Scheme B

Chaudhary Ranbir Singh University, Jind

Scheme of Examination for the Chemistry Subject in Under Graduate Programmes
As per NEP 2020 Curriculum and Credit Framework for Undergraduate Programmes
(Multiple Entry- Exit, Internships and Choice Based Credit System LOCF) with effect from the session 2023-24 (in phased manner)

Semester	Course Type	Applicable Scheme	Course Code	Nomenclature of course	Credits			Contact hours L: Lecture P: Practical T:Tutorial			Internal Assessment Marks		End term Examination Marks		Total Marks	Examination hours	
					Total	Theory (T)	Practical (P)	L	P	Total	T	P	T	P		T	P
2nd YEAR																	
3	MCC-4	Scheme B	B-23-CHE-304	**Inorganic Chemistry-II:** Chemistry of s- and p-block elements	4	3	1	3	2	5	20	10	50	20	100	3	3
	MCC-5	Scheme B	B-23-CHE-305	**Organic Chemistry II:** Oxygen and Nitrogen containing functional groups	4	3	1	3	2	5	20	10	50	20	100	3	3
	CC-M3	Scheme B	B-23-CHE-204	**Physical Chemistry-I:** States of Matter , Chemical Kinetics & Ionic Equilibrium	4	3	1	3	2	5	20	10	50	20	100	3	3

	MDC-3	Scheme B	B-23-CHE-306	**Introductory Chemistry-III:** Chemistry and Social Life	3	2	1	2	2	4	15	5	35	20	75	3	3
	MCC-B	Scheme B	B-23-CHE-307	**Chemistry-B:**	3	2	1	2	2	4	15	5	35	20	75	3	3
4	MCC-6	Scheme B	B-23-CHE-402	**Physical Chemistry-II:** Thermodynamics and Colligative Properties	4	3	1	3	2	5	20	10	50	20	100	3	3
	MCC-7	Scheme B	B-23-CHE-403	**General Chemistry-I:** General Spectroscopy	4	3	1	3	2	5	20	10	50	20	100	3	3
	MCC-8	Scheme B	B-23-CHE-404	**General Chemistry-II:** Nuclear and Polymer Chemistry	4	3	1	3	2	5	20	10	50	20	100	3	3
	DSE-I	Scheme B	B-23-CHE-405 (E1)	**Elective Chemistry-I (Inorganic):** Environmental Chemistry	4	3	1	3	2	5	20	10	50	20	100	3	3
			B-23-CHE-405 (E2)	**Elective Chemistry-II (Organic):** Organic Biomolecules	4	3	1	3	2	5	20	10	50	20	100	3	3
			B-23-CHE	**Elective Chemistry-III(Physical):** Phase Equilibria and	4	3	1	3	2	5	20	10	50	20	100	3	3

			-405 (E3)	Surface Chemistry																
	CC-M4(V)	Scheme B	**From The Available pool of Vocational courses of 4 credits of University as per NEP**		4	3	1	3	2	5	20	10	50	20	100	3	3			
	Internship of 4 credits of 4-6 weeks duration after Fourth semester (if not done after second semester)																			

3rd YEAR

5	MCC-9	Scheme B	B-23-CHE-502	**Inorganic Chemistry III:** Chemistry of Transition Elements & Coordination Chemistry	4	3	1	3	2	5	20	10	50	20	100	3	3			
	MCC-10	Scheme B	B-23-CHE-503	**Organic Chemistry III:** Chemistry of Poly-nuclear Hydrocarbons & Heterocyclic Compounds	4	3	1	3	2	5	20	10	50	20	100	3	3			
	DSE-2	Scheme B	B-23-CHE-504(E4)	**Elective Chemistry-IV (Inorganic):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3			
			B-23-CHE-	**Elective Chemistry-V (Organic):**	4	3	1	3	2	5	20	10	50	20	100	3	3			

			504 (E5)	To be decided																
			B-23-CHE-504 (E6)	**Elective Chemistry-VI(Physical):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3			
	DSE-3	Scheme B	B-23-CHE-505 (E7)	**Elective Chemistry-VII (Inorganic):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3			
			B-23-CHE-505 (E8)	**Elective Chemistry-VIII (Organic):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3			
			B-23-CHE-505 (E9)	**Elective Chemistry-IX (Physical):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3			
	CC-M5 (V)	Scheme B	**From The Available pool of Vocational courses of 4 credits of University as per NEP**		4	3	1	3	2	5	20	10	50	20	100	3	3			

4th YEAR

6	MCC-11	Scheme B	B-23-CHE-602	**Physical Chemistry-III:** Electrochemical Cells, Chemical Kinetics & Catalysis	4	3	1	3	2	5	20	10	50	20	100	3	3			

MCC-12	Scheme B	B-23-CHE-603	**General Chemistry-III:** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3

SC-4	Scheme B	B-23-CHE-604 (E10)	**Elective Chemistry-X (Inorganic):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3
	Scheme B	B -23-CHE-604 (E11)	**Elective Chemistry-XI (Organic):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3
	Scheme B	B-23-CHE-604 (E12)	**Elective Chemistry-XII (Physical):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3
DSE-5	Scheme B	B-23-CHE-605 (E13)	**Elective Chemistry-XIII (Inorganic):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3
	Scheme B	B-23-CHE-605 (E14)	**Elective Chemistry-XIV (Organic):** To be decided													
	Scheme B	B-23-CHE-605 (E15)	**Elective Chemistry-XV (Physical):** To be decided	4	3	1	3	2	5	20	10	50	20	100	3	3
CC-M6 (V)	Scheme B	**From The Available pool of Vocational courses of 4 credits of University as per NEP**		4	3	1	3	2	5	20	10	50	20	100	3	3

Note: 1) Four Credits of Internship Earned By a Student during Summer Internship after 2nd Semester or 4th Semester Will Be Taken Into Account In Fifth Semester of a Student Who Pursue 3 Year UG Programme Without Taking Exit Option

heme of 7th and 8th semester will be decide later on.

Course composition-Theory/Theory + Tutorial			
Course Credit	Internal Assessment marks	End term exam marks	Total marks
2	15	35	50
3	25	50	75
4	30	70	100

Course composition-Theory + Practical					
Course Credit	Theory		Practical		Total marks
Theory + Practical	Internal Assessment marks	End term exam marks	Internal Assessment marks	End term exam marks	
1+1	10	20	5	15	50
2+1	15	35	5	20	75
2+2	15	35	15	35	100
3+1	20	50	10	20	100
0+4	NA	NA	30	70	100

1. Internal assessment(30%)shallbebroadlybasedonthefollowingdefinedcomponentsof;
   a. Class participation
   b. Seminar/Presentation/Assignment/Quiz/class test, etc.
   c. Mid Term Exam

Total Internal Assessment Marks(Theory)	Class Participation	Seminar/Presentation/Assignment/Quiz/class test,etc.	Mid-Term Exam
10	4	-	
15	4	4	6
20	5	5	7
25	5	7	10
30	5	10	13
			15

Total Internal Assessment Marks(Practicum)	Class Participation	Seminar/Demonstration/Viva-Voce/Lab record, etc.	Mid-Term Exam
5		5	NA
10		10	NA
15	5	10	NA
30	5	10	15

Course type-MCC-4 Session:2024-25	
PartA–Introduction	
Subject	Chemistry
Semester	III
Nameof Course	**INORGANIC CHEMISTRY – II** : Chemistry of s- and p-block Elements
CourseCode	B-23-CHE-304
Course Type:(MCC/CC/MDC/DSEC/VOC/DSE/PC /AEC/ VAC)	MCC
Level of the course(AsperAnnexure-I	100-199
Pre-requisite forthecourse(ifany)	4.0
Course LearningOutcomes(CLO):	• Learn the fundamental principles of metallurgy and understand the importance of recovery of by-products during extraction. • Applications of thermodynamic concepts like that of Gibbs energy and entropy to the principles of extraction of metals. • Comprehend the theory of Redox, iodometric and iodimetric titrimetric analysis. • Students will learn standard solution preparation for various inorganic titrations.

Credits	**Theory**	**Practical**	**Total**
	3	1	4
ContactHours	45	30	75

Max.Marks:70+30* InternalAssessmentMarks:20+10* EndTermExamMarks:50+20*	Time:03+03*

PartB-Contents of the Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from each SECTION and one question (Question No.1) based on entire syllabus will consist of short answer type. All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculator are allowed.

Unit	Topics
I	**Metallurgy & general properties of s-block elements11 hours** Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, Van Arkel-De Boer process, Zone refining. General characteristics: melting point, flame colouration, reducing nature, diagonal relationships and anomalous behavior of first member of each group. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.
II	**Compounds of s- block elements:** **11 hours** Formation, thermal stability, energetics of dissolution, and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates. Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium. Solutions of alkali metals in liquid ammonia and their properties.
III	**Chemistry of p-block elements** **11 hours** Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Catenation, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group.
IV	**Compounds of p-Block Elements** **12 hours** Acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat on the following: Hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P,As, Sb, Bi), Group 16 and Group 17, Oxoacids of phosphorus, sulphur and chlorine , Interhalogen and pseudohalogen compound, Clathrate compounds

	of noble gases, xenon fluorides (MO treatment of XeF_2).
V	**1. Redox Titrations** **30 hours** (i) Estimation of Fe(II) with $K_2Cr_2O_7$ using diphenylamine as internal indicator. (ii) Estimation of Fe(II) with $K_2Cr_2O_7$ using *N*-phenyl anthranilic acid as internal indicator. (iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using external indicator. **2. Iodo/Iodimetric Titrations** (i) Estimation of Cu(II) using sodium thiosulphate solution (Iodometrically). (ii) Estimation of $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically). (iii) Estimation of antimony in tartaremeticiodimetrically.

SuggestedEvaluationMethods	
InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA	**End TermExamination:** 50+20*
PartC-LearningResources	

7. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denney, R. C. (1989), Vogel's Text book of

RecommendedBooks/e-resources/LMS:

1. Lee, J. D.; (2010), Concise Inorganic Chemistry, Wiley India.
2. Huheey, J. E.; Keiter, E. A.; Keiter; R.L.; Medhi, O.K. (2009), Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education.
3. Atkins, P. W.; Overton, T. L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. A. (2010), Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
4. Miessler, G. L.; Fischer P. J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.
5. Housecraft, C. E.; Sharpe, A. G., (2018), Inorganic Chemistry, 5thEdition, Pearson.
6. Greenwood, N. N.; Earnsaw, A., (1997), Chemistry of Elements, 2nd Edition, Elsevier.
7. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denney, R. C. (1989), Vogel's Text book of Quantitative Chemical Analysis, John Wiley and Sons.
8. Harris, D. C.; Lucy, C. A. (2016), Quantitative Chemical Analysis, 9th Edition, Freeman and Company.
9. Day, R. A.; Underwood, A. L. (2012), Quantitative Analysis, 6th Edition, PHI Learning Private Limited.

**Applicable for courses having practical component.*

Course type-MCC-5

Session:2024-25	
PartA–Introduction	
Subject	Chemistry
Semester	III
Nameof Course	**ORGANIC CHEMISTRY–II** Oxygen and Nitrogen containing functional groups
CourseCode	B-23-CHE-305
Course Type:(MCC/CC /MDC /DSEC/VOC/DS E/PC/AEC/ VAC)	MCC
Levelofthecou rse(AsperAnn exure-I	100-199
Pre-requisite forthe course (ifany)	4.0
Course LearningOutco mes(CLO):	• Understandreactionsofoxygenandnitrogencontainingfunctio nal groups. • Usethesyntheticchemistrylearntinthiscoursetodofunctionalgr ouptransformations. • Buildastrong understandingof means,tools and techniques oforganic synthesis. • Carryoutsystematicanalysisoftheunknownorganic compound. • Usethereactionchemistrylearntthusfartoestablishtheidentityo ftheunknown organic compound.

Credits	**Theory**	**Practical**	**Total**
	3	1	4
ContactHours	45	30	75

Max.Marks:70+30* InternalAssessmentMarks:20+10* EndTermExamMarks:50+20*	Time:03+03*

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1) based on entire syllabus will consist of short answertype). All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	**Chemistry of Carbonyls Compounds11 hours** Preparation of Carbonyl compounds. Reaction of carbonyl compounds with ammonia derivatives, Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, and haloform reaction. Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC), addition reactions of α,β-unsaturated carbonyl compounds: Michael addition.
II	**Carboxylic acid & their derivatives11 hours** General method of preparation of acid and its derivates. Effect of substituents on acidic strength on carboxylic acids, HVZ reaction, typical reactions of dicarboxylic acids and hydroxy acids. Comparative study of nucleophilic acyl substitution for acid chlorides, anhydrides, esters and amides, Mechanism of acidic and alkaline hydrolysis of esters, Dieckmann and Reformatsky reactions, Hoffmannbromamide degradation and Curtius rearrangement. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.
III	**Nitro Compounds, &Amine** **11 hours** **Nitro compounds:** General methods of preparation: from alkyl halides, alkanes, oxidation of amines and oximes. Henry reaction, Nef reaction, Reduction-electrolytic reduction, reaction with nitrous acid, reduction in acidic, basic and neutral medium (for aromatic compounds) **Amines**: Preparation, chirality in amines (pyramidal inversion), Basicity of amines: Effect of substituents, solvent and steric effects, distinction between Primary, secondary and tertiary amines using Hinsberg's method and nitrous acid, Gabriel Phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction and Cope elimination.

IV	**Diazonium salts, Nitriles and Isonitriles** **12 hours** **Diazonium Salts**: Synthetic applications of diazonium salts including preparation of arenes, haloarenes, phenols, cyano and nitro compounds; Coupling reactions of diazonium salts (preparation of azo dyes). **Nitriles**: Preparation using following reactions: Dehydration of amides and aldoximes, substitution reaction in alkyl halides and tosylates, from Grignard reagents and from dehydrogenation of primary amines. Discuss with reaction mechanism: Reaction with Grignard reagent, hydrolysis, addition reaction with HX, NH_3, reaction with aqueous ROH, Reduction reactions-catalytic reduction and Stephen's reaction, Condensation reactions-Thorpe Nitrile Condensation. **Isonitriles**: Preparation from the following reactions: Carbylamine reaction, substitution in alkyl halides and dehydrogenation of *N*-substituted formamides.
V	**Qualitative Analysis*:30 hours** Identification of organic compound characterization by chemical methods: (i) Preliminary Test, (ii) Functional Group Test (iii) Derivative Preparation.

SuggestedEvaluationMethods	
InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA	**End TermExamination:** 50+20*

PartC-LearningResources

RecommendedBooks/e-resources/LMS:

1. Wade, L.G., (2016). **Organic Chemistry**, 8th Edition, Pearson Education.
2. Morrison, R. N., Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
3. Finar, I.L. **Organic Chemistry** Volume 1, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
4. Finar, I.L. **Organic Chemistry** Volume 2, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
5. Solomons, T.W.G., Fryhle, C.B.; Snyder, S.A. (2017), **Organic Chemistry**, 12th Edition, Wiley.
6. Vogel, A.I. (2012). **Quantitative Organic Analysis**, Part 3, Pearson Education.
7. Mann, F.G., Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
8. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, 5th Edition, Pearson.
9. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry**: Qualitative Analysis, University Press.
10. Ahluwalia, V.K., Aggarwal, R. (2004), **Comprehensive PracticalOrganic Chemistry**: Preparation and Quantitative Analysis, University Press.

**Applicableforcourseshavingpracticalcomponent.*

Course type-CC-M3

Session:2024-25			
PartA-Introduction			
Subject	Chemistry		
Semester	III		
Nameof Course	PHYSICALCHEMISTRY–I StatesofMatter,ChemicalKinetics&IonicEquilibrium		
CourseCode	B-23-CHE-204		
Course Type:(MCC/CC /MDC /DSEC/VOC/DS E/PC/AEC/ VAC)	MCC		
Level of thecourse (As perAnnexur e-I)	100-199		
Pre-requisite forthe course (ifany)	4.0		
CourseLearnin gOutcomes(CLO) :	• Learn the mathematicalexpressions fordifferentpropertiesof gas,liquidandsolid andunderstandtheirphysicalsignificance. • Explainthecrystalstructureandcalculate relatedpropertiesof cubicsystems. • Explain the concept of ionization of electrolytes with emphasis onweakacid and baseand hydrolysisof salt. • Student will learn HandonPracticeforestimationdeterminationofViscosityandSurfac etension of a given liquid.		
Credits	Theory	Practical	Total
	3	1	4
ContactHours	45	30	75

Max.Marks:70+30* InternalAssessmentMarks:20+10* EndTermExamMarks:50+20*	Time:03+03*

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1) based on entire syllabus will consist of short answertype. All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	**GaseousState** **11 Hours** Kinetic theory of gases, Maxwell's distribution of velocities and energies (derivationexcluded) Calculation of root mean square velocity, average velocity, and mostProbablevelocity.Collisiondiameter,collisionnumber,collisionfrequencyandmeanfree path (Derivations excluded), Deviation of Real gases from ideal behaviour,Derivation of Van der Waal' s Equation of State, its application in the calculation ofBoyle'stemperature(compression factor) **CriticalPhenomenon** Concept of Critical temperature, critical pressure, critical volume, relationshipBetweencriticalconstantsandVanderWaal'sconstants(Derivationexclud ed)
II	**LiquidState** **11 Hours** Structure of liquids, Properties of liquids – surface tension, refractive index, viscosity,vapourspressureand optical rotation. **SolidState** Classification of solids, Law of constancy of interfacial angles, law of rational indices,Miller indices, elementary ideas of symmetry and symmetry elements, seven crystalsystems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple accountof Lauemethod, rotatingcrystalmethod and powder patternmethod.
III	**ChemicalKinetics** **11 Hours** Concept of reaction rates, rate equation, factors influencing the rate of reaction, Orderand molecularity of areaction, integrated rateexpression for zero,first, Half-lifeperiodofareaction, Arrhenius equation. **DistributionLaw** Nernstdistributionlaw–itsthermodynamicderivation,Nernstdistributionlawafter

	association and dissociation of solute in one of the phases, of distribution law: (i)Determinationofdegreeofhydrolysisandhydrolysisconstantofanilinehydrochloride
IV	**Ionicequilibrium** **12 hours** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degreeof ionization, ionization constant and ionic product of water. Ionization of weak acidsand bases, pH scale, common ion effect; dissociation constants of mono and diproticacids.Salthydrolysis-calculationofhydrolysisconstant. Buffer solutions; derivation of Henderson equation and its applications. Solubility andsolubilityproductofsparinglysolublesalts–applicationsofsolubilityproductprinciple. Qualitative treatment of acid – base titration curves. Theory of acid–baseindicators.
V*	**30hours** **A.Surfacetension measurementsusingstalagmometer.** (i) Determinethe surfacetension by(i)drop number (ii)dropweight method. (ii) Studythevariationofsurfacetension withdifferentconcentrationofdetergentsolutions. Determine CMC. **B.ViscositymeasurementusingOstwald'sviscometer.** (i)Determination ofco-efficient ofviscosityofaunknownaqueous solution.Studythevariationofviscositywith differentconcentration ofsugar solutions.

SuggestedEvaluationMethods

InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA	**End TermExamination:** 50+20*

PartC-LearningResources

RecommendedBooks/e-resources/LMS:

1. Atkins, P.W.; Paula, J.de.(2014), **Atkin's Physical Chemistry Ed.**,10th Edition,OxfordUniversityPress.
2. Ball,D.W.(2017),**PhysicalChemistry**,2nd Edition,Cengage Learning, India.
3. Castellan,G.W.(2004),**Physical Chemistry**,4thEdition,Narosa.
4. Kapoor, K.L. (2015), **A Text book of Physical Chemistry**, Vol 1, 6th Edition, McGraw HillEducation.
5. B.D.khosala, V.C.Garg,A.Gulati,SeniorPracticalPhysicalChemistry,R.Chand(2015).
6. V.K.Ahluwalia,S.Dhingra,A.Gulati,CollegePracticalChemistry,UniversityPress.

AdditionalResources:

1. Moore,W.J.(1972),PhysicalChemistry,5thEdition,LongmansGreen&Co.Ltd.
2. Glasstone, S. (1948), Text book of Physical Chemistry, D. Van No strand company, NewYork.

**Applicableforcourseshavingpracticalcomponent.*

Course type-MDC-3

Session:2024-25			
PartA–Introduction			
Subject	Chemistry		
Semester	III		
Nameof Course	**INTRODUCTORYCHEMISTRY– III** Chemistry and Social Life		
CourseCode	B-23-CHE-306		
Course Type:(MCC/CC /MDC /DSEC/VOC/DS E/PC/AEC/ VAC)	MDC		
Levelofthecou rse(AsperAnn exure-I	0-99		
Pre-requisite forthe course (ifany)	HigherSecondaryotherthan ScienceDiscipline		
CourseLearnin gOutcomes(CLO) :	• Students will learn about chemistry of daily used medicines, soap & detergents • Increase the literacy of chemistry even in non-science students • Understand the basic concept, principle and importance of chemistry • Realize the importance of chemistry in daily life and future requirement		
Credits	**Theory**	**Practical**	**Total**
	2	1	3
ContactHours	30	30	60
Max.Marks:50+25* Internal Assessment Marks:15+05*End TermExamMarks:35+20*		**Time:03+03* Hrs**	

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1) based on entire syllabus will consist of short answertype. All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	**Basics of chemistry 8 hours** Periodic table, Atom and molecules, chemical bonding, properties. Chemistry in Heritage: Extraction and uses of metals like iron and stone in ancient times, metals in ornaments, medicines, weapons and chemistry for preservatives, basics of preservation and few examples of preservatives.
II	**Chemistry in Life 7 hours** Edible and non- edible molecules, biochemistry of foods and medicine with examples: Aspirin, Paracetamol. Ibuprofen and Penicillin, Cephalosporin, Chemistry for industry: Artificial sweeteners, Soaps and detergents and cosmetics, Polymer and Plastics: Uses and environmental issues.
III	**Testing of Chemicals 8 hours** Flame test, solubility test, qualitative and quantitative identification of ions in natural samples like metal copper, iron and chromium ores and adulterant in foods. Chemical pollution/Toxicity: Chemical source of water, air and soil pollution, biomagnification and metal toxicity with example and illustrations. monitoring of air pollution.
IV	**Future of Chemistry** **7 hours** Basics of green chemistry, Reuse and recycling of by-products, zero waste chemistry and Alternate fuel and energy providing chemicals: biodiesel, natural gas and hydrogen.
V*	**30hours** 1. Determine the calcium and magnesium contents in water samples using EDTA methods. 2. Determine the organic contents and pH of soil sample. 3. Estimate the food adulterants in edible items 4. Quantify the presence metals by flame test method 5. Demonstrate the exothermic and endothermic reaction in laboratory 6. Preparation aspirin and paracetamol as well as identify. 7. Demonstrate the protection of rusting of iron after surface spray coating.

	8. Estimate the protein contents in edible samples using chemical methods

SuggestedEvaluationMethods

InternalAssessment:15+05* ➢ **Theory** • ClassParticipation:4 • Seminar/presentation/assignment/quiz/classtestetc.:4 • Mid-TermExam: 07 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:05 • Mid-TermExam:NA	**End TermExamination:** 35+20*

PartC-LearningResources

RecommendedBooks/e-resources/LMS:

1. Lee, J. D., Concise Inorganic Chemistry, Wiley India Pvt. Ltd.
2. Sharma, B. K., Industrial chemistry, Goel Publishing House, India
3. Christian, Gary D., Dasgupta, Purnendu K., Schug, Kevin A., Analytical chemistry, Wiley
4. V. Subramanian, A text book of Environmental chemistry, Wiley

**Applicableforcourseshavingpracticalcomponent.*

Contact Hour

Course Type: MCC-B

Session: 2023-24			
Part A – Introduction			
Subject	Chemistry		
Semester	III		
Name of Course	CHEMISTRY-B		
Course Code	B-23-CHE-307		
Course Type: (MCC/CC/MDC/DSEC/VOC/DSE/PC/AEC/VAC)	CC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	4.0		
Course Learning Outcomes(CLO):	1. Draw the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory and MO diagrams (homo-& hetero-nuclear diatomic molecules). 2. Understand the concept of lattice energy using Born-Landé equation. 3. Understand and explain the electronic displacements and reactive intermediates and their applications in basic concepts. 4. Understand the fundamental Concepts of stereochemistry. 5. Calibrate apparatus used in titrimetric analysis. 6. Prepare standard solutions for titration. 7. Comprehend the theory of acid-base and redox titrations 8. Understand the theory and application of acid-base 9. Understand the theory behind estimation of metal ions and hydrated water		
Credits	**Theory**	**Practical**	**Total**
	3	1	4

Contact Hours	45	30	75
Max. Marks:70+30* Internal Assessment Marks:20+10* End Term Exam Marks:50+20*		Time:03 + 03*	

Part B- Contents of the Course

Instructions for Paper- Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from each SECTION and one question (Question No.1 based on entire syllabus will consist of short answer type. All questions carry equal marks. The candidate is required to attempt five questions in all selecting one from each SECTION. Question No.1 is compulsory. Log table and non-programmable calculator are allowed.

Unit	Topics
I	**Ionic equilibrium** **12 hours** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant. **Buffer solutions;** derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves. Theory of acid–base indicators.
II	**Molecular Orbital Theory:** **11 Hours** Molecular orbital diagrams of homo & hetero diatomic and simple polyatomic molecules [N_2, O_2, C_2, B_2, F_2, CO, NO] and their ions; HCl (idea of s-p mixing and orbital interaction to be given). **Acids and Bases:** Bronsted-Lowry concept of acid-base, relative strength of acids, elementary idea of levelling solvents, Lewis acid-base concept, Hard and Soft Acids and Bases (HSAB), Application of HSAB principle.
III	**Stereochemistry** **11 hours** Stereoisomerism: Optical activity and optical isomerism, asymmetry, chirality, enantiomers, diastereomers. Specific rotation; Configuration and projection formulae: Newmann, Sawhorse, Fischer and their inter conversion. Racemic mixture and their resolution. Relative and absolute configuration: D/L and R/S designations (CIP rules).Geometrical isomerism: cis-trans, syn-anti and E/Z notations. Conformational Isomerism: Alkanes (Conformations, relative stability and

	energy diagrams of Ethane, Propane). Relative stability of cycloalkanes (Baeyer strain theory), Cyclohexane conformations with energy diagram.
IV	**Haloalkanes** **11 hours** Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent; nucleophilic substitution V/s elimination. **Haloarenes** Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; S_NAr, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.
V*	**1. Titrimetric Analysis:** **30 hours** (i) Calibration and use of apparatus (ii) Preparation of solutions of different Molarity/Normality. **2. Estimation of acid and alkali contents: (any two).** (i) Determination of acetic acid in commercial vinegar using NaOH. (ii) Determination of alkali content-antacid tablet using HCl. 3. Study the variation of viscosity with different concentration of sugar solutions. **4. Basic Analysis and Synthesis** (i) Calibration of a thermometer and determination of the melting points of the organic compounds. (ii) Determination of boiling point of liquid compounds. (iii)Concept of Recrystallisation using alcohol/water/alcohol-water as solvent. (iv)Organic Preparation: Acetylation of aniline and phenols.

Suggested Evaluation Methods

Internal Assessment:20+10* ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam: NA	**End Term Examination:** 50+20*

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lee, J.D.; (2010), Concise Inorganic Chemistry, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry Principles of Structure and Reactivity, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010),
5. Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
6. Pfennig, B. W. (2015), Principles of Inorganic Chemistry. John Wiley & Sons.
7. Housecraft, C. E.; Sharpe, A. G., (2018), Inorganic Chemistry, 5th Edition, Pearson.
8. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
9. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.
10. Shiver, D.; Weller, M.; Overton, T.; Rourke, J.; Armstrong, F. (2014), Inorganic Chemistry, 6th Edition, Freeman & Company
11. Das, A. K.; Das, M. (2014), Fundamental Concepts of Inorganic Chemistry, 1st Edition, Volume CBS Publishers & Distributors Pvt. Ltd.
12. Mendham J., Vogel's Quantitative Chemical Analysis, Pearson, 2009.
13. Morrison, R.N., Boyd, R.N., Bhattacharjee, S.K.(2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
14. Finar, I.L. (2002), **Organic Chemistry** (Volume1), 6th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
15. B. Mehta & M. Mehta, Organic Chemistry, PHI Learning, 2005.
16. Eliel, E.L., Wilen, S.H. (1994), **Stereochemistry of Organic Compounds**; Wiley: London.
17. P.S Khalsi, Sterechemistry of Organic Compouns, New Age International PVT. LTD., 2nd edition, (2016).
18. Nasipuri, D.(2018), **Stereo chemistry of Organic Compounds: Principles and Applications**, 4th Edition, New Age International.
19. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
20. Furniss, B.S., Hannaford, A.J., Smith, P.W.G.; Tatchell, A.R (2004), **Vogel's Text book of Practical Organic Chemistry**, Pearson.
21. Atkins, P.W.; Paula, J.de.(2014), Atkin's Physical Chemistry Ed.,10th Edition,Oxford University Press.
22. Ball, D.W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
23. Castellan, G.W. (2004), Physical Chemistry, 4th Edition, Narosa.
24. Kapoor, K.L. (2015), A Text book of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.
25. B. D. khosala, V. C. Garg, A. Gulati, Senior Practical Physical Chemistry, R. Chand (2015).
26. V. K. Ahluwalia, S. Dhingra, A. Gulati, College Practical Chemistry, University Press.

Max.Marks:70

Course type-MCC-6

Session:2024-25			
PartA-Introduction			
Subject	Chemistry		
Semester	IV		
Nameof Course	**PHYSICALCHEMISTRY–II** Thermodynamics and Colligative Properties		
CourseCode	B-23-CHE-402		
Course Type:(MCC/CC /MDC /DSEC/VOC/DSE/PC/AEC/ VAC)	MCC		
Level of thecourse(As perAnnexure-I)	100-199		
Pre-requisite forthe course (ifany)	4.0		
CourseLearning Outcomes(CLO):	• Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties. • Derive the expressions of ΔU, ΔH, ΔS, ΔG, ΔA for an ideal gas under different conditions. • Understand the concept of partial molar properties. • Demonstrate different kinds of phase equilibrium. • Students will learn about existence of a substance in a given phase under different temperature and pressure values.		
Credits	**Theory**	**Practical**	**Total**
	3	1	4
ContactHours	45	30	75

Max.Marks:70+30* InternalAssessmentMarks:20+10* EndTermExamMarks:50+20*	Time:03+03*

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1) based on entire syllabus will consist of short answertype. All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	**Chemical Energetics11 hours** Recapitulation of Intensive and extensive variables; state and path functions; isolated, closed and open systems, concept of heat, Q, work, W, internal energy, U, and enthalpy, H. **First law:** Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities for ideal gas, Joule's experiment, calculations of Q, W, ΔU and ΔH for reversible expansion of ideal gases under isothermal conditions.
II	**Thermochemistry** **11 hours** Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of ionization enthalpy of hydration, enthalpy of formation and enthalpy of combustion, Integral enthalpy of solution, bond dissociation energy and bond enthalpy; Hess's law, Born Haber's cycle (NaCl/ KCl). **Second Law:** Concept of entropy; statements of the second law of thermodynamics (Kelvin and Clausius). Calculation of entropy change for reversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy (Non-PV work and the work function); Free energy change and concept of spontaneity (for ideal gases).
III	**Third Law** **11 hours** Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases. **Systems of Variable Composition:** Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, Change in thermodynamic functions on mixing of ideal gases.

IV	**Solutions and Colligative Properties** **12 hours** Dilute solutions; lowering of vapour pressure, Raoult's law, Henry's law. Thermodynamic basis of the colligative properties - lowering of vapour pressure, elevation of Boiling Point, Depression of Freezing point, Osmotic pressure and derivation of expressions for these using chemical potential. Application of colligative properties in calculating molar masses of normal, dissociated and associated solutes in solutions, Van't Hoff factor and its applications. Concept of activity and activity coefficients.	
V*	**30hours** 1. Determination of critical solution temperature and composition at CST of the phenolwater system 2. Determination of heat capacity of calorimeter. 3. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 4. Determination of the enthalpy of ionization of acetic acid. 5. Determination of enthalpy of neutralization of acetic acid and ammonium hydroxide using Hess's law. 6. Determination of integral enthalpy of solution (both endothermic and exothermic) of salts. 7. Determination of enthalpy of hydration of Copper sulphate.	
SuggestedEvaluationMethods		
InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA		**End TermExamination:** 50+20*

Recommended

PartC-LearningResources

RecommendedBooks/e-resources/LMS:

1. Puri, B. R., Sharma, L. R. and Pathania M. S. (2020), Principles of Physical Chemistry, Vishal Publishing Co.
2. Castellan, G. W. (2004), Physical Chemistry, Narosa.
3. Kapoor, K. L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.
4. Kapoor, K. L. (2015), A Textbook of Physical Chemistry, Vol 2, 6thEdition, McGraw Hill Education.
5. Khosla, B. D.; Garg, V. C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co.
6. Kapoor, K. L. (2019), A Textbook of Physical Chemistry, Vol 7, 1st Edition, McGraw Hill Education.
7. Batra, S. K., Kapoor, V and Gulati, S. (2017) 1st Edition, Experiments in Physical Chemistry, Book Age series.

**Applicableforcourseshavingpracticalcomponent.*

Max.Marks:7

Course type-MCC-7

Session:2024-255			
PartA-Introduction			
Subject	Chemistry		
Semester	IV		
Nameof Course	**General Chemistry-I:** General Spectroscopy		
CourseCode	B-23-CHE-403		
Course Type:(MCC/CC /MDC /DSEC/VOC/DS E/PC/AEC/ VAC)	MCC		
Level of thecourse (As perAnnexur e-I)	100-199		
Pre-requisite forthe course (ifany)	4.0		
CourseLearnin gOutcomes(CLO) :	• Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy. • Interpret various types of spectra and know about their application in structure elucidation • Understand how molecular spectroscopy techniques, UV, IR, NMR and Mass can be used to identify structures of organic compounds.		
Credits	**Theory**	**Practical**	**Total**
ContactHours	3	1	4
	45	30	75

Max.Marks:70+30* InternalAssessmentMarks:20+10* EndTermExamMarks:50+20*	Time:03+03*

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1) based on entire syllabus will consist of short answertype. All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	**11 Hours** Electromagnetic radiation, interaction of electromagnetic radiation with matter, regions of the Spectrum the width and intensity of spectral transitions. Resolving power. **Rotational Spectra**: The rotation of molecules, rotational spectra of diatomic molecules, the spectrum of non-rigid rotator, the effect of isotopic substitutions rotational spectra of linear and symmetric top polyatomic molecules.
II	***Vibrational and Vibrational- Rotational Spectra:*****11 Hours** The vibrating diatomic molecule; simple harmonic vibrations, anharmonicity of vibrations, the diatomic vibrating rotator, the interaction of rotations and vibrations the vibrations of polyatomic molecules, analysis by infrared technique. ***Electronics Spectra:***Electronic spectra of diatomic molecules, vibrational course structure, and rotational fine structure of electronic band. The Frank- Condon principle, intensity of vibrational-electronic band, dissociation energy, the Fortrat diagram.
III	***Raman Spectroscopy:*****12 Hours** Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra, Raman activity of vibrations, vibrational Raman spectra, polarization of light and Raman effect, applications. Principles and Applications of UV and IR Spectra in the structure elucidation of Organic Compounds.

IV	*NMR Spectra for Organic Compounds* **12 Hours** Spin active nuclei, chemical shift, shielding and deshielding, internal standards, spin-spin coupling, equivalent and non- Equivalent Protons, effect of changing solvents and hydrogen bonding on chemical shifts, anisotropic effect. Applications in structure determination.
V*	*Qualitative Analysis* **30hours** Identification of organic compound using spectroscopic methods (UV, IR, NMR & Mass) followed by characterization by chemical methods.

SuggestedEvaluationMethods

InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA	**End TermExamination:** 50+20*

PartC-LearningResources

RecommendedBooks/e-resources/LMS:

1. R.S. Drago: Physical Methods in Inorganic Chemistry, affiliated east-west press pvt. Ltd.-New Delhi (2012).
2. C.N.Banwell: Fundamentals of Molecules Spectroscopy, McGraw Hill Education; 4th edition (2017).
3. D.L. Pavia, G.M. Lampman, G.S. Kriz and J.R. Vyvyan: Introduction to Spectroscopy, Cengage Learning India Private Limited; 5th edition (2015).
4. R.M. Silverstein, G.C. Bassler, and T.C. Morrill: Spectrometric Identification of Organic Compounds, John Wiley, 6th edition, (2002).
5. H. Middleton: Systematic Qualitative Organic Analysis, Edward Arnold & Co. (1948) .
6. H. Clark: Handbook of Organic Analysis-Qualitative and Quantitative, CBS, 4th revised edition (2007).

**Applicableforcourseshavingpracticalcomponent.*

Course type-MCC-8

Session:2024-25			
PartA-Introduction			
Subject	Chemistry		
Semester	IV		
Nameof Course	**General Chemistry-II:** Nuclear and Polymer Chemistry		
CourseCode	B-23-CHE-404		
Course Type:(MCC/CC /MDC /DSEC/VOC/DSE/PC/AEC/ VAC)	MCC		
Level of thecourse (As perAnnexure-I)	100-199 Chemistry		
Pre-requisite forthe course (ifany)	4.0		
CourseLearningOutcomes(CLO):	• Gain knowledge about Nuclear chemistry, radioactive decay, nuclear disasters, andnuclear waste and their disposal. • Describe the composition of air, various air pollutants, effects and control measures ofair pollutants. • List different sources of water, water quality parameters, impacts of water pollution,water treatment. • Identify different industrial effluents and their treatment methods.		
Credits	**Theory**	**Practical**	**Total**
	3	1	4
ContactHours	45	30	75

Max.Marks:70+30* InternalAssessmentMarks:20+10* EndTermExamMarks:50+20*	Time:03+03*

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1) based on entire syllabus will consist of short answertype. All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	***Nuclear Chemistry:*** **11 Hours** The nucleus: subatomic particles, e liquid drop model; forces in nucleus-mesons; stability of nucleus-n/p ratio, binding energy; radioactive elements. Radioactive decay- α-decay, β-decay, γ-decay; neutron emission, positron emission; unit of radioactivity (curie); half-life period; radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger Counters, Scintillation counters.
II	**Nuclear reactions:** **11 Hours** Nuclear fission-theory of nuclear fission; chain reaction; nuclear fusion; nuclear reactors-fast breeder reactors, fuels used in nuclear reactors, separation of isotopes, moderators, coolants; nuclear reactors in India. **Applications**: Dating of rocks and minerals, carbon dating, neutron activation analysis, isotopic labelling studies, nuclear medicine- 99mTc radiopharmaceuticals. Nuclear disasters – Chernobyl disaster, Three Mile Island Disaster, Disposal of nuclear waste and its management.
III	***Preparation, Properties and Uses of Polymers:*** **12 Hours** Brief introduction to polymerisation, mechanism, properties and application of the following polymers: polyolefins, polystyrene, poly(vinyl chloride), poly(vinyl acetate), polyurethanes, acrylic polymers and polyamides. Phenol formaldehyde and urea formaldehyde, Silicone polymers, Conducting Polymers: polyacetylene, polyaniline, polypyrrole, polythiophene., Biopolymer: Cellulose and Chitosan.

IV	*Characterization of Polymers* **12 Hours** Thermal characterisation of polymer: Glass transition temperature (Tg), thermal stability and decomposition of polymers, Molecular weight of polymers (Mn, Mw, etc.) by end group analysis, viscometry, light scattering technique and osmotic pressure methods. Structural characterisation of polymers by IR and NMR spectroscopy.	
V*	**30hours** 1. Determination of dissolved oxygen in a given sample of water. 2. Determination of Chemical Oxygen Demand (COD) in a given sample of water. 3. Determination of Biological Oxygen Demand (BOD) in a given sample of water. 4. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$and potassium chromate). 5. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method. 6. Measurement of dissolved CO_2 in a given sample of water.	
SuggestedEvaluationMethods		
InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA		**End TermExamination:** 50+20*

Course type- DSE-1

Session:2024-25			
PartA–Introduction			
Subject	Chemistry		
Semester	IV		
Nameof Course	**Elective Chemistry-I (Inorganic Chemistry):** Environmental Chemistry		
CourseCode	B-23-CHE-405 (E1)		
Course Type:(MCC/CC /MDC /DSEC/DSE/VOC/DSE/PC/AEC/VAC)	DSE		
Levelofthecourse(AsperAnnexure-I	100-199		
Pre-requisite forthe course (ifany)	4.0		
CourseLearningOutcomes(CLO):	• Synthesize knowledge on the structure and functions of environmental compartments based on the principles of environmental chemistry • Acquire analytical and technical skills to recognize and estimate different environmental chemicals • Apply concepts of environmental chemistry to develop low-cost methods to treat potable and industrial wastewater and manage the quality of water, soil, and air • Relate and interpret the contaminants exposure and its adverse impacts on living organisms and the health of ecosystems • influence the environmental fate of contaminants • Discuss global environmental issues in the background of the chemistry of pollutants		
Credits	**Theory**	**Practical**	**Total**
	3	1	4
ContactHours	45	30	75

Max.Marks:70+30* InternalAssessmentMarks:20+10* End TermExamMarks:50+20*	Time:03+03*

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1) based on entire syllabus will consist of short answertype). All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	***Fundamentals of environmental chemistry:12 Hours*** Atomic structure, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds); mole concept, molarity and normality, quantitative volumetric analysis. ***Thermodynamic system;*** types of chemical reactions; acids, bases and salts, solubility products; solutes and solvents; redox reactions, concepts of pH and pE, electrochemistry, Nernst equation, electrochemical cells. Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, organic functional groups, polarity of the functional groups, synthesis of xenobiotic compounds like pesticides and dyes, synthetic polymers.
II	***Air Pollution*** **10 Hours** Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain, case studies; reactions of NO_2 and SO_2; free radicals and ozone layer depletion, role of CFCs in ozone depletion. ***Chemistry and environment impact of the following:*** Photochemical smog, Greenhouse effect, Ozone depletion Air pollution control, Settling Chambers, Venturi Scrubbers, Electrostatic Precipitators (ESPs).
III	***Water Chemistry*** ***6 Hours*** Chemical and physical properties of water; alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; colloidal particles; heavy metals in water Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment).

IV	***Soil chemistry*** ***6 Hours*** Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil; phenolic compounds in soil. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion-exchange). Water quality parameters for wastewater, industrial water and domestic water.
V*	**30 Hours** 1. Prepare buffers/solutions of different molarity and normality using the given stocks solutions 2. Determine the variations in pH of different soils and water samples using various methods. 3. Estimate hardness of given water samples 4. Determine cation exchange capacity of given soils samples 5. Determine the suitability of water for use for agriculture, industrial and domestic purposes based on selected water parameters 6. Estimate contents of selected heavy metals in given water and soil samples and identify their possible sources 7. Analyse variations in air quality index of different regions and correlate with anthropogenic or natural factors 8. Estimate organic matter contents in different soil types 9. Assess soil health based on the concentration of selected macro elements

SuggestedEvaluationMethods	
InternalAssessment: 20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA	**End TermExamination:** 50+20*
PartC-LearningResources	

RecommendedBooks/e-resources/LMS:

1. Beard, J.M. 2013. **Environmental Chemistry in Society** (2nd edition). CRC Press.
2. Connell, D.W. 2005. **Basic Concepts of Environmental Chemistry** (2nd edition). CRC Press.
3. Harnung, S.E. & Johnson, M.S. 2012. **Chemistry and the Environment**. Cambridge University Press.
4. Hites, R.A. 2012. **Elements of Environmental Chemistry** (2nd edition). Wiley Sons.
5. Manhan, S. E. 2000. **Fundamentals of Environmental Chemistry**. CRC Press.
6. Pani, B. 2007. Textbook of **Environmental Chemistry**. IK international Publishing House.
7. Girard, J. 2013. Principles of **Environmental Chemistry** (3rd edition). Jones & Bartlett.

**Applicableforcourseshavingpracticalcomponent.*

Course type- DSE-1

Session:2024-25			
PartA–Introduction			
Subject	Chemistry		
Semester	IV		
Nameof Course	**Elective Chemistry-II (Organic Chemistry):** Organic Biomolecules		
CourseCode	B-23-CHE-405 (E2)		
Course Type:(MCC/CC /MDC /DSEC/DSE/VOC/DSE/PC/AEC/ VAC)	DSE		
Levelofthecourse(AsperAnnexure-I	100-199		
Pre-requisite forthe course (ifany)	4.0		
CourseLearningOutcomes(CLO):	• Learn and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses. • Gain an insight into the mechanism of enzyme action and inhibition. • Understand the basic principles of drug-receptor interaction and SAR.		
Credits	**Theory**	**Practical**	**Total**
	3	1	4
ContactHours	45	30	75
Max.Marks:70+30* InternalAssessmentMarks:20+10* End TermExamMarks:50+20*		**Time:03+03***	

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1 based on entire syllabus will consist of short answertype). All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	***Carbohydrates*** ***12 Hours*** Classification of carbohydrates, reducing and non-reducing sugars, biological functions, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, determination of configuration of glucose (Fischer proof), cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides: structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.
II	**Amino Acids, Peptides and Proteins** **11 Hours** Classification of amino acids and biological uses of amino Acids, peptides and proteins. Zwitterion structure, isoelectric point and correlation to acidity and basicity of amino acids. Determination of primary structure of peptides, determination of N-terminal amino acid (by Edman method) and C– terminal amino acid (with carboxypeptidase enzyme). Synthesis of simple peptides (up to dipeptides) by N-protection (t-butyloxycarbonyl) & C-activating groups (only DCC) and Merrifield solid phase synthesis, Overview of primary, secondary, tertiary and quaternary structure of proteins, denaturation of proteins.
III	***Nucleotides 11 Hours*** Sugars and bases; Conformation of sugar-phosphate backbone; hydrogen bonding by bases; the double helix; A, B, and Z double helices; Stability of Double Helix; DNA intercalators; Chemical synthesis of DNA. ***Lipids:*** Fatty acids, triacylglycerols, phospholipids, lipid bilayer formation, steroids (cholesterol)
IV	***Enzymes and correlation with drug action:*** ***11 Hours*** Classification of enzymes and their uses (mention Ribozymes). Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and non-competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, -NH2 group, double bond and aromatic ring.

V*	1. Estimation of glucose by Fehling's solution. **30hours** 2. Determination of total sugar content by ferricyanide method (volumetric/colorimetric method). 3. Study of the titration curve of glycine. 4. Qualitative tests for amino acids, proteins and carbohydrates. 5. Separation and identification of mixture of sugars by paper chromatography.	
SuggestedEvaluationMethods		
InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA		**End TermExamination:** 50+20*
PartC-LearningResources		
RecommendedBooks/e-resources/LMS: 1. Finar, I. L. **Organic Chemistry**(Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Berg, J. M.; Tymoczko, J. L.; Stryer, L. (2019), **Biochemistry**, 9th Ed., W. H. Freeman Co Ltd. 4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook of **Practical Organic Chemistry**, Pearson. 5. **Manual of Biochemistry** Workshop, 2012, Department of Chemistry, University of Delhi.		
• Seminar/Demonstration/Viva-voce/Labrecordsetc.:10		50+20*

**Applicableforcourseshavingpracticalcomponent.*

Course type- DSE-1

Session:2024-25			
PartA–Introduction			
Subject	Chemistry		
Semester	IV		
Nameof Course	**Elective Chemistry-III(Physical Chemistry):** Phase Equilibria and Surface Chemistry		
CourseCode	B-23-CHE-405 (E3)		
Course Type:(MCC/CC /MDC /DSEC/DSE/VO C/DSE/PC/AEC/ VAC)	DSE		
Leveloftheco urse(AsperAnn exure-I	100-199		
Pre-requisite forthe course (ifany)	4.0		
CourseLearnin gOutcomes(CLO) :	• Explain different types of phase equilibrium, draw a well labelled phase diagram. • Predict the existence of a substance in a given phase under different conditions of temperature and pressure • Apply the concepts of phase, solutions and distribution law while studying other chemistry courses and every-day life processes. • Explain the type of adsorption that can take place in different systems and predict the conditions to get maximum adsorption.		
Credits	**Theory**	**Practical**	**Total**
	3	1	4
ContactHours	45	30	75

Max.Marks:70+30* InternalAssessmentMarks:20+10* End TermExamMarks:50+20*	Time:03+03*

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1 based on entire syllabus will consist of short answertype). All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	**Phase Equilibria-I*12 Hours*** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H_2O and S), with applications. A comparison between the phase diagram of CO_2 and H_2O. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions (excluding partial miscibility).
II	***Phase Equilibria-II*** **11 Hours** Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), Konovalov's laws, azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications. Three component systems, water-chloroform-acetic acid system, triangular plots.
III	***Surface Chemistry*** ***11 Hours*** Distinction between adsorption and absorption, Physical adsorption: chemisorption, adsorption isotherms (Langmuir and Freundlich). Nature of adsorbed state. Multilayer adsorption, BET equation derivation, thermodynamic treatment of adsorption-Gibbs equation. Applications of Adsorption phenomenon in living systems.
IV	***Colloidal State*** ***11 Hours*** Distinction among true solutions, colloids and suspensions, components of Colloids, classification of colloids - lyophilic, lyophobic; Preparation methods and properties of lyophobic solutions, Hydrophile-lyophile balance (HLB), multi molecular, macromolecular and associated colloids (micelles formation), Schulze -Hardy law.

V*	1. Determination of critical solution temperature and composition at CST of the phenol water system 2. To study the effect of impurities of sodium chloride and succinic acid on the CST of phenol-water system. 3. To study the cooling curves for the following systems: a. Simple eutectic b. Congruently melting systems. 4. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.	**30hours**

SuggestedEvaluationMethods	
InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA	**End TermExamination:** 50+20*

PartC-LearningResources

RecommendedBooks/e-resources/LMS:

1. Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
3. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 3, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L. (2015),A Textbook of Physical Chemistry, Vol 5, 6th Edition, McGraw Hill Education.
5. Ball, D. W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
6. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
7. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.
8. Levine, I.N. (2010), Physical Chemistry, Tata Mc Graw Hill.

**Applicableforcourseshavingpracticalcomponent.*

Course type-CC-M4(V)

Session:2024-25			
PartA-Introduction			
Subject	Chemistry		
Semester	IV		
Nameof Course	**Green Chemistry**		
CourseCode	B-23-CHE-204		
Course Type:(MCC/CC /MDC /DSEC/VOC/DS E/PC/AEC/ VAC)	VOC		
Level of thecourse (As perAnnexur e-I)	100-199		
Pre-requisite forthe course (ifany)	4.0		
CourseLearning Outcomes(CLO):	• Understand the twelve principles of green chemistry and also build the basic understanding of toxicity, hazard and risk related to chemical substances. • Calculate atom economy, E-factor and relate them in all organic synthesis • Appreciate the use of catalyst over stoichiometric reagents. Learn to use green solvents, renewable feedstock and renewable energy sources for carrying out safer chemistry • Appreciate the use of green chemistry in problem solving skills and critical thinking to innovate and find solutions to environmental problems. • Learn to design safer processes, chemicals and products through understanding of inherently safer design (ISD) • Appreciate the success stories and real-world cases as motivation for them to practice green chemistry		
Credits	**Theory**	**Practical**	**Total**

	3	1	4
ContactHours	45	30	75
Max.Marks:70+30* InternalAssessmentMarks:20+10* EndTermExamMarks:50+20*		Time:03+03*	

PartB-Contentsofthe Course

InstructionsforPaper-Setter

Note: The examiner is requested to set nine questions in all, selecting two questions from eachSECTION and one question (Question No.1) based on entire syllabus will consist of short answertype. All questions carry equal marks. The candidate is required to attempt five questions in allselectingonefromeachSECTION.QuestionNo.1iscompulsory.Logtableandnon-programmable calculatorareallowed.

Unit	Topics
I	***Introduction*** ***10 Hours*** Definition of green chemistry and how it is different from conventional chemistry and environmental chemistry. ➢ Need of green chemistry ➢ Importance of green chemistry in- daily life, Industries and solving human health problems (four examples each). ➢ A brief study of Green Chemistry Challenge Awards (Introduction, award categories and study about five last recent awards).
II	***Twelve Principles of Green Chemistry:*** ***12 Hours*** The twelve principles of the Green Chemistry with their explanations, Special emphasis on the following: • Prevention of waste / byproducts, pollution prevention hierarchy. • Green metrics to assess greenness of a reaction: environmental impact factor, atom economy and calculation of atom economy. • Green solvents-supercritical fluids, water as a solvent for organic reactions, ionic liquids, solvent less reactions, solvents obtained from renewable sources. • Catalysis and green chemistry- comparison of heterogeneous and homogeneous catalysis, biocatalysts, asymmetric catalysis and photocatalysis. • Green energy and sustainability. • Real-time analysis for pollution prevention. • Prevention of chemical accidents, designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

III	***Important Applications of Green Chemistry Principles:*** ***12 Hours*** Concept familiarization and application of green chemistry principles using specific examples 1. Prevention of waste/ by products; waste or pollution prevention hierarchy 2. Green metrics to assess greenness of a reaction: Calculation of atom economy of the rearrangement, addition, substitution, and elimination reactions; calculation of E-factor for industrial processes 3. Prevention/ minimization of hazardous/ toxic products 4. Safer Solvent and Auxiliaries: Problems associated with conventional reaction media Some Common Green solvents: Introduction, application, advantages, and disadvantages of green solvents in organic synthesis (taking suitable examples). Special emphasis on the following: i. Super Critical Fluids (with special reference to carbon dioxide) ii. Water: Concept of In-water, and on-water reactions (with special reference to synthesis of terpinol and linalool in water, Benzoin condensation, Heck reaction) iii. Ionic Liquids: Physical properties and classification of Ionic Liquids (with special reference to Diels Alder reaction and Coumarin synthesis in ionic liquids) iv. Biomass derived Solvents: Physicochemical properties, Use of glycerol and its derivatives (Mizoroki–Heck reaction) and 2-methyltetrahydrofuran (Suzuki–Miyaura reaction). 5. Use of renewable starting materials: Illustrate with few examples such as biodiesel, bioethanol, polymers from renewable resources (PLA from corn), Synthesis and properties of 2-Methyltetrahydrofuran, furfural and 5-Aminolevulinic acid (DALA) from levulinic acid **11 Hours**
IV	The following Real-world Cases in green chemistry should be discussed: Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. Designing of environmentally safe marine antifoulant. Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn. **30hours**
V*	Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable). 1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts. 2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided). 3. Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice. 4. Mechanochemical solvent free, solid-solid synthesis of azomethine using ptoluidine and o-vanillin/p-vanillin. 5. Photoreduction of benzophenone to benzopinacol in the presence of sunlight. 6. Photochemical conversion of dimethyl maleate to dimethyl fumarate (cis-trans isomerisation)

1. Anastas, P.T., Warner, J.C. (2014), Green Chemistry, Theory and Practice, Oxford

SuggestedEvaluationMethods	
InternalAssessment:20+10* ➢ **Theory** • ClassParticipation:5 • Seminar/presentation/assignment/quiz/classtestetc.:5 • Mid-TermExam:10 ➢ **Practicum** • ClassParticipation:NA • Seminar/Demonstration/Viva-voce/Labrecordsetc.:10 • Mid-TermExam:NA	**End TermExamination:** 50+20*

PartC-LearningResources

RecommendedBooks/e-resources/LMS:

1. Anastas, P.T., Warner, J.C. (2014), Green Chemistry, Theory and Practice, Oxford University Press.
2. Lancaster, M. (2016), Green Chemistry: An Introductory Text, 3rd Edition, RSC Publishing.
3. Cann, M. C., Connely, M.E. (2000), Real-World cases in Green Chemistry, American Chemical Society, Washington.
4. Matlack, A.S. (2010), Introduction to Green Chemistry, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
5. Alhuwalia, V.K., Kidwai, M.R. (2005), New Trends in Green chemistry, Anamalaya Publishers.
6. Sidhwani, I.T, Sharma, R.K. (2020), An Introductory Text on Green Chemistry, Wiley India Pvt Ltd.
7. Kirchoff, M.; Ryan, M.A. (2002), Greener approaches to undergraduate chemistry experiment, American Chemical Society, Washington DC.
8. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi.
9. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), Introduction to organic Laboratory Technique- A Microscale approach, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
10. Sidhwani I.T. (2015), Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. DU Journal of Undergraduate Research and Innovation, 1(1),131-151. ISSN: 2395-2334.
11. Sidhwani, I.T; Sharma, R.K. (2020), An Introductory Text on Green Chemistry, Wiley India Pvt Ltd.
12. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.

Applicableforcourseshavingpracticalcomponent.