a. Water
   b. Alcohol
   c. Alcohol-Water
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   b. Separation of a mixture of two sugars by ascending paper chromatography
   c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books
SEMESTER- II  
CORE COURSE – Paper IV  
PHYSICAL CHEMISTRY II  

TOTAL MARKS – 100  
(Theory – 70, Practical-30)  

Unit-I  
CHEMICAL THERMODYNAMICS  

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.  
First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.  
Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff’s equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.  

(14 Lectures)  

Unit-II  

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.  
Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.  
Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell 17 relations; thermodynamic equation of state.  

(14 Lectures)  

Unit-III  
SYSTEMS OF VARIABLE COMPOSITION  
Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.  

CHEMICAL EQUILIBRIUM  
Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.  

(18 Lectures)
Unit-IV

Solutions and Colligative Properties: Dilute solutions; lowering of vapour pressure, Raoult’s and Henry’s Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

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Reference Books

CHEMISTRY LAB- C IV LAB

THERMOCHEMISTRY
(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
(c) Calculation of the enthalpy of ionization of ethanoic acid.
(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
(f) Determination of enthalpy of hydration of copper sulphate.
(g) Study of the solubility of benzoic acid in water and determination of ΔH.

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