1.1.3

List of Employability/ Entrepreneurship/ Skill Development Courses with Course Contents

Colour Codes		
Name of the Subjects	Yellow	
Employability Contents	Green	
Entrepreneurship Contents	Light Blue	
Skill Development Contents	Pink	

List of Courses Focus on Employability/ Entrepreneurship/ Skill Development

Department : *Chemistry*

Programme Name : *B. Sc.*

Academic Year : 2024-25

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
1.	CYUDMJL1	Inorganic Chemistry-I (Lab)
2.	CYUDMJT2	Organic Chemistry-I
3.	CYUDMJL2	Organic Chemistry-I (Lab)
4.	CYUDMJL3	Physical Chemistry-I (Lab)
5.	CYUCMJL1	Basic Concepts of Chemistry-III (Lab)
6.	CYUCMJL2	Basic Concepts of Chemistry-IV (Lab)
7.	VOCCYT02	Cement Chemistry
8.	VOCCYL02	Cement Chemistry Practical
9.	VOCCYT01	Green Water Technology
10.	VOCCYL01	Green Water Technology (Lab)
11.	CYUAMJL1	Basic Concepts of Chemistry-I Lab
12.	CYUAMNL1	Fundamental Chemistry-I Lab
13.	CYUAMJL2	Basic Concepts of Chemistry-II Lab
14.	CYUAMNL2	Fundamental Chemistry-II Lab
15.	CYUELT1	Inorganic Chemistry Practical-III
16.	CYUETT2	Analytical Chemistry
17.	CYUELT2	Analytical Chemistry Practical
18.	CYUETC1	Value added Courses

19.	CYUFLT1	Green Chemistry Practical
20.	CYUFTT2	Materials Chemistry
21.	CYUFLT2	Materials Chemistry Practical
22.	CYUFLD1	DSE Courses
23.	CYUFTC1	Value added Courses
24.	CYUFSS1	Seminar
25.	CYUFL	Followed by report submission, presentation and Viva-Voce.

अध्यक्ष/Head
रसायन शास्त्र विभाग
Deptt. of Chemistry
गुरु घासीदास विश्वविद्यालय,
Guru Ghasidas Vishwavidyalaya,
बिलासपुर 495009 (छ.ग.)
Bilaspur 495009 (C.G.)

Scheme and Syllabus

Course Structure Under NEP-2020

4-Years B.Sc.-Chemistry

(to be implemented from 2023-2024)

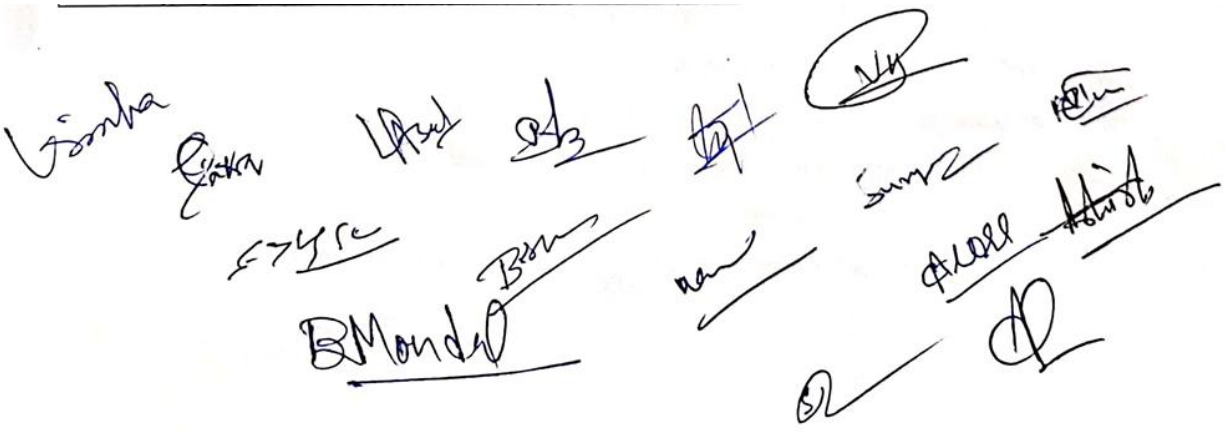
SEMESTER-III

Sem.	Courses	Course Code	Name of the Courses	Level	Credits	Credits (L+T+P)	Int. Marks	Ext. Marks	Total	Nature of Course*
III	Major-I	CYUCMJT1	Basic Concepts of Chemistry-III	3	3	(3+0+0)	30	70	100	Compulsory
		CYUCMJL1	Basic Concepts of Chemistry-III (Lab)		1	(0+0+1)	30	70	100	Compulsory
	Major-II	CYUCMJT2	Basic Concepts of Chemistry-IV	3	3	(3+0+0)	30	70	100	Compulsory
		CYUCMJL2	Basic Concepts of Chemistry-IV (Lab)		1	(0+0+1)	30	70	100	Compulsory
	Minor Or VOC		Opted from the pool of courses offered by Vishwavidyalaya	3	4					Elective
	MDC		Opted from the pool of courses offered by Vishwavidyalaya	1	3					Elective
	AEC		Opted from the pool of courses offered by Vishwavidyalaya	1	2	(2+0+0)	30	70	100	Elective
	SEC		Opted from the pool of courses offered by Vishwavidyalaya	1	3					Elective
Total Credits					**20**					

***The course (compulsory/elective) may be substituted with another online course in the same category.**

MDC: Multidisciplinary Course
AEC: Ability Enhancement Course
SEC: Skills Enhancement Course
VOC: Vocational Course

L: Lectures
T: Tutorials
P: Practicals



Course Structure Under NEP-2020

4-Years B.Sc.-Chemistry

(to be implemented from 2023-2024)

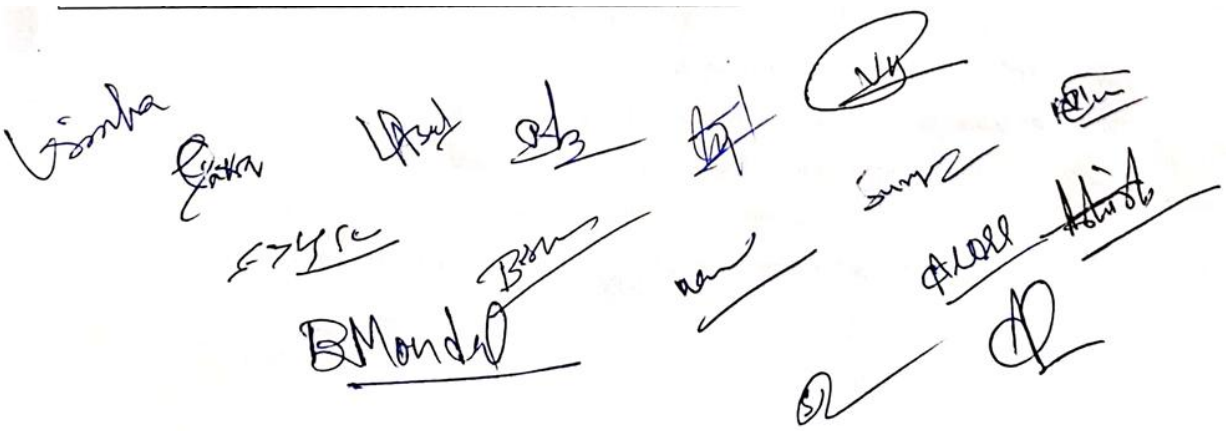
SEMESTER-IV

Sem.	Courses	Course Code	Name of the Courses	Level	Credits	Credits (L+T+P)	Int. Marks	Ext. Marks	Total	Nature of Course*
IV	Major-I	CYUDMJT1	Inorganic Chemistry-I	3	4	(4+0+0)	30	70	100	Compulsory
		CYUDMJL1	Inorganic Chemistry-I (Lab)		1	(0+0+1)	30	70	100	Compulsory
	Major-II	CYUDMJT2	Organic Chemistry-I	3	4	(4+0+0)	30	70	100	Compulsory
		CYUDMJL2	Organic Chemistry-I (Lab)		1	(0+0+1)	30	70	100	Compulsory
	Major-III	CYUDMJT3	Physical Chemistry-I	3	3	(3+0+0)	30	70	100	Compulsory
		CYUDMJL3	Physical Chemistry-I (Lab)		1	(0+0+1)	30	70	100	Compulsory
	Minor Or VOC		Opted from the pool of courses offered by Vishwavidyalaya	3	4					Elective
	AEC		Opted from the pool of courses offered by Vishwavidyalaya	1	2	(2+0+0)	30	70	100	Elective
				Total Credits	**20**					

***The course (compulsory/elective) may be substituted with another online course in the same category.**

AEC: Ability Enhancement Course
VOC: Vocational Course

L: Lectures
T: Tutorials
P: Practicals



DEPARTMENT OF CHEMISTRY
B. Sc. (Chemistry) Course structure under NEP-2020
Academic year 2023 – 2024

Sem.	Courses	Course Code	Number of courses	Level	Credits	Credits (L+T+P)	Int. Marks	Ext. Marks	Total
I	Major-I	CYUAMJ T1	Basic Concepts of Chemistry-I (Theory)	2	3	(3+0+0)	30	70	100
		CYUAMJ L1	Basic Concepts of Chemistry-I (Lab)		1	(0+0+1)	30	70	100
	Minor-I		Opted from the Pool Course offered by University	2	4		30	70	100
	Multidisciplinary		Opted from the Pool Course offered by the University	1	3		30	70	100
	AEC		Opted from the Pool Course offered by University	1	2		30	70	100
	SEC		Opted from the Pool Course offered by University	1	3		30	70	100
	VAC-1		Opted from the Pool Course offered by University	1	2		30	70	100
	VAC-2		Opted from the Pool Course offered by University	1	2		30	70	100
			Total		**20**				**800**

Courses Offered by the Department of Chemistry/School of Physical Science

Sem.	Courses	Course Code	Number of courses	Level	Credits	Credits (L+T+P)	Int. Marks	Ext. Marks	Total
I	Minor-I Offered by the Department	CYUAMN T1	Fundamental Chemistry-I (Theory)	2	4	(3)	30	70	100
		CYUAMN L1	Fundamental Chemistry-I(Lab)			(1)			
	Multidisciplinary Offered by the School of Physical Sciences and Natural Sciences		Conceptual Understanding of Physical Science – I	1	3	(2+1+0)	30	70	100
	SEC Offered by the Department	CYUASE T1	Science Communication and Popularization	1	3	(2+1+0)	30	70	100

Sem.	Courses	Course Code	Number of courses	Level	Credits	Credits (L+T+P)	Int. Marks	Ext. Marks	Total
II	Major-I		Basic Concepts in Chemistry-II (Theory)	2	3	(3+0+0)	30	70	100
			Basic Concepts in Chemistry-II (Lab)		1	(0+0+1)	30	70	100
	Minor-I		Opted from the Pool Course offered by University	2	4		30	70	100
	Multidisciplinary		Opted from the Pool Course offered by the University	1	3		30	70	100
	AEC		Opted from the Pool Course offered by University	1	2		30	70	100
	SEC		Opted from the Pool Course offered by University	1	3		30	70	100
	VAC-1		Opted from the Pool Course offered by University	1	2		30	70	100
	VAC-2		Opted from the Pool Course offered by University	1	2		30	70	100
			Total		**20**				**800**

Semester wise Theory Papers and Practical

B.Sc. Hon's (Chemistry): LOCF 2021-2022

Department of Chemistry, School of Physical Sciences

Course Opted	Course Code	Name of the course	Credit	Hour/ week	Internal Assess	End Sem Exam
		Semester I				
CC-I Theory	CYUATT1	Inorganic Chemistry-I	3	3	30	70
CC-I Practical	CYUALT1	Inorganic Chemistry Practical-I	2	4	30	70
CC-II Theory	CYUATT2	Organic Chemistry-I	3	3	30	70
CC-II Practical	CYUALT2	Organic Chemistry Practical-I	2	4	30	70
AEC-I Theory	CYUATA1	Select one from the Pool of AEC Courses offered	2	2	30	70
SEC-I Theory	CYUATL1	Select one from the Pool of SEC Courses offered	2	2	30	70
GEC-I Theory	CYUATG1	1A Physics-I, 1B Mathematics-I, 1C Zoology-I 1D Botany-1, 1EAnthropology-1, 1F Biotechnology-1, 1G Forensic Science-1	3	3	30	70
GEC-I Practical	CYUALG1	Generic Elective- Practical-I	2	4	30	70
Additional Credit Course I	CYUATC1	Select one from the Pool of Value added Courses offered				
		TOTAL	**19**	**25**	**240**	**560**
		Semester II				
CC-III Theory	CYUBTT1	Physical Chemistry-I	3	3	30	70
CC-III Practical	CYUBLT1	Physical Chemistry Practical-I	2	4	30	70
CC-IV Theory	CYUBTT2	Organic Chemistry-II	3	3	30	70
CC-IV Practical	CYUBLT2	Organic Chemistry Practical-II	2	4	30	70
AEC-II Theory	CYUBTA1	Select one from the Pool of AEC Courses offered	2	2	30	70
SEC-II Theory	CYUBTL1	Select one from the Pool of SEC Courses offered	2	2	30	70
GEC-II Theory	CYUBTG1	2A Physics-I, 2B Mathematics-I, 2C Zoology-I 2D Botany-1, 2EAnthropology-1, 2F Biotechnology-1, 2G Forensic Science-1	3	3	30	70
GEC-II Practical	CYUBLG1	Generic Elective- Practical-II	2	4	30	70
Additional Credit Course II	CYUBTC1	Select one from the Pool of Value added Courses offered				
		Total	**19**	**25**	**240**	**560**
		Semester III				
CC-V Theory	CYUCTT1	Physical Chemistry-II	3	3	30	70
CC-V Practical	CYUCLT1	Physical Chemistry Practical-II	2	4	30	70
CC-VI Theory	CYUCTT2	Organic Chemistry-III	3	3	30	70
CC-VI Practical	CYUCLT2	Organic Chemistry Practical-III	2	4	30	70
CC-VII Theory	CYUCTT3	Molecular Spectroscopy & Photochemistry	3	3	30	70
CC-VII Practical	CYUCLT3	Spectroscopy Practical	2	4	30	70
AEC-III Theory	CYUCTA1	Select one from the Pool of AEC Courses offered	2	2	30	70
GEC-III Theory	CYUCTG1	3A Physics-I, 3B Mathematics-I, 3C Zoology-I 3D Botany-1, 3EAnthropology-1, 3F Biotechnology-1, 3G Forensic Science-1	3	3	30	70
GEC-III Practical	CYUCLG1	Generic Elective- Practical-III	2	4	30	70
Additional Credit Course III	CYUCTC1	Select one from the Pool of Value added Courses offered				
		Total	**22**	**30**	**270**	**630**
		Semester IV				
CC-VIII Theory	CYUDTT1	Physical Chemistry-III	3	3	30	70
CC-VIII Practical	CYUDLT1	Physical Chemistry practical-III	2	4	30	70
CC-IX Theory	CYUDTT2	Inorganic Chemistry-II	3	3	30	70
CC-IX Practical	CYUDLT2	Inorganic Chemistry practical-II	2	4	30	70
CC-X Theory	CYUDTT3	Introduction to Quantum Chemistry	3	3	30	70
CC-X Practical	CYUDLT3	QuantumChemistry Practical	2	4	30	70

AEC-IV Theory	**CYUDTA1**	Select one from the Pool of AEC Courses offered	2	2	30	70
GEC-IV Theory	**CYUDTG1**	4A Physics-I, 4B Mathematics-I, 4C Zoology-I 4D Botany-1, 4EAnthropology-1, 4F Biotechnology-1, 4G Forensic Science-1	3	3	30	70
GEC-IV Practical	**CYUDLG1**	Generic Elective- Practical-IV	2	4	30	70
Additional Credit Course IV	**CYUDTC1**	Select one from the Pool of Value added Courses offered				
		Total	**22**	**30**	**270**	**630**
Summer Internship*	**CYUDLF1**		6*	90	30	70

		Semester V				
CC-XI Theory	**CYUETT1**	Inorganic Chemistry-III	3	3	30	70
CC-XI Practical	**CYUELT1**	Inorganic Chemistry Practical-III	2	4	30	70
CC-XII Theory	**CYUETT2**	Analytical Chemistry	3	3	30	70
CC-XII Practical	**CYUELT2**	Analytical Chemistry Practical	2	4	30	70
AEC-V Theory	**CYUETA1**	Select one from the Pool of AEC Courses offered	2	2	30	70
DSE-I Theory	**CYUETD1**	Select one from the Pool of DSE Courses offered	3	3	30	70
DSE-I Practical	**CYUELD1**	Select one from the Pool of DSE Courses offered	2	4	30	70
DSE-II Theory	**CYUETD2**	Select one from the Pool of DSE Courses offered	3	3	30	70
DSE-II Practical	**CYUELD2**	Select one from the Pool of DSE Courses offered	2	4	30	70
Additional Credit Course V	**CYUETC1**	Select one from the Pool of Value added Courses offered				
		TOTAL	**22**	**30**	**270**	**630**
		Semester VI				
CC-XIII Theory	**CYUFTT1**	Green Chemistry	3	3	30	70
CC-XIII Practical	**CYUFLT1**	Green Chemistry Practical	2	4	30	70
CC-XIV Theory	**CYUFTT2**	Materials Chemistry	3	3	30	70
CC-XIV Practical	**CYUFLT2**	Materials Chemistry Practical	2	4	30	70
DSE-III Theory	**CYUFTD1**	Select one from the Pool of DSE Courses offered	3	3	30	70
DSE-III Practical	**CYUFLD1**	Select one from the Pool of DSE Courses offered	2	4	30	70
Seminar	**CYUFSS1**	Followed by report submission and seminar	2	4	30	70
Dissertation/Project	**CYUFL**	Followed by report submission, presentation and Viva-Voce.	7	14	30	70
Additional Credit Course VI	**CYUFTC1**	Select one from the Pool of Value added Courses offered				
		MOOC's**				
			2-5	2-5		
		TOTAL	**24**	**34**	**240**	**560**
TOTAL CREDITS AND MARKS			**134**			

Unit – III: Chemistry of Metallic Carbonyls and Nitrosyls

Metallic Carbonyls: General methods of preparation, general properties, Structure and nature of M-CO bonding in carbonyls, Effective atomic number (EAN) rule as applied to metallic carbonyls, 18-electron rule as applied to metallic carbonyls. Metallic Nitrosyls: Some metallic nitrosyls, Effective atomic number (EAN) rule as applied to metallic nitrosyls. Metal carbonyl nitrosyls.

(10 Lectures)

Unit – IV: Inorganic Polymers

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

(8 Lectures)

Unit – V: Bioinorganic Chemistry

Inorganic composition of living organisms, Carbonic anhydrase and carboxypeptidase. Toxicity of metal ions (Hg, Pb, Cd, and As), toxicity, chelating agents in medicine. Iron and its application in biosystems, Haemoglobin; Storage and transfer of iron.

(6 Lectures)

Recommended Books/References:

- Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann, 1997.
- Selected Topics in Inorganic Chemistry by Wahid U. Malik, G. D. Tuli and R. D. Madan

CYUDMJL1: Inorganic Chemistry-I (Lab)

Credit 1 (30 Hours)

1. Qualitative Analysis:

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on understanding of the chemistry of different reactions. Following radicals may be analyzed: Carbonate, nitrate, nitrite, sulphide, sulphate, sulphite, acetate, fluoride, chloride, bromide, iodide, borate, oxalate, phosphate, ammonium, potassium, lead, copper, cadmium,

bismuth, tin, iron, aluminium, chromium, zinc, manganese, cobalt, nickel, barium strontium, calcium, magnesium. Mixtures containing one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and I^-. Spot analysis/tests should be done whenever possible.

2. Gravimetric Analysis:

(i) Estimation of nickel (ll) using Dimethylglyoxime (DMG).
(ii) Estimation of copper as CuSCN
(iii) Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.

3. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. (Also find the λ_{max} of the prepared complex using instrument).

4. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Recommended Books:

- *Vogel's Qualitative Inorganic Analysis*, Revised by G. Svehla. Pearson Education, **2002**.
- *Marr & Rockett Practical Inorganic Chemistry*, John Wiley & Sons **1972**.
- *Vogel's Quantitative Chemical Analysis*, 5th Edition, John Wiley & Sons, **1989**.

Course Outcomes and their mapping with Programme Outcomes

PO / CO	PO									PSO				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3		3	1	1		1	2	2	3	1	3
CO2	2	2	1		3	2	1		1	3	3	2	2	3
CO3	3	1	2		2	1	1		1	3	2	3	2	3
CO4	3	1	2		3	1	1		1	3	2	3	1	3
CO5	3	1	2		3	1	2		1	3	2	3	1	3
Weightage: 1-Sightly; 2-Moderately; 3-Strongly														

Semester	Nature of Course	Course Code	Name of the course	Credits
IV	Major (Level 3)	CYUDMJT2	Organic Chemistry-I	Theory 4 (60 Lectures)
		CYUDMJL2	Organic Chemistry-I (Lab)	Practical: 1 (30 Hours)

CYUDMJT2: Organic Chemistry-I

Level 3, Credit 4 (60 Lectures)

Course Outcomes:

Graduate will understand:

1. Carbonyl compounds and their reactivity.
2. Carboxylic acids and derivatives.
3. Organic name reactions.
4. Organic rearrangement reactions.
5. Organic synthesis via enolates.

Unit – I: Carbonyl Compounds

Nomenclature, General properties: Solubility; Preparation of carbonyl compounds: From Grignard reagents, alcohols, nitriles, via Ozonolysis reactions etc.; General reactions of carbonyl compounds: Comparison of reactivity of aldehyde and ketones towards nucleophilic addition reactions. Nucleophilic addition reactions: Hydrations, acetal-ketal formations, etc.; Oxidation and reduction reaction, Condensation reactions: Synthesis of imines, oximes, hydrazones, semicarbazones etc. Keto-enol tautomerism.

(12 Lectures)

Unit – II: Carboxylic Acids & Its Derivatives

Nomenclature, General properties: Solubility, melting points, boiling points, Comparison of acidity of carboxylic acids; General method for the preparation of carboxylic acids, amides, esters, anhydrides, acid halides, and acid azides; Relative reactivity of carboxylic acids and their chemical reactions.

(12 Lectures)

Unit – III: Organic Name Reactions

Rosenmud reduction, Aldol condensation reaction, Perkin reaction, Wittig Reaction, Cannizzaro reaction, Benzoin condensation, Haloform reaction.

(12 Lectures)

Unit – IV: Important Organic Rearrangement Reactions

Beckmann rearrangement, Lossen rearrangement, Curtius rearrangement, Smith rearrangement, Wolf rearrangement: Arndt-Eistert synthesis.

(12 Lectures)

Unit – V: Organic Synthesis *via* Enolates

Preparation of DEM and EAA. Synthesis of mono- and di-carboxylic acids, Synthesis of diketones, uracil, barbutric acid using DEM/EAA: Michael addition reaction.

(12 Lectures)

Recommended Books/References:

- '*Organic Chemistry"*, R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
- "*Organic Chemistry"*, S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.
- *"Organic Chemistry"*, I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in1996], ELBS and Longman Ltd., New Delhi.
- *"A Guide Book to Mechanism in Organic Chemistry"*, P. Sykes, 6th Edition (1997), Orient Longman Ltd., New Delhi.
- *"Organic Chemistry"*, J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).
- "*Organic Chemistry"*, G. Solomon, Willey India, Paper Back, 9th Edition.
- "*Modern Organic Chemistry"*, M. K. Jain and S. C. Sharma, Vishal Publishing CO. Jalandhar, India, 4th Edition (2012)

CYUDMJL2: Organic Chemistry-I (Lab)

Credit 1 (30 Hours)

1. Functional group detection of organic compounds containing nitro and its derivatives.
2. Functional group detection of organic compounds containing amine and its derivatives.
3. Functional group detection of organic compounds containing amide and its derivatives.
4. Functional group detection of aromatic hydrocarbons and its derivatives.

Recommended Books:

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)

Course Outcomes and their mapping with Programme Outcomes

PO / CO	PO									PSO				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	2		3	1	1		1	2	3	3	1	3
CO2	3	2	1		3	2	1		1	3	3	2	2	3
CO3	3	2	2		2	1	1		1	3	2	3	1	3
CO4	2	1	2		3	1	1		1	3	2	3	1	3
CO5	3	1	2		3	1	2		1	3	2	3	1	3
Weightage: 1-Sightly; 2-Moderately; 3-Strongly														

CYUDMJL3: Physical Chemistry-I (Lab)

Credit 1 (30 Hours)

1. Conductometry:

(a) Determination of cell constant.

(b) Determination of equivalent conductance, degree of dissociation, and dissociation constant of a weak acid.

(c) Perform the following conductometric titrations:

(i) Strong acid *versus* strong base

(ii) Weak acid *versus* strong base

(iii) Dibasic acid *versus* strong base

2. Potentiometry:

(a) Perform the following potentiometric titrations:

(i) Strong acid *versus* strong base

(ii) Weak acid *versus* strong base

(iii) Dibasic acid *versus* strong base

3. To construct the phase diagram for a three-component liquid system consisting of Chloroform, Acetic acid, and Water.

4. Determination of the partial molal volume of methanol solution in water

5. Determination of the transport number by moving boundary method.

Reference Books:

- J. Elias, *A Collection of Interesting General Chemistry Experiments*, Revised Ed., University Press, **2007**.
- C. W. Garland, J. W. Nibler and D. P. Shoemaker, *Experiments in Physical Chemistry*, 8th Ed., McGraw-Hill, **2003**.
- A. M. Halern and G. C. McBane, *Experimental Physical Chemistry: A Laboratory Textbook*, 3rd Ed., W. H. Freeman and Company, **2006**.
- S. K. Maity and N. K. Ghosh, *Physical Chemistry Practical*, NCBA, **2015**.
- F. Daniels, R. A. Alberty, J. W. Williams, C. D. Cornwell, P. Bender and J. E. Harriman, *Experimental Physical Chemistry*, 7th Ed., McGraw-Hill, **1970**.

Course Outcomes and their mapping with Programme Outcomes

PO / CO	PO									PSO				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	2		3	1	1		1	2	3	3	1	3
CO2	3	2	1		3	2	3		1	3	1	2	2	3
CO3	3	1	2		2	1	1		2	3	2	3	1	3
CO4	2	1	3		3	1	1		1	3	2	3	1	3
CO5	3	2	2		3	1	2		1	3	2	3	1	3
Weightage: 1-Sightly; 2-Moderately; 3-Strongly														

Unit – V: Aliphatic Alcohols and Ethers:

General properties of alcohols. Synthesis of alcohols from alkenes via hydroboration-oxidation, oxymercuration-demercuration. Reactions of alcohols: Dehydration, oxidation and distinction of primary, secondary and tertiary alcohols. Acetal and ketal formation, Pinacole-pinacolone rearrangement. Preparation and general reactions of ethers; C-O bond cleavage reactions, nucleophilic ring-opening of epoxides.

(10 Lectures)

Recommended Books/References:

- Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999.
- Lee, J.D. Concise Inorganic Chemistry, ELBS,1991.
- Atkins, P. W and Shriver D. N. Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).
- 'Organic Chemistry", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
- "Organic Chemistry", S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.
- "Organic Chemistry – Structure and Reactivity", Seyhan N. Ege, 3rd Edition (1998), ITBS Publishers and Distributors, Delhi.
- "Organic Chemistry", I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in1996], ELBS and Longman Ltd., New Delhi.
- "A Guide Book to Mechanism in Organic Chemistry", P. Sykes, 6th Edition (1997), Orient Longman Ltd., New Delhi.
- "Organic Chemistry", J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).
- "Organic Chemistry", G. Solomon, Willey India, Paper Back, 9th Edition.
- "Modern Organic Chemistry", M. K. Jain and S. C. Sharma, Vishal Publishing CO. Jalandhar, India, 4th Edition (2012).

CYUCMJL1: Basic Concepts in Chemistry-III (Lab)

Credit 1 (30 Hours)

Inorganic Chemistry

1. Preparation of tetraaminecopper(II) sulfate, [Cu(NH3)4H2O]SO4.
2. Preparation of *cis-* and *trans-* potassium dioxalatodiaquachromate(III) complex.
3. Preparation of potassium trioxalatoferrate(III) complex.

Organic Chemistry

1. Functional group detection of organic compounds containing carboxylic acid & sulphonic acid.
2. Functional group detection of organic compounds containing aliphatic alcohol & aromatic alcohol.
3. Functional group detection of organic compounds containing aldehyde & ketone.

Note: Experiments may be added/deleted subject to availability of time and facilities.

Recommended Books:

- Marr and Rockett, Practical Inorganic Chemistry, John Wiley & Son 1972.
- Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education,2002.
- Marr & Rockett Practical Inorganic Chemistry. John Wiley & Sons1972.

Course Outcomes and their mapping with Programme Outcomes

PO / CO	PO									PSO				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3		3	1	1		1	2	2	3	1	3
CO2	2	1	2		3	2	1		1	3	2	2	1	3
CO3	2	1	2		2	1	1		1	3	2	3	2	3
CO4	3	1	2		3	1	1		1	3	2	3	1	3
CO5	3	1	2		3	1	2		1	3	2	3	1	3
Weightage: 1-Sightly; 2-Moderately; 3-Strongly														

Recommended Books/References:

- P. Atkins, J. d. Paula and K. James, *Physical Chemistry*, 11th Ed., Oxford University Press, **2018**.
- T. Engel and P. Reid, *Physical Chemistry*, 3rd Ed., Pearson, **2014**.
- K. L. Kapoor, *A Text Book of Physical Chemistry: Thermodynamics and Chemical Equilibrium, Vol. 2*, 5th Ed., McGraw-Hill, **2015**.
- K. J. Laidler and J. H. Meiser, *Physical Chemistry*, 2nd Ed., CBS Publishers, **2006**.
- B. R. Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, 47th Ed., Vishal Publishing Co., **2018**.
- R. P. Rastogi and R. R. Mishra, *An Introduction to Chemical Thermodynamics*, 6th Ed., Vikash Publishing House, **2018**.
- S. Alberty, *Physical Chemistry*, 3rd Ed., John Wiley & Sons, Inc., **2003**.
- A. M. Halern and G. C. McBane, *Experimental Physical Chemistry: A Laboratory Textbook*, 3rd Ed., W. H. Freeman and Company, **2006**.
- P. Patnaik, *Dean's Analytical Chemistry Handbook*, 2nd Ed., Mc-Graw Hill, **2004**.
- C. W. Garland, J. W. Nibler, and D. P. Shoemaker, *Experiments in Physical Chemistry*, 8th Ed., McGraw-Hill, **2003**.
- G. H. Jeffery, J. Bassett, J. Mendham, and R. C. Denny, *Vogel's Text book of Quantitative Chemical Analysis*, 5th Ed., John Wiley & Sons, **1989**.
- R. de Levie, *How to use excel® in analytical chemistry and in general scientific data analysis*, Cambridge University Press, **2004**.

CYUCMJL2: Basic Concepts in Chemistry-IV (Lab)

Credit 1 (30 Hours)

1. Calibration of weights and glasswares.
2. Preparation of solutions for given concentrations.
3. Programming of computer applications.
4. Graph plotting with data provided.
5. pH metry

(a) pH metric titration of (i) strong acid *versus* strong base, (ii) weak acid *versus* strong base.

(b) Determination of dissociation constant of a weak acid.

6. Chemical Equilibrium:

- Equilibrium constant of methyl acetate hydrolysis reaction.
- Study the equilibrium of at least one of the following reactions by the distribution method:

(a) $I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$

(b) $Cu^{2+}(aq) + n NH_3(aq) \rightleftharpoons [Cu(NH_3)_n]^{2+}$

7. Chemical Kinetics:

- Study the kinetics of the following reactions.
  - **(a)** Order of reaction of I_2 – acetone – H^+ ion.
  - **(b)** Integrated rate method:
    - **i.** Acid hydrolysis of methyl acetate with hydrochloric acid
    - **ii.** Saponification of ethyl acetate.

Note: *Any other experiment will be carried out in the class if permit.*

Recommended Books:

- J. Elias, *A Collection of Interesting General Chemistry Experiments*, Revised Ed., University Press, **2007**.
- C. W. Garland, J. W. Nibler and D. P. Shoemaker, *Experiments in Physical Chemistry*, 8th Ed., McGraw-Hill, **2003**.
- A. M. Halern and G. C. McBane, *Experimental Physical Chemistry: A Laboratory Textbook*, 3rd Ed., W. H. Freeman and Company, **2006**.
- S. K. Maity and N. K. Ghosh, *Physical Chemistry Practical*, NCBA, **2015**.
- A. K. Nad, B. Mahapatra and A. Ghoshal, *An Advanced Course in Practical Chemistry*, 3rd Ed., New Central Book Agency, **2014**.
- J. B. Yadav, *Advanced Practical Physical Chemistry*, Krishna Prakashan Media, **2010**.
- B. Viswanathan and P. S. Raghavan, *Practical Physical Chemistry*, Viva Books, **2009**.
- G. H. Jeffery, J. Bassett, J. Mendham, and R. C. Denny, *Vogel's Text book of Quantitative Chemical Analysis*, 5th Ed., John Wiley & Sons, **1989**.
- R. Brent, *The Golden Book of Chemistry Experiments*, Golden Press, **1960**.
- https://www.originlab.com

Course Outcomes and their mapping with Programme Outcomes

PO / CO	PO									PSO				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3		3	1	1		1	2	2	3	1	3
CO2	2	1	3		3	2	1		1	3	1	2	2	3
CO3	3	1	2		2	1	1		1	3	2	3	2	3
CO4	3	1	2		3	1	1		1	3	2	3	1	3
CO5	3	1	2		3	1	2		1	3	2	3	1	3
Weightage: 1-Sightly; 2-Moderately; 3-Strongly														

Semester	Nature of Course	Course Code	Name of the course	Credits
II/III/IV	VOC (Level 3)	VOCCYT02	Cement Chemistry	Theory 1 (15 Lectures)
		VOCCYL02	Cement Chemistry (Lab)	Practical: 3 (90 Hours)

VOCCYT02: Cement Chemistry

Level 3, Credit 1 (15 Lectures)

Course Outcomes:

Course Outcome 1:

- Outcome 1.1: Introduction and definition of Cement material
- Outcome 1.2: Chemistry of raw materials used in cement manufacturing
- Outcome 1.3: Properties of calcareous and argillaceous materials.

Course Outcomes 2

- Outcome 2.1 Selection & chemical analysis of major and minor raw materials
- Outcome 2.2: Effect of adding gypsum, auxiliary components of cement raw materials
- Outcome 2.3: Cement components and their effects

Course Outcome 3:

- Outcome 3.1: Determination of acidic oxides such as SO_3, SiO_2,
- Outcome 3.2: Determination of basic oxides such as Al_2O_3, Fe_2O_3, CaO, MgO,
- Outcome 3.3: Determination of LOI (loss on ignition),
- Outcome 3.4: determination of total carbonate and magnesium carbonate (TC and MC).

Course Outcome 4:

- Outcome 4.1: Different methods of raw mix design, two, three, four component designs,
- Outcome 4.2: Criteria for raw mix design,
- Outcome 4.3: Chemical composition of raw materials of cement clinker,
- Outcome 4.4: Potential clinker composition.

Course Outcome 5:

- Outcome 5.1: Different methods of cement manufacturing, dry process, wet process, semi dry process
- Outcome 5.2: Setting and hardening of cement, reactions during setting and hardening
- Outcome 5.3: function of gypsum, and hydration reaction of gypsum
- Outcome 5.4: ISI specification of Portland cement

Unit – I:

Cement, chemistry of raw materials used in cement manufacturing, calcareous and argillaceous materials, limestone, high grade, low grade, feed take grade, chalk, marl, clay component, iron ore, bauxite, clay, gypsum, fly ash, slag, properties of calcareous and argillaceous materials.

(3 Lectures)

Unit – II:

Selection & chemical analysis of major and minor raw materials such as CaO, alumina, iron oxide, silica, alkalis, sulfur, magnesium oxide, effect of adding gypsum, auxiliary components of cement raw materials, chlorides, fluoride. P_2O_5, cement components and their effects.

(3 Lectures)

Unit – III

Determination of acidic oxides such as SO_3, SiO_2, determination of basic oxides such as Al_2O_3, Fe_2O_3, CaO, MgO, determination of LOI (loss on ignition), determination of total carbonate and magnesium carbonate (TC and MC).

(3 Lectures)

Unit – IV

Different methods of raw mix design, two, three, four component designs, criteria for raw mix design, chemical composition of raw materials of cement clinker, quality control at the lime stone quarry, potential clinker composition.

(3 Lectures)

Unit – V

Different methods of cement manufacturing, dry process, wet process, semi dry process, their advantages and disadvantages, block diagram of dry process and wet process, Setting and hardening of cement, reactions during setting and hardening, sequence of changes during setting and hardening of cement (block diagram), function of gypsum, and hydration reaction of gypsum. Setting and hardening of blended Portland cements. ISI specification of Portland cement.

(3 Lectures)

Recommended Books/References:

- Introduction to Colloid & Surface Chemistry, Duncan J. Shaw, 4th Edition, Butterworth, **1992**.
- Chemistry of Cement and Concrete, Peter C. Hewlett, 4th Edition, Elsevier Science & Technology Books, **2004**.
- Special Inorganic Cements, Ivan Odler, E&FN Spon (Taylor & Francis Group), 2000.
- Alkali activated materials: state-of-the-art report, RILEM TC 224-AAM (Vol. 13), J. L. Provis and J.S. Van Deventer, Eds., Springer Science & Business Media, **2013**.
- Lothenbach, B. and Winnefeld, F., **2006**. Thermodynamic modelling of the hydration of Portland cement. *Cement and Concrete Research*, 36 (2), pp.209-226.
- Gartner, E.M. and Macphee, D.E., **2011**. A physico-chemical basis for novel cementitious binders. Cement and Concrete Research, 41(7), pp.736-749.
- Gartner, E.M. and Jennings, H.M., **1987**. Thermodynamics of calcium silicate hydrates and their solutions. Journal of the American Ceramic Society, 70(10), pp.743-749.

VOCCYL02: Cement Chemistry (Lab)

Level 3, Credit 3 (90 Hours)

LIST OF EXPERIMENTS

S. No.	Title of Experiments
1.	Determination of acidic oxides(SO_3,SiO_2).
2.	Determination of Basic oxides (Al_2O_3,Fe_2O_3,CaO, MgO).
3.	Determination of loss on ignition.
7.	Determination of Compressive strength.
8.	Determination of fineness by sieving.
9.	Determination of Insoluble residue.
10.	Determination of soundness by Le Chtalier's expansion.
11.	Determination of drying shrinkage.
12.	Determination of calcium content in cement.
13.	Industrial visit
14.	Any other related experiments available in the laboratory/ industry in proximity.

Recommended Books:

- Vogel's Qualitative Inorganic Analysis, A. I. Vogel, Prentice Hall.
- Vogel's textbook of chemical quantitative analysis, Longman Scientific
- Cement Chemistry, H.F.W. Taylor, 2nd Edition, Thomas Telford, **1997**.
- Textbook of Engineering Chemistry by SS Dara and SS Umare, Publisher S Chand, **2024**.
- Engineering Chemistry by Jain and Jain Publisher: Dhanpat Rai Publishing Company, **2015**.

Course Outcomes and their mapping with Programme Outcomes

PO / CO	PO									PSO				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	2		3	1	1		1	3	2	3	1	3
CO2	2	2	1		2	1	2		2	3	2	2	1	3
CO3	2	1	2		3	1	1		1	3	2	2	2	3
CO4	3	1	2		3	3	2		1	1	2	3	1	2
CO5	3	1	3		3	1	1		1	3	2	3	1	3
Weightage: 1-Sightly; 2-Moderately; 3-Strongly														

Semester	Nature of Course	Course Code	Name of the course	Credits
II/III/IV/V/VI	VOC (Level 2)	VOCCYT01	Green Water Technology	Theory 1 (15 Lectures)
		VOCCYL01	Green Water Technology (Lab)	Practical: 3 (90 Hours)

VOCCYT01: Green Water Technology

Level 2, Credit 1 (15 Lectures)

Course Outcomes:

Course Outcome 1:
- Outcome 1.1: Introduction to various types of water samples.
- Outcome 1.2: Sampling of various types of water sample.
- Outcome 1.3: factors affecting the quality and stability of water sample.

Course Outcome 2:
- Outcome 2.1 Determination of physical and chemical properties of water samples.
- Outcome 2.2: Importance of potable water and its necessity for life.
- Outcome 2.3: Introduction to water pollutions and their impact on environment.

Course Outcome 3:
- Outcome 3.1: Different water pollutants and their effect on flora and fauna.
- Outcome 3.2: introduction of water treatment technologies.
- Outcome 3.3: Introduction of Sorbents of Phyto and animal origin.

Course Outcome 4:
- Outcome 4.1: Introduction of composite materials for polluted water treatment.
- Outcome 4.2: Introduction of natural polymer based composite material.
- Outcome 4.3: Various methods used for addressing water pollution problems.

Unit – I:

Distribution of water on earth, Types of water, Water quality as given by W.H.O., Indian Standard specification laid down for Potable water. Sampling and testing of various water bodies. Factors affecting quality and stability of particular water bodies. What is natural water.

(3 Lectures)

Unit – II:

Determination of Physical and chemical properties of water. What are D.O., B.O.D. and C.O.D. What are Soft and Hard water. What are their effects on flora and fauna. What is Potable water, why water is necessary for life. What is water pollution and how environment is affected by the polluted water.

(4 Lectures)

Unit – III

Study of different water pollutants and their effects on flora and fauna. Brief introduction of the following water treatment technology: Osmosis, Reverse Osmosis, Resins for Cationic and Anionic exchanges, Sorbents of Phyto & Animal origin.

(4 Lectures)

Unit – IV

Some knowledge on Composite materials. What are natural polymer based composite materials. Different methods of using such composite materials in addressing polluted water. How they are environment friendly.

(4 Lectures)

Recommended Books/References:

- Senior Practical Physical Chemistry, B. D. Khosla, R. Chand & Co. Chemistry Practical, O. P. Pandey, D.N. Bajpai, S. Giri, S. Chand.

VOCCYL01: Green Water Technology (Lab)

Level 2, Credit 3 (90 Hours)

LIST OF EXPERIMENTS

1. Determination of BOD of Water sample.
2. Determination of COD of Water sample.
3. Determination of pH of Water samples.
4. Determination of Temporary Hardness of Water.
5. Determination of Total Hardness of Water.
6. Determination of TDS of Water Sample.
7. Determination of Metal Ions in Water Samples.
8. Determination of Turbidity of Water samples.
9. Determination of Chloride Contents in Water Samples by Using Argentometric Titration Method.
10. Determination of N and P in Water Samples.

Recommended Books:

- Vogel's Qualitative Inorganic Analysis, A. I. Vogel, Prentice Hall.
- Vogel's textbook of chemical quantitative analysis, Longman Scientific
- Comprehensive Practical Organic Chemistry, V. K. Ahluwalia, & R. Aggarwal, Universities
- Press.
- Laboratory Manual of Organic Chemistry, R. K. Bansal, New Age Pub.
- Senior Practical Physical Chemistry, B. D. Khosla, R. Chand & Co. Chemistry Practical, O. P. Pandey, D.N. Bajpai, S. Giri, S. Chand.

5. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
6. BR Puri, LR Sharma, MS Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 2018

BSc-I Chemistry (Major Lab)

Basic Concepts in Chemistry I Laboratory

Inorganic Chemistry

(A) Acid-Base Titrations

(i) Titration of very weak acid-boric acid

(ii) Estimation of carbonate and hydroxide present together in mixture.y

(iii) Estimation of carbonate and bicarbonate present together in a mixture.

(B) Redox Titrations

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

Physical Chemistry

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

Recommended text books/references:

Longman.
- E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
- I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- ArunBahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand

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PRACTICAL – Fundamental Chemistry-1 (Lab) **(30 Hours)**

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 titrating it with $K_2Cr_2O_7$ using internal 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.

Reference Books:

- Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.
- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
- A. K. Nad, B. Mahapatra and A. Ghosal, An Advanced Course in Practical Chemistry, New Central Book Agency Priv. Ltd, 2011

Inorganic Chemistry

UNIT-I: Chemistry of s, p and d Block Elements **12 Lectures**

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and Catenation, Complex formation tendency of s and p block elements. Classification of Metal-Hydrides. Structure, Bonding, and Uses: Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of Nitrogen, Phosphorus Sulphur and Chlorine. Occurrence and uses, rationalization of inertness of noble gases, Bonding in noble gas compounds (Valence bond and MO treatment for XeF_2).

d block elements: General electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states. Difference between the first, second and third row transition elements.

UNIT-II: Bioinorganic Chemistry **8 Lectures**

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on distribution of metals. Sodium/K-pump, Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), Iron and its application in biosystems, Haemoglobin.

Recommended books/references:

1 Lee, J.D. Concise Inorganic Chemistry, ELBS,1991.
2 Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y.1994.
3 Greenwood, N.N., Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
4 Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH,1999.
5 Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
6 Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010
7 Atkins, P. W and Shriver D. N. Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).

Semester-II (Practical)

Physical Chemistry

1. Thermochemistry:

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat

carbocations/carbanions and heterocyclic compounds with suitable examples.

capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(e) Determination of basicity/proticity of a poly-protic acid by the thermo-chemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of copper sulfate.

(g) Study of the solubility of benzoic acid in water and determination of ΔH.

2. pH metry

(a) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

(b) Preparation of buffer solutions of different pH by:

Sodium acetate-acetic acid

Ammonium chloride-ammonium hydroxide

(c) pH metric titration of (i) strong acid *versus* strong base, (ii) weak acid *versus* strong base.

(d) Determination of dissociation constant of a weak acid.

(e) To study the dissociation constant of amino acid (glycine) and hence the isoelectric point of the acid.

3. Chemical Equilibrium:

- Equilibrium constant of methyl acetate hydrolysis reaction.
- Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
- Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
  - **(a)** simple eutectic and
  - **(b)** congruently melting systems
- Distribution of acetic/ benzoic acid between water and cyclohexane.
- Study the equilibrium of at least one of the following reactions by the distribution method:
  - **(a)** $I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$
  - **(b)** $Cu^{2+}(aq) + nNH_3(aq) \rightleftharpoons [Cu(NH_3)_n]^{2+}$

carbocations/carbanions and heterocyclic compounds with suitable examples.

Reference Books:

- J. Elias, *A Collection of Interesting General Chemistry Experiments*, Revised Ed., University Press, **2007**.
- C. W. Garland, J. W. Nibler and D. P. Shoemaker, *Experiments in Physical Chemistry*, 8th Ed., McGraw-Hill, **2003**.
- A. M. Halern and G. C. McBane, *Experimental Physical Chemistry: A Laboratory Textbook*, 3rd Ed., W. H. Freeman and Company, **2006**.
- P. C. Kamboj, *University Practical Chemistry*, 1st Ed., Vishal Publishing, **2013**.
- S. K. Maity and N. K. Ghosh, *Physical Chemistry Practical*, NCBA, **2015**.
- A. K. Nad, B. Mahapatra and A. Ghoshal, *An Advanced Course in Practical Chemistry*, 3rd Ed., New Central Book Agency, **2014**.
- J. B. Yadav, *Advanced Practical Physical Chemistry*, Krishna Prakashan Media, **2010**.
- B. Viswanathan and P. S. Raghavan, *Practical Physical Chemistry*, Viva Books, **2009**.

Inorganic Chemistry

(A) **Iodo / IodimetricTitrations**

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution(Iodometrically).

(ii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

(i) Preparation of Aluminium potassium sulphate (Potash alum) and Chrome alum.

(Note: Experiments may be added/deleted subject to availability of time and facilities)

Reference Books:

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition Pearson, 2009.

Organic Chemistry

(A) Identification of elements (N, S, Cl, Br & I) present in organic compounds.

(B) Identification of Functional groups (Acids, Phenolic OH & Keto) present in organic compounds.

Reference Books:

1. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000)

carbocations/carbanions and heterocyclic compounds with suitable examples.

of esters. *Reactions:* Hell – Vohlard - Zelinsky Reaction. *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and theirinterconversion. *Reactions:* Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction,Perkin condensation.

Amines and Diazonium Salts: Amines (Aliphatic and Aromatic): (Upto 5 carbons), *Preparation*: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamidereaction. *Reactions:* Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts:*Preparation:*from aromatic amines. *Reactions:* conversion to benzene, phenol, dyes. **(6Hours)**

Reference Books:

- T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- ArunBahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.
- G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
- G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel& J. R. Townsend: *General Chemistry*CengageLening India Pvt. Ltd., New Delhi (2009).
- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
- R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

FUNDAMENTAL CHEMISTRY PRACTICAL – II **(30 Hours)**

Section – A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).

5. Determination of enthalpy of hydration of copper sulphate.

6. Study of the solubility of benzoic acid in water and determination of *H*.

Ionic Equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid
(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section – B: Organic Chemistry

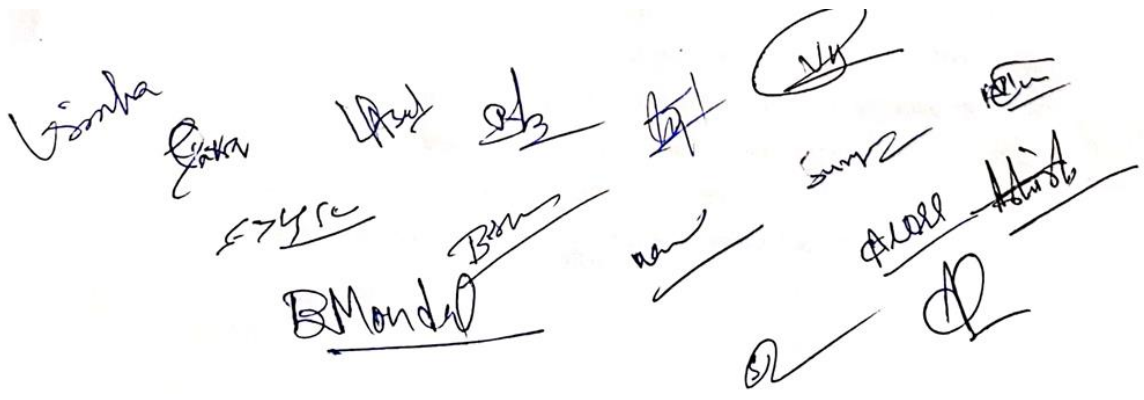
I Systematic Qualitative Organic Analysis of Organic Compounds possessingmonofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

II

1. Criteria of Purity: Determination of melting and boiling points.
2. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
3. Preparations: Mechanism of various reactions involved to be discussed.

Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols
(c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone



contraction, separation of lanthanides (ion-exchange method only).

UNIT-IV: Bioinorganic Chemistry **10 Lectures**

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on distribution of metals.Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), toxicity, chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Recommended text books/References:

1. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
2. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
3. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
4. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
5. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.

Inorganic Chemistry-III (Practical)

1. Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on understanding of the chemistry of different reactions. Following radicals may be analyzed:

   Carbonate, nitrate, nitrite, sulphide, sulphate, sulphite, acetate, fluoride, chloride, bromide, iodide, borate, oxalate, phosphate, ammonium, potassium, lead, copper, cadmium, bismuth, tin, iron, aluminum, chromium, zinc, manganese, cobalt, nickel, barium strontium, calcium, magnesium. Mixtures containing one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) **or** combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-,Cl^- and Br^-, Cl^- and I^-, $Br^-$and I^-, NO_3^- and Br^-, NO_3^- and I^-. Spot analysis/tests should be done whenever possible.
2. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.
3. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. (Also find the λ_{max} of the prepared complex usinginstrument).
4. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitutionmethod.

Note: Experiments may be added/deleted subject to availability of time and facilities

Recommended text books/references:

1. Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla. Pearson Education,2002.
2. Marr & Rockett *Practical Inorganic Chemistry.* John Wiley & Sons1972.

Semester	Course	Name of the course	Credits
V	CC 12	Analytical Chemistry	Theory:3
			Practical: 2

Learning objective:

After completion of the course, the student shall be able to understand:

- Familiarization with fundamentals of analyticalchemistry.
- Basics of spectroscopic, thermal, electrochemicaltechniques
- Learning basics of separation techniques and itsapplications.
- Understanding analytical tools, statistical methods applied to analyticalchemistry.
- Understanding principle of UV-Vis spectroscopy and itsapplications.
- Understandingprinciplesofthermo-gravimetric analysis and study of thermaldecomposition of materials/characterization ofmaterials.
- Understanding basics of electro-analytical techniques and itsapplications.
- Understandingprinciplesofseparationtechnology andits use in advanced instrumentations.

Analytical Chemistry (Theory)

UNIT-I: Qualitative and quantitative aspects of analysis **4 Lectures**

Tools in analytical chemistry and their applications, Sampling, evaluation of analytical data, errors, accuracy and precision, statistical test of data; F, Q and t-test, rejection of data, and confidence intervals.

UNIT-II: Spectroscopy **8Lectures**

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

Vibration spectroscopy: Basic principles of instrumentation, sampling techniques. Application of IR spectroscopy for characterization through interpretation of data. Effect and importance of

UV-Visible Spectrometry: Basic principles of instrumentation, principles of quantitative analysis using estimation of metal ions from aqueous solution, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

UNIT-III: Thermal analysis **6 Lectures**

Theory of thermogravimetry (TG and DTG), instrumentation, estimation of Ca and Mg from theirmixture.

UNIT-IV: Electroanalytical methods **6 Lectures**

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. determination of pKa values.

UNIT-V: Separation techniques **16 Lectures**

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction

of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography techniques: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis using LC, GLC, TLC andHPLC.

Recommended Books/Reference Books:

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

2 Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. WardsworthPublishing California, USA,1988.

3 Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.

4 Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman,2016.

5 Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis, Saunder College Publications,(1998).*

6 Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, EllesHarwood John Wiley1979.

7 Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand,1974.

8 Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition)1998

9 Skoog D.A., Holler F.J., Nieman T.A., Principles of instrumental analysis, 5thEdn., Brooks & Cole(1997).

Analytical Chemistry (Practical)

At least two experiments from each section

I. Chromatography:

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, andCr^{3+}.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the $R_f$values.

(iii) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their $R_f$values.

(iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

(i) To separate a mixture of Ni^{2+}& Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.

(ii) Determine the pH of the given aerated drinks fruit juices, shampoos andsoaps.

(iii) Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

III. Analysis of soil:

(i) Determination of pH ofsoil.

(ii) Total solublesalt

(iii) Estimation of calcium, magnesium, phosphate,nitrate

IV. Ionexchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchangeresins.

(ii) Separation of metal ions from their binarymixture.

(iii) Separation of amino acids from organic acids by ion exchangechromatography.

V. Spectrophotometry

(i) Determination of pKa values of indicator using spectrophotometry.

(ii) Structural characterization of compounds by infraredspectroscopy.

(iii) Determination of dissolved oxygen inwater.

(iv) Determination of chemical oxygen demand(COD).

(v) Determination of Biological oxygen demand(BOD).

(vi) Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Note: Experiments may be added/deleted subject to availability of time and facilities

Recommended text books/references:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson,2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA,1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York,2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman,2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New AgeInternational Publisher,2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning IndiaEdition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied*

Semester	Course	Name of the course	Credits=02
I-VI	VAC-6	Eco-Friendly Lubricants – Chemistry And Application	Theory+ Practical

1. **Department:** Chemistry
2. **Nameof the Course:** **Eco-friendly Lubricants – Chemistry and Application**
3. **Natureof the Course:** Certificate
4. **Modeof the Course:** Online/Offline/Physical
5. **NumberofSeats:** 20
6. **EligibilityCriteriaforAdmission:** 10+2 (OngoingUGstudents)

13. Syllabus:

UNIT I: Definition of Lubricants and Lubrication: Definition,Brief history and progress of Lubricants. Composition of Lubricants. Additives used in Lubricants. Functions and various characteristic features of Lubricants.Role of Lubricants in Engineering Chemistry.

UNIT II:Classification of Lubricants: Solid, liquid, semi-solid and synthetic Lubricants. Properties of Lubricants: viscosity, iodine number, aniline point, emulsion number, flash and fire point, drop point, cloud and pour point, corrosion stability, saponification number etc.

UNIT III: Various Lubrication Methods: Grease Lubrication, Oil Lubrication, etc. Mechanism of Lubrication: thick film, thin film and extreme pressure lubrication. Essential requirements of a good lubricant. Application of Lubricants: Automotive engine oils, tractor, other motors, industrial, aviation, marine etc.

UNIT IV: Eco-friendly Lubricants and Disposal Techniques: Eco-friendly Lubricants, Lanolin: composition, modern developments, production and applications, Guidelines for the proper disposal, Biodegradability of Lubricants, Stabilization and reuse, Degradation through tillage or composting, Dumping, Storage of waste.

14. SuggestiveReadings:

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C_2S_3); Green chemistry in sustainabledevelopment.

Recommended Books/References:

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.and Connely, M.E. *Real-World cases in Green Chemistry*, ACS(2000).
5. Ryan, M.A. and Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, (2002).
6. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, Second Edition,2010.

Green Chemistry (Practical)

Any six experiments may be conducted

1. Preparation and characterization of nanoparticles of gold using tealeaves.
2. Preparation of biodiesel from vegetable/ waste cookingoil.
3. Use of molecular model kit to stimulate the reaction to investigate how the atom economy illustrates GreenChemistry.
4. Reactions like addition, elimination, substitution and rearrangement may also be studied for the calculation of atomeconomy.
5. Benzoin condensation using Thiamine Hydrochloride as a catalyst (instead ofcyanide).
6. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dryice.
7. Mechanochemical solvent free synthesis ofazomethines
8. Solvent free, microwave assisted one pot synthesis of phthalocyanine Cu(II)complex.

Semester	Course	Name of the course	Credits
VI	CC 14	Chemistry of Materials	Theory:3
			Practical: 2

Learning objective:

After completiton of the course, the learner shall be able to understand:

- Crystalline solids – parameters,symmetry.
- Silica based materials inapplications.
- Technological importance of ionic liquids, preparation of materials– using sol-gel technique.
- Nano-structured materials, self-assembledstructure.
- Composites and itsapplications
- Understanding basic parameters of crystalline solids, symmetry and crystalstructures.
- Mesoporous/microporous silica based materials, functionalized hybrid materials and its applications.
- Preparation of inorganic solids, host-guest chemistry, ionic liquids and itssignificance.
- Understanding self-assembled structures, nano-structured materials, carbon nanotubes, applications.
- Understanding composites and their industrialapplications.

Chemistry of Materials (Theory)

UNIT-I: Basics of crystalline solids **8 Lectures**

Crystalline solids, crystal systems, Bravais lattices, coordination number, packing factors – cubic, hexagonal, diamond structures, lattice planes, Miller indices, interplanar distances, directions, types of bonding , lattice energy, Madelung constants, Born Haber cycle, cohesive

UNIT-II: Silica based materials **8 Lectures**

Introduction to Zeolites, metallosilicates, silicalites and related microporous materials, Mesoporous silica, metal oxides and related functionalized mesoporous materials: Covalent organic frameworks, Organic-Inorganic hybrid materials, periodic mesoporous organo silica, metal organic frameworks: H_2 /CO_2 gas storage and catalytic applications

UNIT-III: Inorganic solids/ionic liquids of technological importance **8 Lectures**

Preparation of inorganic solids: Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydro-thermal method, Ion-exchange and Intercalation methods. Introduction to Solid electrolytes, inorganic liquid crystals. Ionic liquids, forces responsible for ionic liquids, synthesis and application of imidazolium and phosphonium based ionic liquids. Host-guest chemistry (elementaryideas).

UNIT-IV: Nanomaterials **8 Lectures**

Overview of nanostructures and nano-materials: classification. Preparation of gold and silver

metallic nanoparticles, self-assembled nanostructures-control of nano-architecture-one dimensional control.Carbon nanotubes and inorganic nanowires.

UNIT-V: Composite materials **8 Lectures**

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

Recommend books/References:

1. Atkins P, Overton T., Rourke J. Weller M. and Armstrong F *Shriver and Atkins. Inorganic Chemistry* Oxford University Press, Fifth Edition,2012.
3. Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. JohnWiley,1974.
4. Poole, C.P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley2003.
5. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning,2002.

Chemistry of Materials (Practical)

1. Preparation of urea-formaldehyderesin
2. Preparations of novalac resin/resolresin
3. Synthesis of materials/porous materials (Sol-gel, hydrothermal, microwave). (Similarly other materials synthesis can bedesigned).
4. Preparation of silver nano material. (Similarly other nano materials of other metals synthesis can bedesigned).
5. Analysis of XRD pattern ofcrystals.
6. Interpretation of FTIR, NMR and UV-Vis data of givenmaterial.
7. Estimation of particle size from the BET, SEMtechniques.
8. Density measurement of ionicliquids
9. Determining dynamic viscosities of given ionicliquids
10. Determination of hydration number IRspectra.

Note: Experiments may be added/deleted subject to availability of time and facilities

DISCIPLINE SPECIFIC ELECTIVE COURSES

Semester	Course	Name of the course	Credits
V,VI	DSE1	Medicinal Chemistry	Theory: 3
			Practical: 2

Learning objective:

After completion of the course, the learner can be able to understand:

- The basics of medicinal chemistry, biophysicalproperties
- Biological activityparameters
- Drugmetabolism
- Biophysical and chemical properties of enzymes, hormones, vitamins
- Concept of rational drug design

Unit 1: Bio-physicochemical properties

Acidity/Basicity, Solubility, Ionization, Hydrophobic properties, Hydrophilic properties, Lipinski Rule, Drug-like properties, Understanding of the biological activity parameters such as K_i, K_d, LD_{50}, EC_{50}, IC_{50}, CC_{50}, ADMET properties.

Unit 2: Structural properties

Isosterism, Bioisosterism, Nonclassical isosteres, Understanding of the 3D-structure along with bond length, bond angle and dihydral angle, Concept of Configuration and Conformation with examples, Concept of stereochemistry in terms of biological response with examples, Stereoselective receptors or enzymes such as muscarinic receptor, Stereochemically pure drug and recemates, Examples such as catecholamines, etc.

Unit 3: Drug target understanding

Metabolism, Drug metabolism, Anti-metabolite, Enzyme inhibitor, Agonist, Antagonist, Examples.

Unit 4: Medicinal Chemistry of Therapeutic Agent

Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, Anticancer, CNS acting drugs, Adrenergic Agents, Cholinergic Drugs, Diuretics, Cardivascular, local anesthetic agent, Analgesic Agents, Histamine and Antihistamine agents.

Unit 5: Steroids, Prostaglandins, Enzyme, Hormone and Vitamins

Biophysico-chemical properties, Steroid Hormone Receptors, Chemical Contraceptive agents, COX-2 inhibitors, Prostaglandins for Ophthalmic use, pharmaceutically important enzyme products such as Pancreatin, Trypsin, Insulin. Classification of vitamins with examples.

Unit 6: Concept of rational drug design

Structure activity relationship, Drug-receptor understanding, Molecular modeling, Structure based drug design. QSAR.

Recommended books/References:

Semester	Course	Name of the course	Credits
V,VI	DSE3	Polymer Chemistry	Theory: 3
			Practical: 2

Learning objective:

After completion of the course, the learner can be able to understand:

- The mechanism of polymer materialformation.
- Molecular weight and structure propertyrelationship
- Polymerization procedure and Zigler-Nattacatalysis.
- Characterization ofpolymers

Unit 1: Introduction

Polymer, monomer, examples of polymers, biopolymers, classification, polymerization process, degree of polymerization, condensation, addition polymers, kinetics of addition polymerization process.

Unit 2: Polymeric Structure and Property Relationship

Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average, weight average, viscosity average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

Unit 3: Polymerization Chemistry

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension.Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

Unit 4: Characterization of Polymers

Molecular Weight Determination by Light Scattering, Osmometry, End-Group Analysis, Viscosity, Gel Permeation Chromatography; Application, of FTIR, UV-visible, NMR, and Mass Spectroscopy for Identification of polymers.

Recommended books/References:

1. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork.1990.
2. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt,1996.
3. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press,1987
4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York(1970).
5. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007,Wiley.
6. J.R.Fried, Polymer Science and Technology, (2005), PHIpublication.
7. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers,

Semester	Course	Name of the course	Credits
V,VI	DSE6	Advanced Analytical Chemistry	Theory: 3
			Practical: 2

Learning Objectives:

After completion of the course, the learner can be able to understand:

- Methods in chemical analysis.
- Polarography: Instrumentation and applications.
- Theory and application of atomic spectroscopy.
- Theory and application thermogravimetric analysis.
- Theory and principle of chromatography.
- Analysis of fuel and drugs.

Unit 1: Statistical methods in chemical analysis

Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation, test of significance, the F-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method).

Unit 2: Polarography

Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications.

Unit 3: Atomic spectroscopy

Atomic absorption spectroscopy, theory and application (with some examples).

Unit 4: Thermal analysis

Theory, methodology, instruments and applications of theromogravimetric analysis (TGA/DTA), and differential scanning calorimetry (DSC).

Unit 5: Chromatography

Principles of chromatography, paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC.

Unit 6: Analysis of fuel and drugs

Fuel analysis: Solid, liquid and gaseous fuels, ultimate and proximate analysis of solid fuel, Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point.

Drug analysis: Classification of drugs, Analysis of some standard drug using various chromatographic techniques.

Recommended books/references:

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

2 Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing California, USA,1988.

Semester	Course	Name of the course	Credits
V,VI	DSE8	**Organic Spectroscopy**	Theory: 3
			Practical: 2

Learning Objectives:

After completion of the course, the learner can be able to understand:

- Spectroscopic techniques used for characterization of organic compounds.
- Basic Principles of UV, IR and NMR Spectroscopy and Mass Spectrometry.
- Application of various spectroscopy in characterization of chemical compounds.

Unit 1: Basic Principles of UV Spectroscopy

Application of Woodward-Fiser rule in interpretation of Organic compounds: Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiation, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λmax of conjugated dienes and α,β – unsaturated compounds.

Unit 2: Basic principles of IR Spectroscopy

Identification of Functional groups of various classes of organic 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).

Unit 3: NMR (^{1}H and ^{13}C NMR)

Application of Chemical Shifts, Splitting of signals, Spin coupling and Over Houser effect in interpretation of NMR spectra, Isotopic exchange

Unit 4: Basic principles Mass Spectrometry

Application of fragmentation rule in characterization of organic compounds.Problems on structure elucidation of organic compounds based on spectral data.

Recommended Books/References:

1. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of Organic Compounds*, John Wiley &Sons.
2. John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India(2012).

Suggested laboratory experiments

1. Purification method for liquid, solid organic substance (distillation, recrystallization, chromatorgrapy)
2. Analysis of spectra of UV-Vis, FTIR, NMR and Mass of simple organic compounds. (azodyes, acetanilides, benzoic acid, etc.)

Note: Experiments may be added/deleted subject to availability of time and facilities

Semester	Course	Name of the course	Credits=02
I-VI	VAC-5	POLYMER CHEMISTRY	Theory+ Practical

1. **Department:** Chemistry
2. **Name of the Course:** Certificate Course in Polymer Chemistry
3. **Nature of Course:** Certificate or Value Added Course: Certificate
4. **Mode of Course:** Online / Offline / Physical: Hybrid Mode (online + Offline 60:40 %)
5. **Number of Seats:** 20
6. **Eligibility Criteria for Admission:** Intermediate/ B Sc in any discipline with Chemistry as a paper

Syllabus on Polymer Chemistry (Certificate Course)

Credits: 02 **30 Lectures**

Unit 1

Introduction: Background, Nomenclature, Classifications, Examples and Applications, Principles of Polymerization

Unit II

Synthesis of Polymers: Step-Growth Polymerization, Radical Chain Polymerization, Controlled Radical Polymerization, Copolymerization Ionic Chain Polymerization, Coordination Polymerization, Ring-Opening Polymerization, Polymerization techniques.

Unit III

Characterization of Polymers: Determination of Molecular Weight, Frictional Properties of Polymers in Solution, Hydrodynamic Size, DSC, TGA and SEM.

Unit IV

Polymer Properties: Crystallinity in polymers, Glass transition temperature, Rheological properties, Mechanical, Optical, Electrical, Surface and Other Industrially Relevant Properties Degradation of polymers.

Unit V

Some industrially important Polymer reactions, Polymer Processing: Polymer additives, compounding and processing techniques