VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM & SYLLABUS (DRAFT) OF

BACHELOR OF SCIENCE WITH CHEMISTRY

(MULTIDISCIPLINARY STUDIES)

3-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes

(CCFUP), 2023 & NEP, 2020

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VIDYASAGAR UNIVERSITY

BACHELOR OF SCIENCE IN LIFE SCIENCES/ PHYSICSL SCIENCES with CHEMISTRY

(*under CCFUP, 2023*)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. in Life Sc. / Physical Sc. with Chemistry	1st	I			**SEMESTER-I**					
			Major (Disc.-A1)	**CEMPMJ101**	**T: Atomic Structure, Redox Reactions and precipitation reactions, general organic chemistry & aliphatic hydrocarbons; P: Practical** ***(To be studied by the students taken Chemistry as Discipline-A)***	**4**	**3-0-1**	**15**	**60**	**75**
			SEC	**SEC01**	***To be chosen from SEC-01 of Discipline A/B/C of their Hons. prog.***	**3**	**0-0-3**	**10**	**40**	**50**
			AEC	**AEC01**	Communicative English-1 (***common for all programmes***)	**2**	**2-0-0**	**10**	**40**	**50**
			MDC	**MDC01**	Multidisciplinary Course-1 (***to be chosen from the list***)	**3**	**3-0-0**	**10**	**40**	**50**
			VAC	**VAC01**	VAC-01: ENVS (***common for all programmes***)	**4**	**2-0-2**	**50**	**50**	**100**
			Minor (Disc.-C1)	**CEM MI01/C1**	**T:Atomic Structure, Acids and Bases, Redox Reactions & States of Matter; P: Practical** ***(To be studied by the students taken Chemistry as Discipline-C)***	**4**	**3-0-1**	**15**	**60**	**75**
			Semester-I Total			**20**				**400**
		II			**SEMESTER-II**					
			Major (Disc.-B1)		***To be decided*** ***(Same as like A1 for students taken Chemistry as Discipline-B)***	**4**	**3-0-1**	**15**	**60**	**75**
			SEC	**SEC02**	***To be chosen from SEC-02 of Discipline A/B/C of their Hons. prog.***	**3**	**0-0-3**	**10**	**40**	**50**
			AEC	**AEC02**	MIL-1 (***common for all programmes***)	**2**	**2-0-0**	**10**	**40**	**50**
			MDC	**MDC02**	Multi Disciplinary Course-02 (***to be chosen from the list***)	**3**	**3-0-0**	**10**	**40**	**50**
			VAC	**VAC02**	VAC-02 (***to be chosen from the list***)	**4**	**4-0-0**	**10**	**40**	**50**
			Minor (Disc.-C2)	**CEM MI 02/C2**	**T:States of Matter & Chemical Kinetics; P: Practical** ***(To be studied by the students taken Chemistry as Discipline-C)***	**4**	**3-0-1**	**15**	**60**	**75**
			Summer Intern.	**CS**	Community Service	**4**	**0-0-4**	**-**	**-**	**50**
			Semester-II Total			**24**				**400**
			TOTAL of YEAR-1			**44**	**-**	**-**	**-**	**800**

P MJ= Major Programme (Multidisciplinary), MI = Minor, A/B = Choice of Major Discipline; C= Choice of Minor Discipline; SEC = Skill Enhancement Course, AEC = Ability Enhancement Course, MDC = Multidisciplinary Course, VAC = Value Added Course; CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical, MIL = Modern Indian Language, ENVS = Environmental Studies

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MAJOR (MJ)

MJ A1/B1: Atomic Structure, Redox Reactions and precipitation reactions, general organic chemistry & aliphatic hydrocarbons **Credits 04 (FM: 75)**

MJ A1/B1T: Atomic Structure, Redox Reactions and precipitation reactions, general organic chemistry & aliphatic hydrocarbons **Credits 03 [45L]**

Course contents:

Section A: Inorganic Chemistry-1

Atomic Structure:

Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenicwavefunctions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1*s* and 2*s* atomic orbitals. Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Redox Reactions and precipitation 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. 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)

Solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

Section B: Organic Chemistry-1

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis* – *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

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Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *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 KMnO4, ozonolysis and oxidation with hot alk. $KMnO_4$.

Suggested Readings:

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 India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
8. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
9. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
11. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.

MJ A1/B1P: Atomic structure, Bonding, general organic chemistry & aliphatic hydrocarbons (Practical) Credits 01

Course Outline:

Section A: Inorganic Chemistry - Volumetric Analysis

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 titratingwith $K_2Cr_2O_7$ using redox indicator..
5. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
   (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Suggested Readings:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. 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.
4. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

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MINOR (MI)

MI-1/C1: Same as Minor-1 (CEMMI01) of Chemistry (Hons) programme — **Credits 04, Full Marks: 75**

MI-2/C2: Same as Minor-2 (CEMMI02) of Chemistry (Hons) programme — **Credits 04, Full Marks: 75**

SKILL ENHANCEMENT COURSE (SEC)

TO BE CHOSEN FROM THE BUCKET OF SECs OF SELECTED DISCIPLINE A/B/C
(As per A/B/C Hons. Prog. Syllabus)

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(*Under CCFUP, 2023*)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. in Life Sc. / Physical Sc. with Chemistry	2nd	III	**SEMESTER-III**							
			Major-A2	CEMPMJ02	**T: General Chemistry-I; P: Practical** *(To be studied by students taken* **Chemistry** *as Discipline- A)*	4	3-0-1	15	60	75
			Major-A3	CEMPMJ03	**T: General Chemistry-II; P: Practical** *(To be studied by students taken* **Chemistry** *as Discipline- A)*	4	3-0-1	15	60	75
			SEC	SEC03	*To be taken from SEC-03 of Discipline C.*	3	0-0-3	10	40	50
			AEC	AEC03	Communicative English-2 (***common for all programmes***)	2	2-0-0	10	40	50
			MDC	MDC03	Multidisciplinary Course-3 (***to be chosen from the list***)	3	3-0-0	10	40	50
			Minor-3 (Disc.-C3)	CEMMIN03	**T: Inorganic Chemistry –II & Organic Chemistry-II; P: Practical** *(To be studied by students taken Chemistry as Discipline- C)*	4	3-0-1	15	60	75
					Semester-III Total	20				375
		IV	**SEMESTER-IV**							
			Major-B2		*To be decided (Same as MajorA2 for Chemistry taken as Discipline-B)*	4	3-0-1	15	60	75
			Major-B3		*To be decided (Same as Major–A3 for* **Chemistry** *taken as Discipline-B)*	4	3-0-1	15	60	75
			Major (Elective) -1	CEMMJE-01	**To be chosen from the given options** *(To be studied by students taken Chemistry as Discipline- A)*	4	3-0-1	15	60	75
			AEC	AEC04	MIL-2 (***common for all programmes***)	2	2-0-0	10	40	50
			Minor -4 (Disc.-C4)	CEMMIN04	**T: Physical Chemistry –III & Inorganic Chemistry-III; P: Practical** *(To be studied by students taken Chemistry as Discipline- C)*	4	3-0-1	15	60	75
			Summer Intern.	IA	Internship / Apprenticeship- **activities to be decided by the Colleges following the guidelines to be given later**	4	0-0-4	-	-	50
					Semester-IV Total	22				400
					TOTAL of YEAR-2	42	-	-	-	775

MJP = Major Programme (Multidisciplinary), MI = Minor, A/B = Choice of Major Discipline; C= Choice of Minor Discipline; SEC = Skill Enhancement Course, AEC = Ability Enhancement Course, MDC = Multidisciplinary Course, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical, MIL = Modern Indian Language

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MAJOR (MJ)

MJ A2/B2: General Chemistry-I **Credits 04 (FM: 75)**

MJ A2/B2T: General Chemistry-I **Credits 03 [45L]**

FIRST LAW OF THERMODYNAMICS AND THERMOCHEMISTRY, CHEMICAL KINETICS, CHEMICAL PERIODICITY, CHEMICAL BONDING AND MOLECULAR STRUCTURE, AROMATIC HYDROCARBONS, ALKYL AND ARYL HALIDES

Course contents:

A. THERMODYNAMICS-PART-I: First Law of Thermodynamics and Thermochemistry

(7 LECTURES)

(I) First Law of Thermodynamics, Thermochemistry: Some basic concepts, Zeroth law of Thermodynamics and its applications, First law of thermodynamics and its applications. Work in various processes, Internal Energy, Enthalpy, Heat capacity, Adiabatic changes of states.
Basic laws of thermochemistry, Standard states; Kirchhoff's equation. Enthalpy of reactions for various processes; bond dissociation enthalpy and the average bond enthalpy, adiabatic flame temperature.

B. CHEMICAL KINETICS **(8 LECTURES)**

Introduction, Differential rate law, rate constant and its unit, order and molecularity: Integrated rate laws for simple reactions involving only one reactant, Integrated rate laws involving more than one reactants. Pseudo first order reactions. Determination of order of a reaction: method of differential rate law, method of half-life time. Complex reactions: Opposing reactions, Equilibrium Constant; Consecutive reactions, slowest step is the rate determining step. Parallel reactions Temperature dependence of rate constant; Arrhenius equation, energy of activation. Homogeneous catalysis: with reference to acid-base catalysis.

Chemical Periodicity: **(6 LECTURES)**

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. 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.

Chemical Bonding and Molecular Structure: **(12 LECTURES)**

Ionic Bonding: General characteristics of ionic bonding. lattice energy, solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation (no derivation need) for calculation of lattice energy, Born-Haber cycle and its applications. Fajan's rules and its applications.
Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics or *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): H_2, B_2, C_2, N_2, O_2, F_2. MO diagram of CO. Comparison of VB and MO approaches.

Functional Organic Chemistry **(12 LECTURES)**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

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Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons)

Preparation: from alkenes *and* alcohols.

Reactions: Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis.

Aryl Halides

Preparation: (Chloro, bromo and iodo-benzene case): Using Sandmeyer& Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne formation: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Suggested Readings:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley &Sons (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, NewDelhi (1988).
4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
7. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
8. P.C. Rakshit, Physical Chemistry
9. S Pahari, Physical Chemistry
10. H. Chatterjee, Physical Chemistry
11. A. Nag, Physical Chemistry
12. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt.Ltd., New Delhi (2009).
13. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
14. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
15. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
16. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
17. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in InorganicChemistry*, John Wiley & Sons.
18. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles ofStructure and Reactivity*, Pearson Education India, 2006.

MJ A2/B2P: General Chemistry-I (Practical) **Credits 01**

Section A: Physical Chemistry:

1. Study of kinetics of acid-catalyzed hydrolysis of ester
2. Study of kinetics of decomposition of H2O2
3. Study the kinetics of inversion of cane sugar using polarimeter.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol)
2. Criteria of Purity: Determination of melting and boiling points.
3. **Identification of a pure organic compound**

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Solid compounds: oxalic acid, tartaric acid, succinic acid, resorcinol, urea, glucose, benzoic acid and salicylic acid.

Section C: Inorganic Chemistry - Qualitative semi micro analysis of mixtures containing three radicals**.**

1. **Acid Radicals**: NH_4^+, Na^+, K^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, $Mn^{2+/4+}$, $Fe^{2+/3+}$, $Co^{2+/3+}$, Ni^{2+} and Cu^{2+}.
2. **Basic Radicals**: Cl^- , Br^-, I^-, SCN^- , S^{2-} , SO_4^{2-} , NO_3^- , NO_2^- , PO_4^{3-}, BO_3^{3-} and H_3BO_3.

Suggested Readings:

1. 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.
2. Ghosh S. , Das Sharma M , Majumder D and Manna S, "Chemistry in Laboratory", Santra Publication Pvt Ltd, 2019
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
4. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand &Co.: New Delhi (2011)

MJ A3/B3: General Chemistry-II **Credits 04 (FM: 75)**

MJ A3/B3T: General Chemistry-II **Credits 03 [45L]**

THERMODYNAMICS-II AND STATES OF MATTER, FUNCTIONAL ORGANIC CHEMISTRY & COORDINATION CHEMISTRY

Course contents:

A. THERMODYNAMICS-II: Second Law of Thermodynamics and Auxilliary State Functions: (8 LECTURES)

Limitations of 1st law of thermodynamics, Statement of 2nd law of thermodynamics. Carnot engine: Carnot cycle, Efficiency of Carnot, Carnot's theorem; statements only. Concept of entropy (S). Properties of entropy. Conditions of spontaneity and equilibrium in terms of entropy. Entropy change of systems, surroundings and the universe for various processes and transformations.

Gibbs free energy (G) and Helmholtz free energy (A). Their physical significance. Thermodynamic criteria for spontaneity and equilibrium in terms of change in G and A.

B. STATES OF MATTER-I: Gaseous State and Liquid State (14 LECTURES)

(I) Kinetic Theory of Gases: Postulates, Derivation of basic equation of Kinetic Theory of Gases, Concept of pressure and temperature. Derivation of empirical gas laws from the basic equation of Kinetic Theory of Gases.

(II) Maxwell's velocity distribution in 3D. Nature of the distribution, graphical representation, calculation of average, RMS, most probable speed and average kinetic energy. Maxwell's kinetic energy distribution in 3D. Nature of the distribution and graphical representation of average kinetic energy. Principle of Equipartition of energy and its limitations, Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Wall collision. Rate of effusion and Graham's law of effusion. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

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(III) Deviation of gases from ideal behaviour: Liquifaction of gases and Andrew's curve, critical constants. Law of continuity of states, Compressibility factor; Amagat's plots. Kammerling-Onnes or the virial equation of state.

(IV) van der Waals equation and its features; Application in explaining real gas behaviour, Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states; van der Waals equation expressed in virial form and significance of second virial coefficient; Boyle temperature.

Brief discussions of viscosity and surface tension of liquids:

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

C. Functional Organic Chemistry: **(12 LECTURES)**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: *Preparation:* Preparation of 1^{o}, 2^{o} and 3^{o} alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation
Diols*:* (Upto 6 Carbons) Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case)

Preparation: Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten-Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

D. Coordination Chemistry: **(11 LECTURES)**

Concept of double salt, complex salt, Werner's theory, Classification of ligands: chelating ligands and chelate complexes, Valence Bond Theory (VBT): Inner and outer orbital complexes of Fe, Co, Ni and Cu (coordination numbers 4 and 6). Stereoisomerism in complexes with coordination numbers 4 and 6. Limitation of VBT. IUPAC system of nomenclature (mononuclear complexes only).

Suggested Readings:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.

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6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
7. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
8. Castellan, G.W. Physical Chemistry
9. P.C. Rakshit, Physical Chemistry
10. S Pahari, Physical Chemistry
11. H. Chatterjee, Physical Chemistry
12. A. Nag, Physical Chemistry
13. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
14. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
15. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
16. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
17. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
18. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
19. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.
20. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.

MJ A3/B3P: General Chemistry-II (Practical) **Credits 01**

Course Outline:

Section A: Physical Chemistry

1. Determination of relative viscosity coefficient of an unknown solution using Ostwald viscometer
2. Determination of relative surface tension of an unknown solution using Stalagmometer.

Section B: Organic Chemistry

A. Identification of a pure organic compound

Liquid Compounds: methyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene.

B. Inorganic Chemistry: Complexometric titration:

1. Estimation of Zn(II)
2. Estimation of Ca(II)
3. Estimation of Mg(II)
4. Determination of hardness of water.

Suggested Readings:

1. 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.
2. Ghosh S. , Das Sharma M , Majumder D and Manna S, "Chemistry in Laboratory", Santra Publication Pvt Ltd, 2019
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
4. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

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Major Elective (MJE)-01: Quantum Mechanics-II, Photochemistry, Chemistry of s & p Block Elements, Polynuclear Hydrocarbons and Application of Spectroscopy to Simple Organic Molecules. **Credits 04 (FM: 75)**

Major Elective (MJE)-01T: **Credits 03 [45L]**

Course contents:

A. QUANTUM MECHANICS-II: Postulates of Quantum Mechanics: (12 LECTURES)

Postulate-1 of Quantum mechanics: Genesis of Schrodinger equation, Time independent Schrodinger equation and its nature, Wave function, Born's probabilistic interpretation of wave function, acceptability criteria of wave function, Normalized wave functions and normalization procedure, Orthogonal and orthonormal set of wave functions, Degeneracy of wave functions, Postulate-2 of Quantum Mechanics: Classical observable, concepts of operators, Linear operators, Systematic approach to construct quantum mechanical operator for a classical observable, Various examples. Postulate-3 of Quantum Mechanics: Eigen value equations, Commutation relations and their physical significance. Important theorems regarding commutations and simultaneous eigen functions. Postulate-4 of Quantum Mechanics: Average values of a classical observable in a quantum state, Representation of quantum mechanics, Hermitian operator; definition properties and examples, Theorems of Hermitian operators, Postulate-5 of Quantum Mechanics: Time dependent Schrodinger equation, Concept of stationary states, Ehrenfest equation of states.

B. PHOTOCHEMISTRY: (8 LECTURES)

Basic laws of photochemistry, Quantum yield, Lambert-Beer's law: Lambert-Beer's law and its limitations, Absorbance, transmittance and molar extinction coefficient, calibration curve. Photophysical Processes: Fluorescence, phosphorescence, internal conversion and intersystem crossing, Jablonskii diagram, photostationary state or photochemical equilibrium, photosensitized reaction.

C. Chemistry of *s* and *p* block elements: (Lecture 10)

Group trends in electronic configuration, common oxidation states, inert pair effect, diagonal relationship, Oxo/Peroxo acids of P, S and Cl. Study of the following compounds with emphasis on: preparation, structure & bonding, properties and uses: Li_2O, Na_2O_2 and KO_2, boric acid, borax, sodium perborate, boron nitrides, borazines, borohydrides (diborane), carbides (covalent and ionic type), diamond, graphite, silicones, phosphazenes, sulphur-nitrogen binary compounds, interhalogen compounds, polyhalide ions, pseudohalogens, Chlorofluorocarbons (CFCs). Separation of Noble gases, Clathrates; Structure and properties of XeF_2, XeF_4, XeF_6.

D. Polynuclear Hydrocarbons and Application of Spectroscopy to Simple Organic Molecules: (15 LECTURES)

Polynuclear Hydrocarbons: Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene.

Application of Spectroscopy to Simple Organic Molecules:

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic

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shifts. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α,β-unsaturated Compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Suggested Readings:

1. James E. Huheey, Ellen Keiter & Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
2. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
3. G.L. Miessler & Donald A. Tarr: Inorganic Chemistry, Pearson Publication.
4. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
5. F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley & Sons.
6. I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
7. John R. Dyer: Applications of Absorption Spectroscopy of Organic Compounds,
8. Prentice Hall.
9. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of
10. Organic Compounds, John Wiley & Sons.
11. R.T. Morrison & R.N. Boyd: Organic Chemistry, Prentice Hall.
12. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
13. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
14. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
15. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
16. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
17. Castellan, G.W. Physical Chemistry
18. P.C. Rakshit, Physical Chemistry
19. S Pahari, Physical Chemistry
20. H. Chatterjee, Physical Chemistry
21. A. Nag, Physical Chemistry
22. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
23. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).

Major Elective (MJE)-01P: Practical — Credits 01

Course Outline:

Section A: Inorganic Chemistry

1. Verification of Beers law and determination of molar extinction coefficient and concentration of a color absorbing species ($K_2Cr_2O_7$ and $KMnO_4$ solutions) using a colorimeter or spectrophotometer.
2. Determination of pK_{In} of Bromocresol green indicator and the determination of pH of an unknown buffer spectrophotometrically
3. Study of of $K_2S_2O_8$ – KI kinetics and determination of rate constant spectrophotometrically.

Section B: Inorganic Chemistry

1. Estimation of Ni(II) using dimethylglyoxime (DMG)
2. Paper chromatographic separation of (a) Ni(II) and Co(II) (b) Fe(III) and Al(III) (b) Identify and separate the sugars present in the given mixture by paper chromatography.

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Suggested Readings:

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. 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.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
6. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
7. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
8. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

OR

Major Elective (MJE)-01 Green Chemistry. **Credits 04 (FM: 75)**

Major Elective (MJE)-01T: Green Chemistry **Credits 03 [45L]**

Course Contents:

Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

a. Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
b. Prevention/ minimization of hazardous/ toxic products reducing toxicity. Risk = (function) hazard × exposure; waste or pollution prevention hierarchy.
c. Green solvents – supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents.
d. Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
e. Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.
f. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
g. Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

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h. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Green Synthesis/ Reactions and some real world cases:

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to iodine)
4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
5 Designing of Environmentally safe marine antifoulant.
6 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
7 n efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
8 Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils
9 Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Suggested Readings:

1. Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
2. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
4. Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
5. Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
6. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.

Major Elective (MJE)-01T: Green Chemistry Lab Credits 01

1. Using renewable resources

- Preparation of biodiesel from vegetable/ waste cooking oil.

2. Avoiding waste

- Principle of atom economy.
- Use of molecular model kit to stimulate the reaction to investigate how the atom economycan illustrate Green Chemistry.
- Preparation of propene by two methods can be studied
  (I) Triethylamine ion + OH^- → propene + trimethylpropene + water
  (II) 1-propanol $\xrightarrow{H_2SO_4/\Delta}$ propane + water
- Other types of reactions, like addition, elimination, substitution and rearrangement shouldalso be studied for the calculation of atom economy.

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3. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

Suggested Readings:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
7. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition,2010.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach*, W.B.Saunders,1995.

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MINOR (MI)

MI-3/C3: Same as Minor-3 (CEMMIN03) of Chemistry (Hons) programme — **Credits 04**, **Full Marks: 75**

MI-4/C4: Same as Minor-4 (CEMMIN04) of Chemistry (Hons) programme — **Credits 04**, **Full Marks: 75**

SKILL ENHANCEMENT COURSE (SEC)

(To be studied by students taken Chemistry as Discipline- C)

SEC-03 P: Same as SEC-03 (CEMSEC03) of Chemistry (Hons) programme — **Credits 03**, **Full Marks: 50**

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VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM & SYLLABUS (DRAFT) OF

BACHELOR OF SCIENCE WITH CHEMISTRY

(MULTIDISCIPLINARY STUDIES)

3-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes

(CCFUP), 2023 & NEP, 2020

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VIDYASAGAR UNIVERSITY

BACHELOR OF SCIENCE IN LIFE SCIENCES/ PHYSICSL SCIENCES with CHEMISTRY

(*Under CCFUP, 2023*)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. in Life Sc. / Physical Sc. with Chemistry	3rd	V	**SEMESTER-V**							
			Major-A4	CEMPMJ04	T: General Chemistry-III; P: Practical *(To be studied by students taken* Chemistry *as Discipline- A)*	4	3-0-1	15	60	75
			Major-A5	CEMPMJ05	T: General Chemistry-IV; P: Practical *(To be studied by students taken* Chemistry *as Discipline- A)*	4	3-0-1	15	60	75
			Major-A6	CEMPMJ06	T: General Chemistry-V; P: Practical *(To be studied by students taken* Chemistry. *as Discipline- A)*	4	3-0-1	15	60	75
			Major (Elective) -2	CEMMJE02	Quantum Mechanics-III and Statistical Thermodynamics, Heterocyclic Compounds, Organometallics; OR Pharmaceutical Chemistry *(To be studied by students taken* Chemistry *as Discipline- A)*	4	3-0-1	15	60	75
			Minor-5 (Disc.-C5)	CEMMIN05	T Organic Chemistry – III & Physical Chemistry - IV;: Practical *(To be studied by students taken* Chemistry *as Discipline- C)*	4	3-0-1	15	60	75
			Semester-V Total			20				375
		VI	**SEMESTER-VI**							
			Major-B4		*To be decided(Same as Major- A4 for* Chemistry *taken as Discipline-B)*	4	3-0-1	15	60	75
			Major-B4		*To be decided(Same as Major–A5 for* Chemistry *taken as Discipline-B)*	4	3-0-1	15	60	75
			Major-B4		*To be decided(Same as Major–A6 for* Chemistry *taken as Discipline-B)*	4	3-0-1	15	60	75
			Major (Elective) -3	CEMMJE03	Molecular Spectroscopy, Surface Chemistry, Organic Rearrangement Reactions, Mo Theory and Bio-Inorganic Chemistry OR Analytical Clinical Biochemistry *(To be studied by students taken* Chemistry *as Discipline- A)*	4	3-0-1	15	60	75
			Minor -6 (Disc.-C6)	CEMMIN06	T: Inorganic Chemistry-IV & Organic Chemistry-IV; P: Practical *(To be studied by students taken* Chemistry *as Discipline- C)*	4	3-0-1	15	60	75
			Semester-VI Total			20				375
			TOTAL of YEAR-3			40	-	-	-	700
			Eligible to be awarded Bachelor of Science in Multidisciplinary Studies with Chemistry *on Exit*			126	**Marks (Year: I+II+III)**			2325

MJP = Major Programme (Multidisciplinary), MI = Minor, A/B = Choice of Major Discipline; C= Choice of Minor Discipline; CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

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MAJOR (MJ)

Major A/B 4: General Chemistry-III

(Credits 04; Full Marks: 75)

MJ A4/B4T: General Chemistry-III (Theory) Credits 03 [45L]

THERMODYNAMICS-III AND ELECTROCHEMISTRY-I, FUNCTIONAL ORGANIC CHEMISTRY & CHEMISTRY OF d-BLOCK ELEMENTS.

A. THERMODYNAMICS-III: (Chemical and Ionic Equilibrium) (12 LECTURES)

Concept of Chemical Potential, van't Hoff's reaction isotherm, True Equilibrium constant K_p and K_c. pseudo equilibrium constant K_x and their interrelations. van't Hoff's equations, Le Chatelier's principle and its its applications.

Concept of mean ionic activity and mean ionic activity coefficient. Ionic strength, Debye-Huckel limiting law. Solubility, activity solubility product, concentration solubility product of sparingly soluble salt. Effect of addition of inert electrolyte on the solubility and concentration solubility product. Common ion effect and its applications. pH, calculation of pH in various solutions, ionic product of water, Dissociation constants of weak acids and weak bases, Buffer and buffer capacity, Henderson equation, salt hydrolysis and expressions of pH, acid-base neutralisation reactions, Acid-base neutralization curves, Indicator and its choice for neutralization reactions.

B. ELECTROCHEMISTRY-I: Conductance (8 LECTURES)

Conductance in a solution: Strong and weak electrolytes, Conductance, Specific Conductance, cell constant, Equivalent and molar conductance and their interrelations. Variation of specific and equivalent conductance with dilution for strong and weak electrolytes. Ionic mobility, Kohlrausch's law of independent migration of ions. Ionic conductance and transport number. Relation between ionic mobility and ionic conductance. Application of conductance measurement; Conductometric titrations; principles and various examples.

Functional Organic Chemistry: (18 LECTURES)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)
Preparation: from acid chlorides and from nitriles. *Reactions:* Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Carboxylic acids and their derivatives
Carboxylic acids (aliphatic and aromatic)
Preparation: Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell-Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Up to 5 carbons)
Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their inter-conversion.
Reactions: Reformatsky Reaction, Perkin condensation.

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Chemistry of d- block elements (3d, 4d & 5d): (7 Lectures)

General comparison of 3d, 4d and 5d elements in term of electronic configuration, oxidation states, redox properties, stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Study of the following compounds with emphasis on preparation, properties and uses: $KMnO_4$, $K_2Cr_2O_7$, Peroxo compounds of Cr, $K_4[Fe(CN)_6]$, sodium nitroprusside.

Recommended Reading:

1. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
2. P.C. Rakshit, Physical Chemistry
3. S Pahari, Physical Chemistry
4. H. Chatterjee, Physical Chemistry
5. A. Nag, Physical Chemistry
6. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
7. Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
8. Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
9. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
12. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
13. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
14. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
15. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
16. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
17. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.
18. James E. Huheey, Ellen Keiter & Richard Keiter: *Inorganic Chemistry: Principles ofStructure and Reactivity*, Pearson Publication.

MJ A4/B4P: General Chemistry-III (Practical) Credits 01 [30 Hrs.]

Physical Chemistry

- Conductometric titrations
  (a) Weak dibasic acid vs. Strong base
  (b) Mixed acid vs. strong base
- Determination of ionization constant and equivalent conductance at infinite dilution of an weak acid.
- Determination of solubility and concentration solubility product of a sparingly soluble salt (say KHTa) using acid-base titration.

Organic Chemistry:

- Systematic Qualitative Analysis of organic compounds possessing mono functional groups: (-COOH, phenolic -OH, aldehyde, ketone, amide, aromatic nitro, aromatic primary amine.

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Inorganic Chemistry:

1. Estimation of Fe(II) and Fe(III) in a given mixture.
2. Estimation of Fe(III) and Cu(III) in a mixture.

Recommended Reading:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbookof Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
2. Ghosh S. , Das Sharma M , Majumder D and Manna S, "Chemistry in Laboratory", Santra Publication Pvt Ltd, 2019
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
4. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
5. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press.

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Major A/B5: General Chemistry-IV

(Credits 04; Full Marks: 75)

MJ A5/B5T: General Chemistry-IV (Theory) Credits 03 [45L]

ELECTROCHEMISTRY-II & STATES OF MATTER-II, AMINES AND DIAZONIUM SALTS, CARBOHYDRATES, CHEMICAL KINETICS AND CRYSTAL FIELD THEORY.

Course contents:

A. ELECTROCHEMISTRY-II: (8 LECTURES)

Thermodynamics of reversible Galvanic cell. Electromotive Force (EMF) and the standard EMF their temperature dependence. Nernst equation. Oxidation and reduction potential and their relation. Spontaneity and equilibrium of a redox reaction in terms of reduction potential, Equilibrium constant and the standard reduction potential. Electrochemical series. Construction and representations of cell from the redox reaction. Redox reaction from the representation of the cell. Chemical cell with and without transference. Concentration cells with and without transference, Liquid junction potential and its elimination, Salt bridge. Role of electrolyte and the agar powder. Principle determination of pH using glass electrode. Potentiometric titrations

B. STATES OF MATTER-II: SOLID STATE (7 LECTURES)

General properties of solid state. Crystalline and amorphous solid. Fourteen Bravais Lattice. Some basic concepts of crystalline solid; lattice, basis, crystal structure, unit cell, face, edge, vertices, interfacial angle etc. crystal planes and their graphical representations, Different types of cubic crystals; SC, BCC and FCC. Calculation of packing efficiency, Weiss and Miller indices, Interplanar spacing between two identical parallel planes, X-ray diffraction: Bragg's law, Alternative form of Bragg's law, Determination of crystal structure from the systematic absence of certain planes in x-ray diffraction. Structure of NaCl and KCl crystals.

C. AMINES AND DIAZONIUM SALTS & CARBOHYDRATES: (15 LECTUERS)

Amines (Aliphatic and Aromatic): (Upto 5 carbons): Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Electrophilic substitution (case aniline): nitration, bromination, sulphonation. *Diazonium salts*: *Preparation:* from aromatic amines. *Reactions:* conversion to benzene, phenol, dyes.

Carbohydrates:

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

D. CRYSTAL FIELD THEORY: (15 LECTURES)

Crystal Field Theory: splitting of d^n configurations in octahedral and tetrahedral and square planar field, Crystal field stabilization energy (CFSE) in weak and strong fields system; pairing energy and calculation of Δ_o, Factors affecting the magnitude of Δ_o. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion in coordination compound: Jahn-Teller distortion (Z-in & Z-out

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with suitable examples). Limitations of CFT. Determination of spinel structure using CFSE. Magnetism and Colour: spin magnetic moments of coordination compounds, paramagnetic susceptibility & Curie–Weiss law (without derivation), concept of ferro & ferri-magnetism and anti-ferromagnetism (with suitable examples). d-d transitions: Selection rules for electronic spectral transitions (Laporte and spin selection rule); concept of charge transfer spectra related to coordination compounds.

Recommended Reading:

1. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
2. P.C. Rakshit, Physical Chemistry
3. S Pahari, Physical Chemistry
4. H. Chatterjee, Physical Chemistry
5. A. Nag, Physical Chemistry
6. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
7. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
8. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
9. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
10. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
11. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
12. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.
13. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson.

MJ A5/B5T: General Chemistry-IV (Practical) Credits 01 [30Hrs.]

Course Outline:

1. **Quantitative Estimations**
   A. Estimation of acetic acid in commercial vinegar
   B. Estimation of glucose by titration using Fehling's solution
   C. Estimation of vitamin-C (reduced)
   D. Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method
   E. Estimation of phenol by bromination (Bromate-Bromide) method

2. Measurement of 10Dq by spectrophotometric method.
3. Determination of the composition of the Fe^{3+} -salicylic acid complex solution by Job's method.

Recommended Reading:

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

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Major A/B6: General Chemistry-V

(Credits 04; Full Marks: 75)

MJ A6/B6 T: General Chemistry-V (Theory) Credits 03 [45L]

THERMODYNAMICS-IV and QUANTUM MECHANICS-I, AMINO ACIDS, PEPTIDES AND PROTEINS, CHEMISTRY OF LANTHANIDES.

Course contents:

A. THERMODYNAMICS-IV: Solutions & Phase Equilibrium (15 LECTURES)

(I) Solutions: Colligative properties: Vapour pressure, effect of addition of nonvolatile solute, Raoult's law, relative lowering of vapour pressure as a colligative property, Chemical potential of the components in of solution, Origin of colligative properties, Raoult's law; Thermodynamic derivation of various colligative properties such as (i) Elevation of boiling point, (ii) Depression of freezing point and (iii) Osmotic pressure and vant' Hoff equation, .Reverse osmosis, Solubility as a colligative property. Inter-relations among various colligative properties, abnormal colligative properties of electrolytic solution, van't Hoff factor, van'f Hoff factor and degree of dissociation of weak electrolyte. Determination of molecular weight using various colligative properties.

(II) Phase Equilibrium: Definitions of phase, component and degrees of freedom with various examples; Gibb's phase rule (without derivations). Triple point. Clapeyron equation; Clausius-Clapeyron equation. Phase diagram for water, CO_2 and Sulphur

B. QUANTUM MECHANICS-I: Historical Developments: (10 LECTUERES)

Particle aspect of light: Photoelectric effect: Compton effect. Wave aspects of particle: de Broglie's wave particle duality. Heisenberg Uncertainty Principle: Position-Momentum Uncertainty principle, Energy-time uncertainty principle.

C.Amino Acids, Peptides and Proteins: (15 LECTURES)

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point. *Reactions of Amino acids*: ester of – COOH group, acetylation of –NH2 group, complexation with Cu^{2+} ions, ninhydrin test. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and withcarboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl). Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

D. Chemistry of Lanthanides: (5 LECTURES)

Comparison on Electronic configuration, oxidation states, spectral and magnetic properties; lanthanide contraction, separation of lanthanides (ion-exchange method only).

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Recommended Reading:

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. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
7. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
10. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
11. Cotton, F. A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
12. Shriver, D. F.&Atkins,P.W.*InorganicChemistry*,OxfordUniversityPress.
13. Wulfsberg, G. *Inorganic Chemistry*,VivaBooksPvt. Ltd.
14. Rodgers,G.E.*Inorganic&SolidStateChemistry*,CengageLearningIndiaLtd.,2008.
15. Castellan, G.W. Physical Chemistry
16. P.C. Rakshit, Physical Chemistry
17. S Pahari, Physical Chemistry
18. H. Chatterjee, Physical Chemistry
19. A. Nag, Physical Chemistry
20. Sinha, S. P., Ed., Lanthanide and Actinide Research (Journal, Vol. 1, 1986).

MJ A6/B6 P: General Chemistry-V (Practical) Credits 01 [30Hrs]

Course Outline:

Physical Chemistry

1. Determination of concentrations of unknown solution of $K_2Cr_2O_7$ and the standard reduction potential of Fe^{3+}/Fe^{2+} couple by potentiometric titration.
2. Determination of concentrations of unknown solution of KCl and the solubility product of AgCl by potentiometric titration.
3. Determination of concentration of an unknown solution of a weak acid (monobasic or dibasic) and pK_a value(s) by pH-metric titrations using a glass electrode.

Inorganic Chemistry:

1. Determination of dissolved oxygen in water.
2. Determination of available oxygen in pyrolusite.
3. Estimation of Iron/Fe2O 3 in cement.
4. Estimation of Cu in Brass.

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Suggested Readings:

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons.
8. Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand.

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Major Elective

(To be studied by students taken Chemistry as Discipline- A)

Major Elective (MJE)-2:

(Credits 04; FM: 75)

MJE-2T: Quantum Mechanics-III and Statistical Thermodynamics, Heterocyclic Compounds, Organometallics **Credits 03 [45L]**

Course contents:

A. QUANTUM MECHANICS-III: Applications to exactly solvable problems (12 LECTURES)

Particle in a box problem (PIAB), Simple Harmonic Oscillator (SHO), Rigid Rotor (RR), H-atom problem

B. STATISTICAL THERMODYNAMICS (8 LECTURES)

Introduction to statistical thermodynamics, Some basic concepts; Thermodynamic system, Instantaneous configuration, Macrostates, microstates, Thermodynamic weight, Postulate of equal a priori probabilities, Most dominating configurations. Maxwell-Boltzmann (MB) statistics for classical identical particles which are distinguishable. Boltzmann definition of entropy. Thermodynamic Partition function, Thermodynamic quantities in terms of partition function. Evaluation of molecular partition function. Translational partition function and properties of ideal gases. Rotational, vibrational and electronic partition functions. 3rd law of Thermodynamics.

C. HETEROCYCLIC COMPOUNDS: (13 LECTURES)

5-and 6-membered rings with one heteroatom; Synthesis: pyrrole: Knorr synthesis, Paal-Knorr synthesis, Hantzsch; furan: Paal-Knorr synthesis, Feist Benary synthesis; thiophenes: Paal-Knorr synthesis, Hinsberg synthesis; pyridine: Hantzsch synthesis; Reactivity, orientation and important reactions of furan, pyrrole, thiophene and pyridine.

D. ORGANOMETALLICS: (12 LECTURES)

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. 18-electron and 16-electron rules, Applications of 18-electron rule to metal carbonyls, nitrosyls complexes. General methods of preparation and structure of mono and binuclear carbonyls of 3d series. π-acceptor behaviour of CO, synergic effect and use of IR data to explain extent of back bonding in metal carbonyl organometallic complexes. Zeise's salt: Preparation, structure, evidences of synergic effect. Metallocene: Ferrocene, cobaltocene and nickelocene, Preparation and reactions of ferrocene (acetylation, nitration, alkylation, metallation, Mannich Condensation).

Recommended Reading:

1. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson.
2. G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry*, Pearson Publication.
3. J.D. Lee: *A New Concise Inorganic Chemistry*, E.L.B.S.
4. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.
5. I.L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds*, Prentice Hall.

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7. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
8. R.T. Morrison & R.N. Boyd: *Organic Chemistry*, Prentice Hall.
9. Peter Sykes: *A Guide Book to Mechanism* in *Organic Chemistry*, Orient Longman.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.
11. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
12. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
13. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
14. Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
15. Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications* Cambridge University Press (2015).
16. Castellan, G.W. Physical Chemistry
17. P.C. Rakshit, Physical Chemistry
18. S Pahari, Physical Chemistry
19. H. Chatterjee, Physical Chemistry
20. A. Nag, Physical Chemistry

MJE-2P: Practical: **Credits 01 (30 Hrs.)**

Practical:

Inorganic Chemistry:

Preparation of the following compounds

(i) Tetraamminecarbonato cobalt (III) nitrate
(ii) Tetraammine copper (II) sulphate
(iii) Potassium trioxalatoferrate (III) trihydrate
(iv) Mohr's salt
(v) $[Mn(acac)_3]$ (acac= acetylacetonate)

Organic Chemistry:

Preparation of following organic compounds

(i) Pthalimide from Pthalic anhydride
(ii) Benzil from benzoin
(iii) Benzalacetophenone from Benzaldehyde
(iv) p-Bromoaniline from p-Bromoacetanilide

Recommended Reading:

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbookof Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

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MJE-2T: Pharmaceutical Chemistry (Theory) **Credits 03 [45L]**

Course contents:

Drugs & Pharmaceuticals:

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatoryagents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam) Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation:

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.

MJE-2P: Pharmaceutical Chemistry (Practical) **Credits 01 [30Hrs]**

Practical:

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

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Major Elective (MJE)-3:

(Credits 04; FM: 75)

MJE-3T: Molecular Spectroscopy, Surface Chemistry, Organic Rearrangement Reactions, Mo Theory And Bio-Inorganic Chemistry (Theory): Credits 03[45L]

Course contents:

A. MOLECULAR SPECTROSCOPY: (13 LECTURES)

Nature of light with special reference of electromagnetic radiation. Separation of these motions and the Born-Oppenheimer approximation.

Rotation spectroscopy or Microwave spectroscopy, Vibrational spectroscopy or IR spectroscopy: Raman spectroscopy: Mutual exclusion principle. Determination of structure of A_2B type molecules.

B. SURFACE CHEMISTRY: Adsorption and Colloids (10 LECTURES)

(I) Adsorption: definition, difference between adsorption and absorption, Different types of adsorption; Physical and chemical adsorption and their distinctive features, Extent of adsorption, Adsorption isotherms for adsorption of gases on solid surface: Freundlich and Langmuir adsorption isotherm (with derivation), Surface active agent, Micelle and Critical Micelle Concentration.

(II) Colloidal system: definition and general properties, Classifications of colloids. Lyophobic and lyophilic colloids and their distinctive features, Electrical properties of lyophobic colloids, Origin of charge, Flocculation and Schultz-Hardy rule, Optical properties of colloids, Tyndall effect, Protective action of lyophilic colloid and Gold number.

C. REARRANGEMENT ORGANIC REACTIONS, MO THEORY: (12 LECTURES)

Rearrangement to electron-deficient nitrogen: Hofmann, Curtius, Lossen, Schmidt and Beckmann.
Rearrangement to electron-deficient carbon: Wolff rearrangement in Arndt-Eistert synthesis, Benzil-Benzilic acid rearrangement
Rearrangement to electron-deficient oxygen: Baeyer-Villiger oxidation, and Dakin reaction.

MO THEORY: qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π *, n – MOs; basic idea about Frontier MOs (FMO); 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)
Hückel's rules for aromaticity; concept of antiaromaticity and homoaromaticity; non-aromatic molecules.

D. BIO-INORGANIC CHEMISTRY: (10 LECTURES)

Basic chemical reactions and the role of metal ions (specially Na^+, K^+, Mg^{2+}, Ca^{2+}, $Fe^{2+/3+}$, Ca^{+2}, $Cu^{+/2+,}$ and Zn^{2+}) in the biological systems. Di-oxygen (O_2) management protein: Hemoglobin (Hb) (only structure and bio-functions), Electron transfer proteins: Fe-S proteins (Ferredoxins, Rubredoxins etc). Hydrolytic enzymes: carbonate bicarbonate buffering system and carbonic anhydrase (with mechanism).

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Concept of passive transport & Active transport: Na/K pump; Toxicity of heavier metals (Hg, Cd, Pb, As) and their effects.

Recommended Reading:

- Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.*
- *S. S. Dara: A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. NewDelhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
- G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

MJE-3P: Industrial Chemicals & Environment (Practical): Credits 01 (30Hrs.)

Practical:

Physical Chemistry

a. Verification of Freundlich adsorption isotherm using adsorption of acetic acid from its aqueous solution by activated charcoal.
b. Determination of partition coefficient of iodine in between organic solvents (CCl_4 or $CHCl_3$) and water.
c. Determination of upper critical solution temperature (UCST) and the corresponding composition for Phenol-water system.

Inorganic Chemistry:

a. Determination of Chemical Oxygen Demand (COD)
b. Determination of Biological Oxygen Demand (BOD)
c. Determination of available chlorine in bleaching powder.
d. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).

Recommended Reading:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt. Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

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OR

MJE-3T: Analytical Clinical Biochemistry (Theory): Credits 03[45L]

Course contents:

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Carbohydrates*:* Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.

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), 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.

Hormone*:* Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.

Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

Enzymes**:** Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis.

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: Collection and preservation of samples. Formation of urine. Composition an estimation of constituents of normal and pathological urine.

MJE-3P: Analytical Clinical Biochemistry (Practical): Credits 01 (30Hrs.)

Practical:

Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.

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6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Suggested Readings:

1. T.G. Cooper: Tool of Biochemistry.
2. Keith Wilson and John Walker: Practical Biochemistry.
3. Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
4. Thomas M. Devlin: Textbook of Biochemistry.
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's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
8. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

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MINOR (MI)

(To be studied by students taken Chemistry as Discipline- C)

MI-5/C5: Same as Minor-5 (CEMMIN05) of Chemistry (Hons.) programme **Credits 04**
Full Marks: 75

MI-6/C6: Same as Minor-6 (CEMMIN06) of Chemistry (Hons.) programme **Credits 04**
Full Marks: 75

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