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

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

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.

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.

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.

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

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).

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).

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.

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.

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.

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.

OR

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).

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).

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.

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.

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.

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