CALICUT UNIVERSITY – FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**BASIC INORGANIC AND NANO CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Concept of atom and molecule Constituents of the atom, Rutherford's model of the atom. Periodic table and classification of elements to different blocks, Basic knowledge of qualitative and quantitative analysis Titration and use of indicators				
Course Summary	This course is intended to provide basic knowledge in inorganic chemistry and nanochemistry. The student gets an understanding of the Bohr model of the atom and the modern quantum mechanical model of the atom through the first module of this course. Different types of chemical bonding are also included in the first module. General properties of the atom and the variation of these properties in the periodic table are also discussed in this course. Basic principles of analytical chemistry are included in the third module of this course which includes acid-base titration, redox titration, complexometric titration, and mixture analysis. This course also tries to explore the basic principles and importance of nanochemistry. To master the laboratory skills acid-base titration, and redox titration experiments are incorporated into this course structure.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	**To Understand the structure of atoms and rules regarding the arrangement of electrons in an atom.**	U	C	Instructor-created exams / Quiz /Assignment
CO2	**To discuss the chemical bonding, theories of chemical bonding and predict molecular shapes using VSEPR theory**	U	F	Instructor-created exams / Quiz /Assignment

CO3	**To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications**	U	F	Instructor-created exams / Quiz /Assignment
CO4	**To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis**	U	C	Instructor-created exams / Quiz /Assignment
CO5	**To understand the basics of Nano chemistry & to describe the synthesis of nanomaterials, carbon nanotubes, and their applications,**	U	F	Instructor-created exams / Quiz /Assignment
CO6	**To Perform different titrations and execute open-ended experiments safely and effectively**	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		**Atomic structure and Chemical Bonding**	**15**	**34**
	1	Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.	2	
	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
	3	Quantum numbers and their significance	1	
	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of $BeCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. NH_4^+, SO_4^{2-}	2	
	7	Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP^2 (ethylene), SP^3 (CH_4), SP^3d (PCl_5), SP^3d^2 (SF_6)	2	

	8	Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation of bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories	2	
II		**Periodic Properties**	**5**	**10**
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henry Mosley, Moseley's periodic law - Modern periodic law – Long form periodic table.	**2**	
	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	**3**	
III		**Analytical Chemistry**	**15**	**34**
	11	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass.	**2**	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	**2**	
	13	Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations :	**3**	
	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
	15	Principles in the separation of cations in qualitative analysis	**2**	
	16	Common ion effect and solubility product and its applications in qualitative analysis	**2**	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	**2**	
IV		**Nano Chemistry**	**10**	**20**
	18	Introduction, Definition of nanomaterials and nanotechnology –Classification of nanomaterials based on dimension with examples for each 0D, 1D, and 2D	**2**	
	19	Synthesis of nanomaterials: top-down processes and Bottom–up processes	**2**	
	20	Carbon nanotubes, Types of Carbon nanotubes – SWCNT and MWCNT, Synthesis of Carbon nanotubes - electric arc discharge, laser ablation, and chemical vapor deposition.	**3**	

	21	Important properties of carbon nanotubes and applications of carbon nanotubes.	**1**	
	22	Fullerenes, graphene - (basic concept only, no classification is required) Applications of nanomaterials.	**2**	
V		**Basic Inorganic Chemistry Practical:** **Acid-Base titrations and Redox titrations**	**30**	
		General Instructions For weighing electronic balance must be used. For titrations, double burette titration method should be used. Standard solution must be prepared by the student. Use a safety coat, gloves, shoes and goggles in the laboratory. A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		
		Importance of lab safety – Burns, Eye accidents, Cuts, gas poisoning, Electric shocks, Treatment of fires, Precautions and preventive measures. Weighing using electronic balance, Preparation of standard solutions.		
	I	**Neutralization Titrations** 1. Strong acid – strong base. 2. Strong acid – weak base. **3.** Weak acid – strong base.		
	II	**Redox Titrations - Permanganometry:** 4. Estimation of oxalic acid. 5. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt **Redox Titrations - Dichrometry** 6. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator. 7. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator. **Redox Titrations - Iodimetry and Iodometry:** 8. Estimation of iodine. **9.** Estimation of copper		
	III	**Open-ended experiments - Suggestions** Iodometry: Estimation of chromium. Determination of acetic acid content in vinegar by titration with NaOH. Determination of alkali content in antacid tablets by titration with HCl. Determination of available chlorine in bleaching powder.		

References

1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.
3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
4. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.
5. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.
6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
7. M. A. Shah, Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.
8. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.
9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2				2		1				1		
CO 2	2				2		1				1		
CO 3	1				2		1				1		
CO 4	1		1		2		1				1		
CO 5	1				2		1				1		
CO 6			2		1		1		1		2		

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6	✓	✓	✓	

CALICUT UNIVERSITY – FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**QUANTUM MECHANICS, SOLID STATE AND GASEOUS STATE**				
Type of Course	**MINOR**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Basic idea the structure of atom 2. Fundamentals of states of matter 3. Basic knowledge in analytical principles				
Course Summary	1. This course aims to introduce the failures of classical theories in explaining many experiments and the emergence of quantum theory. 2. This course also aims to realise the theories of different states of matter and their implications. 3. This course also aims to develop proficiency in qualitative analysis and to familiarize physical chemistry experiments				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the importance and the impact of quantum revolution in science.	U	F	Instructor-created exams / Quiz /Assignment
CO2	To evaluate the properties of solids	E	C	Instructor-created exams / Quiz /Assignment
CO3	To analyse the behaviour of gases	An	C	Instructor-created exams / Quiz /Assignment
CO4	To understand the properties of gaseous state and how it links to thermodynamic systems.	U	C	Instructor-created exams / Quiz /Assignment
CO5	To perform the cation analysis on a provided mixture containing two cations.	An	P	Lab work

CO6	To enable the students to determine the physical properties (physical constants).	Ap	P	Lab work

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Introduction to Quantum mechanics**	**15**	**32**
	1	Postulates of quantum mechanics – derivation of time-independent Schrodinger equation	2	
	2	Particle in one dimensional box problem- Schrodinger equation, derivation for expression of energy, quantisation of energy levels, HOMO-LUMO transition in 1,3-butadiene Particle in three dimensional box (no derivation)- Concept of degeneracy of energy levels	3	
	3	Harmonic oscillator model, Schrodinger equation and Energy levels (basic idea only, no derivation)	1	
	4	Spherical polar coordinates and Rigid rotor model (no derivation, basic idea only), Expression for energy, Spherical harmonics, Angular momentum	2	
	5	Quantum mechanics of Hydrogen-like atoms - Hamiltonian operator of H-like systems, The Schrodinger equation in spherical polar coordinates, separation of variables	3	
	6	Wave functions or atomic orbitals, radial and angular parts of atomic orbitals. Quantum numbers (n, l, m).	2	
	7	The Stern - Gerlach experiment and the concept of electron spin, spin quantum number.	2	
II		**Solid state**	**10**	**22**
	8	Classification of solids: Amorphous, Crystalline, Lattice points, lattice energy (general idea), unit cell, seven crystal systems.	2	
	9	Weiss and Miller indices - Bravais lattices, Close packing in crystals, examples of simple cubic, bcc and fcc lattices,	1	
	10	Explanation of electrical properties using concepts of bands, Explanation of conductors, semiconductors and insulators, Super conductors	2	
	11	Magnetic Properties: classification - diamagnetic, paramagnetic, antiferromagnetic, ferro and ferrimagnetic, permanent and temporary magnets.	3	
	12	Defects in crystals – stoichiometric and non-stoichiometric defects (Basic ideas only).	2	
III		**Gaseous state - I**	**10**	**22**

	13	Characteristics of gases	1	
	14	Postulates of kinetic theory of gases	2	
	15	Maxwell's distribution of molecular velocities – Root mean square, average and most probable velocities.	3	
	16	Collision number – Mean free path – Collision diameter	1	
	17	Viscosity of gases, including their temperature and pressure dependence,	1	
	18	Relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.	2	
IV	**Gaseous state -II**		**10**	**22**
	19	Behaviour of real gases - Deviation from ideal behaviour – Compressibility factor	3	
	20	Causes of deviation from ideal behaviour - van der Waals equation of state (derivation not required) – Expression of van der Waals equation in virial form and calculation of Boyle temperature	4	
	21	PV isotherms of real gases – Continuity of states – Isotherm of van der Waals equation	1	
	22	Critical phenomena (basic idea only) – Critical constants and their determination (derivation not required) – Relationship between critical constants and van der Waals constants.	2	
V	**Practical** A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		**30**	
	1	Inorganic Qualitative Analysis (semi – micro analysis) ● Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH_4^+, Pb^{2+}, $Cu^{2+,}$ Cd^{2+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+} , Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, and Mg^{2+} ● Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures)	25	
	2	Open ended experiments– Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc]	5	

Reference Books

1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.

2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
5. Anthony R. West, Solid State Chemistry and its Applications, 2nd Edn., Wiley-Blackwell, 2014.
6. L. V. Azaroff, Introduction to Solids, Tata McGraw Hill Publishing Company, New Delhi, 1960.
7. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
8. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
9. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
10. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2				2		1						
CO2	2				2		1						
CO3	2				2		1						
CO4	2				2		1						
CO5			2		2		1				1		
CO6			2		2		1				1		

Correlation Levels :

Level	Correlation
0	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓	✓	
CO6	✓	✓	✓	

CALICUT UNIVERSITY – FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**BASIC ORGANIC CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**III**				
Academic Level	**200-299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Fundamental Concepts of organic chemistry- Nomenclature, Isomerism, Fuctional groups, Homologous series				
Course Summary	This course explores basics of organic chemistry reaction mechanism, Reactions and mechanism of important functional groups and stereochemistry				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the basic concepts of reaction mechanisms	U	C	Instructor-created exams / Assignment
CO2	To realise types of organic reactions and intermediates	Ap	P	Instructor-created exams Assignment / quizes
CO3	To analyse important application of functional groups	An	P	Assignment / seminar/Internale xam
CO4	To understand how different functional groups confer distinct properties and reactivity, influencing the chemical behaviour of molecules	U	C	Assignment/Seminar/
CO5	To realise the imporantace of stereoisomerism,optical activity and chirality/	U	C	Assignment/Group Discussion
CO6	To enable the students to develop analytical skills in organic qualitative analysis.	Ap	P	Observation of practical skill/Viva voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Basic concepts of Organic Chemistry.**	**15**	**30**
	1	Introduction- Homolysis and Heterolysis with suitable examples. Curley arrow rules. Reagents – Electrophiles, nucleophiles and free radicals	2	
	2	Electron Displacement Effects: Inductive effect, Definition - Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents.	2	
	3	Electromeric effect: Definition – Characteristics - +E effect and -E effect - Addition of H+ to ethene and addition of CN- to acetaldehyde.	1	
	4	. Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene,nitrobenzene, Phenol and Aniline	3	
	5	Hyperconjugation effect: Definition – Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	1	
	6	Steric effect	1	
	7	Reaction intermediate:Type ,shape and stability of Carbocations, carbanions and free radicals.	3	
	8	Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions- Defintion and one example	2	
II		**Chemistry of alkyl halides, Alcohols and phenols**	**10**	**23**
	9	**Akyl halides** Preparation of alkyl halides from alkanes and alkenes – Wurtz reaction and Fittig's reaction. SN1 and SN2 reactions of alkyl halides-Mechanism and stereochemistry.	3	
	10	**Alcohols**: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only).	2	
	11	**Reactions of Alcohols**-Substitution, dehydration, oxidation and esterification. Haloform reaction - iodoform test – Luca's test – Chemistry of methanol poisoning, harmful effect of ethanol in human body	3	

	12	**Phenols**: Preparation from chlorobenzene. Comparison of acidity of phenol, p-nitrophenol and p-methoxyphenol –.	1	
	13	Preparation and uses of phenolphthalein	1	
III	**Chemistry of carbonyl compounds and amines**		**10**	**22**
	14	**Aldehydes & Ketones**: Preparation from alcohols – Comparison of reactivity of aldehydes and ketones. Nucleophilic addition reactions-addition of HCN and bisulphite. Clemmension reduction and wolff kishner reduction	3	
	15	**Carboxylic Acids**: Preparation from Grignard reagent – Decarboxylation – Kolbe electrolysis.	2	
	16	**Amines**: Preparation from nitro compounds – Hofmann's bromamide reaction – Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methylamine and aniline	3	
	17	**Diazonium salts**:Preparation and synthetic application of benzene diazonium chloride.	1	
	18	Preparation and uses of methyl orange	1	
IV	**Stereochemistry**		**10**	**23**
	19	**Stereosiomerism:** definition, classification. Geometrical Isomerism: Definition, Condition, Geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid. cis and trans isomerism, E and Z configurations. Methods of distinguishing geometrical isomers using melting point and dipolemoment.	3	
	20	**Conformations**: Newman projection, Saw-horse projection. Conformations of ethane, n-butane, and cyclohexane. Relative stability and energy diagrams. Conformation of methyl cyclohexane.	3	
	21	**Optical Isomerism** - Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with one and two chiral-centres-Lactic acid and tartaric acid. Distereoisomers, meso-structures .	3	
	22	Racemic, mixture. Racemisation and resolution	1	
V	**PRACTICALS RELATED TO THE MODULE II and III**		**30**	
	1	Reactions of Organic Compounds	4	
	2	II. Functional groups test for 1. Phenols -Phenol 2. Amines-Aniline 3. Aldehydes and ketones -benzaldehyde, benzophenone). 4. Carboxylic acid (benzoic acid, cinnamic acid). 5. Carbohydrates (glucose). 6. Amides (benzamide, urea	20	
	3	III.Preparation of organic compounds- open ended	6	

References

1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.

3. Kalsi, P. S., Stereochemistry Conformation and Mechanism; 8thEdn, New Age International, 2015

4. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.

5. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.

6. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

7. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.

8. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

9 . Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2nd Edn., Pearson Education, Noida, 2013

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	-	2	-	1	-	2			1	2	1	
CO 2	2		2	-	-	1	2			2	1	1	
CO 3	2	-	2	-	-	2	2			2	1		
CO 4	2	-	2		2	2	2			2	1		
CO 5	2		-	-	2	-	2			2	1		
CO 6	2	-	2		-	2	2		1		2		1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Seminar/Group Discussion	Quizes/viva	Observation Of practical Skill	End Semester Examinations
CO 1	✓	✓				✓
CO 2	✓	✓		✓		✓
CO 3	✓		✓			✓
CO 4		✓	✓			✓
CO 5		✓	✓			✓
CO 6				✓	✓	✓