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 : 2023-24

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
1.	CYUAMJL1	Basic Concepts of Chemistry-I Lab
2.	CYUAMNL1	Fundamental Chemistry-I Lab
3.	CYUAMJL2	Basic Concepts of Chemistry-II Lab
4.	CYUAMNL2	Fundamental Chemistry-II Lab
5.	CYUCLT1	Physical Chemistry Practical-II
6.	CYUCTT2	Organic Chemistry-III
7.	CYUCLT2	Organic Chemistry Practical-III
8.	CYUCLT3	Spectroscopy Practical
9.	CYUCLG1	Generic Elective- Practical-III
10.	CYUCTC1	Value added Courses
11.	CYUDLT1	Physical Chemistry practical-III
12.	CYUDLT2	Inorganic Chemistry practical-II
13.	CYUDLG1	Generic Elective- Practical-IV
14.	CYUDTC1	Value added Courses
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

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**			

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

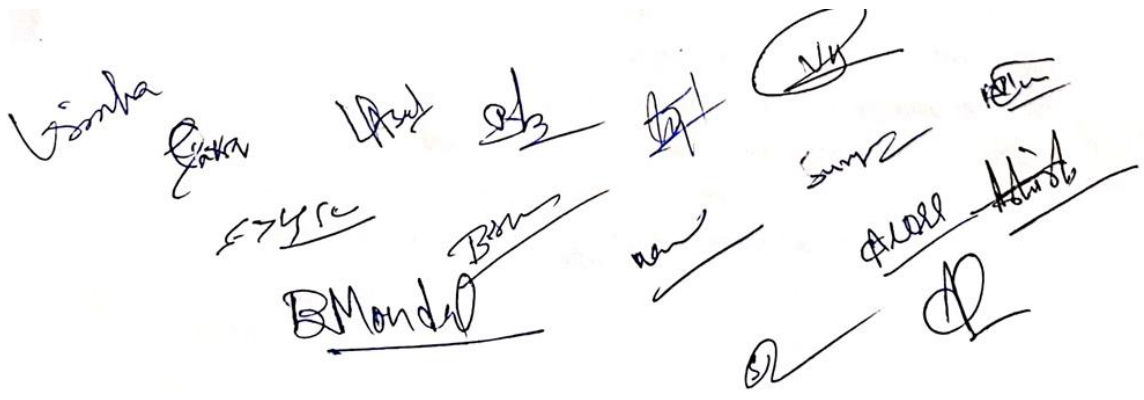
I Systematic Qualitative Organic Analysis of Organic Compounds possessingmonofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

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



Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

UNIT VII: Dilute solutions **6 Lectures**

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties: [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amountof solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Recommended Books/References

1 Atkins P. and De Paula, J. *Physical Chemistry* Tenth Ed., OUP, 2014.
2 Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa, 2004.
3 Engel, T. and Reid, P. *Physical Chemistry 3rd Ed.,* Prentice Hall,2012.
4 McQuarrie, D. A. and Simon, J. D. *Molecular Thermodynamics* Viva Books, 2004.
5 Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001
6 *Commonly Asked Questions in Thermodynamics.* CRC Press,2011.
7 Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2010. 8 Metz, C.R. *2000 solved problems in chemistry,* Schaum Series,2006.

Physical Chemistry-II (Practical)

1. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities onit.
2. Study the equilibrium of at least one of the following reactions by the distribution method:
   (i) I_2 (aq)+I^-→I_3^-(aq)
   (ii) Cu^{2+}(aq) + $n$$NH_3$ →$Cu(NH_3)_n$
3. Study the kinetics of the followingreactions.
   a. Acid hydrolysis of methyl acetate with hydrochloricacid.
   b. Saponification of ethylacetate.

Adsorption

Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid and selected organic dye(s) on activated charcoal.

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

Recommended Books/References:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand, New Delhi,2011.
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry,* Eighth Edition,McGraw-Hill(2003).
3 Halpern, A. M. and McBane, G. C. *Experimental Physical Chemistry,* Third Edition, W, H. Freeman (2003).

Semester	Course	Name of the course	Credits
III	CC 6	Organic Chemistry-III	Theory:3
			Practical: 2

Learning objective:

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

- Nitrogen containing functional groups and theirreactions.
- Familiarization with polynuclear hydrocarbons and theirreactions.
- Heterocyclic compounds and theirreactions.
- Alkaloids andTerpenes
- Understanding reactions and reaction mechanism of nitrogen containing functional groups.
- Understanding the reactions and mechanisms of diazoniumcompounds.
- Understanding the structure and their mechanism of reactions of selected polynuclear hydrocarbons.
- Understanding the structure, mechanism of reactions of selected heterocycliccompounds.
- Classification, structure, mechanism of reactions of few selected alkaloids andterpenes.

OrganicChemistry-III (Theory)

UNIT I: Nitrogen Containing Functional Groups **8 Lectures**

Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium salts: Preparation and synthetic applications.

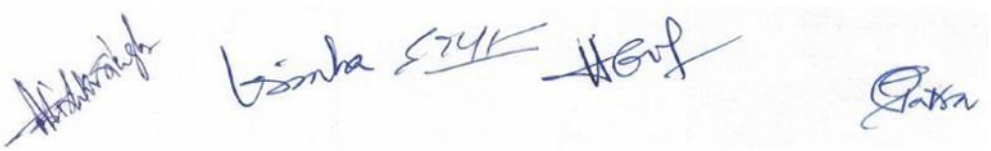
UNIT II: Polynuclear Hydrocarbons **8 Lectures**

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.**UNIT III:Heterocyclic Compounds** **12 Lectures**

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction Derivatives of furan: Furfural and furoic acid.

UNIT IV: Alkaloids **6 Lectures**

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of



Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

UNIT V: Terpenes **6 Lectures**

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.

Recommended Text Books/references:

1. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7thEdn., Pearson.
2 Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons (1976).
3 Solomons, T.W., Fryhle Craig, *Organic Chemistry,* John Wiley & Sons, Inc(2009).
4 McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
5 Kalsi, P. S. *Organic reacations and their mechanisms*, New Age Science(2010).
6 Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press Inc., New York(2001).
7 Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan(2010).
8 Bansal R. K. *Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms*, New Age, Third Edition (1999).
9. Clayden J., Greeves N., Warren S., Organic Chemistry, (2nd Ed)., (2012), Oxford University Press.

Organic Chemistry-III (Practical)

1. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols,etc.
2. Identification of functional groups of simple organic compounds by IR spectroscopy and NMR spectroscopy
3. Preparation of methylorange.
4. Extraction of caffeine from tealeaves.
5. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars using simple labprocedures.

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

Recommended Books/References:

1. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson(2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education(2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson(2012).
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press(2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press(2000).

edition).

5. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi(2006).

Molecular Spectroscopy & Photochemistry (Practical)

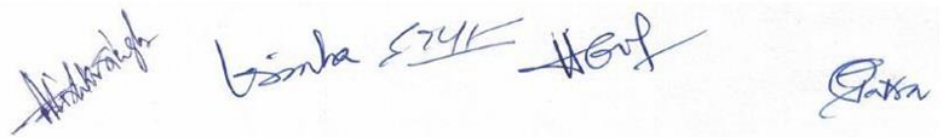
(i) Determination of indicator constant-colorimetry.

(ii) Verification of Beer's Law - Determination of concentration of solution by colorimetry.

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

Suggested books/reference books:

1. Practicals in physical chemistry – a modern approach, P.S.Sindhu,Macmillan,
2. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier.



- R. Sarkar (Part-I & II), General & Inorganic Chemistry, Central.
- R. L. Dutta (Part-I & II), Inorganic Chemistry, The New Book Stall.
- J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
- F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
- D. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press.
- Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.

GE PRACTICAL – III (Solid, Solutions, Phase Equilibrium,Chemical Kinetics, Conductance & Periodic Properties and Chemistry of s-, p-, and d- block elements)

(30 Hours)

Section – A: Physical Chemistry

Distribution

Study of the equilibrium of one of the following reactions by the distribution method:

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

$Cu^{2+}(aq) + xNH_3(aq) \rightleftharpoons [Cu(NH_3)_x]^{2+}$

Phase equilibria

a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.

b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.

c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

(I) Surface tension measurement (use of organic solvents excluded).

a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

b) Study of the variation of surface tension of a detergent solution with concentration.

(II) Viscosity measurement (use of organic solvents excluded).

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III) Chemical Kinetics

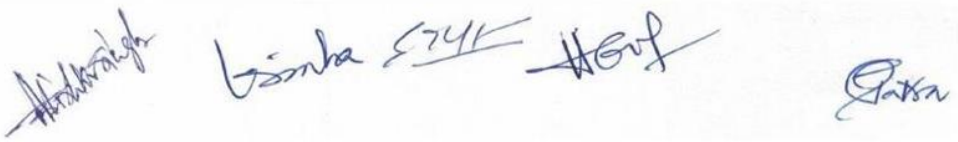
Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.
   b. Saponification of ethyl acetate.
   c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate

Conductance

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 vs. strong base
   ii. Weak acid vs. strong base

Potentiometry

Perform the following potentiometric titrations:

a) Strong acid vs. strong base
b) Weak acid vs. strong base
c) Potassium dichromate vs. Mohr's salt

Section – B: Inorganic Chemistry

Semi-micro qualitative analysis using H_2S of mixtures- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH^{4+}, Pb^{2+}, Ag^{+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^{+}, Anions : CO_3^{2-}, S^{2-}, SO^{2-}, $S_2O_3^{2-}$, NO_3^{-}, NO_2^{-}, Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^{-}

(Spot tests should be carried out wherever feasible)

Reference Books:

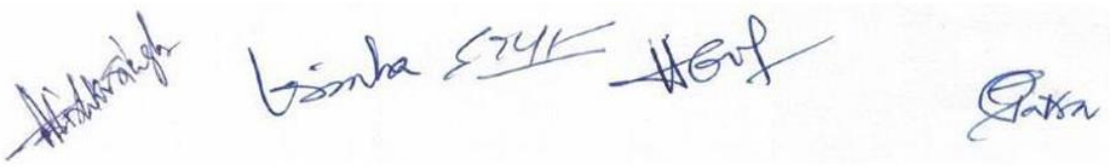
- B.D. Khosla: Senior Practical Physical Chemistry, R. Chand & Co.
- A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- A. K. Nad, B. Mahapatra and A. Ghosal, An Advanced Course in Practical Chemistry, New Central Book Agency Priv. Ltd, 2011
- V. K. Ahluwalia, S. Dhingra& A. Gulati, College Practical Chemistry, University Press, Delhi.

CERTIFICATE COURSEs/VALUE ADDED COURSES

Semester	Course	Name of the course	Credits=02
I-VI	VAC-3	Fuel Chemistry	Theory+ Practical

1. **Department** Chemistry
2. **Name of the Course:** Certificate Course in Fuel Chemistry
   Nature of Course(Certificate/ Value Added): Certificate
3. **Mode of Course:** Hybrid Mode (Online + Offline)
   Online / Offline / Physical
4. **Number of Seats:** 20
5. **Eligibility Criteria for Admission:** 12th Pass, Ongoing B Sc in any discipline with Chemistry as a paper.
6. **Introduction and relevance of Course**:

   In the present scenario energy are first and foremost requirement for the socio-economic development of the society and nation as well which is also recognized by United Nations (UN) as one of the very important and inevitable common goals for the sustainable development goals (SDGs). This course will enable the scientific knowledge, skill and hands-on experience about the most non-renewable energy sources fossil fuels (coal, petroleum, and natural gas) to meet out the energy demand of the country. This will assist them to be industry ready to contribute effectively in the field of coal, petroleum chemistry and technology. In the Bilaspur city the regional research centre of CSIR-Central Institute of Mining and Fuel Research (CIMFR) is located where they recruit the project assistant and project fellow having the knowledge and experience on fuel chemistry, therefore, this course will provide job opportunities too.
7. **Objectives of the course**: The course will have the following objectives
   - To know about the sources of energies.
   - To study the fuel as the main source of energy particularly fossil fuels.
   - To know the chemical compositions of different fuels
   - To study Domestic and industrial applications of coal.
   - To understand about petroleum and petrochemical industry.
   - Various prospects of lubricants
8. **Learning outcome of the course**:
   - Understand both conventional based fuels, and alternative & renewable fuels.



- Understand the chemistry that underpins coal and petroleum fuel science and technology.
- They will understand the refining processes used to produce fuels and lubricants and will know how differences in chemical composition affect properties of fuels and their usage in different applications.
- Understand the fuel product specifications, various test methods used to qualifydifferent types of fuels as well characterization methods.
- They will get experimental experience on fossil fuels like coal, petroleum, and natural gas)
- Students can get job opportunities in various projects of of CSIR-Central Institute of Mining and Fuel Research (CIMFR).

9. Number of lectures: 2 hour per week (02 Credit)

10. Number of practical's (if any): 2 hour per week (01 Credit)

11. List of experiments (If any)-

- Determination of flash point & fire point of given fuel sample.
- Determination of viscosity index, cloud point, pour point of given fuel sample.
- Determination of calorific value of given fuel sample/coal sample using bomb calorimeter. Proximate analysis of given coal sample.
- Determination of the iodine number of oil.
- Determination of the saponification number of oil.

12. Syllabus:

Credits: 02 **30 Lectures**

Unit 1

Review of energy sources (renewable and non-renewable). Energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission.Classification of fuels and their calorific value. Solid, liquid and gaseous fuels, ultimate and proximate analysis of solid fuel

Unit II

Coal as Fuel: Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point. Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Unit III

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining anddifferent types

of petroleum products and their applications Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Unit IV

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (flash point, fire point, viscosity index, cloud point, pore point) and their determination.

13. Suggestive Readings:

- Industrial Chemistr by Stocchi, E. Vol-I, Ellis Horwood Ltd. UK (1990).
- Engineering Chemistry by Jain, P.C. & Jain, M. Dhanpat Rai & Sons, Delhi.
- A Text Book of Engineering Chemistry S. S. Dara S Chand & Company
- Industrial Chemistry by Sharma, B.K. & Gaur, H. Goel Publishing House, Meerut (1996).
- Chemistry of Fossil Fuels and Biofuels by Harold Schobert , Cambridge University Press 2013.
- The Chemistry and Technology of Coal by James G. Speight, CRC Press Boca Raton (2012)
- Water for Energy and Fuel Production, Yatish T. Shah, CRC Press Boca Raton (2014)
- Process Chemistry of Coal Utilization: Impacts of Coal Quality and Operating Conditions by Stephen Niksa, Elsevier 2019
- Chemistry of Coal Conversion by Richard H. Schlosberg Springer (1985).
- The Chemistry and Technology of Petroleum by James G. Speight CRC, Boca Raton (2014).
- Lubricants and Lubrication by Wilfried Dresel, Wiley (2017).

14. Course Coordinator (Name & Designation)

Dr S S Thakur, Assistant Professor

Prof G, K Patra, Professor

15. Evaluation Criteria:

Components	Class Test	Hands on Experiment	End Semester	Total
Weightage (%)	**20**	**20**	**60**	**100**

16. Infra Structure requirements (if any): Basic laboratory with small instrument like flash and fire point apparatus, Bomb Calorimeter, viscometer, consumables chemicals etc.

17. Financial Requirement (if any): Rs. 50,000/- for instrument and chemicals

18. Proposed fee for the Course (if any): 5000/- (or as per direction of the university)

19. Budgetary provisions : 50, 000/-

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts.Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

UNIT-IV: Surface chemistry **10 Lectures**

Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, Derivation of Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.

Recommended books/References:

1. Atkins P. W. and De Paula J., *Physical Chemistry, (*tenth edition) Oxford University Press, 2014.
2 Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa,2004.
3 McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books,2004.
4 Engel, T. & Reid, P. *Physical Chemistry* Third Edition,Prentice-Hall,2012.
5 Zundhal, S.S. *Chemistry concepts and applications* Cengage India, 2011
6 Ball, D. W. *Physical Chemistry* Cengage India, 2012.
7 Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP, 2009.
8 Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill, 2011.
9 Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill,2009.

PhysicalChemistry-III (Practical)

Conductometry

1 Determination of cellconstant
2 Equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3 Conductometric titrations of: (i) Strong acid Vs. strong base, (ii) Weak acid vs. strong base, (iii) Mixture of strong acid and weak acid vs. strong base.

Potentiometry

Potentiometric titrations of: (i) Strong acid vs. strong base, (ii) Weak acid vs. strong base (iii) Dibasic acid vs. strong base, (iv) Potassium dichromate vs. Mohr'ssalt.

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

Recommend books/References:

1 Khosla, B. D.; Garg, V. C. and Gulati, A. *Senior Practical Physical Chemistry,* R. Chand New Delhi,2011.
2 Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry* Eighth Edition*;* McGraw-Hill: New York,2003.
3 Halpern, A. M. and McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York,2003.

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).

Inorganic Chemistry-II (Practical)

(A) Iodo / IodimetricTitrations

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

(ii) Estimation of (i) arsenite and (ii) antimonyiodimetrically

(iii) Estimation of available chlorine in bleaching powderiodometrically.

(B) Inorganicpreparations

(i) Cuprous Chloride,Cu_2Cl_2

(ii) Preparation of Aluminium potassium sulphate (Potash alum) or Chromealum.

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

Recommended books/references:

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

(8 Hours)

Reference Books:

- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.,* Saunders College Publishing, Fort Worth (1992).
- Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
- Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall.
- Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.,* Prentice Hall.
- G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
- G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
- 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).
- B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
- R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
- J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
- F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
- D. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press.
- R. L. Dutta (Part-I & II), Inorganic Chemistry, The New Book Stall.
- Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.
- S. Chand. 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).
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.,* W. H. Freeman.
- Berg, J. M., Tymoczko, J. L. &Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman

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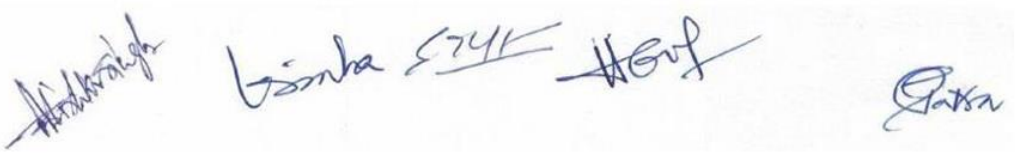
GEPRACTICAL – IV (Electrochemistry, Chemical Kinetics, Co-ordination compounds, Organometallics and Molecules of life

(30 Hours)

Section – A: AnalyticalChemistry

1. Estimation of the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oxinate in a given solution gravimetrically.
2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.
4. To draw calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given coloured compound and estimate the concentration of the same in a given solution.
5. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} -



phenanthroline complex in solution by Job's method.

6. Determination of concentration of Na+ and K+ using Flame Photometry.

Section – B: Inorganic Chemistry

1. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given)
   Binary mixture of nickel and cobalt, copper and nickel, zinc and magnesium, iron and copper; aluminium and nickel.
2. Preparation of any two of the following complexes:
   (a) tetraaammine copper (II) sulphate
   (b)tetraamminecarbonatocobalt (III) nitrate
   (c) potassiumtrioxalatochromate (III)
   (d) potassiumtrioxalatoferrate (III)
   (e) sodiumhexanitritocabaltate (III)
   (f) prussin blue

Section – C: Organic Chemistry

1. Determination of the concentration of glycine solution by formylation method.
2. Titration curve of glycine
3. Action of salivary amylase on starch
4. Effect of temperature on the action of salivary amylase on starch.
5. Determination of the saponification value of an oil/fat.
6. Determination of the iodine value of an oil/fat
7. Differentiation between a reducing/nonreducingsugar.
8. Extraction of DNA from onion/ cauliflower

Reference Books:

- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.,* Saunders College Publishing, Fort Worth (1992).
- Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
- Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall.
- Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.,* Prentice Hall.
- G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
- G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
- A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- A. K. Nad, B. Mahapatra and A. Ghosal, An Advanced Course in Practical Chemistry, New Central Book Agency Priv. Ltd, 2011
- V. K. Ahluwalia, S. Dhingra& A. Gulati, College Practical Chemistry, University Press, Delhi.

Semester	Course	Name of the course	Credits=02
I-VI	VAC-1	**EFFICIENT TECHNOLOGIES FOR FOOD PROCESSING AND SHELF LIFE EXTENSION**	Theory+ Practical

1. Department: Chemistry
2 Name of the Course: Certificate Course in
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: 10+2 in any discipline.
7. **Introduction and relevance of Course**: Food processing which includes both fresh and packaged food involves handling of foods, preparation and storage through the subsequent stages so that the pathogens and toxic components present in food are destroyed and deactivated making the food safer and hygienic. Food preservation techniques combines science-based knowledge with technologies, to prevent spoilage and extend shelf-life and ensure consumers free of pathogenic microorganism food. Deterioration of food leads to loss of quality including color, texture, taste as well as nutritive value.By preserving food, food waste can be reduced, which is an important way to decrease production costs and increase the efficiency of food systems, improve food security and nutrition and contribute towards environmental sustainability.For instance, it can reduce the environmental impact of food production
8. **Objectives of the course:**
   - ✓ To impart knowledge in the area of food science and technology
   - ✓ To aware with the recent technologies used in food preservation and processing
   - ✓ To understand the quality control of different food items
   - ✓ To understand the importance of food safety and food management

1. Learning outcome of the course:

After completing this certificate course the learner will be able to:

- ✓ understand the food processing and technology, its history,development and present status
- ✓ explain the significance and basic concepts of the subject
- ✓ aware of the skills required to be a professional food technologist
- ✓ aware of the career opportunities available and educational
- ✓ qualifications required for specific careers in the industry
- ✓ know the scope for self employment as small, medium or large scaleentrepreneurs.

10. Number of lectures (I hour =1 credit per week): 1 (01 hour)
11. Number of practical's (if any) (2 hours = 1 Credit per week) 1(2 Hour)
12. List of experiments (If any)- attached with annexure I
13 Syllabus:

Credits: 02 **30 Lectures**

Unit I

Introduction: Food Constituents & Functions, Quality and Safety Aspects of Food, Factors Affecting Quality during Processing and Storage, Role of Water in Food and its Shelf Life, Browning Reactions

Unit II

Technologies in Food Preservation: Principles of Food Preservation, Traditional Food Preservation Technologies, High Pressure Processing of Food, Membrane Technology, Food Irradiation, Hurdle Technology.

Unit III

Nanotechnology in Food Packing: Nano encapsulation,Nanoemulsions, Nanoparticles/active packagingNanoclays in packaging, Nanocomposites in packaging, Nanosensors at the packaging and processing plant, Nanosensors in plastic film packages/ Electronic tongue/ Intelligent packaging, NanosensorsNanofibresColor changing labels: Nanocochelates/ nanodroplets, Nanofilms/ Nanolaminates

Unit IV

Food Quality enhancement and analysis: Rancidity, Natural Antioxidants,High Energy RTE Food Paste, Ozonation of Food Grains, Food Fortification: Iron Fortified Rice (IFR), Nutri Dal and Fortified Noodles, Hyper Spectral Imaging for Quality Analysis of Food Grains, Non-Destructive Methods for Analysis of Grain Quality, Detection of Spoilage in Grains using Biosensors.

Practical

- To study the effect of enzymatic browning in fruits and vegetables.
- To study different types of blanching of fruits and vegetables.
- Preservation of food by canning.
- To perform cut out analysis of caned product.
- Preservation of food by high concentration of sugar i.e. jam.
- Preservation of food by high concentration of salt/acid i.e. pickle.
- Preservation of food by addition of chemicals i.e. tomato ketchup.
- Preservation of food by drying in a cabinet drier.
- Preservation of fruits & vegetables by freezing.

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