FOUR-YEAR UNDERGRADUATE PROGRAMME (CU-FYUGP)

B. Sc. CHEMISTRY

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<tr><td>Programme</td><td colspan="5">B. Sc. Chemistry</td></tr>
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<tr><td>Type of Course</td><td colspan="5">MAJOR</td></tr>
<tr><td>Semester</td><td colspan="5">III</td></tr>
<tr><td>Academic Level</td><td colspan="5">200 – 299</td></tr>
<tr><td rowspan="3">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours</td></tr>
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<tr><td>4</td><td>4</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">• Early atom models – John Dalton’s atomic theory, the discharge tube experiment and discovery of electrons, the plum-pudding model, the gold foil experiment and the invention of the nucleus, the nuclear model of the atom, failures of the nuclear model.
• Mathematical prerequisites - basic understanding of differentiation, partial differentiation, integration, technique of separation of variables. Cartesian and spherical polar coordinate systems.
• VSEPR theory, postulates and applications</td></tr>
<tr><td>Course Summary</td><td colspan="5">Properties of bulk matter can be examined from the viewpoint of thermodynamics. But it is essential to know how these properties stem from the behaviour of individual atoms and molecules. The laws of quantum mechanics decide the properties of the micro-world. The course introduces the basic principles of quantum mechanics and explains how quantum mechanics has revolutionised our understanding of atomic structure and chemical bonding.</td></tr>
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Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used

CO1	*recognize* the importance and the impact of quantum revolution in science.	R	F	Assignment
CO2	*identify* the wave functions of hydrogen atom as atomic orbitals.	U	C	Class tests/Viva
CO3	*apply* the concept of atomic orbitals in chemical bonding (the mixing of wave functions of the two combining atoms).	Ap	C	Seminar/ Class tests
CO4	*relate* the concept of hybridization as linear combination of atomic orbitals of the same atom.	An	P	Class tests/Assignment
CO5	*instill* an atomic/molecular level philosophy in the minds of the students.	C	M	Viva
* - 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 (45 +30)	Marks
I	**The Quantum revolution and its early impact in atomic structure**		**8**	**21**
	1	Experiments which led to the development and generalisation of quantum theory – black body radiation, Planck's quantum hypothesis, photoelectric effect, Einstein's generalisation of quantum theory	3	
	2	Atomic model partly based on quantum theory – Bohr's theory of the atom, calculation of Bohr radius, velocity and energy of an electron.	3	
	3	Atomic spectra of hydrogen and explanation using Bohr's theory; Limitations of Bohr's theory; Louis de Broglie's matter waves – wave-particle duality; Davisson and Germer experiment.	2	
	Sections from References: **Section A**			

II	**Introductory Quantum Chemistry and the Quantum Mechanical Model of the Atom**		**22**	**42**
	4	Heisenberg's uncertainty principle and the need of quantum mechanics for the micro world; ***Postulates of quantum mechanics*** - *Wave function postulate*, Physical significance of the wave function, The Born interpretation of the wave function and probability density. Well behaved functions, orthonormal functions	2	
	5	*Time-dependent Schrodinger equation postulate* – Deduction of Time independent Schrödinger wave equation for conservative systems. Laplacian and Hamiltonian operators.	2	
	6	*Operator postulate* - linear and Hermitian operators, eigenfunctions and eigenvalues of an operator. *Eigenvalue postulate*. Hermitian operators have real eigenvalues. *Average value or expectation value postulate*	2	
	7	***Applications of time independent Schrödinger wave equation*** *Particle in a one dimensional box with infinite potential energy walls* – derivation of wave functions and energy, normalization of wave function, plots of wave functions and probability densities, average value of position, average value of momentum, calculation of energy levels and absorption band in butadiene using the particle in a box model.	4	
	8	*Particle in a one dimensional box with finite potential energy walls* (derivation not required) – Introduction to tunnelling, Principle of Scanning Tunnelling Microscopy (STM)	1	
	9	*Particles in a three dimensional box* – separation of variables and derivation of wave functions and energy, degeneracy of states in a cubic box.	2	
	10	*Hydrogen atom* - Hamiltonian operator of H-like systems, separation of nuclear and electronic motions - The Born-Oppenheimer approximation, The Schrodinger equation in spherical polar coordinates, separation of variables	3	
	11	Wave functions or atomic orbitals, radial and angular parts of atomic orbitals. Quantum numbers (n, l, m). Radial functions and their plots, Radial distribution functions and	3	

		their plots, Angular functions and their plots (1s, 2s and $2p_z$ only).		
	12	The Stern - Gerlach experiment and the concept of electron spin, spin quantum number, spin orbitals (elementary idea only). Antisymmetric wave functions and Pauli's exclusion principle.	2	
	13	Exact solution of the Schrodinger equation is impossible for multi-electron atoms - Need for approximation methods.	1	
	Sections from References: **Section A**			
III	**Bonding in Diatomic Molecules**		**12**	**21**
	14	Hamiltonian operator of H_2 molecule - Born-Oppenheimer approximation, approximate theories of chemical bonding – *(ways of mixing of wave functions of different atoms)*.	1	
	15	*Valence bond theory of H_2 molecule* - trial wave function, improvements by including delocalisation of electrons, mutual screening and partial ionic character. Potential energy profile of H_2 molecule formation - equilibrium geometry, Comparison of theoretical and experimental energy profiles.	3	
	16	*Molecular orbital theory of* H_2 molecule –linear combination of atomic orbitals (LCAO), bonding and antibonding molecular orbitals, wave function as product of one electron functions, electron distribution in bonding and antibonding molecular orbitals, overlap integral, normalisation of bonding and antibonding molecular orbitals.	3	
	17	MO diagrams of homonuclear diatomic molecules – He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2; Bond order, stability and magnetic properties of these molecules.	2	
	18	MO diagrams of heteronuclear diatomic molecules - CO and NO; Bond order.	2	
	19	Comparison of VB and MO theories.	1	
	Sections from References: **Section B**			
IV	**Bonding in Polyatomic Molecules**		**6**	**14**
	20	Concept of Hybridization: Need of hybridization, Definition *(mixing of wave functions of the same atom)*	1	

	21	LCAO of the central atom – coefficients of atomic orbitals in the linear combination of sp (BeH_2), sp^2 (BH_3) and sp^3 (CH_4) hybridization (derivation not required)	4	
	22	Other examples of hybridization – Geometry of molecules like PCl_5, SF_6 and IF_7.	1	
	Sections from References: **Section B**			
V	**Open Ended Module: Learning through problem solving and plots**		**12**	
	1	● Plots of wave functions of particle in a box using excel or other software ● Plots of angular parts of atomic orbitals using any freeware ● Problem solving sections ● Connections with inorganic chemistry topics		
	Sections from References: **Section A & Section B**			

Books and References:

Section A

1. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, Viva, 2001.

2. I. N. Levine, Quantum Chemistry, 6th Edn., Pearson Education Inc., 2009.

3. R.K. Prasad, Quantum Chemistry, 3rd Edition, New Age International, 2006.

Section B

1. James E. Huheey, Ellan A. Keiter, Richard L. Keiter, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edn., Harper Collins, 1993.

2. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A Molecular Approach*, Viva, 2001.

Further reading

1. F.L. Pilar, Elementary Quantum Chemistry 2 ND 2nd Edn., Dover, 1990.

2. P. W. Atkins, R. S. Friedman, Molecular Quantum Mechanics, 4th Edn., Oxford University Press, 2005

3. Donald, A. McQuarrie, *Quantum Chemistry*, University Science Books, 1983 (first Indian edition,Viva books,2003)

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/viva	Practical skill Evaluation	End Semester Examinations
CO 1		✓		✓
CO 2		✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ORGANIC CHEMISTRY 1**				
Type of Course	**MAJOR /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	Basics of organic chemistry-Functional groups, Homologous series, Nomenclature and isomerism				
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 basics of Organic chemistry	U	C	Test /Seminar
CO2	To understand the basic concepts of reaction mechanisms	U	p	Discussion/ Assignment
CO3	To recognize the various types of organic reactions and reaction intermediates	An	P	Quizzes/Test
CO4	To realise the importance of stereoisomerism, optical activity and chirality	Ap	P	Discussion/Seminar /Assignment
CO5	To enable the students to improvise Molecular models	Ap	P	Assignment/Test

CO6	To empower students in various separation and purification techniques	Ap	P	Lab work/Viva

* - 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**	**12**	**26**
	1	IUPAC Nomenclature of multifunctional acyclic and cyclic compounds. Structural isomerism.	2	
	2	Hybridization and bonding in organic compounds (methane, ethane, ethylene and acetylene	2	
	3	Localised and delocalised bonding. Hydrogen bonding, effect of hydrogen bonding on physical and chemical properties of compounds	1	
	4	Organic acids and bases	2	
	5	Basics of MO theory as applied to organic molecules -Ethylene and Buta-1,3-diene.	3	
	6	Aromaticity-Huckel's rule for aromaticity (Benzenoid compounds)	2	
II		**Organic reaction mechanisms**	**12**	**26**
	7	Types of bond fission-Homolytic and Heterolytic fission	1	
	8	Arrow formalism used in reaction schemes.	1	
	9	Electrophiles and Nucleophiles	1	
	10	Electron displacement Effects: Inductive effect and Field effect, Steric effect- Acidity and basicity of organic compounds based on Field effect and steric effect.	2	
	11	Electromeric effect, Mesomeric effect	2	
	12	Hyperconjugation- Stability of alkenes.	1	
	13	Reactive intermediates: Structure, formation and stability of carbocations, carbanions, free radicals, carbenes and nitrenes.	3	
	14	Pericyclic reactions and its classifications	1	

III	**Stereochemistry-I**		**14**	**30**
	15	Stereoisomerism: Conformational isomerism and configurational isomerism. Representation of stereostructures of organic molecules using Flying wedge, Fischer, Sawhorse and Newmann projections.	3	
	16	Inter conversion of different projections of L-tartaric acid and 3-chloro-2-butanol.	3	
	17	Conformational Isomerism – Conformational analysis of Ethane, n- butane and cyclohexane with PE diagram.	3	
	18	Conformation of mono substituted cyclohexanes. Relative stability of conformations.	2	
	19	Configurational isomerism: Geometrical isomerism in alkenes, cycloalkanes and oximes. Cis-trans, Syn-Anti and E-Z notations, sequence rule.	3	
IV	**Purification and Characterization Techniques**		**7**	**16**
	20	Distillation- Simple, fractional, steam and vacuum distillations	2	
	21	Recrystallisation, sublimation, solvent extraction.	2	
	22	Chromatography, stationary phase, mobile phase, Rf values, -TLC, Column chromatography, HPLC and GC (basic concepts only).	3	
V	**Practicals**		**30**	
	1.	**Introduction to organic lab**	4	
	2	1. Distillation of Aniline, 2. Distillation of Limonene (from orange peels) 3. Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol 4. Sublimation of a dicarboxylic acid/Naphthalene 5. Molecular model construction and conformation of ethane 6. Molecular model construction of Ethylene or Acetylene 7. Molecular model construction of acetaldehyde and Cyclohexane.	20	
	3	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

10.An Improved Method for the Extraction and Thin-Layer W Chromatography of Chlorophyll a and b from Spinach Hao T. Quach, Robert L. Steeper, and G. William Griffin, J Chem Edn, 2004, 81, 385

11. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, S D Sarkar and L Nahar, John Wiley and sons, Ltd.

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/viva/seminar	Practical skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2		✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6		✓	✓	✓

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**ORGANIC CHEMISTRY IN DAILY LIFE**				
Type of Course	**MINOR**				
Semester	**3**				
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. Basic concepts of Organic Chemistry 2. Chemistry and its importance in daily life				
Course Summary	This course ensure students to acquire a profound understanding of Organic Chemistry, emphasizing fundamental reactions, concepts and its implication in daily life.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts of reaction mechanisms through the step by step processes involved in chemical reactions	U	C	Instructor-created exams / Assignment
CO2	To recognize the various types of organic reactions and reaction intermediates	Ap	P	Assignment / seminar/quizzes
CO3	To understand how different functional groups confer distinct properties and reactivity, influencing the chemical behaviour of molecules.	U	C	Assignment/Seminar/Internal exam
CO4	To understand the importance of Chemistry in Daily Life.	Ap	P	Group work /Assignment
CO5	To understand the role of Chemistry in human	Ap	P	Group work /Assignment

	happiness index and life expectancy.			
CO6	To empower students to cultivate analytical skills in organic qualitative/quantitative analysis by emphasizing systematic approaches.	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	Homolytic and heterolytic fission with suitable examples. Curly arrow rules. Types of reagents -Electrophiles, Nucleophiles and Free radicals.	1	
	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.	2	
	4	Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene, phenol and aniline.	2	
	5	Hyperconjugation effect: Definition, Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	2	
	6	Steric effect and its importance in reactivity.	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-Definition and example.	2	
II		**Chemistry of Alkyl halides, Alcohols and Phenols**	**10**	**22**
	9	Akyl halides- Preparation of alkyl halides from alkanes and alkenes- Wurtz reaction and Fittig's reaction. SN^1 and SN^2 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**	**23**
	14	Aldehydes & Ketones: Preparation from alcohols. Comparison of reactivity of aldehydes and ketones.	1	
	15	Nucleophilic addition reactions in aldehydes and ketone. Addition of HCN and bisulphite. Clemmensen reduction and Wolff Kishner reduction.	2	
	16	Carboxylic Acids: Preparation from Grignard reagent-Decarboxylation-Kolbeelectrolysis.	2	
	17	Amines: Preparation from nitro compounds-Hofmann's bromamide reaction, Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methylamine and aniline.	3	
	18	Diazonium salts: Preparation and synthetic application of benzene diazonium chloride. Preparation and uses of methyl orange.	2	
IV	**Chemistry in Daily Life**		**10**	**23**
	19	Petrochemicals*:* Name, carbon range and uses of fractions of petroleum distillation. Octane number, Cetane number, Flash point. LPG and CNG: Composition and uses.	2	
	20	Pharmaceuticals: Drug - Chemical name, generic name and trade names with examples. Antipyretics, analgesics, antibiotics, antacids, antiseptics (definition and examples, structure not expected).	2	
	21	Dyes*:* Definition- Requirements of a dye. Theories of colour and chemical constitution. Structure and applications of martius yellow, indigo and alizarin.	3	
	22	Food: Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) Commonly used permitted and non-permitted food colours (structures not required).	3	
V	**Organic Chemistry Practicals**		**30**	
	23	General Reactions of Organic Compounds	4	
	24	Study of the reactions of functional groups from the following list. 1. Phenols –(phenol) 2. Amines-(aniline) 3. Aldehydes and Ketones-(benzaldehyde, benzophenone). 4. Carboxylic acids (benzoic acid, cinnamic acid). 5. Carbohydrates (glucose). 6. Amides (benzamide, urea)	20	
	25	Organic Preparations.	6	

References

1. Morrison, R. T. & 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. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
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5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
6. Jayashree Ghosh. A textbook of Pharmaceutical Chemistry, 3 rd Edn. S Chand and Company Ltd. New Delhi,1999
7. B. Srilakshmi. Food Science 5th Edn. New Age publishers, New Delhi, 2010.
8. K. Singh. Chemistry in Daily Life. Prentice Hall of India, New Delhi
9. 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.
10. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

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				✓	✓	✓

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)
BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**ORGANIC CHEMISTRY AND POLYMERS**				
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. Basic concepts of Organic Chemistry 2. Basic concepts of Polymer Chemistry				
Course Summary	This course ensure students to acquire a profound understanding of Organic Chemistry and Polymer Chemistry by emphasizing fundamental reactions and concepts.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts of reaction mechanisms through the step by step processes involved in chemical reactions	U	C	Instructor-created exams / Assignments
CO2	To recognize the various types of organic reactions and reaction intermediates	Ap	P	Assignment / seminar/quizes
CO3	To understand how different functional groups confer distinct properties and reactivity, influencing the chemical behaviour of molecules.	U	C	Assignment/Seminar/Class test
CO4	To understand the significance of polymers in daily life by recognizing their ubiquitous presence in materials and products.	Ap	P	Group work /Assignment

CO5	To understand the applications of different polymers.	Ap	P	Group work /Assignment
CO6	To empower students to cultivate analytical skills in organic qualitative/quantitative analysis by emphasizing systematic approaches.	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**	**32**
	1	Homolytic and heterolytic fission with suitable examples. Curly arrow rules. Types of reagents -Electrophiles, Nucleophiles and Free radicals.	1	
	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.	2	
	4	Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene, phenol and aniline.	2	
	5	Hyperconjugation effect: Definition, Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	2	
	6	Steric effect and its importance in reactivity.	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-Definition and example.	2	
II	**Chemistry of Alkyl halides, Alcohols and Phenols**		**10**	**22**
	9	Akyl halides- Preparation of alkyl halides from alkanes and alkenes- Wurtz reaction and Fittig's reaction. SN^1 and SN^2 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,	2	

		proof spirit and power alcohol (mention only).		
	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.	1	
	15	Nucleophilic addition reactions in aldehydes and ketone. Addition of HCN and bisulphite. Clemmensen reduction and Wolff Kishner reduction.	2	
	16	Carboxylic Acids: Preparation from Grignard reagent-Decarboxylation-Kolbe electrolysis.	2	
	17	Amines: Preparation from nitro compounds-Hofmann's bromamide reaction, Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methylamine and aniline.	3	
	18	Diazonium salts: Preparation and synthetic application of benzene diazonium chloride. Preparation and uses of methyl orange.	2	
IV	**Polymers**		**10**	**22**
	19	Classification based on origin (natural, semi synthetic and synthetic), synthesis (addition and condensation), structure (linear, branched chain and cross linked) and intermolecular forces (elastomers, fibres, thermoplastics and thermosetting polymers).	3	
	20	Tacticity- Types of Polymerisation. Chain and step growth polymerizations- Free radical, ionic and coordination polymerizations.	2	
	21	Structure and applications of synthetic rubbers (Buna-S, Buna-N and neoprene), synthetic fibres (Nylon 66, Nylon 6 and dacron), thermoplastics (polyethene, polystyrene, PVC and teflon) and thermosetting plastics (bakelite and melmac).	3	
	22	Uses of kevlar, nomex and lexan- Biodegradable polymers (PGA, PLA and PHBV) and their applications.	2	
V	**Organic Chemistry Practicals**		**30**	
	23	General Reactions of Organic Compounds	4	
	24	Study of the reactions of functional groups from the following list. 1. Phenols –(phenol) 2. Amines-(aniline)	20	

		3. Aldehydes and Ketones-(benzaldehyde, benzophenone). 4. Carboxylic acids (benzoic acid, cinnamic acid). 5. Carbohydrates (glucose). 6. Amides (benzamide, urea)		
	25	Organic Preparations.	6	

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1. Morrison, R. T. & 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. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
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10. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	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				✓	✓	✓

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**APPLIED 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 2. Basic concept of organic reaction mechanism, Chemistry of functional group				
Course Summary	This course explores organic spectroscopy, Chemistry of aromatic hydrocarbons, applications like medicinal chemistry and separation techniques				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concept of various spectroscopic techniques	U	C	Exams/Assignment
CO2	To provide a comprehensive understanding of aromatic hydocarbons	U	C	Exams/Assignment/ Group discussion
CO3	To provide basic knowledgeof medicinal chemistry	U	C	Internal test/Seminar
CO4	To understand role of chemistry in human life	An	C	Seminar/Assignment /Qizes
CO5	To provide concepts various separation and purification techniques	U	P	Exams/Seminar
CO6	To empower students in various separation and purification techniques	Ap	P	Lab work/Viva

* - 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		**Organic spectroscopy**	**15**	**30**
	1	Origin of spectra - Interaction of electromagnetic radiation with matter. Different types of energy levels in molecules: Rotational, vibrational and electronic levels.	2	
	2	Statement of Born-Oppenheimer approximation - Fundamental laws of spectroscopy and selection rules (derivations not required).	1	
	3	*UV-Visible Spectroscopy:* Basic principle- Beer-Lambert's law - Electronic transitions in molecules ($\sigma\rightarrow\sigma^*$, $n\rightarrow\sigma^*$, $\pi\rightarrow\pi^*$ and $n\rightarrow\pi^*$)	2	
	4	Chromophore and auxochrome - Red shift and blue shift.	1	
	5	λmax calculation for dienes (substituted butadienes)	2	
	6	IR spectroscopy- basic principles, factors affecting absorption frequencies, fingerprint and functional group region.-Characteristic stretching frequencies of O-H, N-H, C-H, C=C, C=N and C=O functional groups	3	
	7	NMR Spectroscopy*:* Introduction - Chemical shift and spin-spin coupling -	2	
	8	Application in elucidating the structure of ethanol, propanal and acetone (detailed study not required).	2	
II		**Chemistry of Aromatic hydrocarbons**	**12**	**27**
	9	Nomenclature and isomerism in substituted benzene. Structure and stability of benzene: Kekule, resonance and molecular orbital description.	2	
	10	Mechanism of aromatic electrophilic substitution: Halogenation, nitration, sulphonation and Friedel-Craft's reactions	3	
	11	Orientating effect of common substituents in aromatic electrophilic substitution	2	
	12	Aromaticity and Huckel's rule	2	
	13	Application to benzenoid (benzene, naphthalene and anthracene) and nonbenzenoid (pyrrole, pyridine and indol) aromatic compounds.	3	

III	**Medicinal Chemistry**		**10**	**23**
	14	Drug: Chemical name, generic name and trade names with examples	2	
	15	Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only).	2	
	16	Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics(definition and examples).	3	
	17	tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).	2	
	18	Synthesis of aspirin and Paracetamol	1	
IV	**Purification and Characterization Techniques**		**8**	**18**
	19	Distillation- Simple, fractional, steam and vacuum distillations	2	
	20	recrystalisation, sublimation, solvent extraction	2	
	21	Chromatography, stationary phase, mobile phase, Rf values	2	
	22	TLC, Column chromatography, HPLC and GC (basic concepts only).		
V	**PRACTICALS RELATED TO THE MODULE II and III**		**30**	
	1	**Introduction to organic lab**	4	
	2	1.Distillation of Aniline, Limonene (from orange peels) 1. Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol 2. Sublimation of a dicarboxylic acid/Naphthalene 3. Chromatographic separations – (any two) a) Separation of a mixture of two amino acids paper chromatography. b) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC) 4. TLC of Spinach	20	
	3	**Open ended** 1. Drawing structures using softwares. 2. Column Chromatography 3. Teacher can select preparation of organic compound related to the topics in the theory like synthesis of aspirin,sanitizer,drugs etc	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.Organic spectroscopy, William Kemp
4.Spectroscopy of organic compounds, P S Kalsi
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6. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
7. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, Satyajit D. Sarker and Lutfun Nahar, Wiley
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10.An Improved Method for the Extraction and Thin-Layer W Chromatography of Chlorophyll a and b from Spinach Hao T. Quach, Robert L. Steeper, and G. William Griffin, J Chem Edn, 2004, 81, 385
11. Quinone Synthesis and a Visual Introduction to Column Chromatography: An Undergraduate Experiment Danielle L. Pearson* and Russell R. A. Kitson* J. Chem. Educ. 2022, 99, 3731−3734

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CO 6	2	-	2		1	2	2		1		2		1

Correlation Levels:

Level	Correlation
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Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

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