



UNIVERSITY OF CALCUTTA

Notification No. CSR/17/2024

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 04.04.2024, approved Chemistry Syllabus including Examination Modalities/ Question pattern for semester wise 4-year Chemistry (Honours & Honours with Research) and 3-year Chemistry (MDC) Courses of Studies under CCF,2022, as follows:

1. Examination Modalities/ Question pattern for Semester 2 to 4 of 4-year Chemistry (Honours & Honours with Research) and for semester 2 to 6 of 3-year Chemistry (MDC) Courses of Studies.
2. Syllabus for semester 1 to 4 of 4-year Chemistry (Honours & Honours with Research). syllabus of semester-1, published in CSR/13/23.dt. 12.07.2023 remains same.
3. Syllabus for semester 1 to 6 of 3-year Chemistry (MDC). syllabus of semester-1, published in CSR/13/23, dt. 12.07.2023 remains same.

The above shall take effect from the academic session 2023-2024.

SENATE HOUSE

Kolkata-700073

08.04.2024


Prof.(Dr.) Debasis Das

Registrar

**Examination Regulations and
Modalities of Semester-wise UG
Examinations**

CHEMISTRY

**Four-Year B.A./B.Sc (Honours and
Honours with Research) Courses of
Studies (Under Curriculum & Credit
framework, 2022)**

(2nd to 4th Semester)

Theoretical examinations

(Questions will cover the entire syllabus with weightage according to the number of lecture-hours per module)

Semester	Course Type (Major/Minor, SEC, IDC)	Paper	Full Marks	Duration	Question Pattern and Marks Distribution
2	Major	CHEM-H-CC2-2-Th	75	3 hours	10 short questions of 2 mark each, 3 questions of 5 marks each and 4 questions of 10 marks each (4+3+3)
	**SEC	CHEM-H-SEC2-2-Th			
	Minor	CHEM-H-CC2-2-Th			
	IDC	CHEM-H-IDC2-2-Th	50	2 hours	10 short questions of 2 mark each, 3 questions of 10 marks each (4+3+3)
3	Major	CHEM-H-CC3-3-Th	75	3 hours	10 short questions of 2 mark each, 3 questions of 5 marks each and 4 questions of 10 marks each (4+3+3)
	Major	CHEM-H-CC4-3-Th			
	SEC	CHEM-H-SEC3-3-Th			
	Minor	CHEM-H-CC1-3-Th			
	IDC	CHEM-H-IDC3-3-Th	50	2 hours	10 short questions of 2 mark each, 3 questions of 10 marks each (4+3+3)
4	Major	CHEM-H-CC5-4-Th	75	3 hours	10 short questions of 2 mark each, 3 questions of 5 marks each and 4 questions of 10 marks each (4+3+3)
	Major	CHEM-H-CC6-4-Th			
	Major	CHEM-H-CC7-4-Th			
	Major	CHEM-H-CC8-4-Th			
	Minor	CHEM-H-CC2-4-Th			

** Full marks, Duration and Question Pattern will be decided by the University

Practical Examinations

Semester	Course Type (Major/Minor)	Paper	Full Marks	Duration	Question Pattern and Marks Distribution
2	Major	CHEM-H-CC2-2-P	25	3 hours	20 marks Examination + 5 marks Laboratory notebook. Experiments by lottery.
	Minor	CHEM-H-CC2-2-P	25	3 hours	
3	Major	CHEM-H-CC3-3-P	25	3 hours	20 marks Examination + 5 marks Laboratory notebook. Experiments by lottery.
	Major	CHEM-H-CC4-3-P	25	3 hours	
	Minor	CHEM-H-CC1-3-P	25	3 hours	
4	Major	CHEM-H-CC5-4-P	25	3 hours	20 marks Examination + 5 marks Laboratory notebook. Experiments by lottery.
	Major	CHEM-H-CC6-4-P	25	3 hours	
	Major	CHEM-H-CC7-4-P	25	3 hours	
	Major	CHEM-H-CC8-4-P	25	3 hours	
	Minor	CHEM-H-CC2-4-P	25	3 hours	

Examination to be conducted by,

- 1) **For Chemistry Major Papers:** Both Internal and External Examiners, following the instructions of UGBOS. (Away Centre)
- 2) **For Chemistry Minor Papers:** Internal examiners (2) following the instructions of UGBOS. (Home Centre)

Tutorial Examinations

Semester	Course Type (SEC, IDC)	Paper	Full Marks	Duration	Question Pattern and Marks Distribution	Examination to be conducted/ Evaluation by
2	IDC	CHEM-H-IDC2-2-Tu	25	1 hour examination	20 Marks (10 short questions of 2 marks each) + 5 marks for Tutorial Handbook	To be conducted by Internal examiners(2) following the instructions of UGBOS (Home Centre)
3	SEC	CHEM-H-SEC3-3-Tu				
	IDC	CHEM-H-IDC3-3-Tu				

THREE-YEAR B.A./B.Sc

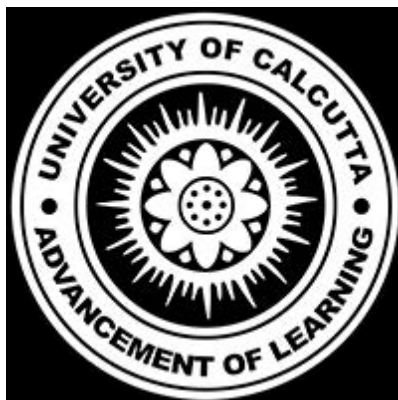
(Multidisciplinary Courses of Studies, under Curriculum & Credit framework, 2022)

(2nd to 6th Semester)

Type of examinations	Paper	Full Marks	Duration	Question Pattern and Marks Distribution	Examination to be conducted/ Evaluation by
Theoretical	All MDC Theoretical Papers (Core Course 1 &2, Minor),SEC	75	3 hours	10 short questions of 2 mark each, 3 questions of 5 marks each and 4 questions of 10 marks each (4+3+3)	-----
	IDC	50	2 hours	10 short questions of 2 mark each, 3 questions of 10 marks each (4+3+3)	-----
Practical	All MDC Practical Papers(Core Course 1 &2, Minor)	25	3 hours	20 marks Examination + 5 marks Laboratory notebook. Experiments by lottery.	To be conducted by Internal examiners(2) following the instructions of UGBOS (Home Centre)
Tutorial	SEC and IDC	25	1 hour	20 Marks (10 short questions of 2 marks each) + 5 marks for Tutorial Handbook	To be conducted by Internal examiners(2) following the instructions of UGBOS (Home Centre)

THREE-YEAR B.A./B.Sc
(Multidisciplinary Courses of Studies, under
Curriculum & Credit framework, 2022)

SYLLABUS
FOR
CHEMISTRY



UNIVERSITY OF CALCUTTA

Chemistry Course Structure (CC1 & CC2)
For
Three-year MULTIDISCIPLINARY Studies
(Theory)

Semester	Paper Code	Paper Name	Brief Descriptions
1	CHEM-MD-CC1-1-Th	Chemistry MDC- I	Extra nuclear structure of atoms and Periodicity, Basics of Organic Chemistry Bonding and Physical Properties , Stereochemistry – I, Thermodynamics – I, Chemical Kinetics-I.
2	CHEM-MD-CC2-2-Th	Chemistry MDC- II	Kinetic Theory and Gaseous state, Chemical Bonding – I , Theoretical principles of inorganic qualitative analysis , Stereochemistry – II, General Treatment of Reaction Mechanism-I
3	CHEM-MD-CC3-3-Th	Chemistry MDC- III	Aromatic Substitution Reaction , General Treatment of Reaction Mechanism-II, Stereochemistry – III Conformation , Substitution, elimination, Addition to alkenes, dienes, alkynes..
4	CHEM-MD-CC4-4-Th	Chemistry MDC- IV	Chemical bonding- II, Acids and bases, Radioactivity.
	CHEM-MD-CC5-4-Th	Chemistry MDC- V	Thermodynamics-II , Applications of Thermodynamics – I , Electrochemistry- I.
5 & 6	CHEM-MD-CC6-5-Th	Chemistry MDC- VI	Stereochemistry – IV, Chemistry of Carbonyl Compounds, Organometallics.
	CHEM-MD-CC7-5-Th Or CHEM-MD-CC7-6-Th	Chemistry MDC- VII	Transport processes and Liquid State, Solid State, Application of Thermodynamics - II, Electrochemistry- II.
	CHEM-MD-CC8-6-Th	Chemistry MDC- VIII	Coordination chemistry, Redox reactions .

Important Points

If Chemistry is considered by a student as CC1(Core Course 1 in the CSR/04/2023, dated 23rd June, 2023 of University of Calcutta) then He / She will take CHEM-MD-CC6-5-Th and CHEM MD-CC7-5-Th in Semester 5 and CHEM-MD-CC8-6-Th in Semester 6. On the other hand if Chemistry is opted as CC2 (Core Course 2 in the CSR/04/2023, dated 23rd June, 2023 of University of Calcutta) then He / She will take CHEM-MD-CC6-5-Th in Semester 5 and CHEM-MD-CC7-6-Th & CHEM-MD-CC8-6-Th in Semester 6.

Chemistry Course Structure (CC1 & CC2)
For
Three-year MULTIDISCIPLINARY Studies
(Practical)

Semester	Paper Code	Paper Name	Brief Descriptions
1	CHEM-MD-CC1-1-P	Chemistry MDC- I	Acid-Base Titration, Oxidation-Reduction Titrimetry.
2	CHEM-MD-CC2-2-P	Chemistry MDC- II	Qualitative semimicro analysis of mixtures containing three radicals
3	CHEM-MD-CC3-3-P	Chemistry MDC- III	Identification of Single organic Compound.
4	CHEM-MD-CC4-4-P	Chemistry MDC- IV	Complexometric Titration
	CHEM-MD-CC5-4-P	Chemistry MDC- V	Chemical Kinetics (Analytical).
5 & 6	CHEM-MD-CC6-5-P	Chemistry MDC- VI	Qualitative analysis of single solid Organic compounds.
	CHEM-MD-CC7-5-P Or CHEM-MD-CC7-6-P	Chemistry MDC- VII	Surface Tension, Viscosity, Conductometry.
	CHEM-MD-CC8-6-P	Chemistry MDC- VIII	Estimation of mixtures of metal ions.

Important Points

If Chemistry is considered by a student as CC1(Core Course 1 in the CSR/04/2023, dated 23rd June, 2023 of University of Calcutta) then He / She will take CHEM-MD-CC6-5-P and CHEM MD-CC7-5-P in Semester 5 and CHEM-MD-CC8-6-P in Semester 6. On the other hand if Chemistry is opted as CC2 (Core Course 2 in the CSR/04/2023, dated 23rd June, 2023 of University of Calcutta) then He / She will take CHEM-MD-CC6-5-P in Semester 5 and CHEM-MD-CC7-6-P & CHEM-MD-CC8-6-P in Semester 6.

Chemistry Course Structure (Minor)
For
Three-year MULTIDISCIPLINARY Studies
(Theory)

Semester	Paper Code	Paper Name	Brief Descriptions
3	CHEM-MD-CC1-3-Th	Chemistry MDC- I	Extra nuclear structure of atoms and Periodicity, Basics of Organic Chemistry Bonding and Physical Properties , Stereochemistry – I, Thermodynamics –I, Chemical Kinetics-I.
4	CHEM-MD-CC2-4-Th	Chemistry MDC- II	Kinetic Theory and Gaseous state, Chemical Bonding – I , Theoretical principles of inorganic qualitative analysis , Stereochemistry – II, General Treatment of Reaction Mechanism-I
5	CHEM-MD-CC3-5-Th	Chemistry MDC- III	Aromatic Substitution Reaction , General Treatment of Reaction Mechanism-II, Stereochemistry –III Conformation , Substitution, elimination, Addition to alkenes, dienes, alkynes..
5	CHEM-MD-CC4-5-Th	Chemistry MDC- IV	Chemical bonding- II, Acids and bases, Radioactivity
6	CHEM-MD-CC5-6-Th	Chemistry MDC- V	Thermodynamics II , Applications of Thermodynamics – I , Electrochemistry-I.
6	CHEM-MD-CC6-6-Th	Chemistry MDC- VI	Stereochemistry – IV, Chemistry of Carbonyl Compounds, Organometallics..

**Chemistry Course Structure (Minor)
For
Three-year MULTIDISCIPLINARY Studies
(Practical)**

Semester	Paper Code	Paper Name	Brief Descriptions
3	CHEM-MD-CC1-3-P	Chemistry MDC- I	Acid-Base Titration, Oxidation-Reduction Titrimetry.
4	CHEM-MD-CC2-4-P	Chemistry MDC- II	Qualitative semimicro analysis of mixtures containing three radicals
5	CHEM-MD-CC3-5-P	Chemistry MDC- III	Identification of Single organic Compound.
5	CHEM-MD-CC4-5-P	Chemistry MDC- IV	Complexometric Titration
6	CHEM-MD-CC5-6-P	Chemistry MDC- V	Chemical Kinetics (Analytical).
6	CHEM-MD-CC6-6-P	Chemistry MDC- VI	Qualitative analysis of single solid organic compound.

Summer Internship:

All the students are required to do one 3 credits Summer Internship at the end of the 2nd or 4th or 6th semester. Students completing Internship at the end of the 2nd semester will be allowed to take exit from the course and will be awarded Certificate of 45 (42+3) credits. Students completing Internship at the end of the 4th semester will be allowed to take exit from the course and will be awarded Diploma of 88 (85+3) credits. Students completing Internship at the end of the 6th semester and after successful completion of all the 6 semesters will be awarded B.A./ B.Sc. Degree of 128 (125+3) credits. [Following the Notification No. CSR/04/2023, dated 23rd June, 2023 of University of Calcutta].

CHEMISTRY MDC

PAPER :CHEM-MD-CC1-1-Th/CHEM-MD-CC1-3-Th

(Credit : Theory -03, Practical – 01)

Chemistry MDC- I

Theory: (45 Lectures)

Module : I

(15 Lectures)

Extra nuclear structure of atoms and Periodicity:

Wave-Particle duality; de Broglie hypothesis. Heisenberg's uncertainty principle. Introducing Schrödinger equation . Hydrogen and hydrogen like systems (detailed solution not required) .Concept of Atomic Orbital ; shapes of s, p and d orbitals . Radial and angular distribution curves.Extension to multielectronic systems. Aufbau principle and its limitations; Pauli's exclusion principle ; Hund's rules and multiplicity. Effective nuclear charge. Shielding and penetration; Slater's rule.

The general idea about modern periodic table, atomic and ionic radii, ionization energy, electron affinity and electro negativity –definition, trends of variation in periodic table and their application in explaining and predicting the chemical behavior of elements and compounds. Electronegativity scales (Pauling's, Mulliken's and Allred-Rochow's scales). Inert pair effect.

Module : II

Basics of Organic Chemistry Bonding and Physical Properties:

(10 Lectures)

Valence Bond Theory

Nomenclature of Organic Compounds, Concept of hybridisation, shapes and structures of molecules, double bond equivalent (DBE), Resonance (including hyperconjugation) and Resonance energy.

Electronic displacements

Inductive effect, bond polarization and bond polarizability; steric effect, steric inhibition of resonance.

MO Theory

Qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ , σ^* , π , π^* , n – MOs; concept of HOMO, LUMO and SOMO; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6] annulenes; charged systems: 3-,4-,5-7 membered ring systems); Hückel's rules for aromaticity up to [8] annulene; concept of antiaromaticity; non-aromatic molecules.

Physical properties

Melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments.

Stereochemistry – I

(05 Lectures)

Bonding geometries of carbon compounds and representation of molecules: tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying wedge and Newman projection formulae and their inter translations. Concept of chirality and symmetry: symmetry elements, molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of stereogenicity, chiral centres and number of stereoisomers: systems involving 1/2-chiral centre(s).

Module : III

Thermodynamics -I :

(9 Lectures)

Concept of systems (open, closed and isolated) and surroundings . State of a system; Intensive and extensive variables. Partial derivatives. Exact and inexact differentials. Path function and State function. Concept of heat and work. Zeroth law of thermodynamics. Concept of thermodynamic reversibility. Concept of internal energy and 1st law of thermodynamics. Enthalpy and heat capacity, Relations between C_p and C_v . Isothermal and Adiabatic processes; Calculations of ΔU , ΔH , q and w involving ideal gases in different processes.

Enthalpy of reaction. Hess's law. Enthalpy of formation and combustion. Kirchhoff's equation.

Chemical Kinetics-I:

(6 Lectures)

Concept of order and molecularity. Rate laws for zero , 1st and 2nd order reactions and in general for any n-th order reaction. Determination of order of a reaction by half-life and differential methods. Rate determining step and steady state approximation. Opposing, Consecutive and parallel reactions (first order steps only). Temperature dependence of rate constant and Arrhenius equation.

Recommended Text Books:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Atkins, Overton, Rourke, Weller, Armstrong; Shriver & Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press (2010).
3. Finar, I. L. Organic Chemistry (Volume 1), 6th Edition, Pearson Education, 2002
4. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
5. Nasipuri, D. Stereochemistry of Organic Compounds, 4th Edition, New Age International Pvt Ltd, 2020
6. Levine, I. N. Physical Chemistry, 6th Edition McGraw-Hill India, 2011
7. Castellan, G. W. Physical Chemistry, Narosa, 2004
8. Atkins, P. W. & Paula, J. de, Atkins' Physical Chemistry, 11th Edition, Oxford University Press, 2018
9. G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Edition, Pearson India, 2008

Practical : (30 Lectures)

PAPER: CHEM-MD-CC1-1-P /CHEM-MD-CC1-3-P

- (1) Calibration and use of apparatus.
- (2) Preparation of primary standard solutions Oxalic Acid and $K_2Cr_2O_7$)

Acid-Base Titrations:

- (3) Standardization of NaOH standard oxalic acid solution.
- (4) Estimation of carbonate and bicarbonate present together in a mixture
- (5) Estimation of acetic acid in commercial Vinegar.

Oxidation-Reduction Titrimetry:

- (6) Standardization of $KMnO_4$ standard oxalic acid solution.
- (7) Estimation of Fe(II) using standardized $KMnO_4$ solution.
- (8) Estimation of Fe(III) using standard $K_2Cr_2O_7$ solution.
- (9) Estimation of Fe(II) and Fe(III) in a given mixture using standard $K_2Cr_2O_7$ solution.

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015

CHEMISTRY MDC

PAPER :CHEM-MD-CC2-2-Th/CHEM-MD-CC2-4-Th

(Credit : Theory -03, Practical – 01)

Chemistry MDC- II

Theory: (45 Lectures)

Module : I

Kinetic Theory and Gaseous state:

(8 Lectures)

Concept of pressure and temperature from kinetic theory of gas.

Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Wall collision and rate of effusion Calculation of number of molecules having energy $\geq \epsilon$, Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases

Real gas and Virial equation:

(7 Lectures)

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 behavior ; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states; Virial equation of state; van der Waals equation expressed in the Virial form and significance of second virial coefficient; Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea.

Module : II

Chemical Bonding – I:

(10 Lectures)

i) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its application and limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. Defects in solids (elementary idea). Solubility energetics of dissolution process.

ii) Covalent bond: Polarizing power and polarizability, ionic potential, Fajan's rules, Lewis structures, formal charge, Valence Bond Theory, The hydrogen molecule (Heitler – London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rules, dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs (examples from main group chemistry) and multiple bonding (σ and π bond approach).

Theoretical principles of inorganic qualitative analysis:

(5 Lectures)

Basic principles involved in analysis of cations and anions and solubility products, common ion effect.

Principle involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

Module : III

Stereochemistry – II :

(8 Lectures)

Chirotopicity and its relationship with stereogenicity; concept of pseudoasymmetry for ABA type systems. Relative and absolute configuration: *R/S* descriptors; *erythro/threo* and *meso* nomenclature of compounds; *E/Z* descriptors for C=C, combination of *R/S*- and *E/Z* isomerisms. Optical activity of chiral compounds: optical rotation, and specific rotation; racemic compounds, racemisation (through cationic, anionic intermediates); resolution of acids and bases via diastereomeric salt formation; optical purity and enantiomeric excess.

General Treatment of Reaction Mechanism –I:

(7 Lectures)

Reactive intermediates

Carbocations (carbenium and carbonium ions), non-classical carbocations, carbanions, carbon radicals: generation and stability, structure and electrophilic/nucleophilic behaviour of reactive intermediates (elementary idea).

Reaction thermodynamics

Free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change *via* BDE, intermolecular & intramolecular reactions.

Reaction kinetics

Rate constant and free energy of activation; free energy profiles for one-step, and two-step reactions; catalyzed reactions, principle of microscopic reversibility; Hammond's postulate.

Substitution Reaction

Free-radical substitution reaction: halogenation of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate.

Recommended Text Books:

1. Lee, J. D. *Concise Inorganic Chemistry*, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Atkins, Overton, Rourke, Weller, Armstrong; Shriver & Atkins' *Inorganic Chemistry*, 5th Ed., Oxford University Press (2010).
3. Finar, I. L. *Organic Chemistry (Volume 1)*, 6th Edition, Pearson Education, 2002
4. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
5. Nasipuri, D. *Stereochemistry of Organic Compounds*, 4th Edition, New Age International Pvt Ltd, 2020
6. Levine, I. N. *Physical Chemistry*, 6th Edition McGraw-Hill India, 2011
7. Castellan, G. W. *Physical Chemistry*, Narosa, 2004
8. Atkins, P. W. & Paula, J. de, *Atkins' Physical Chemistry*, 11th Edition, Oxford University Press, 2018
9. G. L. Miessler, D. A. Tarr, *Inorganic Chemistry*, 3rd Edition, Pearson India, 2008

Practical : (30 Lectures)

PAPER: CHEM-MD-CC2-2-P/CHEM-MD-CC2-4-P

Qualitative semimicro analysis of mixtures containing three radicals. Emphasis should be given to the understanding of the chemistry of different reactions (only water /acid soluble salts):

Cation Radicals

Na^+ , K^+ , Ca^{2+} , Sr^{2+} , Ba^{2+} , Al^{3+} , Cr^{3+} , Fe^{3+} , $\text{Mn}^{2+}/\text{Mn}^{4+}$, $\text{Co}^{2+}/\text{Co}^{3+}$, Ni^{2+} , Cu^{2+} , Zn^{2+} , Pb^{2+} , NH_4^+ , $\text{Sn}^{2+}/\text{Sn}^{4+}$

Anion Radicals

F^- , Cl^- , Br^- , I^- , $\text{S}_2\text{O}_3^{2-}$, S^{2-} , SO_4^{2-} , NO_3^- , NO_2^- , PO_4^{3-} , BO_3^{3-} , CrO_4^{2-} / $\text{Cr}_2\text{O}_7^{2-}$, SCN^- , $[\text{Fe}(\text{CN})_6]^{3-}$, $[\text{Fe}(\text{CN})_6]^{4-}$, AsO_4^{3-} , BrO_3^- , IO_3^-

Reference Books:

1. Svehla & Sivasankar, Vogel's Qualitative Inorganic Analysis, 7th Ed., Pearson, 2012.
2. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015

CHEMISTRY MDC

PAPER : CHEM-MD-CC3-3-Th/CHEM-MD-CC3-5-Th

(Credit : Theory -03, Practical – 01)

Chemistry MDC- III

Theory: (45 Lectures)

Module : I

Aromatic Substitution:

(12 Lectures)

Electrophilic aromatic substitution

Mechanisms and evidences in favour of it including PKIE; orientation and reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbonelectrophiles (reactions: chloromethylation, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt); *Ips*o substitution.

Nucleophilic aromatic substitution

Addition-elimination mechanism and evidences in favour of it; S_N1 mechanism; *cine* substitution (benzyne mechanism), structure of benzyne.

Birch Reduction of benzenoid aromatics

Benzene, Alkylbenzene, Anisole, Benzoic acid (with mechanism).

General Treatment of Reaction Mechanism –II

(8 Lectures)

Concept of organic acids and bases

Concept of pK_a and pK_{aH} , effect of structure, substituent and solvent on acidity and basicity; proton sponge.

Tautomerism:

Basic difference between tautomerism and resonance, prototropy (keto-enol, phenol-keto); composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism, basic ideas about valence tautomerism and ring-chain tautomerism.

Module : II

Stereochemistry –III

(3 Lectures)

Conformation-I :

Basic idea of conformation. Conformational Nomenclature (Newman & Sawhorse): eclipsed, staggered, gauche, syn and anti; Special reference to preferred geometry for β -elimination. Relative stability of conformers on the basis of steric effect: butane-gauche interaction.

Substitution and Elimination Reactions:

(10 Lectures)

Nucleophilic substitution reactions

Substitution at sp^3 centre [systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides, α -halocarbonyls]: mechanisms (with evidence), relative rates & stereochemical features: S_N1 , S_N2 , S_N2' , S_N1' (allylic rearrangement) and S_Ni ; effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite); substitutions involving NGP (with heteroatoms and phenyl groups).

Elimination reactions

$E1$, $E2$, $E1cB$ and Ei (pyrolytic *syn* eliminations); formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity; comparison between substitution and elimination reactions, comparison between nucleophilicity and basicity.

Module : III

Chemistry of alkenes and alkynes:

(12 Lectures)

Addition to C=C

Mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic addition to 1,3-butadiene; concept of kinetic and thermodynamic control of products; radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; interconversion of *E* and *Z* alkenes.

Addition to C≡C (in comparison to C=C)

Mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff addition) and stereoselectivity; reactions: hydrogenation, Hg(II) ion catalysed hydration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity.

Recommended Text Books:

1. Finar, I. L. Organic Chemistry (Volume 1), 6th Edition, Pearson Education, 2002
2. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
3. Morrison, R. N. & Boyd, R. N. and Bhattacharjee, Organic Chemistry, 7th Edition, Pearson Education, 2010

Practical : (30 Lectures)

PAPER: CHEM-MD-CC3-3-P/CHEM-MD-CC3-5-P

Identification of Pure Single organic Compound.

Solid compounds:

Oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid

Liquid Compounds:

Formic acid, acetic acid, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

Reference Books:

1. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015

2.Furniss , Hannaford, Smith, Tatcholl, Vogel's Textbook of Practical Organic Chemistry ,5thEdition , Pearson India, 2003

CHEMISTRY MDC

PAPER :CHEM-MD-CC4-4-Th/CHEM-MD-CC4-5-Th

(Credit : Theory -03, Practical – 01)

Chemistry MDC- IV

Theory: (45 Lectures)

Module : I

Chemical bonding -II:

(28 Lectures)

Molecular orbital concept of bonding

The approximations of the theory, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach): sigma and pi bonds and delta interaction, multiple bonding. Orbital designations: gerade, ungerade, HOMO, LUMO. Orbital mixing,. MO diagrams of H₂, Li₂, Be₂, B₂, C₂, N₂, O₂, F₂, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO⁺, CN⁻, HF, BeH₂, CO₂ and H₂O. Bond properties: bond orders, bond lengths.

Metallic Bond

Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Weak Chemical Forces

Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points.

Module : II

Acids and bases:

(12 Lectures)

Acid-Base concept

Arrhenius concept, theory of solvent system (in H₂O, NH₃, SO₂ and HF), Bronsted-Lowry's concept, Lux Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects. Relative strength of acids, Pauling's rules. HSAB principle.

Thermodynamic acidity parameters

Drago-Wayland equation. Superacids, Gas phase acidity and proton affinity.

Acid-base equilibria in aqueous solution

Proton transfer equilibria in water, pH, buffer. Acid-base neutralization curves; indicator, choice of indicators.

Module : III

Radioactivity

(05 Lectures)

Nuclear stability

Nuclear stability and nuclear binding energy.

Nuclear Reactions

Artificial radioactivity, fission, fusion and spallation.

Radiocarbon dating

Recommended Text Books:

1. G. L. Miessler, D. A. Tarr, *Inorganic Chemistry*, 3rd Edition, Pearson India, 2008
2. A. G. Sharpe, C. E. Housecroft, *Inorganic Chemistry* 3rd Edition, Pearson India, 2002
3. Svehla & Sivasankar, *Vogel's Qualitative Inorganic Analysis*, 7th Ed., Pearson, 2012.

Practical : (30 Lectures)

PAPER: CHEM-MD-CC4-4-P/CHEM-MD-CC4-5-P

Complexometric Titration

1. Ca(II) and Mg(II) in a mixture
2. Hardness of water
3. Fe(III) and Al(III) in a mixture
4. Cu(II) and Zn(II) in a mixture
5. Cu(II) and Ni(II) in a mixture

Reference Books:

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
2. *Practical Workbook Chemistry (Honours)*, UGBOS, Chemistry, University of

Calcutta, 2015

CHEMISTRY MDC

PAPER :CHEM-MD-CC5-4-Th/CHEM-MD-CC5-6-Th

(Credit : Theory -03, Practical – 01)

Chemistry MDC- V

Theory: (45 Lectures)

Module : I

Thermodynamics- II:

(20 Lectures)

Second Law

Need for a Second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Carnot engine and refrigerator; Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation; Carnot's theorem; Values of $\int dQ/T$ and Clausius inequality; Physical concept of Entropy; Entropy is a measure of the microscopic disorder of the system. Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work; Temperature – Entropy diagram.

Useful work and The Gibbs and Helmholtz function. Changes at constant T, P. Application to electric work. Criteria for spontaneity and equilibrium. Gibbs- Helmholtz equation, The Gibbs Function and useful work in Biological systems. Gibbs free energy and spontaneous phase transition.

Maxwell's relations; Joule-Thomson experiment and its consequences; inversion temperature; Joule-Thomson coefficient for a van der Waals gas; General heat capacity relations

Systems of Variable Compositions

State functions for system of variable compositions. Criteria of equilibrium and spontaneity in systems of variable composition. Partial molar quantities, dependence of thermodynamic parameters on composition; Chemical potential as an escaping tendency. Gibbs-Duhem equation, Entropy and Gibbs function for mixing of ideal gases, the chemical potential of ideal mixtures. The Fugacity function of a pure real gas. Calculation of the fugacity of a van der Waals gas using compressibility factor. Activities and activity coefficients. Choice of standard states.

Module : II

Applications of Thermodynamics – I:

(8 Lectures)

Chemical Equilibrium

Thermodynamic conditions for equilibrium, degree of advancement; van't Hoff's reaction isotherm (deduction from chemical potential); Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Van't Hoff's reaction isobar and isochore from different standard states; Le Chatelier's principle and its derivation, variation of equilibrium constant under different conditions Nernst's distribution law; Solvent Extraction.

Module : III

ELECTROCHEMISTRY-I:

(i) Conductance

(9 Lectures)

Ion conductance; Conductance and measurement of 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; Debye-Huckel limiting law-brief qualitative description. Estimation of activity coefficient for electrolytes using Debye-Huckel limiting law. Ostwald's dilution law; Ionic mobility; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations. Transport number, Principles of Moving-boundary method .

(ii) Ionic Equilibrium

(8 Lectures)

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 Salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Determination of hydrolysis constant conductometrically. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action. Theory of acid-base indicators; selection of indicators and their limitations.

Recommended Text Books:

1. Levine, I. N. Physical Chemistry, 6th Edition McGraw-Hill India, 2011
2. Castellan, G. W. Physical Chemistry, Narosa , 2004
3. Atkins, P. W. & Paula, J. de, Atkins' Physical Chemistry, 11th Edition, Oxford University Press, 2018

Reference Books:

1. Denbigh, K. The Principles of Chemical Equilibrium, Cambridge University Press
2. Zemansky, M. W. & Dittman, R.H , Heat and Thermodynamics, Special Indian Edition , 8th Edition, Tata-McGraw-Hil ,2017
3. Klotz, Irving M , Rosenberg, Robert M, Chemical Thermodynamics ,Wiley India , 2013

Practical : (30 Lectures)

PAPER: CHEM-MD-CC5-4-P/CHEM-MD-CC5-6-P

Physical Chemistry Practicals:

1. Determination of rate constant of the reaction between H_2O_2 and acidified KI solution using Clock reaction.
2. Determination of the rate constant for the decomposition of H_2O_2 using FeCl_3 as catalyst.
3. Determination of the rate constant for the first order acid catalyzed hydrolysis of an ester.
4. To study the kinetics of the inversion of cane sugar using a polarimeter.

Reference Books:

1. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015

CHEMISTRY MDC

PAPER :CHEM-MD-CC6-5-Th/CHEM-MD-CC6-6-Th

(Credit : Theory -03, Practical – 01)

Chemistry MDC- VI

Theory: (45 Lectures)

Module : I

Stereochemistry – IV:

(08 Lectures)

Conformation-II

Concept of dihedral angle, torsion angle; energy barrier of rotation, concept of torsional and steric strains; relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding; butane gauche interaction; conformational analysis of ethane, propane, *n*-butane, and 2-methylbutane; 1,2-dihaloalkanes and ethylene glycol.

Module : II

Chemistry of carbonyl Compounds:

(32 Lectures)

Nucleophilic Addition to C=O

Structure and reactivity of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; formation of hydrates, cyanohydrins and bisulphite adduct; nucleophilic addition-elimination reactions with alcohols, thiols and nitrogen-based nucleophiles; reactions: benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig and Corey-Chaykovsky reaction; Rupe rearrangement, oxidations and reductions: Clemmensen, Wolff-Kishner, LiAlH_4 , NaBH_4 , MPVO redox equilibrium, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols.

Exploitation of acidity of α -H of C=O

Formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO_2 (Riley) oxidation; condensations (mechanism with evidence): Aldol, Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann; Mannich reaction, Perkin reaction; alkylation of active methylene compounds; synthetic applications of diethyl

malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines and silyl enol ethers) in connection with alkylation, acylation and aldol reaction.

Nucleophilic addition to α,β -unsaturated carbonyl system

General principle and mechanism (with evidence); direct and conjugate addition, addition of enolates (Michael reaction), Robinson annulations reaction.

Substitution at sp^2 carbon (C=O system)

Mechanism (with evidence): $\text{B}_{\text{AC}2}$, $\text{A}_{\text{AC}2}$, $\text{A}_{\text{AC}1}$, $\text{A}_{\text{AL}1}$ (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison).

Module : III

Organometallics

(5 Lectures)

Grignard reagents, Gilman cuprates: preparation and reactions (mechanism with evidence); addition of Grignard to carbonyl compounds; substitution on $-\text{COX}$; Conjugate addition by Gilman cuprates; Corey-House synthesis; abnormal behaviour of Grignard reagents; comparison of reactivity among Grignard, and organocopper reagents; Reformatsky reaction; concept of umpolung.

Recommended Text Books:

1. Finar, I. L. Organic Chemistry (Volume 1), 6th Edition, Pearson Education, 2002
2. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
3. Morrison, R. N. & Boyd, R. N. and Bhattacharjee, Organic Chemistry, 7th Edition, (Pearson Education), 2010
4. Nasipuri, D. Stereochemistry of Organic Compounds, 4th Edition, New Age International Pvt Ltd, 2020

Practical : (30 Lectures)

PAPER: CHEM-MD-CC6-5-P/CHEM-MD-CC6-6-P

Qualitative analysis of single solid organic compound:

1. Detection of special elements (N, S, Cl) by Lassaigne's test
2. Solubility and classification (solvents: H₂O, 5% HCl, 5% NaOH and 5% NaHCO₃)
3. Detection of the following functional groups by systematic chemical tests: aromatic amino (Ar-NH₂), aromatic nitro (-NO₂), amido (-CONH₂, including imide), phenolic -OH, carboxylic acid (-COOH), carbonyl (distinction between -CHO and >C=O); only one test for each functional group is to be reported. Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups in known and unknown (**at least six**) organic compounds.

Reference Books:

1. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015
2. Furniss, Hannaford, Smith, Tatcholl, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Pearson India, 2003

CHEMISTRY MDC

PAPER :CHEM-MD-CC7-5-Th/CHEM-MD-CC7-6-Th

(Credit : Theory -03, Practical – 01)

Chemistry MDC- VII

Theory: (45 Lectures)

Module : I

Transport processes and Liquid State:

(9 Lectures)

Viscosity

General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by falling sphere method and using Ostwald's viscometer. Temperature variation of viscosity of liquids and comparison with that of gases. Relation between viscosity coefficient of a gas and mean free path.

Surface tension and energy

Surface tension, surface energy, excess pressure, capillary rise and surface tension; Work of cohesion and adhesion, spreading of liquid over other surface; Temperature dependence of surface tension

Module : II

Solid State:

(12 Lectures)

Bravais Lattice and Laws of Crystallography

Types of solid, Bragg's law of diffraction; Laws of crystallography (Haüy's law and Steno's law); Permissible symmetry axes in crystals; Lattice, space lattice, unit cell, crystal planes, Bravais lattice. Packing of uniform hard sphere, close packed arrangements (fcc and hcp); Tetrahedral and octahedral voids. Void space in cubic systems.

Crystal planes

Distance between consecutive planes [cubic and orthorhombic lattices]; Indexing of planes, Miller indices; calculation of d_{hkl} ; Relation between molar mass and unit cell dimension for cubic system; Bragg's law . Determination of crystal structure: Structure of NaCl and KCl crystals.

Module : III

Application of Thermodynamics – II:

(16 Lectures)

Colligative properties

Vapour pressure of solution; Ideal solution, ideally dilute solution and colligative properties; Raoult's law. Thermodynamic derivations(using chemical potential) relating (i) Elevation of boiling point of an ideally dilute solution containing a non- volatile nonelectrolyte solute, (ii) Depression of freezing point of an ideally dilute solution containing a non -volatile nonelectrolyte solute (iii) Osmotic pressure of an ideally dilute solution containing a non-volatile nonelectrolyte solute with the molality / molar concentration of solute in solution . Applications in calculating molar masses of normal, dissociated and associated solutes in solution; Abnormal colligative properties.

Phase Equilibrium

Definitions of phase, component and degrees of freedom; Phase rule and its derivations; Definition of phase diagram; Phase diagram for water, CO₂, Sulphur. First order phase transition and Clapeyron equation; Clausius-Clapeyron equation - derivation and use;

Binary solutions: Liquid vapour equilibrium for two component systems. Ideal solution at fixed temperature and pressure;Lever Rule. Principle of fractional distillation; Duhem-Margules equation; Henry's law; Konowaloff's rule; Positive and negative deviations from ideal behaviour; Azeotropic solution; Liquid-liquid phase diagram using phenol- water system; Solid-liquid phase diagram; Eutectic mixture

ELECTROCHEMISTRY-II:

(8 Lectures)

Electromotive Force

Rules of oxidation/reduction of ions based on half-cell potentials,; Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using glass electrodes. Concentration cells with and without transference, liquid junction potential; Potentiometric Titration.

Recommended Text Books:

1. Levine, I. N. Physical Chemistry, 6th Edition McGraw-Hill India, 2011
- 2.Castellan, G. W. Physical Chemistry, Narosa , 2004
- 3.Atkins, P. W. & Paula, J. de, Atkins' Physical Chemistry, 11th Edition, Oxford University Press, 2018

Practical : (30 Lectures)

PAPER: CHEM-MD-CC7-5-P/CHEM-MD-CC7-6-P

Physical Chemistry Practicals:

1. Surface tension measurements using Stalagmometer:

- a)Determine the surface tension of a given solution by drop weight method using a stalagmometer.
- b) Study the variation of surface tension of acetic acid solutions with concentration and hence determine graphically the concentration of an unknown solution of acetic acid.

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 and hence determine graphically the concentration of an unknown solution .

3. Solubility Product:

- a) Determination of solubility and solubility product of a sparingly soluble salt in water, and in various electrolytic media by titrimetric method.

b) Determination of the activity solubility product of KHTa from the variation of concentrated solubility product with the ionic strength of the solution

Reference Books:

1. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015

CHEMISTRY MDC

PAPER :CHEM-MD-CC8-6-Th

(Credit : Theory -03, Practical – 01)

Chemistry MDC-VIII

Theory: (45 Lectures)

Module : I

Coordination chemistry:

(20 Lectures)

Basics of coordination chemistry

Werner's theory, ligands, IUPAC nomenclature, Isomerism (constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes)

Valence bond theory and crystal field theory:

VB description and its limitations. Elementary Crystal Field Theory: splitting of d^n configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy. Spectrochemical series. Jahn- Teller distortion. Octahedral site stabilization energy (OSSE). Metal-ligand bonding (MO concept, elementary idea), sigma- and pi-bonding in octahedral complexes(qualitative pictorial approach) and their effects on the oxidation states of transitional metals (examples).

Module : II

Electronic spectra of complexes and magnetic properties

(10 Lectures)

d-d transitions; L-S coupling; qualitative Orgel diagrams for $3d^1$ to $3d^9$ ions. Racah parameter. Selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra (elementary idea). Orbital and spin magnetic moments, spin only moments of d^n ions and their correlation with effective magnetic moments, including orbital contribution; quenching of magnetic moment.

Module : III

Redox reactions :

(15 Lectures)

Basic principle of redox reactions

Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions. Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential.

Redox titrations

Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples).

Recommended Text Books:

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, Okhil K. Medhi , Principles of Structure and Reactivity, 5th Edition ,Pearson India, 2022
2. H. J. Arnikaar, Essentials of Nuclear Chemistry , 5th Edition , New Age International Pvt, Ltd. , 2022
3. G. Friedlander, J.W. Kennedy, E. S. Macias , J.M. Miller , Nuclear and radiochemistry , 3rd Edition , John Wiley , 1981

Practical : (30 Lectures)

PAPER: CHEM-MD-CC8-6-P

Inorganic Chemistry Practicals:

Estimation of mixtures of metal ions

1. Estimation of Fe^{3+} and Cu^{2+} in a mixture.
2. Estimation of Fe^{3+} and Cr^{3+} in a mixture.
3. Estimation of Fe^{3+} and $\text{Cr}_2\text{O}_7^{2-}$ in a mixture.
4. Estimation of Fe^{3+} and Mn^{2+} in a mixture.
5. Estimation of Cr^{3+} and Mn^{2+} in a mixture.

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015

SKILL ENHANCEMENT COURSE

CHEMISTRY

PAPER :CHEM-MD-SEC-Th

(Credit : Theory -03, Tutorial – 01)

Theory: (45 Lectures)

CHEMISTRY IN DAILY LIFE

Module : I

(15 Lectures)

Dairy Products:

Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk.

Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages.

Food additives, adulterants, and contaminants:

Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate.

Artificial food colorants:

Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.

Module : II

(15 Lectures)

Vitamins:

Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1.

Oils and fats:

Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test.

Soaps & Detergents:

Definition, classification, manufacturing of soaps and detergents, composition and uses

Module : III**(15 Lectures)****Chemical and Renewable Energy Sources:**

Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy.

Polymers:

Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronics, automobile components, medical fields and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.

Recommended Text Books:

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. AshtoushKar. Medicinal Chemistry (TwoColour Edition), New Age International Pvt Ltd, 2022
3. Edward Cox Henry , The Chemical analysis of Foods , Hardcover , Hassell Street Press , 2021
4. Fred Billmeyer : Textbook of polymer science; Wiley 3rd addition.

Tutorial:(15 hours)**PAPER: CHEM-MD-SEC-Tu**

1. Estimation of Vitamin C
2. Determination of Iodine number of oil.
3. Determination of saponification number of oil.
4. Determination of methyl alcohol in alcoholic beverages.

Interdisciplinary Course in Chemistry

PAPER: CHEM-MD-IDC-Th

(Credit : Theory -02, Tutorial – 01)

Theory: (30 Lectures)

CHEMISTRY IN DAILY LIFE

Module : I

(10 Lectures)

Dairy Products:

Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages.

Food additives, adulterants, and contaminants:

Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate.

Artificial food colorants:

Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.

Module : II

10 Lectures)

Vitamins:

Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1.

Oils and fats:

Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test.

Soaps & Detergents:

Definition, classification, manufacturing of soaps and detergents, composition and uses

Module : III**(10 Lectures)****Chemical and Renewable Energy Sources:**

Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer.

Polymers:

Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronics, automobile components, medical fields and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.

Recommended Text Books:

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. AshtoushKar. Medicinal Chemistry (TwoColour Edition), New Age International Pvt Ltd, 2022
3. Edward Cox Henry , The Chemical analysis of Foods , Hardcover , Hassell Street Press , 2021
4. Fred Billmeyer : Textbook of polymer science; Wiley 3rd addition.

Tutorial:(15 hours)**PAPER: CHEM-MD-IDC-Tu**

1. Estimation of Vitamin C.
2. Determination of Iodine number of oil.
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4. Determination of methyl alcohol in alcoholic beverages.