Marudhar Kesari Jain College for Women (Autonomous)

Vaniyambadi

Regulations 2026 - 2027

PG Department of Chemistry

Post Graduate Programme
Master of Science in Chemistry

CONTENT

1. Preamble

2. Programme Outcomes

3. Programme Specific Outcomes

4. Eligibility for Admission

5. Methods of Evaluation and Assessments

6. Skeleton & Syllabus

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION

1. Preamble

Chemistry plays a pivotal role in all aspects of physical & biological sciences, engineering, agriculture, medicine, and allied health disciplines. The knowledge of chemistry is essential for student to make the sustainable development and face the upcoming societal change. To impart the basic knowledge of science to young women community, the Department of Chemistry started B.Sc. Programme in the year 2017 followed by M.Sc. Chemistry Programme at 2020. The department offers Chemistry program with the aim of producing chemists with high professional competence, in carrying out both basic and applied chemistry research. The department has well equipped with the latest instruments required to carry out practical experiments in the laboratories and separate library with all needed books.

The faculty members have contributed research towards publication of several research papers in national and international conferences and peer reviewed journals. The research has been carried out in frontier areas of chemistry such as environmental chemistry, electrochemistry, nano materials, coordination chemistry, synthetic organic chemistry, photochemistry, polymer chemistry, and green chemistry. As extension activities, our faculty members and students visit remote villages and various industries in training them to develop entrepreneurial skills and competencies.

In the forthcoming academic year, B.Sc. & M.Sc. Chemistry syllabus provides an integrated and unified approach towards chemical sciences covering all branches of chemistry and following Choice Based Credit System with Outcome Based Education. The curriculum is rigorous in accord to international standards and covers theory and practical courses with full emphasis to construct intellectual assets. In the final semester, the PG students are encouraged to carry out research project in reputed research institutions to enhance their exposure level and placement abilities.

2. PROGRAMME OUTCOMES (PO)

Programme	**M.Sc., Chemistry**
Programme Code	**24PCH**
Duration	**2 years[PG]**
Programme Outcomes	**PO1: Disciplinary Knowledge:** Acquire knowledge in chemistry and apply the knowledge in their day-to-day life for betterment of self and society. **PO2: Cognitive and Problem-Solving Skills:** Develop critical, analytical thinking and problem-solving skills. **PO3: Societal and Environmental Impact:** Address and develop solutions for societal and environmental needs at local, regional, and national levels. **PO4: Research-Related Skills**: Develop research skills in defining problems, formulating and testing hypotheses, analyzing, interpreting, and drawing conclusions from data. **PO5: Employability and Entrepreneurship:** Enhance employability and entrepreneurship among students, along with ethical and communication skills. **PO6: Self-Directed Learning**: Work independently and engage in lifelong learning and continuous professional development. **PO7: Moral and Ethical Awareness/Reasoning**: Understand the importance of ethical behavior in professional contexts and be able to recognize and address ethical dilemmas. **PO8: Lifelong Learning and Adaptability:** Be prepared for lifelong learning and professional development, including the ability to adapt to changes in technology, business practices, and economic conditions.

3. PROGRAMME SPECIFIC OUTCOMES (PSO)

Programme Specific Outcomes:	**PSO1: Placement:** Apply principles of organic, inorganic, and physical chemistry to design and synthesize novel compounds, contributing to advancements in pharmaceuticals, materials science, and sustainable industries. **PSO2: Research and Development:** Develop expertise in Nano Science and Green Chemistry to design and implement sustainable, pollution-free technologies with high accuracy, fostering innovation in environmental protection, industrial applications, and entrepreneurship. **PSO3: Contribution to the Society:** Integrate practical expertise in compound analysis to ensure precision in quality control, research, and innovation, contributing to industrial growth and societal well-being.

4. Eligibility for Admission:

Candidate for admission to the first year of M.Sc., Chemistry shall be required to have passed the UG with Chemistry.

5. Methods of Evaluation and Assessments

Methods of Evaluation		
Internal Evaluation		25 Marks
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview	
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate Between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Department of Chemistry

Course Code	Course Category	Title of the Course	Ins. Hrs/ Week	Credit	Marks		Total
					CIA	ESE	
Semester – I							
26PCHC11	Core – 1	Organic Reaction Mechanism – I	6	5	25	75	100
26PCHC12	Core – 2	Physical Chemistry - I	6	5	25	75	100
26PCHC13P	Core – 3	Organic Chemistry Practical	4	4	25	75	100
26PCHE11/ 26PCHE12	DCE – 1	Nano and Green Chemistry / Medicinal Chemistry	5	3	25	75	100
26PCHE13/ 26PCHE14	DCE – 2	Material Science / Molecular Spectroscopy	5	3	25	75	100
26PCHA11	AECC-1	Chemistry in Consumer Products.	2	2	25	75	100
26PCHR11	HR	VE - 1 Human Rights	2	2	25	75	100
			30	**22**	**150**	**450**	**600**
Semester – II							
26PCHC21	Core – 4	Organic Reactions Mechanism-II	6	5	25	75	100
26PCHC22	Core – 5	Physical Chemistry – II	6	5	25	75	100
26PCHC23P	Core – 6	Physical Chemistry Practical	5	4	25	75	100
26PCHE21/ 26PCHE22	DCE – 3	Water Treatment and Analysis/ Industrial Chemistry	5	3	25	75	100
26PCHE23/ 26PCHE24	DCE – 4	Nuclear Chemistry/ Heterocyclic Chemistry	5	3	25	75	100
26PCHS21	SEC-1	Chemistry in Food Preservation	3	2	25	75	100
			30	**22**	**150**	**450**	**600**
Semester – III							
26PCHC31	Core – 7	Organic Synthesis and Photochemistry	6	5	25	75	100
26PCHC32	Core – 8	Coordination Chemistry – I	6	5	25	75	100
26PCHC33P	Core – 9	Inorganic Chemistry Practical	6	4	25	75	100
26PCHE31/ 26PCHE32	DCE – 5	Computational Chemistry/ Solid State Chemistry	6	3	25	75	100
26PCHS31	SEC – 2	Research Tools and Techniques	2	2	25	75	100
26PCHIK31	IKS*		2		25	75	100
26PCHIN31	Internship	Internship	2	2	25	75	100

			30	**21**	**175**	**525**	**700**
Semester – IV							
26PCHC41	Core –10	Coordination Chemistry –II	6	5	25	75	100
26PCHC42	Core – 11	Structure and Bonding in Inorganic Compounds	6	5	25	75	100
26PCHC43P	Core – 12	Practical-IV-Analytical Instrumentation Techniques	4	3	25	75	100
26PCHC44P	Core – 13	Project	6	6	25	75	100
26PCHE41/ 26PCHE42	DCE – 6	EC – 41 Electrochemistry EC – 42 Pesticide Chemistry	4	3	25	75	100
26PCHP41	PEC	Drug Analysis and Quality Control	2	2	25	75	100
26PCHL41	SLC	Environmental Chemistry	2	2	25	75	100
	MOOC	**NPTEL (Online)**					100
			30	**26**	**175**	**525**	**800**
			120	**91**	**650**	**1950**	**2700**
Students must complete at least one online course (MOOC) from platforms like SWAYAM, NPTEL, within the third semester. Additionally, engaging in a specified Self-learning Course is mandatory to qualify for the degree, and successful participation will be acknowledged with an extra credit of 2*.							

CC: Core Course
DCE: Discipline Centric Elective
SEC: Skill Enhancement Course
PEC: Professional Enhancement Course
SLC: Self Learning Course
IKS: Indian Knowledge System (Non- Credit Course)
AECC: Ability Enhancement Compulsory Course

1ST YEAR: FIRST SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHC11	Organic Reaction Mechanism–I	3	1	2	5	6	25	75	100
Category	Core Course	Theory							

Learning Objectives

Student will be able

LO1	To understand the feasibility and the mechanism of various organic reactions.
LO2	To comprehend the techniques in the determination of reaction mechanisms.
LO3	To learn the concept of stereochemistry involved in organic compounds.
LO4	To correlate and appreciate the differences involved in the various types of organic reaction mechanisms.
LO5	To design feasible synthetic routes for the preparation of organiccompounds.

Unit	Content	Hours
1	**Methods of Determination of Reaction Mechanism:** Reaction intermediates. The transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions: Hammond postulate. Methods of determining mechanism: non-kinetic methods – product analysis, determination of intermediates - isolation, detection, and trapping. Effect of structure on reactivity: Hammett and Taft equations.	18
2	**Aromatic and Aliphatic Electrophilic Substitution:** Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions. Aliphatic electrophilic substitution Mechanisms: SE_2 and SE_i, SE_1 - Mechanism and evidences.	18
3	**Aromatic and Aliphatic Nucleophilic Substitution:** Aromatic nucleophilic substitution: Mechanisms - SNAr, SNi and Benzyne mechanisms - Evidences. Reactivity of nucleophile, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur - nucleophiles, Bucherer and Rosenmund reactions, Von Richter, Sommelet-Hauser and Smiles rearrangements. SN_1 and SN_2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.	18
4	**Stereochemistry-I:** Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S notations, proR, proS, absolute and relative configurations. Chiral shift reagents and chiral solvating reagents. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations and	18

	asymmetric synthesis. Stereoselective and stereospecific synthesis.	
5	**Stereochemistry-II:** Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and poly substituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and ORD curves, Cotton effect.	18

CO	Course Outcomes	Knowledge Level
Student will be able		
1	To recall the basic principles of organic chemistry.	K1, K2, K3
2	To understand the formation and detection of reaction intermediates of organic reactions.	K1, K2, K3, K4
3	To predict the reaction mechanism of organic reactions and stereochemistry of organic compounds.	K1, K2, K3
4	To apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.	K1, K2, K3, K4
5	To design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.	K1, K2, K3, K4

Textbooks:	
1	March J. and Smith M. "Advanced Organic Chemistry", John-Wiley and Sons.5th ed.,2001.
2	Gould E.S. "Mechanism and Structure in Organic Chemistry", Holt, Rinehart and Winston Inc., 5th ed., 1959.
3	Kalsi P. S. "Stereochemistry of Carbon Compounds", New Age International Publishers, 8th ed., 2015.
4	Bruice P.Y. "Organic Chemistry", Prentice Hall,7th ed.,2013.
5	Clayden J, Greeves N. and Warren S. "Organic Compounds", Oxford University Press, 2nd ed.,2014.
Reference Books:	
1	Carey F.A. and Sundberg R. J. "Advanced Organic Chemistry Part-A and B", Kluwer Academic/ Plenum Publishers, 5thed., 2007.
2	Morris D.G. "Stereochemistry", RSC Tutorial Chemistry Text1, 2001.
3	Isaacs N.S. "Physical Organic Chemistry", ELBS, Longman, UK, 1987.
4	Eliel E.L. "Stereochemistry of Carbon Compounds", Tata-McGraw Hill, 2000.

5	Finar I.L. “Organic chemistry”, Vol-1&2,6th ed., Pearson Education Asia, 2004.
Web resources:	
1	https://www.masterorganicchemistry.com/reaction-guide/
2	https://www.khanacademy.org/science/organic-chemistry/aromatic-compounds/reactions-benzene/v/electrophilic-aromatic-substitution
3	https://m.youtube.com/watch?v=Efh5GkVbhEc
4	https://chem.libretexts.org/Courses/Sacramento_City_College/SCC%3A_Chem_420_-_Organic_Chemistry_I/Text/06%3A_Stereochemistry_at_Tetrahedral_Centers/6.01%3A_Chirality
5	https://www.masterorganicchemistry.com/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	3	3	3	3	3	3
CO5	2	3	3	3	3	3	3	2	3	3	3
Total	12	15	14	15	14	15	15	13	15	15	15
Average	**2.4**	**3.0**	**2.8**	**3.0**	**2.8**	**2.4**	**3.0**	**2.6**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: FIRST SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHC22	Physical Chemistry-I	3	1	2	5	6	25	75	100
Category	Core Course	Theory							

Learning Objectives

Student will be able

LO1	To recall the fundamentals of thermodynamics and the composition of partial molar quantities.
LO2	To understand the classical and statistical approach of the functions.
LO3	To compare the significance of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein.
LO4	To correlate the theories of reaction rates for the evaluation of thermodynamic parameters.
LO5	To study the mechanism and kinetics of reactions.

Unit	Content	Hours
1	**Classical Thermodynamics:** Partial molar properties Chemical potential, Gibb's-Duhem equation-binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases – Fugacity- determination of fugacity by graphical and equation of state methods-dependence of temperature, pressure and composition. Thermodynamics of ideal and non-ideal binary mixtures, Duhem – Margulus equation applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states -determination-vapour pressure, EMF and freezing point methods.	18
2	**Statistical thermodynamics I**: Introduction of statistical thermodynamics concepts of thermodynamic and mathematical probabilities-distribution of distinguishable and non-distinguishable particles. Assemblies, ensembles, canonical particles. Maxwell – Boltzmann, Fermi Dirac & Bose-Einstein Statistics comparison and applications. Partition functions-evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases.	18
3	**Statistical thermodynamics II**: Thermodynamic functions in terms of partition functions-calculation of equilibrium constants. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function residual entropy, equilibrium constants and equipartition principle. Heat capacity of mono and di atomic gases-ortho and para hydrogen. Heat capacity of solids-Einstein and Debye models.	18
4	**Irreversible Thermodynamics:** Theories of conservation of mass and energy entropy production in open systems by heat, matter and current flow, force and flux concepts. Onsager theory-validity and verification- Onsager reciprocal relationships. Electro kinetic and thermo mechanical effects-Application of irreversible thermodynamics to biological systems	18

5	**Kinetics of Reactions:** Complex and fast reactions: Transition state theory- Factors determine the reaction rates in solution – primary salt effect and secondary salt effect. Chain reactions-chain length, kinetics of $H_2 – Cl_2$ & $H_2 – Br_2$ reactions (Thermal and Photochemical reactions) – Rice Herzfeld mechanism. Study of fast reactions-relaxation methods temperature and pressure jump methods -stopped flow flash photolysis methods and pulse radiolysis. Kinetics of polymerization-free radical, cationic, anionic polymerization	18

CO	Course Outcomes	Knowledge Level
Student will be able		
1	To explain the classical and statistical concepts of thermodynamics.	K1, K2, K3
2	To compare and correlate the thermodynamic concepts to study the kinetics of chemical reactions.	K1, K2, K3, K4
3	To discuss the various thermodynamic and kinetic determination.	K1, K2, K3
4	To evaluate the thermodynamic methods for real gases ad mixtures.	K1, K2, K3, K4
5	To compare the theories of reactions rates and fast reactions.	K1, K2, K3, K4

Textbooks:	
1	J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd ed, S.L.N.Chand and Co., Jalandhar, 1986.
2	I.M. Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th edition, W.A.Benjamin Publishers, California, 1972
3	K. J. Laidler, "*Chemical Kinetics*", 3rd ed., Pearson, Reprint – 2013.
4	M.C. Gupta, "*Statistical Thermodynamics*", 1st ed., New Age International Pvt. Ltd., New Delhi, 1995.
Reference Books:	
1	D.A. Mcqurrie And J.D. Simon, Physical Chemistry – A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.
2	S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan Publishers, New York, 1974
3	R.P. Rastogi and R.R. Misra, Classical Thermodynamics, Vikas Publishing, Pvt. Ltd., New Delhi, 1990.
4	K.B. Ytsiimiriski, "Kinetic Methods of Analysis", Pergamom Press,1996.
5	Gurdeep Raj, Phase rule, Goel Publishing House, 2011.
Web Resources:	
1	https://nptel.ac.in/courses/104/103/104103112//

2	https://bit.ly/3tL3GdN

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	2	3	3	3
CO2	2	3	3	3	2	3	3	2	3	3	3
CO3	3	3	3	2	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	3	2	3	3	3
CO5	3	2	3	3	3	3	3	2	3	3	3
Total	14	14	15	14	14	15	15	10	15	15	15
Average	**2.8**	**2.8**	**3.0**	**2.8**	**3.0**	**3.0**	**3.0**	**2.0**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: FIRST SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHC13P	Organic Chemistry Practical	1	1	2	4	4	25	75	100
Category	Core Course	Practical							

Learning Objectives

Student will be able

LO1	To understand the concept of separation, qualitative analysis and preparation of organic compounds.
LO2	To develop analytical skill in the handling of chemical reagents for separation of binary and ternary organic mixtures.
LO3	To analyze the separated organic components systematically and derivative them suitably.
LO4	To construct suitable experimental setup for the organic preparations involving two stages.
LO5	To experiment different purification and drying techniques for the compound processing.

Unit	Content	Hours
1	**Separation and analysis:** a) Two component mixtures. b) Ternary component (Demo only)	15
2	**Estimations:** a) Estimation of Phenol (Bromination) b) Estimation of Aniline (Bromination)	15
3	**Estimations:** a) Estimation of Glucose (Redox) b) Estimation of Glycine (Acidimetry) C) Estimation of Amino group (Acetylation)	15
4	**Preparation of Organic Compounds (Single stage):** a) Methyl-m-nitro benzoate from ethyl benzoate (nitration) b) Benzo phenone oxime from benzophenone (addition) c) o-Chlorobenzoic acid from anthranilic acid (Sand mayer reaction) d) p-Benzoquinone from hydroquinone (oxidation) e) Phenylazo-2-naphthol from aniline (diazotization)	15

CO	Course Outcomes	Knowledge Level

Student will be able		
1	To recall the basic principles of organic separation, qualitative analysis and preparation.	K1, K2, K3
2	To explain the method of separation and analysis of separated organic mixtures andconvert them as derivatives by suitable preparation method.	K1, K2, K3, K4
3	To determine the characteristics of separation of organic compounds by various chemical reactions.	K1, K2, K3
4	To develop strategies to separate, analyze and prepare organic compounds.	K1, K2, K3, K4
5	To formulate a method of separation, analysis of organic mixtures and design suitable procedure for organic preparations.	K1, K2, K3, K4

Textbooks:	
1	Mohan, "Organic Analytical Chemistry: Theory and Practice", Narosa, 2003.
2	Ahluwalia V. K, Bhagat ., and Agarwal R, "Laboratory Techniques in Organic Chemistry", I. K. International, 2005.
3	Gnanaprakasam N. S. and Ramamurthy G, "Organic Chemistry Lab Manual", S. V. Printers, 1987.
4	Vogel A. I, Tatchell A. R, Furniss B. S, Hannaford A. J. and Smith P. W. G, "Vogel's Textbook of Practical Organic Chemistry", 5th ed., Prentice Hall, 1989.
5	Jonathan Clayden, Nick Greeves and Stuart Warren, "Organic Practical: Techniques and Transformations", Oxford University Press, 2014.
Reference Books:	
1	Tatchell A. R, Furniss B. S, Hannaford A. J, Smith P. W. G. and Tatchell A. R, "Vogel's Textbook of Practical Organic Chemistry", Pearson Education Ltd., 2009.
2	Hayden-McNeil, "Organic Chemistry Laboratory Notebook", Hayden-McNeil Publishing, 2010.
3	John C. Gilbert and Stephen F. Martin, "Experimental Organic Chemistry: A Miniscale & Microscale Approach", Cengage Learning, 2015.
4	Jerry R. Mohrig, David Alberg, Gretchen Hofmeister, and Paul F. Schatz, "Techniques in Organic Chemistry", W. H. Freeman, 2010.
5	James W. Zubrick, "Organic Chemistry: A Laboratory Manual", Wiley, 2001.
Web Resources:	
1	https://www.ncbi.nlm.nih.gov/books/NBK547700/
2	https://webbook.nist.gov/chemistry/
3	https://www.nist.gov/publications/certification-standard-reference-materialr-917d-d-glucose-dextrose
4	https://chem.libretexts.org/Courses/Sonoma_State_University/SSU_Chem_335B/Material_for_Exam_3/Chapter_18%3A_Electrophilic_Aromatic_Substitution/18.4_Nitration_and_Sulfonation
5	https://www.masterorganicchemistry.com/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
Average	**2.4**	**3.0**	**2.6**	**3.0**	**2.8**	**2.4**	**3.0**	**2.6**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: FIRST SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHE11	Nano and Green Chemistry	3	2	0	3	5	25	75	100
Category	Elective Course	Theory							

Learning Objectives

Student will be able

LO1	To understand the various types of nanomaterials and their properties.
LO2	To describe the methods for measuring mechanical Properties
LO3	To learn the applications of synthetically important nanomaterials.
LO4	To discuss the principles of green chemistry.
LO5	To propose green synthesis for industrial production

Unit	Content	Hours
1	**Nanomaterials** Nanoparticles in the Environment- Nanomaterials in the atmosphere, Particle Characterization, Types of Transport, Routes of Exposure, Deposition mechanism, Potential mechanism of Nano size particle toxicity	15
2	**Mechanical properties measurement** Nanoindentation principles- elastic and plastic deformation -mechanical properties of materials in small dimensions- -Hardness testing of thin films and coatings	15
3	**Advanced nanostructured materials** Allotropes of carbon: Graphene, CNT, C-dots, Fullerenes – Inorganic: Organic hybrids – Ferrofluids- Zeolites- Core-shells – Nanostructures of Zinc Oxide: -Additive Manufacturing of 3D Nano architected Metals – Nanorobots	15
4	**Introduction to Green Chemistry:** Introduction-Need, Goals -Twelve principles of Green Chemistry with examples. and Limitations Green Chemistry-Chemical accidents, terminologies, International green chemistry organizations	15
5	**Green Synthesis and Advanced Techniques** Choice of starting materials-reagents, catalysts and solvents-Green chemistry in everyday life- Green reagents -Green solvents-Microwave and sonochemical synthesis Environmental Benefits	15

CO	Course Outcomes	Knowledge Level

Student will be able		
1	To explain methods of fabricating nanostructures	K1, K2, K3
2	To relate the unique properties of nanomaterials to reduce dimensionality of the material.	K1, K2, K3, K4
3	To discuss applications of advanced nano materials	K1, K2, K3
4	To recall the basic chemical techniques used in conventional industrial preparations and in green innovations.	K1, K2, K3, K4
5	To understand the various techniques used in chemical industries and in laboratory.	K1, K2, K3, K4

Textbooks:	
1	Sanjay Mathur and Mrityunjay Singh, "Nanostructured Materials andNanotechnology",2nd ed., Willey,2008.
2	V. K. Ahluwalia and M. R. Kidwai, "New Trends in Green Chemistry", 1st ed., Anamalaya Publishers, 2005
Reference Books:	
1	Pradeep T, "A Textbook of Nanoscience and Nanotechnology", McGrawHill Education,2017.
2	Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers, Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby, Elsevier, 2009.
3	NANO: The Essentials: Understanding Nanoscience and Nanotechnology, T. Pradeep, McGraw Hill (2017)
4	A. S. Matlack, "Introduction to Green Chemistry", 1st ed., Marcel Dekker, 2001.
5	P. T. Anastas and J. K. Warner, "Oxford Green Chemistry-Theory and Practical", 1st ed., University Press, 1998.
Web Resources:	
1	https://www.nano.gov/
2	https://ocw.mit.edu/courses/3-091sc-introduction-to-solid-state-chemistry-fall-2010/
3	https://chemistry.berkeley.edu/topics/green-chemistry

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	2	3	2	3	3	3	2	3
CO3	3	3	2	2	3	3	3	2	3	3	3
CO4	2	3	3	3	2	3	3	3	3	3	3
CO5	2	3	3	2	3	2	3	3	3	3	3
Total	12	15	14	12	13	13	15	14	15	14	13
Average	**2.4**	**3**	**2.8**	**2.4**	**2.6**	**2.6**	**3**	**2.8**	**3**	**2.8**	**2.6**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: FIRST SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHE12	Medicinal Chemistry	3	2	0	3	5	25	75	100
Category	Elective Course	Theory							

Learning Objectives

Student will be able

LO1	To study the chemistry behind the development of pharmaceutical materials.
LO2	To gain knowledge on mechanism and action of drugs.
LO3	To understand the need of antibiotics and usage of drugs.
LO4	To familiarize with the mode of action of diabetic agents and treatment of diabetes.
LO5	To identify and apply the action of various antibiotics

Unit	Content	Hours
1	**Introduction to receptors:** Introduction, targets, Agonist, antagonist, partial agonist. Receptors, Receptor types, Theories of Drug – receptor interaction, Drug synergism, Drug resistance, physicochemical factors influencing drug action	15
2	**Antibiotics:** Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicllins and tetracyclins, clinical application of penicillins, cephalosporin.Current trends in antibiotic therapy	15
3	**Antihypertensive agents and diuretics:** Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride	15
4	**Analgesics, Antipyretics and Anti-inflammatory Drugs:** Introduction, Mechanism of inflammation, classification and mechanism of action and paracetamol, Ibuprofen, Diclofenac, naproxen, indomethacin, phenylbutazone and meperidine. Medicinal Chemistry of Antidiabetic Agents Introduction, Types of diabetics, Drugs used for the treatment, chemical classification, Mechanism of action, Treatment of diabetic mellitus. Chemistry of insulin, sulfonyl urea.	15
5	**Traditional Indian Medicine system:** Introduction to Ayurveda, Siddha, Unani, Homeopathy & Sowa- Rigpa Systems and Traditional Formulations - Important Medicinal Plants mentioned in ancient – Nochi, Adathoda, Tulasi, Vallarai, Sirukurunjan, Amla, Shatavari, Moringa, Punarnava - Agro-techniques of Few Aromatic Plants - AYUSH Products, food, nutraceuticals, cosmetics and agrochemicals, - Case Study : Value added products of Neem, Aloe, Licorice,	15

	Ashwagandha.	
CO	**Course Outcomes**	**Knowledge Level**
Student will be able to		
1	Predict a drugs properties based on its structure.	K1, K2, K3
2	Describe the factors that affect its absorption, distribution, metabolism, and excretion, and hence the considerations to be made in drug design.	K1, K2, K3, K4
3	Explain the relationship between drug's chemical structure and its therapeutic properties.	K1, K2, K3
4	Designed to give the knowledge of different theories of drug actions at molecular level.	K1, K2, K3, K4
5	Identify different targets for the development of new drugs for the treatment of infectious and GIT.	K1, K2, K3, K4

Textbooks:	
1	Wilson, Charles Owens: Beale, John Marlowe; Block, John H, Lipincott William, 12th edition, 2011.
2	Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th edition, Oxford University Press, 2013.
3	Jayashree Ghosh, A text book of Pharmaceutical Chemistry,S. Chand and Co.Ltd,1999,1999 edn.
Reference Books:	
1	Foye's Principles of Medicinal Chemistry, Lipincott Williams, Seventh Edition, 2012.
2	Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham, David P. Rotella, Alfred Burger, Academic press, 2010.
3	Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, John M.Beale Jr and John M. Block, Wolters Kluwer, 2011,12th edition.
4	P.Parimoo,A Textbook of Medical Chemistry, New Delhi: CBSPublishers.1999
5	S.Ramakrishnan, K.G.Prasannanand R.Rajan, Textbook of Medical Biochemistry, Hyderabad Orient Longman.3rd edition, 2001.
Web Resources:	
1	https://www.ncbi.nlm.nih.gov/books/NBK482447/
2	https://training.seer.cancer.gov/treatment/chemotherapy/types.html
3	https://www.classcentral.com/course/swayam-medicinal-chemistry-12908

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	2	2	2	3	2	2	2	3	3	3
Total	12	14	13	14	14	12	14	13	15	15	15
Average	**2.4**	**2.8**	**2.6**	**2.8**	**2.8**	**2.4**	**2.8**	**2.6**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: FIRST SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHE13	Materials Science	3	2	0	3	5	25	75	100
Category	Elective Course	Theory							

Learning Objectives

Student will be able

LO1	To understand the crystal structure, growth methods and X-ray scattering.
LO2	To explain the optical, dielectric and diffusion properties of crystals.
LO3	To recognize the basis of semiconductors, superconductivity materials and magnets.
LO4	To study the synthesis, classification and applications of nanomaterials.
LO5	To learn about the importance of materials used for renewable energy conversion.

Unit	Content	Hours
1	**Crystallography:** Symmetry - unit cell and Miller indices - crystal systems - Bravais lattices - point groups and space groups - Xray diffraction-Laue equations-Bragg's law-reciprocal lattice and its application to geometrical crystallography. Crystal structure–powder and single crystal applications. Electron charge density maps, neutron diffraction-method and applications.	15
2	**Crystal Growth Methods :** Nucleation–equilibrium stability and metastable state. Single crystal –Low and high temperature, solution growth– Gel and sol-gel. Crystal growth methods- nucleation– equilibrium stability and metastable state. Melt growth - Bridgeman-Stockbarger, Czochralski methods. Flux technique, physical and chemical vapour transport. Lorentz and polarization factor - primary and secondary extinctions.	15
3	**Properties of Crystals :** Optical studies - Electromagnetic spectrum (qualitative) refractive index – reflectance – transparency, translucency and opacity. Types of luminescence – photo-, electro-, and injection luminescence, LEDs – organic, Inorganic and polymer LED materials - Applications. Dielectric studies-Polarisation - electronic, ionic, orientation, and space charge polarisation. Effect of temperature, dielectric constant, dielectric loss. Types of dielectric breakdown–intrinsic, thermal, discharge, electrochemical and defect breakdown.	15
4	**Special Materials:** Superconductivity: Meissner effect, Critical temperature and critical magnetic Field, Type I and II superconductors, BCS theory-Cooper pair, Applications. Soft and hard magnets – Domain theory Hysteresis Loop-Applications. Magneto and giant magnetoresistance. Ferro, ferri and antiferromagnetic materials applications, magnetic parameters for recording applications.	15

5	**Materials for Renewable Energy Conversion:** Solar Cells: Organic, bilayer, bulk heterojunction, polymer, perovskite based. Solar energy conversion: lamellar solids and thin films, dye-sensitized photo voltaic cells, coordination compounds anchored onto semiconductor surfaces – Ru (II) and Os(II) polypyridyl complexes. Photochemical activation and splitting of water, CO_2 and N_2. Manganese based photo systems for water-splitting. Complexes of Rh, Ru, Pd and Pt - photochemical generation of hydrogen from alcohol.	15

CO	Course Outcomes	Knowledge Level
Student will be able		
1	To understand and recall the synthesis and characteristics of crystal structures, semiconductors, magnets, nanomaterials and renewable energy materials.	K1, K2, K3
2	To integrate and assess the structure of different materials and their properties	K1, K2, K3, K4
3	To analyze and identify new materials for energy applications.	K1, K2, K3
4	To explain the importance of crystal structures, piezoelectric and pyroelectric materials, nanomaterials, structures and synthesis.	K1, K2, K3, K4
5	To design and develop new materials with improved property for energy applications.	K1, K2, K3, K4

Textbooks:	
1	S. Mohan and V. Arjunan, "*Principles of Materials Science"*, 2nd ed., MJP Publishers, 2016.
2	Arumugam, "*Materials Science*", 2nd ed., Anuradha Publications, 2007.
3	Giacavazzo et. al., "*Fundamentals of Crystallography*", 2nd ed., International Union of Crystallography, Oxford Science Publications, 2010.
4	Woolf son, "*An Introduction to Crystallography*", 3rd ed., Cambridge University Press, 2012.
5	James F. Shackelford and Madanapalli K. Muralidhara, "I*ntroduction to Materials Science for Engineers*", 6th ed., Pearson Press, 2007.
Reference Books:	
1	L. G. Arora, "*Solid State Chemistry*", 2nd., Anmol Publications, New Delhi, 2001.
2	Q. K. Puri and V. K. Babbar, "*Solid State Physics*", 5th ed., S Chand and Company Ltd, 2001.
3	C. Kittel, "*Solid State Physics*", 5th ed., John-Wiley and Sons, NY, 1966.
4	D. P. Meyers, "*Introductory Solid State Physics*", 1st ed., Viva Books Private Ltd., 1998.
5	A. R. West, "*Solid State Chemistry and Applications*", 2nd ed., John-Wiley and Sons, 1987.
Web Resources:	

1	https://en.wikipedia.org/wiki/Crystal_structure
2	https://en.wikipedia.org/wiki/Czochralski_method
3	https://en.wikipedia.org/wiki/Dielectric
4	https://en.wikipedia.org/wiki/Superconductivity
5	https://en.wikipedia.org/wiki/Solar_cell

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	3	3	2	2	3	2
CO2	2	2	3	3	3	3	3	3	3	3	3
CO3	3	3	2	2	3	3	3	2	3	3	3
CO4	3	3	3	2	3	3	2	3	3	3	2
CO5	2	2	2	3	3	3	3	3	3	3	3
Total	13	13	13	12	14	15	14	13	14	15	13
Average	**2.6**	**2.6**	**2.6**	**2.4**	**2.8**	**3.0**	**2.8**	**2.6**	**2.4**	**3.0**	**2.6**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: FIRST SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHE14	Molecular Spectroscopy	3	1	1	3	5	25	75	100
Category	Elective Course	Theory							

Learning Objectives

Student will be able

LO1	To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.
LO2	To gain the principles of vibrational spectroscopy.
LO3	To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.
LO4	To predict knowledge of the NMR, fine structure of ESR absorption, Hyperfine structure, double resonance in ESR.
LO5	To carry out the structural elucidation of molecules using differentspectral techniques.

Unit	Content	Hours
1	**Rotational and Raman Spectroscopy:** Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Stokes and anti-Stokes lines.Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion.	15
2	**Vibrational Spectroscopy:** Vibrations of molecules, harmonic and an harmonic oscillators - vibrational energy expression, energy level diagram. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies.	15
3	**Electronic Spectroscopy:** Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and pre-dissociation spectra. $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules. Lasers: Laser action, population inversion properties of laser radiation, examples of simple laser systems.	15
4	**NMR and ESR Spectroscopy:** Spin-spin interactions: Homonuclear coupling interactions - AX, AX_2, AB types. ^{13}C NMR and structural correlations, Satellites. ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; The g value and the hyperfine coupling parameter. Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling.	15

5	**Mass Spectrometry, EPR and Mossbauer Spectroscopy:** Ionization techniques- Electron ionization (EI), chemical ionization (CI), fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation. EPR spectra of anisotropic systems - anisotropy in g value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei. **Practice:** Structural elucidation of simple organic molecules by UV-Visible, FT-IR, NMR, and Mass spectral data. GCMS, Flame Photometry and HPLC (Demo)	15

CO	**Course Outcomes** **Student will be able**	**Knowledge Level**
1	To understand the importance of rotational and Raman spectroscopy.	K1, K2, K3
2	To apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.	K1, K2, K3, K4
3	To evaluate different electronic spectra of simple molecules using electronic spectroscopy.	K1, K2, K3
4	To perform the most commonly used NMR and ESR spectroscopy to interpret the chemical compounds and their characteristics.	K1, K2, K3, K4
5	To develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass, EPR and Mossbauer Spectroscopy.	K1, K2, K3, K4

Textbooks:	
1	Banwell C. N. and McCash E. M, "Fundamentals of Molecular Spectroscopy", 4th Ed., Tata McGraw Hill, New Delhi, 2000.
2	Silverstein R. M. and Webster F. X, "Spectroscopic Identification of Organic Compounds", 6th ed., John Wiley & Sons, New York, 2003.
3	Kemp W, "Applications of Spectroscopy", English Language Book Society, 1987.
4	Williams D. H. and Fleming I, "Spectroscopic Methods in Organic Chemistry", 4th ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988.
5	Straughan B. P. and Walker S, "Spectroscopy", Vol.3, Halstead Press, Sydney, 1978.
Reference Books:	
1	Barrow G. M, "Introduction to Molecular Spectroscopy", McGraw Hill, NewYork, 1964.
2	Sharma Y. R, "Elementary Organic Spectroscopy–Principles and Chemical Applications, S.Chand, New Delhi, 1992.
3	Rahman A, "Nuclear Magnetic Resonance-Basic Principles", Springer-Verlag, New York, 1986.
4	Nakamoto K, "Infrared and Raman Spectra of Inorganic and Coordination Compounds - PartB", 5th ed., John Wiley & Sons Inc., New York, 1997.
5	Weil J. A, Bolton J. R. and Wertz J. E, "Electron Paramagnetic Resonance", Wiley Interscience, 1994.
Web Resources:	

1	https://www.nist.gov/spectroscopy
2	https://cccbdb.nist.gov/
3	https://webbook.nist.gov/chemistry/
4	https://nationalmaglab.org/user-facilities/nmr-mri-s/
5	https://acsanalytical.org/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
Average	**2.4**	**3.0**	**2.6**	**3.0**	**2.8**	**2.4**	**3.0**	**2.6**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: FIRST SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHA11	Chemistry in Consumer Products	1	1	0	2	2	2	25	75
Category	AEC	Theory							

Learning Objectives

Student will be able

LO1	To learn step-by-step process of various types of soap manufacturing.
LO2	To explore the formulation and development of detergent products.
LO3	To gain knowledge of common raw materials used in cosmetics, including oils, waxes, colors, preservatives and fragrances.
LO4	To understand the cosmetic formulation principles, including the selection of active ingredients, excipients, and additives to achieve desired skincare effects.
LO5	To identify common toxic chemical ingredients found in skincare and toiletries products.

Unit	Content	Hours
1	**Soaps:** Types of Soaps, manufacture of soaps, formulation of toilet soaps – different ingredients used – soft soaps, shaving soaps,herbal soaps and antibacterial soaps.	6
2	**Detergents:** Types of detergents - anionic detergents and cationic detergents – manufactures and applications; detergent performance; Green detergents - sustainable alternatives.	6
3	**Cosmetics:** Cosmetics - Introduction about raw materials in cosmetics - (oil, waxes, color, preservative and fragrance). Shampoo - different kinds shampoo – anti-dandruff, anti-lice, herbal and baby shampoo, hair dye – manufacture of conditioners (raw materials and uses only).	6
4	**Skin Care Products:** Preparation of cosmetics - skin and hair - skin lighteners, sun screen lotions - skin toners anti wrinkling creams. Lip care - lip gloss – lipsticks - lip liners, moisturizers - crack creams, Sun cream and UV rays protecting cream.	6
5	**Toxicity:** Toxic chemical ingredients – skincare products – toiletries products – carcinogens; preservatives - parabens, formaldehyde-releasing agents, fragrances - phthalates, surfactants - sodium lauryl sulfate, and colorants - coal tar dyes.	6

CO	Course Outcomes	Knowledge Level

Student will be able		
1	To learn about various soap making techniques.	K1, K2, K3
2	To understand the structure-property relationships of surfactants in detergents.	K1, K2, K3, K4
3	To apply the knowledge to develop cosmetic products with desired properties.	K1, K2, K3
4	To understand the cosmetic formulation principles, both skin and hair products.	K1, K2, K3, K4
5	To explore the adverse health effects associated with harmful chemicals found in skincare and toiletries products.	K1, K2, K3, K4

Text books:	
1	David A. Katz and Richard A. Lawton, "Chemistry of Household Products", Thomson Learning, 2001.
2	Richard J. Farn, "Chemistry and Technology of Surfactants", Blackwell Publishing, 2006.
3	NIIR Board, "Modern Technology of Cosmetics", Asia Pacific Business Press Inc., New Delhi, 2004.
4	Ernest W. Flick, "Cosmetic and Toiletry Formulations", Noyes Publications, 2001.
5	D. F. Williams and W. H. Schmitt, "Chemistry and Technology of Cosmetics and Toiletries", Blackie Academic & Professional, 1992.
Reference Books:	
1	André O. Barel, Marc Paye, and Howard I. Maibach, "Handbook of Cosmetic Science and Technology", CRC Press, 2001.
2	Charles S. Sell, "Chemistry of Fragrances: From Perfumer to Consumer", Royal Society of Chemistry, 2006.
3	O. Michael Showell, "Handbook of Detergents, Part F: Production", CRC Press, 2009.
4	Romanowski P. and Schueller R, "Beginning Cosmetic Chemistry: Practical Knowledge for the Cosmetic Industry", Allured Books, 3rd ed., 2009.
5	J. A. Joule and K. Mills, "*Heterocyclic Chemistry"*, 4th ed., John-Wiley, 2010.
Web Resources:	
1	https://www.gutenberg.org/
2	https://openlibrary.org/
3	https://www.cleaninginstitute.org/
4	https://www.aad.org/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
Average	**2.4**	**3.0**	**2.6**	**3.0**	**2.8**	**2.4**	**3.0**	**2.6**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: SECOND SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHC21	Organic Reaction Mechanism-II	3	1	2	5	6	25	75	100
Category	Core Course	Theory							

Learning Objectives

Student will be able

LO1	To understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic and annulene compounds.
LO2	To gain knowledge about mechanism involved in various types of organic reactions with evidences.
LO3	To validate the applications of synthetically important reagents.
LO4	To correlate the reactivity between aliphatic and aromatic compounds.
LO5	To design synthetic routes for synthetically used organic reactions.

Unit	Content	Hours
1	**Elimination and Free Radical Reactions:** Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, Detection and stability of radicals, characteristics of free radical reactions - Reactions of radicals: Polymerization, addition, halogenations, aromatic substitutions, rearrangements.	18
2	**Oxidation and Reduction Reactions:** Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, permanganate, osmium tetroxide, oxidation of saturated hydrocarbons, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide-dicyclohexyl carbodiimide (DMSO-DCCD). Mechanism of reduction reactions: Rosenmund, McFadyen-Steven's reduction, Hydroboration with cyclic systems, MPV and Bouveault- Blanc reduction.	18
3	**Rearrangements:** Rearrangements to electron deficient carbon: Wagner-Meerwein, Demjanov, Dienone-phenol, Baker-Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement. Intramolecular	18

	rearrangements –, Benzidine rearrangements.	
4	**Addition to Carbon Multiple Bonds:** Mechanisms: (a) Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen; (b) Addition to carbon-hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, Wittig reaction, Prins reaction. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates – Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.	18
5	**Reagents and Modern Synthetic Reactions:** Lithium diisopropylamine (LDA), Sodium cyanoborohydride ($NaBH_3CN$), *meta*-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), Triethylamine (TEA), Diazobicyclo [5.4.0] undec-7-ene (DBU), Di isopropyl azo dicarboxylate (DIAD), Diethyl azo dicarboxylate (DEAD), *N*-bromo succinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyl trimethyl ammonium tribromide (PTAB). Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Heck reaction, Negishi reaction, Baylis-Hillman reaction.	18

CO	**Course Outcomes**	**Knowledge Level**
Student will be able		
1	To recall the basic principles of aromaticity of organic and heterocyclic compounds.	K1, K2, K3
2	To understand the mechanism of various types of organic reactions.	K1, K2, K3, K4
3	To predict the suitable reagents for the conversion of selective organic compounds.	K1, K2, K3
4	To correlate the principles of substitution, elimination, and addition reactions.	K1, K2, K3, K4
5	To design new routes to synthesis organic compounds.	K1, K2, K3, K4

Text books:	
1	J.Marchand M.Smith,"*Advanced Organic Chemistry"*,5thed., John-Wiley and Sons.

	2001.
2	E. S. Gould, "*Mechanism and Structure in Organic Chemistry"*, 1st ed.,Holt, Rinehart and Winston Inc., 1959.
3	P. S. Kalsi, "*Stereochemistry of carbon compounds"*, 8thed., New Age International Publishers, 2015.
4	P.Y. Bruice,"*Organic Chemistry"*,7thed., Prentice Hall, 2013.
5	R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, "*Organic Chemistry"*, 7th ed., Pearson Education, 2010.
Reference Books:	
1	S.H.Pine,"*Organic Chemistry"*,5th ed, Mc Graw Hill International Edition, 1987.
2	L. F. Fieser and M. Fieser, "*Organic Chemistry"*, 4th ed., Asia Publishing House, Bombay, 2000.
3	O. P. Agarwal, "*Organic Chemistry: Reactions & Reagents*", 53rd ed., Krishna Prakashan Media (P) Ltd., 2015.
4	T. L. Gilchrist, "*Heterocyclic Chemistry"*, 2nd ed., Longman Press, 1989.
5	J. A. Joule and K. Mills, "*Heterocyclic Chemistry"*, 4th ed., John-Wiley, 2010.
Web Resources:	
1	https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic
2	https://www.organic-chemistry.org/
3	https://www.masterorganicchemistry.com/
4	https://onlinecourses.nptel.ac.in/
5	https://www.masterorganicchemistry.com/

Mapping with Programme Outcomes and Programme Specific Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	2	3	3
CO3	3	3	2	3	3	3	3	2	3	3	2
CO4	3	2	3	3	3	2	3	3	2	3	3
CO5	2	3	2	3	3	3	3	2	3	3	3
Total	13	14	13	15	14	12	15	13	13	15	14
Average	**2.6**	**2.8**	**2.6**	**3.0**	**2.8**	**2.6**	**3.0**	**2.6**	**2.6**	**3.0**	**2.8**

3– Strong, 2–Medium, 1-Low

1ST YEAR: SECOND SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHC22	Physical Chemistry II	3	1	2	5	6	25	75	100
Category	Core Course	Theory							

Learning Objectives

Student will be able

LO1	To understand the essential characteristics of wave functions and need for the quantum mechanics.
LO2	To know the importance of quantum mechanical models of particle in a box, rigic rotor and harmonic oscillator.
LO3	To analyze the quantum mechanics to hydrogen and polyelectronic systems
LO4	To familiarize the symmetry in molecules and predict the point groups
LO5	To apply quantum and group theories to analyze molecular models, vibrations and electronic spectra

Unit	Content	Hours
1	**Introduction to Quantum Mechanics:** Black body radiation, wave particle duality , uncertainty principle, photoelectric effect, hydrogen spectrum. Need for quantum mechanics, postulates of quantum mechanics Particle wave and Schrodinger wave equation-Time independent and time dependent. Wave function, properties of wave function- Normalized orthogonal, orthonormal, Eigen values and Eigen function: Hermitian properties of operators.	18
2	**Applications to Particles,** Quantum Models and Hydrogen Atom: Application of Schrodinger wave equation to particle in a box-(1D, 2D and BD). Degeneracy, free particles. Harmonic Oscillator-wave equation and solution, anharmonicity, force constant and its significance. Rigid rotor wave equation and solution, calculation of rotational constants and bond length of diatomic molecules.	18
3	**Applications to Poly Electron Atoms:** Approximation methods: variation methods- trial wave function, variation integral and application to particle in 1D box slanted bottom. Perturbation method - first order applications. Hartree-Fock self-consistent field method, Helium atom-electron spin, Pauli's exclusion principle and Slater determinant. Hohenberg-Kohn theorem and Kohn-Sham equation. Molecular orbital theory and Heitler London (VB) treatment.	18
4	**Group Theory**: Groups, sub groups, symmetry elements and symmetry Operations. Point groups-Classification, axial, non-axial and dihedral point groups-Cn, Cnh, Dn, Dnh, Dnd, Td and Oh. Matrix representation and classes of symmetry operations, reducible irreducible and direct product representation. variation	18

	function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene, butadiene and Benzene.	
5	**Applications of Group Theory**: Reducing the reducible representation into irreducible representation. Properties of irreducible representation, Great orthogonality theorem. Construction of character table for C2v, C2h, C3v and D2h point groups. Hydrogen Molecule- Applications of group theory to molecular vibrations and hybridization of simple molecules (H20, NH3, BF3, CH4, XeF4). Electronic spectra of ethylene.	18
CO	**Course Outcomes**	**Knowledge Level**
Student will be able		
1	To discuss the characteristics of wave functions and symmetry functions.	K1, K2, K3
2	To classify the symmetry operation and wave equations	K1, K2, K3, K4
3	To apply the concept of quantum mechanics and group theory to predict the electronic structure.	K1, K2, K3
4	To specify the appropriate irreducible representations for theoretical applications.	K1, K2, K3, K4
5	To develop skills in evaluating the energies of molecular spectra.	K1, K2, K3, K4

Textbooks:	
1	R.K. Prasad, "Quantum Chemistry', New Age International Publishers, New Delhi, 4h ed, 2010
2	Samuel Glasstone, "Textbook of Physical Chemistry", Macmillan India Ltd, New Delhi 2"ed., 1998.
Reference Books:	
1	N. Levine, "Quantum Chemistry", Allyn& Bacon Inc, 4t ed, 1983.
2	"P.W. Atkins, J, de Paula, J. Keeler, " Atkins' Physica/ Chemistry', Oxford University Press, Oxford, 11"ed., 2018
3	John O'M. Bockris and Amulya K. N. Reddy, "Modern Electrochemistry: lonics" (Volume 1,Plenum Press, New York, 2"ed., 1998.
4	R.L. Flurry. Jr, "Symmetry Group Theory and Chemical applications", Prentice HallInc,1980
5	J. M. Hollas, "Symmetry in Molecules', Chapman and Hall, London, Reprint, 2011
Web Resources:	

1	https://empslocal.ex.ac.uk/people/staff/mrwatkin//teaching/Level%202%20Spectroscopy/LGroupTheory.paf
2	https://www.scribd.com/document/630369698/Quantum-Mechanics-notes

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
Average	2.4	3.0	2.6	3.0	2.8	2.4	3.0	2.6	3.0	3.0	3.0

3 – Strong, 2- Medium, 1- Low

1ST YEAR: SECOND SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHC23P	Physical Chemistry Practical	1	1	3	4	5	25	75	100
Category	Core Course	Practical							

Learning Objectives	
Student will be able	
LO1	To understand the principle of conductivity experiments through conductometric titrations
LO2	To evaluate the order of the reaction, temperature coefficient, and activation energy of the reaction by following pseudo first order kinetics.
LO3	To construct the phase diagram of two component system forming congruent melting solid and find its eutectic temperatures and compositions.
LO4	To determine the kinetics of adsorption of oxalic acid on charcoal
LO5	To develop the potential energy diagram of hydrogen ion, charge density distribution and Maxwell's speed distribution by computational calculation.

Unit	Content	Hours
1 & 2	**Conductivity Experiments** 1.Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation. 2. Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid. 3. Determination of solubility of a sparingly soluble salt. 4. Acid-base titration (strong acid and weak acid vs NaOH). 5. Precipitation titrations (mixture of halides only).	30
3	**Kinetics** 1. Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and also the activation energy of the reaction. 2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.	15
4 & 5	**Phase diagram** Construction of phase diagram for a simple binary system 1. Naphthalene-biphenyl 2. Benzophenone- diphenyl amine Adsorption Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).	30

CO	**Course Outcomes**	**Knowledge Level**
Student will be able		
1	To recall the principles associated with various physical chemistry experiments.	K1, K2, K3
2	To scientifically plan and perform all the experiments.	K1, K2, K3, K4
3	To observe and record systematically the readings in all the experiments.	K1, K2, K3
4	To calculate and process the experimentally measured values and compare with graphical data.	K1, K2, K3, K4
5	To interpret the experimental data scientifically to improve students' efficiency for societal developments	K1, K2, K3, K4

Textbooks:	
1	B. Viswanathan and P.S. Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.
2	Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
Reference Books:	
1	J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2	G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.
4	Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014.
Web Resources:	
1	https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pd
2.	https://Conductometric Titration - PDFCOFFEE.COM

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	3	3	3	2	3	3	3	3	3	2
CO2	3	3	3	3	3	2	3	2	3	2	3
CO3	3	2	2	3	2	2	3	3	3	3	3
CO4	3	3	2	2	3	3	2	3	3	3	3
CO5	3	3	3	3	3	3	2	3	2	3	3
Total	14	14	13	14	13	13	13	14	14	14	14
Average	2.8	2.8	2.6	2.8	2.6	2.6	2.6	2.8	2.8	2.8	2.8

3 – Strong, 2- Medium, 1- Low

1ST YEAR: SECOND SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHE21	Water Treatment and Analysis	3	2	0	3	5	25	75	100
Category	Elective Course	Theory							

Learning Objectives

Student will be able

LO1	To impart knowledge about the various methods of Water Analysis and Treatment of Water.
LO2	To learn the principles and methods of water treatment processes, including coagulation, sedimentation, filtration, and disinfection.
LO3	To develop skills to analyze water quality using laboratory techniques to measure parameters such as pH, turbidity, hardness, alkalinity, and dissolved oxygen.
LO4	To evaluate the effectiveness of different water and wastewater treatment systems used for domestic and industrial purposes.
LO5	To promote safe and sustainable water management practices to ensure clean and potable water for public health and environmental protection

Unit	Content	Hours
1	**Introduction** - Characteristics of water - Alkalinity - Hardness - Unit of hardness - Total solids - Oxidation - Transparency - Silica content - Purification of Water for drinking purpose - Potability of water - Clarification - Coagulation - Contact and Electrochemical Coagulation - Sterilisation and Disinfection of water - Precipitation - Aeration - Ozonisation - Chlorination.	15
2	**Water Softening Methods** - Clark's process - Lime soda process - Modified lime soda process - Permutit or Zeolite process - Ion exchange process - Demineralisation of water - Determination of Hardness of water - Titration method - Complexometric method using EDTA - Expressing Hardness - Equivalents of Calcium Carbonate - Problems to determine Temporary and Permanent Hardness.	15
3	**Hard water and Industries** - Industrial water treatment - Boiler feed water method of Softening - Prevention of plumbo solvency - Scales in boilers - Consequences - Internal conditioning methods - Desalination of Brackish water - Elecrodiaysis - Reverse osmosis - Removal of Fe, Mn and Silicic acid - Effluent Treatment of Water from Paper Industry, Petrochemicals, Fertilizer industry and Power station.	15
4	**Water analysis - Sampling of Water for analysis** - Chemical Substances affecting Potability - Colour, Turbidity, Odour, Taste, Temperature, pH and Electrical Conductivity - Analysis of Solids present in water - Suspended Solids - Dissolved Solids - Total Acidity - Alkalinity - Free CO_2 - Free Chlorine - Ca, Mg, Fe, Mn, Ag	15

	and Zn - Water in Industry - Pollution of Water by Fertilisers, Detergents, Pesticides and Industrial wastes.	
5	**Analysis of Chemical Substances Affecting Health** - NH3, Nitrate, Nitrite, Cyanide, Sulphate, Sulphide, Chloride and Fluoride - Measurement of Toxic Chemical Substances - Analysis of Chemical Substances indicative of Pollution - Dissolved oxygen - Biochemical Oxygen Demand (BOD) - Chemical Oxygen Demand (COD) - Bacteriological Examination of Water.	15

CO	Course Outcomes	Knowledge Level
Students will be able		
1	To understand the Classify water based on the presence of dissolved salts in it.	K1, K2, K3
2	To explain the various methods to make the water potable.	K1, K2, K3, K4
3	To understand the softening methods of hardwater and determine hardness of water	K1, K2, K3
4	To understand electrodialysis and RO methods to desalinate Brackish water.	K1, K2, K3, K4
5	To Analyse the presence of Chemical substances in water indicative of pollution by measuring BOD and COD.	K1, K2, K3, K4

Textbooks:	
1	J.D. Perry, "*Distillation: Principles and Applications"*, 5th ed., McGraw-Hill Education, 2015.
2	Leo M. L. Nollet & Leen S. P. De Gelder, CRC Press-2017
Reference Books:	
1	Industrial Chemistry (Including Chemical - Engineering) - B. K. Sharma - Goel Publishing House, Meerut (1987).
2	Pollution Control in Process Industries - S. P. Mahajan - Tata McGraw Hill Publishing Company Ltd., New Delhi (1991).
3	Water Pollution and Management - C. K. Varashney - Wiley Eastern Ltd., Chennai -20 (1991)
4	S. K. Garg – *Environmental Engineering (Vol. 1: Water Supply Engineering),* 33rd Revised Edition- 2017

5	Industrial Chemistry B.K. Sharma ,5th edition-1982
Web Resources:	
1	https://theconstructor.org/environmental-engg/characteristics-of-waterphysical-chemical-biological/4735/
2	https://www.egr.msu.edu/~hashsham/courses/ene806/docs/
3	https://irpcdn.multiscreensite.com/915207aa/files/uploaded/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	3	2	3	3	3	2
CO2	3	3	3	2	3	2	2	3	3	3	3
CO3	3	2	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	2	3	2	3	3
CO5	3	3	2	3	3	2	2	3	3	3	3
Total	15	13	13	14	14	12	11	15	14	15	14
Average	**3.0**	**2.6**	**2.6**	**2.8**	**2.8**	**2.4**	**2.2**	**3.0**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: SECOND SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Cour se Code	Title of the Course								
26PCHE22	Industrial Chemistry	4	1	0	3	5	25	75	100
Category	Elective Course	Theory							

Learning Objectives	
Student will able	
LO1	To make the students learn about fertilizers
LO2	To understand the importance of sugar Industries
LO3	To learn the importance of Chemical explosives
LO4	To study about the leather industries.
LO5	To understand the importance of water industry

Unit	Content	Hours
1	**Fertilizers**: Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts. **Agrochemical industries:** Important categories of insecticides, fungicides, herbicides, rodenticide, Mode of action and synthesis of common pesticides like gammexane, DDT, aldrin, Parathion, Malathion, Baygon,	15
2	**Paints & Varnishes**: Primary constituents of paints, Dispersion medium (solvent), binder Pigments, formulation of paints and varnishes. Requirements of a good paint. Cleansing Agents: Preparation of toilet and washing soaps, synthetic detergents-alkyl aryl sulphonates, ethanolamines, nonionic detergents, builders, additives, corrosion inhibitors.	15
3	**Chemical Explosives** : Preparation and chemistry of lead azide, nitroglycerine, nitrocellulose, TNT, RDX,Dynamite, cordite, picric acid, gunpowder, introduction to rocket propellants. **Electrochemical Industries:** Production of materials like chlorine, caustic soda ,sodium chlorate, perchlorates, Batteries – primary and secondary cells, solar cells, fuel cells.	15
4	**Leather Industry**: Curing, preservation and tanning of hides and skins, process of dehairing and dyeing. Treatment of tannery effluents. **Water Industry**: Pollution of water by fertilizers, detergents, pesticides and industrial wastes, BOD, COD, thermal pollution. Water Treatment – Ion exchange, electrodialysis, reverse osmosis, softening of hard water.	15

	Sugar: Cane sugar manufacture, recovery of sugar from molasses, sugar estimation sugar industries in India.	
5	**Petroleum:** Origin, refining, Cracking, reforming, knocking and octane number, LPG, synthetic gas, synthetic petrol. Fuel Gases: Large scale production, storage, hazards and uses of coal gas, water gas, producer gas, and oil gas. **Cement:** Manufacture – Wet Process and Dry process, types, analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India. Ceramics: Important clays and feldspar, glazing and vitrification. Glass: Composition and manufacture of glass. Types of glasses- optical glass, coloured glasses and lead glass.	15

CO	Course Outcomes	Knowledge Level
Student will be able		
1	To Acquire knowledge of fertilizers	K1, K2, K3
2	To Appreciate the importance of sugar industries in India	K1, K2, K3, K4
3	To Explain the Acquire knowledge of Chemical explosives	K1, K2, K3
4	To Designed to Illustrate the importance of leather industries	K1, K2, K3, K4
5	To Identify the importance of water industry	K1, K2, K3, K4

Textbooks:	
1	Sharma, B.K. Industrial Chemistry, 9th ed.; Goel Publishing House: Meerut, 1998. 2.. 3. 4. 5.
2	Wilkinson, J.B.E. Moore, R.J. Harry's Cosmeticology, 7th ed.; Chemical Publishers : New York, 1982
Reference Books:	
1	Jain, P.C.; Jain, M. Engineering Chemistry, 16th ed.; Dhanapet Rai: Delhi, 1992.
2	George Howard, Principles and Practice of Perfumes and Cosmetics, Stanley Therones, Cheltenham: UK, 1987.
3	Thankamma Jacob, Foods, Drugs and Cosmetics - A Consumer Guide, Macmillan : London, 1997.

4	ShankuntalaManay, N.; Shadaksharaswamy, M. Food Facts and Principles, 3rd ed.; New Age Publication, 2008.
5	Neeraj Pandey, KhushdeepDharni, Intellectual Property Rights, PHI Learning, 2014.
Web Resources:	
1	http://www.sciencecases.org/irradiation/irradiation_notes.asp
2	http://discovery.kcpc.usyd.edu.au//9.5.5/
3	https://www.wipo.int/about-ip/en/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	2	3	3	3
CO2	2	3	3	3	2	3	3	2	3	3	3
CO3	3	3	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	3	2	3	3	3
CO5	3	2	3	3	3	3	3	2	3	3	3
Total	13	14	15	15	14	15	15	10	15	15	15
Average	**2.6**	**2.8**	**3.0**	**3.0**	**2.8**	**3.0**	**3.0**	**2.0**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: SECOND SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHE23	Nuclear Chemistry	3	1	1	3	5	25	75	100
Category	Elective Course	Theory							

Learning Objectives	
Student will be able	
LO1	To understand the structure and stability of atomic nuclei and nuclear forces.
LO2	To study the principles of radioactivity and different modes of radioactive decay.
LO3	To learn about nuclear reactions, fission and fusion processes.
LO4	To understand the working principles of nuclear reactors and nuclear energy production.
LO5	To understand the applications of radioisotopes and radiochemical techniques in science and technology

Unit	Content	Hours
1	**Nuclear Structure and Stability:** Composition of atomic nucleus: protons, neutrons and nuclear particles - Nuclear size, nuclear radius and nuclear density - Isotopes, isobars, isotones and nuclear stability-Mass defect and binding energy-Packing fraction and binding energy curve-Nuclear forces and characteristics-Nuclear models: Liquid drop model and Shell model	15
2	**Radioactivity and Decay Processes:** Natural and artificial radioactivity-Radioactive decay law and decay constant- Half-life and mean life-Radioactive series and radioactive equilibrium- Modes of decay: Alpha decay**,** Beta decay (β^-, β^+ and electron capture) Gamma emission-Decay energy and decay schemes	15
3	**Nuclear Reactions:** Nuclear reactions and reaction equations- Nuclear reaction energetics (Q-value)- Nuclear cross section- Compound nucleus theory- Types of nuclear reactions:(n,p), (n,α), (p,n) reactions-Photonuclear reactions**:** Nuclear fission and fusion reactions Chain reactions and critical mass	15

4	**Nuclear Energy and Reactors:** Principles of nuclear fission- Energy released in nuclear reactions- Nuclear reactors: components and working- Types of nuclear reactors (thermal, fast breeder)- Reactor fuels and moderators- Radiation hazards and safety measures Nuclear waste management	15
5	**Radiochemistry and Applications:** Radioactive isotopes and radioisotope production- Radiochemical techniques and tracer methods Measurement of radioactivity: Geiger–Müller counter, Scintillation counter and Ionization chamber- Applications of radioisotopes in: Medicine (diagnosis and therapy), Agriculture, Industry, Chemical research, Radiometric dating methods (Carbon-14, Uranium dating)	15

CO	Course Outcomes	Knowledge Level
Student will be able		
1	To understand nuclear structure and stability by explaining nuclear particles, nuclear forces, isotopes, and nuclear models.	K1, K2, K3
2	To analyze radio active decay processes and radioactive equilibrium	K1, K2, K3, K4
3	To interpret nuclear reactions, Q-values, and chain reactions.	K1, K2, K3
4	To understand the working principles of nuclear reactors and nuclear energy production.	K1, K2, K3, K4
5	To apply knowledge of radioisotopes in medicine, agriculture, industry, and scientific research.	K1, K2, K3, K4

Textbooks:	
1	Friedlander, G., Kennedy, J.W., Macias, E.S., and Miller, J.M.,"Nuclear and Radiochemistry",3rd Edition, 1981, John Wiley & Sons
2	Arnikar, H. J.,"Essentials of Nuclear Chemistry", 4th Edition, 2011, New Age International Publishers
3	Choppin, G., Liljenzin, J.O., and Rydberg, J.,"Radiochemistry and Nuclear Chemistry", 3rd Edition, 2002, Butterworth-Heinemann
4	Cotton, F. A. and Wilkinson, G., "Advanced Inorganic Chemistry", 6th Edition, 1999, John Wiley & Sons
5	Lee, J. D., "Concise Inorganic Chemistry", 5th Edition, 1996, Blackwell Science

Reference Books:	
1	Krane, K. S."Introductory Nuclear Physics", 1st Edition, 1987, John Wiley & Sons
2	Lilley, J, "Nuclear Physics: Principles and Applications", 1st Edition, 2001, John Wiley & Sons
3	Glasstone, S. and Sesonske, A.,"Nuclear Reactor Engineering", 4th Edition, 1994, Springer
4	Knoll, G. F., "Radiation Detection and Measurement", 4th Edition, 2010, John Wiley & Sons
5	Ehmann, W. D. and Vance, D. E.,"Radiochemistry and Nuclear Methods of Analysis", 1st Edition, 1991, John Wiley & Sons
Web resources:	
1	https://nptel.ac.in/courses/104/106
2	https://chem.libretexts.org
3	https://www.iaea.org/resources
4	https://www.khanacademy.org/science/physics/nuclear-physics
5	https://www.sciencedirect.com/topics/chemistry/nuclear-chemistry

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	3	3	2	3	2	3	3	3
Total	12	15	13	15	14	12	15	13	15	15	15
Average	**2.4**	**3.0**	**2.6**	**3.0**	**2.8**	**2.4**	**3.0**	**2.6**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: SECOND SEMESTER

Department of Chemistry		L	T	P	Credits	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHE24	Heterocyclic Chemistry	4	1	0	3	5	25	75	100
Category	Elective Course	Theory							

Learning Objectives	
Student will be able	
LO1	To know the student about chemistry of heterocyclic compounds.
LO2	To know the student about chemistry of nonaromatic heterocyclic compounds.
LO3	To understands the strategies for designing the chemical synthesis.
LO4	To make the students knowledgeable in meso ionic heterocycles.
LO5	To know the student about chemistry of higher heterocyclic compounds.

Unit	Content	Hours
1	**Nomenclature of Heterocycles:** Introduction, nomenclature systems- systematic nomenclature system (Hantzsch – Widman system) and replacement nomenclature system for monocyclic, fused, spiro and bridged heterocycles. Aromatic heterocycles: Introduction, chemical behavior of aromatic heterocycles, classification (structural types). Criteria of aromaticity in heterocycles (bond lengths, dipole moments, empirical resonance energy, delocalization energy, Dewar resonance energy, chemical shits and ^{1}HNMR spectra)	15
2	**NON-AROMATIC HETEROCYCLES:** Introduction, strain, bond angle strain, torsional strain and their consequences in small ring heterocycles, conformations of six membered heterocycles – molecular geometry, barriers to ring inversion, pyramidal inversion and 1,3 diaxial interactions. Stereoelectronic effect in saturated six membered heterocycles- anomeric effect, other related effects and attractive interactions through space.	15
3	**SMALL RING HETEROCYCLES:** Three membered and four membered heterocycles: Synthesis and reactions of aziridines, oxiranes, thiranes, azetidines, oxetanes and thietanes. Benzo- fused five membered heterocycles: Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes.	15
4	**MESO IONIC HETEROCYCLES:** General classification, chemistry of some important meso-ionic heterocycles of type A and B and their applications. Six membered heterocycles with on heteroatom: Synthesis and reactions of pyrylium	15

	salts and pyrones and their comparisons with pyridinium and thiopyrylium salts and pyridones.	
5	**HIGHER HETEROCYCLES** Six membered heterocycles with two or more heteroatom: Synthesis and reactions of diazines. triazines and tetrazines. Seven and large membered heterocycles: Synthesis and reactions of azepines, oxepines , thiepines and diazepines. Synthesis of five and six membered heterocycles with P, As, Sb and Bi.	15
CO	**Course Outcomes**	**Knowledge Level**
Student will be able		
1	Explain the structure, classification, and chemical properties of heterocyclic compounds.	K1, K2, K3
2	Describe the chemistry and reactivity of non-aromatic heterocyclic compounds.	K1, K2, K3, K4
3	Apply synthetic strategies and methodologies for the design and preparation of heterocyclic compounds.	K1, K2, K3
4	Analyze the structure, properties, and significance of meso-ionic heterocycles.	K1, K2, K3, K4
5	Evaluate the chemistry and applications of higher heterocyclic compounds.	K1, K2, K3, K4

Textbooks:	
1	Heterocyclic Chemistry, Vol. 1-3, R. R. Gupta, M. Kumar and V. Gupta , Spinger Verlag.
2	Heterocyclic Chemistry, John A. Joule and Keith Mills, 5th Edition, Wiley, 2010 (Reprinted 2013)
Reference Books:	
1	The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
2	Heterocyclic Chemistry, J. A. Joule, K. Mills and G. F. Smith, Chapman and Hall.
3	Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical.
4	Contemporary Heterocyclic Chemistry, G. R. Newkome and W.W. Paudler, Wily –inter Science.
5	An Introduction to the Heterocyclic Compounds, R. M. Acheson, John wiely.
Web Resources:	
1	https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/heterocy.htm
2	https://onlinelibrary.wiley.com/journal/19435193
3	https://www.sciencedirect.com/referencework/9780080449920/comprehensive-heterocyclic-chemistry-iii

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	3	3	3	3	3
CO5	2	3	2	2	3	2	2	2	3	3	3
Total	12	15	13	14	15	12	14	13	15	15	15
Average	**2.4**	**3.0**	**2.6**	**2.8**	**3.0**	**2.4**	**2.8**	**2.6**	**3.0**	**3.0**	**3.0**

3 – Strong, 2- Medium, 1- Low

1ST YEAR: SECOND SEMESTER

Department of Chemistry		L	T	P	Cred its	Hours	Marks		
Regulation 2026-27							CIA	ESE	Total
Course Code	Title of the Course								
26PCHS21	Chemistry in Food Preservation	2	1	0	2	3	25	75	100
Category	Skill Course	Theory							

Learning Objectives	
Student will be able	
LO1	To explain the concept, scope, and importance of food preservation.
LO2	To identify and classify different types of food spoilage including physical, enzymatic, chemical, and biological spoilage.
LO3	To analyze the canning process and identify spoilage encountered in canned foods.
LO4	To express the advantages and disadvantages of refrigeration in maintaining food quality.
LO5	To describe the preparation and preservation of fruit beverages including squashes, cordials, nectars, concentrates, and powder beverages.

Unit	Content	Hours
1	**Introduction to food preservation:** Definition and scope of preservation, concept, importance, common terms used in food preservation, Classification of food on the basis of pH value, technology, Principles of food preservation, traditional and modern methods. Food additives –types, Class I and Class II preservatives	9
2	**Food spoilage:** Definition, types of spoilage - physical, enzymatic, chemical and biological spoilage. Mechanism of spoilage and its end products, shelf-life determination.	9
3	**Preservation by use of high temperature:** Pasteurization: types, Sterilization, Canning - spoilage encountered in canned foods, types of containers used for canning foods. Food irradiation – Principles, merits and demerits, effects of irradiation and photochemical methods.	9
4	**Preservation by use of low temperature:** Refrigeration- advantages and disadvantages, freezing: Types of freezing, common spoilages occurring during freezing, difference between refrigeration and freezing.	9
5	**Dehydration of fruits and vegetables:** Preservation by Removal of Moisture-Drying and dehydration - merits and demerits, different types of drying- sun drying and mechanical drying. **Fruit beverages**: Preservation of fruit juices- squashes, cordials, nectars, concentrates and powder.	9

CO	Course Outcomes	Knowledge Level
Student will be able		
1	To explain the concept, scope and importance of food preservation and the common terms used in food preservation.	K1, K2, K3
2	To analyze the mechanisms involved in food spoilage and identify the end products formed during spoilage.	K1, K2, K3, K4
3	To describe the process of canning, types of containers used and the spoilage encountered in canned foods.	K1, K2, K3
4	To compare refrigeration and freezing and analyze their role in extending the shelf life of food products.	K1, K2, K3, K4
5	To interviewing the preparation and preservation of fruit beverages such as squashes, cordials, nectars, concentrates and powder beverages.	K1, K2, K3, K4

Textbooks:	
1	M. S. Rahman, "Handbook of Food Preservation", CRC Press, USA, 2020.
2	B. Srilakshmi, "Food Science", New Age International Publications, New Delhi, 2017.
Reference Books:	
1	N. S. Manay and M. Shadaksharaswamy, "Foods: Facts and Principles", New Age International Publishers, New Delhi, 2004.
2	B. Srilakshmi, "Food Science", New Age International Publishers, New Delhi, 2003.
3	G. Subalakshmi and S. A. Udipi, "Food Processing and Preservation", New Age International Publishers, New Delhi, 2001.
4	R. P. O. Srivastava and S. Kumar, "Fruit and Vegetable Preservation: Principles and Practices", 3rd ed., International Book Distribution Company, 2014.
5	P. J. Fellows, "Food Processing Technology: Principles and Practice", 2nd ed., CRC Woodhead Publishing Ltd., Cambridge, 2016.
Web Resources:	
1	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=111436
2	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=111435
3	http://www.homepreservingbible.com/2247-an-introduction-to-the-drying-food preservation-method/

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	3	2	3	3	3
CO2	3	2	3	3	3	3	2	3	3	3	3
CO3	3	2	3	2	3	3	2	2	3	3	3
CO4	3	3	3	2	3	2	3	2	3	3	3
CO5	3	2	3	3	3	3	3	3	3	3	3
Total	15	12	15	12	15	14	13	13	15	15	15
Average	**3**	**2.4**	**3**	**2.4**	**3**	**2.8**	**2.6**	**2.6**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

Continuous Internal Assessment (CIA) Test

The following procedure will be followed for the award of internal marks:

CIA Exam I: Three hours duration for 75 marks (First 2 ½ Units)

CIA Exam II cum Model Exam: Three hours duration for 75 marks (Full Syllabus)

Internal Mark Distribution	**Theory & Practical**
CIA – I (75 Marks)	5
CIA – II (75 Marks)	5
Library Usage in Hours	5
Attendance	5
Assignment / Seminar / Observation	5
Internal Marks	**25**

Format to Entering in all Continue Internal Assessment (CIA) Tests and Internal Marks

Reg. No.	Name	CIA - 1	CIA - 2	Marks Conversion	Library Usages	Attendance	Assignment / Seminar / Observation	Total Marks	Remarks

Recommendations for Entering Library Usage:

Library usage for PG in hours	**Marks to be awarded**
Minimum 10 Hours	5

Attendance:

Attendance Earned	**Category**	**Marks to be Awarded**
91% and above	Highly Regular	5
75% but below 90%	Regular	4
65% but below 74%	Shortage	3
55% but below 64%	Detained	2
Below 54%	Redo	0

THEORY QUESTION PAPER PATTERN END SEMESTER EXAMINATIONS

FOR UG & PG DEGREE PROGRAMMES - 3 HOURS DURATION

Part A	To answer All the 10 Short Questions (Two Questions from each UNIT)	10 X 2 = 20 Marks
Part B	To answer All the 5 questions (either or, type) (One Question from each UNIT)	5 X 5 = 25 Marks
Part C	To answer 3 questions (out of 5 questions) (One question from each UNIT)	3 X 10 = 30 Marks
TOTAL		**75 Marks**
(Equal Weightage should be given to each unit)		