

**Syllabus and
Scheme of
Examination for
Chemistry (General)
Under CBCS
Curricula**

UNIVERSITY OF GOUR BANGA, MALDA

Draft Scheme/Broad Guidelines of UG CBCS Curriculum



Meaning of the Terms and Abbreviations

- **Discipline Core (DC) Course:** A course that should compulsorily be studied by a candidate as a core requirement of the programme.
- **Elective Course:** A Course which may be very specific or specialized or advanced or supportive to the discipline/ subject of study. These are of three types:
 - **Discipline Specific Elective (DSE) Course:** A course, which may be offered by the main discipline/subject of study.
 - **Generic Elective (GE) Course:** An elective course, chosen from related or unrelated discipline/subject of study.
 - **Dissertation/Project (D.P):** An elective course designed to acquire special/advanced knowledge with an advisory support by a teacher/faculty member.
- **Ability Enhancement Compulsory (AEC) Course:** The course designed for knowledge enhancement consisting of Environmental studies, English Communication/MIL.
- **Skill Enhancement Course (SEC):** These courses are designed to provide value-based and/or skill-based knowledge relating to the main discipline.
- **MCQ:** Multiple Choice Questions
- **MIL:** Modern Indian Language
- **DQ :** Descriptive questions
- **IA:** Internal Assessment (By the respective Department of the Colleges).
- **Teaching terms:** Lectures (L)/Tutorials
Tu/Th(Theory)/Practical(Pr)/Dissertation/Project Work (DP)/Viva (V)/Seminar (S)/Term Paper (TP).
- **ESE:** End Semester Examination

Semester wise Course Structure under CBCS
For B.Sc. General Courses

| ACADEMIC SEMESTERS | C O U R S E S | | | | Credits | Marks |
|--------------------|--|--|--|-------------------------|---------|-------|
| | Discipline Core (DC) | Discipline Specific Elective (DSE) | Ability Enhancement Compulsory (AEC) | Skill Enhancement (SEC) | | |
| SEM-I | DC1 (A1) DC2 (B1) DC3 (C1) (6x3=18) | -- | ENVS (2) | -- | 20 | 200 |
| SEM-II | DC4 (A2) DC5 (B2) DC6 (C2) (6x3=18) | -- | Communicative Bengali/Communi cative English/MIL (2) | -- | 20 | 200 |
| SEM-III | DC7 (A3) DC8 (B3) DC9 (C3) (6x3=18) | -- | -- | SEC-1 (2) | 20 | 200 |
| SEM-IV | DC10 (A4) DC11(B4) DC12 (C4) (6x3=18) | -- | -- | SEC-2 (2) | 20 | 200 |
| SEM-V | -- | DSE1 (A1) DSE2 (B1) DSE3 (C1) (6x3=18) | -- | SEC-3 (2) | 20 | 200 |
| SEM-VI | -- | DSE4 (A2) DSE5 (B2) DSE6(C2) (6x3=18) | -- | SEC-4 (2) | 20 | 200 |
| Total | -- | -- | -- | -- | 120 | 1200 |

Notes:

- Each course is of 50 marks.
- **DC/DSE:** Each course is of 6 credits(Theory - 4 credits + Practical- 2 credit)
Credit = 1 hour duration of teaching (lecture/tutorial) or 2 hour duration of practical period.
- SE:** Covering any two Discipline Cores (DC) out of A, B & C with two courses each, 2x2= 4 SEs (e.g. A=Chemistry, B=Physics, C= Mathematics)
- DSE:** Two DSEs for each DC, i.e., 3x2= 6 DSEs. A student has to opt one paper out of two papers provided from each discipline for SEM V & SEM VI.
- Students have to opt 3 different disciplines as Core disciplines in each of the semester. Options once selected in SEM -I should be continued up to semester –IV without alternation of the discipline.

Detail Curicullam (Chemistry General, Semesterwise)

| Semester | Course | Course Name | Broad area | Credit |
|------------|---|---|---|--------|
| I | Core Course-1 (Theory) DCT1 | CEMGT-1 | Inorganic Chem I + Org Chem I | 4 |
| | Core Course-1 (Practical) DCP1 | CEMGP-1 | Inorganic Chem I + Org Chem I | 2 |
| II | Core Course-4 (Theory) DCT4 | CEMGT-2 | Physical Chemistry I + Inorg Chem II | 4 |
| | Core Course-4 (Practical) DCP4 | CEMGP-2 | Physical Chem I + Inorganic Chem II | 2 |
| III | Core Course-7 (Theory) DCT7 | CEMGT-3 | Physical Chem II + Org Chem II | 4 |
| | Core Course-7 (Practical) DCP7 | CEMGP-3 | Physical Chem II + Org Chem II | 2 |
| | Skill enhancement Course - 1 | CEMHSE-1A | Basic Analytical Chemistry | 2 |
| IV | Core Course-10 (Theory) DCT10 | CEMGT-4 | Physical Chem III + Analytical & Environmental Chemistry | 4 |
| | Core Course- 10(Practical) DCP10 | CEMGP-4 | Physical Chem III + Analytical & Environmental Chemistry | 2 |
| | Skill enhancement Course - 2 | CEMHSE-1B | IT Skills for Chemists | 2 |
| V | Discipline Specific Elective-1 (Theory) | CEMGTDSE-1 | Inorganic Chemistry and Analytical & Industrial Chemistry | 4 |
| | Discipline Specific Elective-1 (Practical) | CEMGPDSE-1 | Inorganic Chemistry and Analytical & Industrial Chemistry | 2 |
| | Discipline Specific Elective-2 (Theory) | As to be offered by the other department(s) | As to be offered by the other department(s) | 4 |
| | Discipline Specific Elective-2 (Practical) | As to be offered by the other department(s) | As to be offered by the other department(s) | 2 |

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| | Discipline Specific Elective-3 (Theory) | As to be offered by the other department(s) | As to be offered by the other department(s) | 4 |
| | Discipline Specific Elective-3 (Practical) | As to be offered by the other department(s) | As to be offered by the other department(s) | 2 |
| | Skill enhancement Course - 3 | CEMHSE-2A | Pharmaceutical Chemistry | 2 |
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| VI | Discipline Specific Elective-4 (Theory) | CEMGTDSE-2 | Advanced Organic and Industrial Chemistry | 4 |
| | Discipline Specific Elective-4 (Practical) | CEMGPDSE-2 | Advanced Organic and Industrial Chemistry | 2 |
| | Discipline Specific Elective-5 (Theory) | As to be offered by the other department(s) | As to be offered by the other department(s) | 4 |
| | Discipline Specific Elective-5 (Practical) | As to be offered by the other department(s) | As to be offered by the other department(s) | 2 |
| | Discipline Specific Elective-6 (Theory) | As to be offered by the other department(s) | As to be offered by the other department(s) | 4 |
| | Discipline Specific Elective-6 (Practical) | As to be offered by the other department(s) | As to be offered by the other department(s) | 2 |
| | Skill enhancement Course - 4 | CEMHSE-2B | Analytical Clinical Biochemistry | 2 |

| Semester - I | | |
|---|--|-----------------|
| CEMGT-1 | Theory: Atomic Structure, Chemical Periodicity, Acids and Bases, Redox Reactions, Fundamentals Organic Chemistry, Stereochemistry, Substitution and Elimination Reactions & Aliphatic | 4 Credit |
| Inorganic Chemistry – I | | |
| <p>1. Atomic Structure (9L) Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, Aufbau principle and its limitations.</p> <p>2. Chemical Periodicity (9L) Classification of elements on the basis of electronic configuration: general characteristics of s-, p-, d- and f-block elements. Positions of hydrogen and noble gases in the periodic table. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.</p> <p>3. Acids and Bases (8L) Brønsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.</p> <p>4. Redox Reactions (4L) Balancing of equations by oxidation number and ion-electron method, Standard electrode potential, formal potential, redox indicator and redox titrations.</p> | | |
| Organic Chemistry – I | | |
| <p>1. Fundamentals of Organic Chemistry (4L) Electronic displacements: Inductive effect, resonance and hyperconjugation; cleavage of bonds: homolytic and heterolytic; structure of organic molecules on the basis of VBT; nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals.</p> <p>2. Stereochemistry (6L) Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, meso compounds; threo and erythro, D and L, cis and trans nomenclature; CIP Rules: R/S (upto 2 chiral carbon atoms) and E/Z nomenclature.</p> <p>3. Nucleophilic Substitution and Elimination Reactions (3L) Nucleophilic substitutions: S_N1 and S_N2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations; elimination vs substitution.</p> <p>4. Aliphatic Hydrocarbons (13L) Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures. Alkanes (up to 5 Carbons). Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: mechanism for free radical substitution:</p> | | |

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| <p>halogenation.</p> <p>Alkenes: (up to 5 Carbons)</p> <p>Preparation: elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; cis alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alkaline KMnO_4) and trans-addition (bromine) with mechanism, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction.</p> <p>Alkynes: (up to 5 Carbons).</p> <p>Preparation: acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO_4, ozonolysis and oxidation with hot alkaline KMnO_4.</p> | | |
| Reference Books | | |
| <p>1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991. 2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley. 3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons. 4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education Ind 5. Sethi, A. Conceptual Organic Chemistry; New Age International Publisher. 6. Parmar, V. S. A Text Book of Organic Chemistry, S. Chand & Sons. 7. Madan, R. L. Organic Chemistry, S. Chand & Sons. 8. Wade, L. G., Singh, M. S., Organic Chemistry. 9. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 10. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 11. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994. 12. Sen Gupta, Subrata. Basic Stereochemistry of Organic molecules. 13. Kalsi, P. S. Stereochemistry Conformation and Mechanism, Eighth edition, New Age International, 2014. 14. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.</p> | | |
| CEMGP-1 | Practical | 2 Credit |
| Inorganic Chemistry - I | | |
| <ol style="list-style-type: none"> 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a 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 $\text{K}_2\text{Cr}_2\text{O}_7$. 5. Estimation of Cu (II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$. | | |
| Organic Chemistry - I | | |
| Qualitative Analysis of Single Solid Organic Compound(s) | | |
| <ol style="list-style-type: none"> 1. Detection of special elements (N, Cl, and S) in organic compounds. 2. Solubility and Classification (solvents: H_2O, dil. HCl, dil. NaOH, dil. NaHCO_3) 3. Detection of functional groups: Aromatic-NO_2, Aromatic-NH_2, $-\text{COOH}$, carbonyl (no distinction of $-\text{CHO}$ and $>\text{C}=\text{O}$ needed), $-\text{OH}$ (phenolic) in solid organic compounds. <p>Experiments 1 to 3 with unknown (at least 6) solid samples containing not more than two of the above type of functional groups should be done.</p> | | |
| Reference Books | | |
| <p>1. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N., University of Calcutta, 2003. 2. Das, S. C., Chakraborty, S. B., Practical Chemistry. 3. Mukherjee, K. S. Text book on Practical Chemistry, New Oriental Book Agency. 4. Ghosal, Mahapatra & Nad, An Advanced course in practical Chemistry, New Central Book Agency. 5. Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors. 6. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996. 7. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.</p> | | |

| Semester - II | | |
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| CEMGT-2 | Theory: Theory: States of Matter & Chemical Kinetics, Chemical Bonding & Molecular Structure, p-Block Elements | 4 Credit |
| Physical Chemistry – I | | |
| <p>1. Kinetic Theory of Gases and Real Gases (12L)</p> <p>a. Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of effusion</p> <p>b. Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases</p> <p>c. Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states</p> <p>d. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only)</p> <p>2. Liquids (5L) Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)</p> <p>3. Solids (5L) Forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law; Structures of NaCl, KCl and CsCl treatment only); Defects in crystals; Glasses and liquid crystals.</p> <p>4. Chemical Kinetics (8L)</p> <p>a) Introduction of qualitative rate law, order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions</p> <p>b) Temperature dependence of rate constant; Arrhenius equation, energy of activation; Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)</p> | | |
| Inorganic Chemistry-II | | |
| <p>1. Chemical Bonding and Molecular Structure (20L)</p> <p>a. Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé 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.</p> <p>b. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples from s and p block elements of linear, trigonal planar, square planar, tetrahedral,</p> | | |

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| <p>trigonal bipyramidal and octahedral arrangements.</p> <p>c. Concept of resonance and resonating structures in various inorganic and organic compounds.</p> <p>d. MO Approach: Rules for the LCAO 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 1st and 2nd periods. (including idea of s- p mixing) and heteronuclear diatomic molecules such as CO, NO and NO⁺. Comparison of VB and MO approaches.</p> <p>2. Comparative study of p-block elements (10L) Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:</p> <ol style="list-style-type: none"> B-Al-Ga-In-Tl C-Si-Ge-Sn-Pb N-P-As-Sb-Bi O-S-Se-Te F-Cl-Br-I <p>Reference Books</p> <p>1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007). 2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004). 3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009). 4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998). 5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985). 6. Chugh, K.L., Agnish, S.L. A Text Book of Physical Chemistry Kalyani Publishers. 7. Bahl, B.S., Bahl, A., Tuli, G.D., Essentials of Physical Chemistry S. Chand & Co. Ltd. 8. Palit, S. R., Elementary Physical Chemistry Book Syndicate Pvt. Ltd. 9. Mandal, A. K. Degree Physical and General Chemistry Sarat Book House. 10. Pahari, S., Physical Chemistry New Central Book Agency. 11. Pahari, S., Pahari, D., Problems in Physical Chemistry New Central Book Agency. 12. Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley. 13. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press. 14. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd. 15. Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008.</p> | | |
| CEMGP-2 | Practical | 2 Credit |
| Physical Chemistry - I | | |
| <ol style="list-style-type: none"> Surface tension measurement (use of organic solvents excluded) <ol style="list-style-type: none"> Determination of the surface tension of a liquid or a dilute solution using a Stalagmometer Study of the variation of surface tension of a detergent solution with concentration Viscosity measurement (use of organic solvents excluded) <ol style="list-style-type: none"> Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer Study of the variation of viscosity of an aqueous solution with concentration of solute Study the kinetics of the following reactions <ol style="list-style-type: none"> Initial rate method: Iodide-persulphate reaction Integrated rate method: <ol style="list-style-type: none"> Acid hydrolysis of methyl acetate with hydrochloric acid Compare the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate | | |
| Inorganic Chemistry - II | | |
| <p>Qualitative semi-micro analysis of mixtures containing three radicals. Emphasis should be given to the understanding of the chemistry of different reactions.</p> <p>Acid Radicals: Cl⁻, Br⁻, I⁻, NO₂⁻, NO₃⁻, S²⁻, SO₄²⁻, PO₄³⁻, BO₃³⁻, H₃BO₃.</p> <p>Basic Radicals: Na⁺, K⁺, Ca²⁺, Sr²⁺, Ba²⁺, Cr³⁺, Mn²⁺, Fe³⁺, Ni²⁺, Cu²⁺, NH₄⁺.</p> <p>Reference Books</p> <p>1. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N.,</p> | | |

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| University of Calcutta, 2003. 2. Palit, S.R., Practical Physical Chemistry Science Book Agency. 3. Mukherjee, N.G., Selected Experiments in Physical Chemistry J. N. Ghose & Sons. 4. Dutta, S.K., Physical Chemistry Experiments Bharati Book Stall. 5. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. 6. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). | | |
| Semester - III | | |
| CEMGT-3 | Theory: Chemical Energetics, Equilibria, Functional Group Chemistry, Organometallic Chemistry | 4 Credit |
| Physical Chemistry – II | | |
| <p>1. Chemical Energetics (13L)</p> <p>a. Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy 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</p> <p>b. Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature</p> <p>c. Statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Carnot engine, refrigerator and efficiency; Entropy change of systems and surroundings for various processes and transformations; Auxiliary state functions (G and A) and Criteria for spontaneity and equilibrium.</p> <p>2. Chemical Equilibrium: (8L) Thermodynamic conditions for equilibrium, degree of advancement; Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Definitions of K_p, K_c and K_x and relation among them; van't Hoff's reaction isotherm, isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle</p> <p>3. Ionic Equilibria: (9L) Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water; Ionization of weak acids and bases, pH scale, common ion effect; Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts; Buffer solutions; Solubility and solubility product of sparingly soluble salts – applications of solubility product principle</p> | | |
| Organic Chemistry-II | | |
| <p>Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures.</p> <p>1. Aromatic Hydrocarbons (7L) Benzene: Preparation: from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: electrophilic substitution (general mechanism); nitration (with mechanism), halogenations (chlorination and bromination), sulphonation and Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene); side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).</p> <p>2. Organometallic Compounds (4L) Introduction; Grignard reagents: Preparations (from alkyl and aryl halide);</p> | | |

concept of umpolung; Reformatsky reaction.

3. Aryl Halides (4L)

Preparation: (chloro-, bromo- and iodobenzene): from phenol, Sandmeyer reactions. Reactions (Chlorobenzene): nucleophilic aromatic substitution (replacement by –OH group) and effect of nitro substituent (activated nucleophilic substitution).

4. Alcohols, Phenols and Ethers (8L)

- a. Alcohols: (up to 5 Carbons). Preparation: 1°-, 2°- and 3°- alcohols: using Grignard reagent, reduction of aldehydes, ketones, carboxylic acid and esters; Reactions: With sodium, HX (Lucas test), oxidation (alkaline KMnO₄, acidic dichromate, concentrated HNO₃); Oppenauer oxidation;
- b. Diols: Preparation (with OsO₄); pinacol- pinacolone rearrangement (with mechanism) (with symmetrical diols only).
- c. Phenols: Preparation: cumene hydroperoxide method, from diazonium salts; acidic nature of phenols; Reactions: electrophilic substitution: nitration and halogenations; Reimer-Tiemann reaction, Houben–Hoesch condensation, Schotten–Baumann reaction, Fries rearrangement and Claisen rearrangement.
- d. Ethers: Preparation: Williamson's ether synthesis; Reaction: cleavage of ethers with HI.

5. Carbonyl Compounds (7L)

Aldehydes and Ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde): Preparation: from acid chlorides, from nitriles and from Grignard reagents; general properties of aldehydes and ketones; Reactions: with HCN, ROH, NaHSO₃, NH₂-G derivatives and with Tollens' and Fehling's reagents; iodoform test; aldol condensation (with mechanism); Cannizzaro reaction (with mechanism), Wittig reaction, benzoin condensation; Clemmensen reduction, Wolff-Kishner reduction and Meerwein-Ponndorf-Verley (MPV) reduction.

Reference Books

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Ekambaram, S. General Chemistry, Pearson.
6. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
8. Chugh, K.L., Agnish, S.L. A Text Book of Physical Chemistry Kalyani Publishers.
9. Bahl, B.S., Bahl, A., Tuli, G.D., Essentials of Physical Chemistry S. Chand & Co. Ltd.
10. Palit, S. R., Elementary Physical Chemistry Book Syndicate Pvt. Ltd.
11. Mandal, A. K. Degree Physical and General Chemistry Sarat Book House.
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19. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
20. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

| CEMGP-3 | Practical | 2 Credit |
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| Physical Chemistry - II | | |
| <p>(Minimum five experiments to complete)</p> <p>Thermochemistry</p> <ol style="list-style-type: none"> 1. Determination of heat capacity of calorimeter for different volumes 2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide 3. Determination of enthalpy of ionization of acetic acid 4. Determination of enthalpy of hydration of copper sulphate <p>Ionic Equilibria</p> <ol style="list-style-type: none"> 1. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH- meter and compare it with the indicator method 2. Preparation of buffer solutions and find the pH of an unknown buffer solution by colour matching method (using following buffers) <ol style="list-style-type: none"> a) Sodium acetate-acetic acid b) Ammonium chloride-ammonium hydroxide 3. Study of the solubility of benzoic acid in water. | | |
| Organic Chemistry - II | | |
| <p>Identification of a pure organic compound</p> <ol style="list-style-type: none"> 1. Solid compounds: oxalic acid, tartaric acid, succinic acid, resorcinol, urea, glucose, benzoic acid and salicylic acid. 2. Liquid Compounds: methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene. <p>Reference Books</p> <p>1. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N., University of Calcutta, 2003. 2. Palit, S.R., Practical Physical Chemistry Science Book Agency. 3. Mukherjee, N.G., Selected Experiments in Physical Chemistry J. N. Ghose & Sons. 4. Dutta, S.K., Physical Chemistry Experiments Bharati Book Stall. 5. Bhattacharyya, R. C, A Manual of Practical Chemistry. 6. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996. 7. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.</p> | | |
| CEMHSE-1A | Basic Analytical Chemistry | 02Credit |
| <ol style="list-style-type: none"> 1. Introduction (2L) Strategies of Analytical Chemistry and its interdisciplinary applicability. Protocol of sampling. Variability and validity of analytical measurements. Presentation of experimental data and results, from the point of view of significant figures. 2. Complexometry (4L) Complexometric titrations, Chelation, Chelating agents, use of indicators. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration. Soil Analysis Composition, pH of soil samples, estimation of calcium and magnesium content. 3. Analysis of water (4L) Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of Biological Oxygen Demand (BOD). | | |

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| 4. Analysis of food products (4L) | | |
| <p>Nutritional value of foods, idea about food processing and food preservations and adulteration.</p> <p>Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.</p> <p>Analysis of preservatives and colouring matter.</p> | | |
| 5. Chromatography (4L) | | |
| <p>Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). To compare paint samples by TLC method.</p> | | |
| 6. Ion-exchange (4L) | | |
| <p>Column, ion-exchange chromatography etc. 2. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).</p> | | |
| 7. Analysis of cosmetics (3L) | | |
| <p>Major and minor constituents and their function</p> <p>Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration</p> | | |
| 8. Suggested Applications (Any one) (2L) | | |
| <p>To study the use of phenolphthalein in trap cases. To analyse arson accelerants. To carry out analysis of gasoline.</p> | | |
| 9. Suggested Instrumental demonstrations (3L) | | |
| <p>Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.</p> <p>Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.</p> <p>Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink</p> | | |
| Reference Books | | |
| <p>1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988. 2. Skoog, D.A., Holler, F.J. & Crouch, S. Principles of Instrumental Analysis, Cengage Learning India Edition, 2007. 3. Skoog, D.A.; West, D.M. & Holler, F.J. Analytical Chemistry: An Introduction 6th Ed., Saunders College Publishing, Fort Worth, Philadelphia (1994). 4. Harris, D. C. Quantitative Chemical Analysis, 9th ed. Macmillan Education, 2016. 5. Dean, J. A. Analytical Chemistry Handbook, McGraw Hill, 2004. 6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India, 1992. 7. Freifelder, D.M. Physical Biochemistry 2nd Ed., W.H. Freeman & Co., N.Y. USA (1982). 8. Cooper, T.G. The Tools of Biochemistry, John Wiley & Sons, N.Y. USA. 16 (1977). 9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996. 10. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009. 11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995). 12. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.</p> | | |
| Semester - IV | | |
| CEMGT-4 | Theory: Solutions, Phase-Equilibria, Conductance, Electrochemistry, Analytical and Environmental Chemistry | 4 Credit |
| Physical Chemistry - III | | |
| 1. Solutions (7L) | | |
| <p>a. Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions; Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions; Distillation of solutions; Lever rule; Azeotropes</p> | | |
| <p>b. Critical solution temperature; effect of impurity on partial miscibility of liquids;</p> | | |

Immiscibility of liquids- Principle of steam distillation; Nernst distribution law and its applications, solvent extraction.

2. Phase Equilibria (7L)

- a. Phases, components and degrees of freedom of a system, criteria of phase equilibrium; Gibbs Phase Rule and its thermodynamic derivation; Derivation of Clausius – Clapeyron equation and its importance in phase equilibria; Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $\text{FeCl}_3\text{-H}_2\text{O}$ and Na-K only)

3. Conductance (8L)

- a. Conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Ostwald's dilution law; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations (acid-base)
- b. Transport Number and principles of Hittorf's and Moving-boundary method

4. Electromotive force (8L)

- a. Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry; Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential; Electrochemical series; Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data
- b. Concentration cells with and without transference, liquid junction potential; pH determination using hydrogen electrode and quinhydrone; Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation)

Analytical and Environmental Chemistry

1. Chemical Analysis

- a. Gravimetric analysis: solubility product and common ion effect; requirements of gravimetry; gravimetric estimation of chloride, sulphate, lead, barium, nickel, copper and zinc.
- b. Volumetric analysis: primary and secondary standard substances; principles of acid-base, oxidation –reduction and complexometric titrations; indicators: acid-base, redox and metal ion; principles of estimation of mixtures: NaHCO_3 and Na_2CO_3 (by acidimetry); iron, copper, manganese and chromium (by redox titration); zinc, aluminum, calcium and magnesium (by complexometric EDTA titration).
- c. Chromatography: Chromatographic methods of analysis: column chromatography and thin layer chromatography.

2. Environmental Chemistry

- a. The Atmosphere: composition and structure of the atmosphere; troposphere, stratosphere, mesosphere and thermosphere; ozone layer and its role; major air pollutants: CO, SO_2 , NO_x and particulate matters – their origin and harmful effects; problem 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.
- b. The Hydrosphere: environmental role of water, natural water sources, water treatment for industrial, domestic and laboratory uses; water pollutants; action of soaps and detergents, phosphates, industrial effluents, agricultural runoff, domestic wastes; thermal pollution, radioactive pollution and their

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| <p>effects on animal and plant life; water pollution episodes: water pollution control measures : 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.</p> <p>3. The Lithosphere: water and air in soil, waste matters and pollutants in soil, waste classification, treatment and disposal; soil pollution and control measures.</p> <p>Reference Books 1.Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007). 2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004). 3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009). 4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998). 5.Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985). 6.Chugh, K.L., Agnish, S.L. A Text Book of Physical Chemistry Kalyani Publishers .7.Bahl, B.S., Bahl, A., Tuli, G.D., Essentials of Physical Chemistry S. Chand & Co. ltd. 8. Palit, S. R., Elementary Physical Chemistry Book Syndicate Pvt. Ltd. 9.Pahari, S., Physical Chemistry New Central Book Agency 10. Pahari, S., Pahari, D., Problems in Physical Chemistry New Central Book Agency 11. Banerjee, S. P. A Text Book of Analytical Chemistry, The New Book Stall. 12. Gangopadhyay, P. K. Application Oriented Chemistry, Book Syndicate. 13. Mondal, A. K & Mondal, S. Degree Applied Chemistry, Sreedhar Publications. 14. Banerjee, S. P. A Text Book of Analytical Chemistry, The New Book Stall</p> | | |
| CEMGP-4 | Practical | 2 Credit |
| Physical Chemistry - III | | |
| <p>(Minimum six experiments to complete)</p> <p>1. Distribution Law (Any one) Study of the equilibrium of one of the following reactions by the distribution method: a. $I_2(aq) + I^-(aq) = I_3^-(aq)$ $Cu^{2+}(aq) + xNH_3(aq) = [Cu(NH_3)_x]^{2+}$</p> <p>2. Conductance a Determination of dissociation constant of a weak acid (cell constant, equivalent conductance are also determined) b. Perform the following conductometric titrations: (Any one) i. Strong acid vs. strong base ii. Weak acid vs. strong base</p> <p>3. Phase equilibria (Any one) a Construction of the phase diagram of a binary system (simple eutectic) using cooling curves b Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it</p> <p>4. Potentiometry a Perform the following potentiometric titrations: i. Weak acid vs. strong base ii. Potassium dichromate vs. Mohr's salt</p> | | |
| Analytic and Environmental Chemistry | | |
| <p>1. To find the total hardness of water by EDTA titration. 2. To find the pH of an unknown solution by comparing color of a series of HCl solutions + 1 drop of methyl orange, and a similar series of NaOH solutions + 1 drop of phenolphthalein. 3. To determine the rate constant for the acid catalysed hydrolysis of an ester. 4. Determination of the strength of the H₂O₂ sample. 5. To determine the solubility of a sparingly soluble salt, e.g. KHTa (one bottle)</p> <p>Reference Books</p> | | |

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| <p>1. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N., University of Calcutta, 2003. 2. Palit, S.R., Practical Physical Chemistry Science Book Agency, 3. Mukherjee, N.G., Selected Experiments in Physical Chemistry J. N. Ghose & Sons, 4. Dutta, S.K., Physical Chemistry Experiments Bharati Book Stall, 5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). 6. Ghosal, Mahapatra & Nad, An Advanced Course in Practical Chemistry, New Central Book Agency. 7. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003. 8. Das, S. C., Chakraborty, S. B., Practical Chemistry.</p> | | |
| CEMHSE-1B | IT skills for Chemist | 02Credit |
| <p>1. Mathematics (10L)</p> <p>i. Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.</p> <p>ii. Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities.</p> <p>iii. Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).</p> <p>iv. Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms). Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton- Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).</p> <p>v. Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).</p> <p>vi. Numerical integration (Trapezoidal and Simpson’s rule, e.g. entropy/enthalpy change from heat capacity data).</p> <p>2. Computer programming (10L)</p> <p>Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis. BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson’s rule), finding roots (quadratic formula, iterative, Newton-Raphson method).</p> <p>3. Hands On (10L)</p> <p>i. Introductory writing activities: Introduction to word processor and structure drawing (ChemSketch) software. Incorporating chemical structures, chemical equations, and expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg’s law, van der Waals equation, etc.) into word processing documents.</p> <p>ii. Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck’s distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.</p> | | |

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| iii. Numeric modelling: Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentration- time data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pKa of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data). iv. Statistical analysis: Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The t test. The F test. v. Presentation: Presentation graphics | | |
| Reference Books 1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008). 2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005). 3. Steiner, E. The Chemical Maths Book Oxford University Press (1996). 4. Yates, P. Chemical calculations. 2nd Ed. CRC Press (2007). 5. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5. 6. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages. 7. Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985). 8. Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996). | | |
| Semester - V | | |
| CEMGTDSE-1 | Theory: Transition Metal & Coordination Chemistry, Analytical and Industrial Chemistry | 4 Credit |
| Inorganic Chemistry - III | | |
| 1. Transition Elements (3d series) (10L) a. General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. b. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only). | | |
| 2. Coordination Chemistry (10L) a. Werner's coordination theory, Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. b. Drawbacks of VBT. IUPAC system of nomenclature. | | |
| 3. Crystal Field Theory (CFT) (10L) a. Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. b. Jahn-Teller distortion, Square planar coordination. | | |
| Analytical and Industrial Chemistry | | |
| 1. Error Analysis and Computer Applications (12L) a. Error analysis: accuracy and precision of quantitative analysis, determinate, indeterminate, systematic and random errors; methods of least squares and standard deviations. b. Computer applications: general introduction to computers, different components of a computer; hardware and software; input and output devices; binary numbers and arithmetic; introduction to computer languages; programming and operating systems. | | |

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| 2. Industrial Chemistry (18L) | | |
| <p>a. Fuels: classification of fuel; heating values; origin of coal, carbonization of coal, coal gas, producer gas, water gas, coal based chemicals; origin and composition of petroleum, petroleum refining, cracking, knocking, octane number, antiknock compounds, kerosene, liquefied petroleum gas (LPG), liquefied natural gas (LNG); petrochemicals (C1 to C3 compounds and their uses).</p> <p>b. Fertilizers: manufacture of ammonia and ammonium salts, urea, superphosphate, biofertilizers.</p> <p>c. Glass and ceramics: definition and manufacture of glasses, optical glass and coloured glass; clay and feldspar, glazing and vitrification, glazed porcelain, enamel.</p> <p>d. Cement: portland cement: composition and setting of cement, white cement.</p> | | |
| Reference Books | | |
| <p>1, Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley. 2. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press. 3. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd. 4. Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008. 5. Gangopadhyay, P. K. Application Oriented Chemistry, Book Syndicate. 6. Mondal, A. K & Mondal, S. Degree Applied Chemistry, Sreedhar Publications. 7. Banerjee, S. P. A Text Book of Analytical Chemistry, The New Book Stall</p> | | |
| CEMGPDSE-1 | Practical | 2 Credit |
| Inorganic Chemistry - III | | |
| <p>1. Complexometric estimation of (i) Mg^{+2} or (ii) Zn^{+2} using EDTA.</p> <p>2. Preparation of any two of the following complexes:</p> <p>a. tetraamminecarbonatocobalt (III) nitrate</p> <p>b. tetraamminecopper(II) sulphate</p> <p>c. potassium trioxalatochromate(III) trihydrate potassium bisoxalatocuprate(II) trihydrate</p> | | |
| Analytical and Industrial Chemistry | | |
| <p>1. Titration of Na_2CO_3 and $NaHCO_3$ mixture vs HCl using phenolphthalein and methyl orange indicators.</p> <p>2. Titration of HCl and CH_3COOH mixture vs NaOH using two different indicators to find the concentration.</p> <p>3. Estimation of available oxygen in pyrolusite</p> | | |
| Reference Books | | |
| <p>1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. 2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009. 3. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003. 4. Das, S. C., Chakraborty, S. B., Practical Chemistry, 5. Ghosal, Mahapatra & Nad, An Advanced Course in Practical Chemistry, New Central Book Agency.</p> | | |
| CEMHSE-2A | | 2 Credit |
| Pharmaceutical Chemistry | | |
| <p>1. Drugs & Pharmaceuticals: (16L)</p> <p>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, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).</p> | | |

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| <p>2. Fermentation: (7L) 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.</p> <p>3. Hands On Practical: (7L) Preparation of Aspirin and its analysis. Preparation of magnesium bisilicate (Antacid).</p> <p>Reference Books</p> <p>1. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013. 2. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012. 3. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.</p> | |
| Semester - VI | |
| CEMGTDSE-2 | Theory: Advanced Organic Chemistry and Industrial Chemistry |
| 4 Credit | |
| Advanced Organic Chemistry | |
| <p>Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures.</p> <p>1. Carboxylic Acids and Their Derivatives (10L)</p> <p>a. Carboxylic acids (aliphatic and aromatic): strength of organic acids: comparative study with emphasis on factors affecting pK values; Preparation: acidic and alkaline hydrolysis of esters (BAC2 and AAC2 mechanisms only) and from Grignard reagents; Reactions: Hell - Vohlard - Zelinsky reaction and Claisen condensation; Perkin reaction.</p> <p>b. Carboxylic acid derivatives (aliphatic): (up to 5 carbons). Preparation: acid chlorides, anhydrides, esters and amides from acids; Reactions: Comparative study of nucleophilicity of acyl derivatives; interconversion among acid derivatives.</p> <p>2. Amines and Diazonium Salts (10L)</p> <p>a. Amines (aliphatic and aromatic): strength of organic bases; Preparation: from alkyl halides, Gabriel's phthalimide synthesis, Hofmann degradation, by reduction of nitro compounds; Reactions: with HNO₂ (distinction of 1^o-, 2^o- and 3^o- amines), Schotten – Baumann reaction, Diazo coupling reaction (with mechanism).</p> <p>b. Diazonium salts: Preparation: from aromatic amines; Reactions: conversion to benzene, phenol, benzoic acid and nitrobenzene.</p> <p>c. Nitro compounds (aromatic): reduction under different conditions (acidic, neutral and alkaline).</p> <p>3. Amino Acids and Carbohydrates (10L)</p> <p>a. Amino Acids: Preparations (glycine and alanine only): Strecker synthesis, Gabriel's phthalimide synthesis; general properties; zwitterion, isoelectric point; ninhydrin reaction.</p> <p>b. Carbohydrates: classification and general properties; glucose and fructose: constitution; osazone formation; oxidation-reduction reactions; epimers of glucose (definition and example only); cyclic structures of glucose (determination of ring-size excluded); ascending (Kiliani – Fischer method) and descending (Ruff's and Wohl's methods) in monosaccharides (aldoses only); mutarotation.</p> | |

| Industrial Chemistry | | |
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| <ol style="list-style-type: none"> 1. Polymers: (4L) Basic concept, structure and types of plastics, polythene, polystyrene, phenolformaldehydes, PVC; manufacture, physical properties and uses of natural rubber, synthetic rubber, silicone rubber; synthetic fibres, nylon-66, polyester, terylene, rayon; foaming agents, plasticizers and stabilizers. 2. Paints: (3L) Primary constituents; formulation of paints; binders and solvents for paints; oil based paints, latex paints, alkyd resin paint. 3. Varnishes: (2L) Constituents of varnishes; formulation of varnishes. 4. Synthetic dyes: (2L) Synthesis of methyl orange, congo red, malachite green, crystal violet. 5. Drugs and pharmaceuticals: (3L) Concept and necessity of drugs and pharmaceuticals; preparation and uses: aspirin, paracetamol, sulphadiazine, quinine, chloroquine, phenobarbital, metronidazole. 6. Fermentation chemicals: (3L) Production and purification of ethyl alcohol, citric acid, lactic acid, vitamin B12, penicillin. Industrial Chemistry. 7. Fats and oils: (3L) Natural fat, edible and inedible oil of vegetable origin; common fatty acids; glycerides; hydrogenation of unsaturated oil, production of vanaspati and margarine. 8. Soaps and detergents: (3L) Production of toilet and washing soaps; enzyme-based detergents, detergent powder; liquid soaps. 9. Pesticides: (3L) Common pesticides: production, applications and residual toxicity of gammaxane, aldrin, parathion, malathion, DDT, paraquat, decamethrin. 10. Food additives: (4L) Food flavour, food colour, food preservatives, artificial sweeteners, acidulants, alkalies, edible emulsifiers and edible foaming agents, sequesterants – uses and abuses of these substances in food beverages. | | |
| Reference Books | | |
| 1. Sethi, A. Conceptual Organic Chemistry; New Age International Publisher. 2. Parmar, V. S. A Text Book of Organic Chemistry, S. Chand & Sons. 3. Madan, R. L. Organic Chemistry, S. Chand & Sons. 4. Ekambaram, S. General Chemistry, Pearson. 5. Wade, L. G., Singh, M. S., Organic Chemistry. 6. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education). 7. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education). 8. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010. 9. Gangopadhyay, P. K. Application Oriented Chemistry, Book Syndicate. 10. Mondal, A. K & Mondal, S. Degree Applied Chemistry, Sreedhar Publications. 11. Banerjee, S. P. A Text Book of Analytical Chemistry, The New Book Stall. | | |
| CEMGPDSE-2 | Practical | 2 Credit |
| Advanced Organic Chemistry | | |
| <ol style="list-style-type: none"> 1. The following reactions are to be performed, noting the yield of the crude product: <ol style="list-style-type: none"> a. Nitration of aromatic compounds b. Condensation reactions c. Hydrolysis of amides/imides d. Acetylation of aromatic amines e. Benzoylation of aromatic amines | | |

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| 2. Purification of the crude product is to be made by crystallisation from water/alcohol. | |
| Industrial Chemistry | |
| <ol style="list-style-type: none"> 1. Estimation of saponification value of oil / ester / fat. 2. Estimation of available chlorine in bleaching powder. 3. Estimation of acetic acid in commercial vinegar. 4. Estimation of amino acid by formol titration | |
| Reference Books | |
| <p>1. Vogel, A. I. Elementary Practical Organic Chemistry, Part 1: Small scale Preparations, CBS Publishers and Distributors. 2. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N., University of Calcutta, 2003. 3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson education. 4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012). 5. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). 6. Practical Workbook Chemistry (Honours), UGBS, Chemistry, University of Calcutta, 2015. 7. Arthur, I. V. Quantitative Organic Analysis, Pearson. 8. Das, S. C., Chakraborty, S. B., Practical Chemistry. 9. Ghosal, Mahapatra & Nad, An Advanced Course in Practical Chemistry, New Central Book Agency..</p> | |
| CEMHSE-2B | 2 Credit |
| Analytical Clinical Biochemistry | |
| <ol style="list-style-type: none"> 1. Review of Concepts from Core Course (8L) Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysaccharides. Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β-pleated sheets, Isolation, characterization, denaturation of proteins. Enzymes: Nomenclature, Characteristics (mention of Ribozymes), and Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry. Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins. Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones. 2. Biochemistry of disease: A diagnostic approach by blood/ urine analysis. (12L) Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin. Urine: Sampling and preservation, composition and estimation of constituents of normal and pathological urine. 3. Hands On Practical (10L) Identification and estimation of the following: <ol style="list-style-type: none"> a) Carbohydrates – qualitative and quantitative. b) Lipids – qualitative. c) Determination of the iodine number of oil. d) Determination of the saponification number of oil. e) Determination of cholesterol using Liebermann- Burchard reaction. f) Proteins – qualitative. g) Isolation of protein. h) Determination of protein by the Biuret reaction. | |

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| <p style="text-align: center;">i) Determination of nucleic acids</p> <p>Reference Books</p> <p>Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977). 2. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009). 3. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann, London (1980). 4. Devlin, T.M., Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons, 2010. 5. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002. 6. Talwar, G.P. & Srivastava, M. Textbook of Biochemistry and Human Biology, 3rd Ed. PHI Learning. 7. Nelson, D.L. & Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman, 2013. 8. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods, D. Van Nostrand & Co., 1961.</p> | |
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N.B.: Please ignore typographical error if any.