KONGUNADU ARTS AND SCIENCE COLLEGE

(Autonomous)
Re-accredited by NAAC with 'A^{+}' Grade (4th Cycle)
Affiliated to Bharathiar University
College of Excellence (UGC)
G.N.Mills Post, Coimbatore - 641029, Tamilnadu, INDIA

PG & RESEARCH DEPARTMENT OF CHEMISTRY

CURRICULUM AND SCHEME OF EXAMINATIONS (CBCS)

(2025 – 2026 ONWARDS)

KONGUNADU ARTS AND SCIENCE COLLEGE

(AUTONOMOUS)

COIMBATORE – 641 029

PG & RESEARCH DEPARTMENT OF CHEMISTRY

VISION AND MISSION OF THE DEPARTMENT

The PG & Research Department of Chemistry aims at holistic development through academic excellence, employability, acquisition of scientific skills and higher research.

PROGRAMME OUTCOMES (PO)

PO 1: Assimilate advanced knowledge in the core subject with relevant practical inputs.

PO 2: Incorporate a more significant and superior knowledge in the major areas of chemistry – Organic chemistry, Inorganic Chemistry and Physical Chemistry.

PO 3: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional practice.

PO 4: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 5: Comprehend and write effective reports, design documentation and make effective presentations.

PO 6: Demonstrate attitude, skills and knowledge of a well-groomed personality at work and social environment.

PO 7: Broaden professional foundation through activities such as teaching (seminars), internships, industrial visits and projects.

PO 8: Build up problem solving, decision-making and communication skills with the educated community.

PROGRAMME SPECIFIC OUTCOMES (PSO)

Upon completion of the programme,

PSO 1 : The students are enabled to integrate the chemistry of many natural products, organic compounds, inorganic compounds, intermediate compounds, drugs and biologically important compounds.

PSO 2 : The students will be proficient in the advanced level understanding of all the areas of chemistry, for facing competitive exams like NET, SET, GATE, etc.,

PSO 3 : The students will be able to clearly articulate scientific information in oral, written and electronic formats.

PSO 4 : The students will be skilled in examining specific phenomena theoretically and /or experimentally, and the graduate is able to contribute to the generation of new scientific insights or to the innovation of new applications of chemical research.

PSO 5 : The students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemistry including an understanding of safe handling of chemicals, environmental issues and key issues of our society in energy, health and medicine.

KONGUNADU ARTS AND SCIENCE COLLEGE (AUTONOMOUS)

COIMBATORE – 641 029

Programme Name: M.Sc., Chemistry

Curriculum and Scheme of Examination under CBCS

(Applicable to students admitted during the academic year 2025-2026)

Semester	Course Code	Title of the Course	Instruction hours/cycle	Exam Marks			Duration of Exam (Hrs)	Credits
				CIA	ESE	Total		
I	25PCH101	Core Paper 1- Organic Chemistry - I	5	25	75	100	3	5
	25PCH102	Core Paper 2 - Inorganic Chemistry - I	5	25	75	100	3	5
	25PCH103	Core Paper 3 - Physical Chemistry - I	5	25	75	100	3	5
	25PCH1E1	Major Elective - 1	5	25	75	100	3	5
		Core Practical 1 - Organic Chemistry Practical - I	3	-	-	-	-	-
		Core Practical 2 - Inorganic Chemistry Practical-I	3	-	-	-	-	-
		Core Practical 3 - Physical Chemistry Practical-I	4	-	-	-	-	-
Total			**30**			**400**		**20**
II	25PCH204	Core Paper 4 - Organic Chemistry - II	5	25	75	100	3	5
	25PCH205	Core Paper 5 - Inorganic Chemistry - II	5	25	75	100	3	5
	25PCH2E2	Major Elective - 2	5	25	75	100	3	5
	25PCH2CL	Core Practical 1 - Organic Chemistry Practical - I	5	40	60	100	6	3
	25PCH2CM	Core Practical 2 - Inorganic Chemistry Practical-I	5	40	60	100	6	3
	25PCH2CN	Core Practical 3 - Physical Chemistry Practical-I	5	40	60	100	6	2
Total			**30**			**600**		**23**
III	25PCH306	Core Paper 6 - Physical Chemistry - II	5	25	75	100	3	5
	25PCH307	Core Paper 7 - Organic Chemistry - III	5	25	75	100	3	5
	25PCH308	Core Paper 8- Inorganic Chemistry-III	4	25	75	100	3	5
	25PCH3N1	Non-Major Elective - 1	4	25	75	100	3	4
		Extra Departmental Course	2	100	-	100	3	2
	25PCH3CO	Core Practical 4 - Physical Chemistry Practical - II	4	40	60	100	6	2
		Core Practical 5 - Organic Chemistry Practical - II	3	-	-	-	-	-
		Core Practical 6- Inorganic Chemistry Practical- II	3	-	-	-	-	-
	25PCH3IT	**Internship Training ******	Grade					
Total			**30**			**600**		**23**
IV	25PCH409	Core Paper 9 - Physical Chemistry - III	5	25	75	100	3	5
	25PCH410	Core Paper 10 - Spectroscopy	5	25	75	100	3	5
	23PGI4N2	Non-Major Elective - 2	4	100	-	100	3	4
	25PCH4CP	Core Practical 5 - Organic Chemistry Practical - II	5	40	60	100	6	3
	25PCH4CQ	Core Practical 6 - Inorganic Chemistry Practical-II	5	40	60	100	6	3
	25PCH4Z1	Project & Viva -Voce	6**	20	80	100	-	4
Total			**30**			**600**		**24**
Total						**2200**		**90**

** 6 hours are allotted for project work, which will not be accounted for staff workload.

Note :

CBCS – Choice Based Credit System,

CIA – Continuous Internal Assessment

ESE – End of Semester Examinations

**** The students shall undergo Internship training / field work for a minimum period of 14 working days at the end of the second semester during summer vacation and submit the report in the third semester which will be evaluated for 100 marks by the concerned guide and followed by an Internal Viva voce by the respective faculty or HOD as decided by the department. According to their marks, the grades will be awarded as given below.

Marks %	Grade
85 – 100	O
70 – 84	D
60 – 69	A
50 – 59	B
< 40	U (Reappear)

Major Electives papers

(2 papers are to be chosen from the following 6 papers)

1. Analytical chemistry
2. Green and Nanochemistry
3. Bioinorganic chemistry
4. Drugs and their development
5. Medicinal chemistry
6. Polymer chemistry

Non-Major Electives papers

(2 papers are to be chosen from the following 4 papers)

1. Environmental science
2. Scientific thesis writing
3. Textile and dye chemistry
4. Information security[#]

[#]To be offered by the respective department

Sub. Code & Title of the Extra Departmental Course (EDC) :

25PCH3X1 – EDC Paper 1 - Food Science

Note: In core subjects, no. of papers both theory and practical are included wherever applicable. However, the total credits and marks for core subjects remain the same as stated below.

Tally Table

Subject	No. of Subjects	Total Marks	Credits
Core – Theory / Practical / Project	17	1700	70
Major Elective Papers	2	200	10
EDC Paper	1	100	2
Non Major Elective Paper	2	200	8
Grand Total	**22**	**2200**	**90**

- 25 % CIA is applicable to all subjects except JOC, ALC and COP which are considered as extra credit courses.
- 100 % CIA for Information Security and EDC.
- The students should complete any **MOOC course available for Online learning platforms like SWAYAM, NPTEL, IIT Bombay Spoken Tutorial, e-Pathshala etc.,** with a minimum of 4 weeks in duration before the completion of the 3rd semester and the course completion certificate should be submitted through the HOD to the Controller of Examinations. Extra credits will be given to the candidates who have successfully completed.
- **Onsite Training** preferably relevant to the course may be undertaken as per the discretion of the faculty or HOD.

Extra credit courses

JOB ORIENTED COURSE

Course code/ Q.P.Code	Title of the Course	Instruction hours/cycle	Exam Marks			Duration of Exam (Hrs)	Credits
			CIA	ESE	Total		
25PCH0J1	JOC - Pharmaceutical Chemistry	2	-	100	100	3	2

ADVANCED LEARNER COURSES *(UNDER SELF STUDY SCHEME)*							
25PCH0D1	ALC- 1 Chemistry of Corrosion	-	-	100	100	3	2
25PCH0D2	ALC- 2 Industrial Chemistry	-	-	100	100	3	2
25PCH0D3	ALC- 3 Advanced Functional Materials	-	-	100	100	3	2

JOC is conducted for 2 hours per cycle outside the college hours.

Components of Continuous Internal Assessment

Components		**Marks**	**Total**
Theory			
CIA I	75	(75+75 = 150/10) 15	25
CIA II	75		
Assignment/Seminar		5	
Attendance		5	
Practical			
CIA Practical		25	40
Observation Notebook		10	
Attendance		5	
Project			
Review		15	20
Regularity		5	

BLOOM'S TAXONOMY BASED ASSESSMENT PATTERN

K1-Remembering; **K2**-Understanding; **K3**-Applying; **K4**-Analyzing; **K5**-Evaluating

1. Theory Examination

CIA I & II and ESE: 75 Marks

Knowledge Level	Section	Marks	Description	Total
K1 – K2 Q1 to 10	A (Answer all)	10 x 1 = 10	MCQ	75
K1 – K5 Q11 to 15	B (Either or pattern)	5 x 5 = 25	Short Answers	
K2 – K5 Q16 to 20	C (Either or pattern)	5 x 8 = 40	Descriptive / Detailed	

2. Practical Examination:

Knowledge Level	Section	Marks	Total
K3	Experiments	50	60
K4	Record Work	10	
K5			

3. Project Viva Voce:

Knowledge Level	Section	Marks	Total
K3	Project Report	60	80
K4	Viva voce	20	
K5			

Subject code: 25PCH101

<table>
<tr><td colspan="3">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="5">Title of the paper: Core Paper 1 – Organic Chemistry I</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
I</td><td>Hours / Cycle
5</td><td>Total Hours
75</td><td>Credits
5</td></tr>
</table>

Course Objectives

1. To motivate the students to comprehend a knowledge on aromaticity and reaction mechanism.
2. To gain understanding in electrophilic and nucleophilic substitution reactions and disconnection approach.
3. To enable the students to elucidate the structure of some terpenoid compounds.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Recall the concepts of aromaticity and the chemistry of intermediates
	CO2	Review the mechanism of electrophilic substitution reactions
	CO3	Illustrate the mechanisms of aliphatic and aromatic nucleophilic substitution reactions
	CO4	Connect the guidelines of retro synthetic approach to solve problems in the planning of organic synthesis
	CO5	Appraise the structural elucidation and synthesis of some important terpenoid compounds and plant pigments

Syllabus

UNIT – I: AROMATICITY (15 hrs)

Huckel's rule – aromaticity in 5 and 6 membered rings (recall). Aromatic systems with electron numbers other than six – systems of two electrons, four electrons (anti aromaticity), eight electrons, ten electrons and more than ten electrons- homo and heteroaromatic compounds – annulenes.

Subject code: 25PCH101

INTERMEDIATES

Generation, Structure and stability of carbocations, carbanions, free radicals, carbenes, nitrenes*.Reaction mechanism: – study of intermediates, isotopic labeling, stereo chemical studies and cross over experiments – Hammonds postulate – Hammett equation –Taft equation.

UNIT – II: ELECTROPHILIC SUBSTITUTION REACTIONS (15 hrs)

Aliphatic electrophilic substitution: SE1 and SE2 reactions - mechanisms and reactivity - keto-enol tautomerism - halogenation of carbonyl compounds - Stork enamine reactions.

Aromatic electrophilic substitution – Arenium ion mechanism – Orientation and reactivity of mono and di substituted benzene - nitration - halogenation and sulphonation - Friedel Crafts alkylation - Friedel Crafts arylation (Scholl reaction) and Friedel Crafts acylation - Jacobsen reaction - formylation with (i) disubstituted formamides (Vilsmeyer- Haack reaction) (ii) zinc cyanide and HCl (Gattermann reaction) (iii) chloroform (Reimer - Tiemann reaction) - carboxylation with (i) carbonyl halides (ii) carbon dioxide (Kolbe Schmidt reaction) - cyanodehydration of aldehydes and ketones (Bradsher reaction) - acylation with nitriles (Hoesch reaction).

UNIT – III: NUCLEOPHILIC SUBSTITUTION REACTIONS (15 hrs)

Aliphatic nucleophilic substitution- SN1, SN2, SNi and neighbouring group mechanisms - kinetics - effects of structure, solvent and leaving and entering group - stereochemistry - hydrolysis of esters - Wurtz reaction - Claisen and Dieckmann condensation - Williamson reactions.

Aromatic nucleophilic substitution- SNAr and Benzyne mechanisms - Ziegler alkylation - Chichibabin–Schiemann reactions.

UNIT– IV: SYNTHETIC METHODOLOGY (15 hrs)

Retrosynthetic approach - synthons and synthetic equivalents– guidelines for disconnections - functional group interconversion- one group c-x disconnection –1,1- 1,2 and-1,3-two group c-x disconnections- one group disconnection C-C, alcohols, carbonyl – regio selectivity – use of acetylenes, aliphatic nitro compounds in organic synthesis- reversal of polarity- order of events, protecting groups.

UNIT – V: TERPENOIDS (15 hrs)

Isoprene rule, isolation, classification and biogenesis of terpenoids, structural elucidation and synthesis of Caryophyline, Zingiberene, β-Eudesmol, Abeitic acid.

PLANT PIGMENTS AND CO-PIGMENTS

Structure and synthesis of flavone, flavanols, isoflavone, coumarins, chromones and anthocyanins (cyanin and pelargonin).

Subject code: 25PCH101

*Denote self-study portion

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. Jerry March (2015) Advanced Organic Chemistry, Wiley eastern limited, 6th Edition, New Delhi.
2. Jagdamba Singh, L. D. S. Yadav (2021) Advanced Organic Chemistry, 19th Edition, Pragati Prakashan Educational Publications, Meerut, India.
3. Jagdamba Singh, L. D. S. Yadav (2020) Organic Synthesis, 16th Edition, Pragati Prakashan Educational Publications, Meerut, India.
4. I.L. Finar (2014) Organic Chemistry, Vol.I, 6th Edition, Vol. II, 5th Edition, Addison Wesley Longman Ltd.
5. O. P. Agarwal (2007) Natural product Chemistry, 21st Edition, Goel Publishing house.
6. Janice Gorzynski Smith (2011) Organic chemistry, 3rd Edition, McGrawHill Publishing.

Reference Books

1. Clayden, Greeves, Warren (2012) Organic Chemistry, 2nd Edition, Oxford University Press.
2. P.S. Kalsi (2020) Organic Reaction Mechanism, 5th Edition, New Age international publishers, India.
3. V.K. Ahluwalia and Rakeshkumar Parashar (2016) Organic reaction mechanisms, 4th Edition, Narosa publishing house.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	S	M	M	H
CO2	S	H	M	S	M
CO3	H	M	L	H	S
CO4	S	M	H	M	M
CO5	S	H	M	S	L

S-Strong H-High M-Medium L-Low

Subject code: 25PCH102

Programme Code: 04		**M.Sc., Chemistry**			Skill development, Employability
Title of the paper: Core Paper 2 – Inorganic Chemistry I					
Batch 2025-2027	Semester I	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To introduce the principles and applications of solid state and nuclear chemistry.
2. To learn about inorganic crystals and structural determination methods
3. To acquire the knowledge of periodic properties and f-block elements, nuclear model, modes of decay and detection, measurement of radio activity, nuclear reactors and applications.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Describe the structures of some ionic solids, spinels and related structures
	CO2	Enumerate the fundamentals solid state chemistry
	CO3	Assess the chemistry of *f*-block elements
	CO4	Appraise the chemistry of inorganic polymers; justify the structures of cages and clusters using Wade's rules
	CO5	Examine the concepts of Nuclear chemistry and the applications of radioisotopes

Syllabus

UNIT – I: STRUCTURE AND BONDING (15 hrs)

Introduction, close packing of atoms and ions – bcc, fcc and hcc voids –radius ratio rule – derivation – its influence on structures – structures of NaCl, CsCl, rutile, fluorite, antifluorite, zinc blende, wurtzite– spinels – normal and inverse spinels and perovskite – lattice energy of ionic crystals –Born Haber cycle and its applications, VSEPR theory with applications to inorganic compounds.

Solid state defects - Stoichiometric and non-stoichiometric defects- electrical properties of solids – insulators –intrinsic and extrinsic semiconductors (n and p type), band theory - superconductors.

UNIT – II: SOLID STATE AND CRYSTALLOGRAPY (15 hrs)

Lattices and unit cells- the crystal systems and Bravais lattices – Miller indices and labeling of planes – symmetry properties – crystallographic point groups and space groups, – relationship between molecular

Subject code: 25PCH102

symmetry and crystallographic symmetry, Fundamentals of X-ray diffraction – powder and rotating crystal methods – systematic absences and determination of lattice type – analysis of X-ray data for cubic system – electron and neutron diffraction-Basic principle, Crystal Growth methods: From melt and solution (hydrothermal, Gel methods).

UNIT – III: CHEMISTRY OF f-BLOCK ELEMENTS (15 hrs)

Lanthanide series – electronic configuration – oxidation states – magnetic properties – colour – ionic radii – lanthanide contraction – chemical reactivity and complex formation – extraction of a mixture of lanthanides from monazite sand – separation of lanthanides – ion exchange method. Actinide series – sources of actinide – preparation of transuranic elements – electronic configurations – oxidation state – colour and complex formation – extraction of thorium from monazite sand and isolation of uranium from pitchblende-comparison of lanthanides and actinides, uses of lanthanides and actinides*.

UNIT – IV: INORGANIC POLYMERS (15 hrs)

Types of inorganic polymers, comparison with organic polymers, Chains – catenation, heterocatenation, silicones, silicates, isopoly and heteropoly anions, sulphur-nitrogen chains, Rings – Borazine, Cyclophosphazenes (synthesis, structure, bonding and properties) – sulphur, nitrogen ring compounds, Homocyclic rings – sulphur rings and cyclophosphines, Cages – phosphorus cage compounds, Boron Cage Compounds – Diborane – Clusters - dinuclear, trinuclear, tetranuclear, hexanuclear and organometallic clusters (structures only), Wade's theory – closo, nido and arachno structures of boranes, carboranes and carbonyl compounds.

UNIT – V: NUCLEAR CHEMISTRY (15 hrs)

Radioactivity – decay constant – half-life period – artificial transmutation – G.M. Counter – Scintillation counter – nuclear forces – nuclear fission and fusion reactions – nuclear models-single particle –liquid drop – nuclear accelerators – linear accelerators – cyclotron, synchrocyclotron, betatron – nuclear reactors – fast breeder reactors – power reactors - radioisotopes and their applications-radioactive isotopes as tracers, analytical, medicinal, agriculture, nuclear power projects in India.

***** Denotes self-study

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Subject code: 25PCH102

Text Books

1. J. D.Lee (2009) Concise Inorganic Chemistry, Fifth edition, S.P. Printers, Delhi.

2. U.K.Malik, G.D.Tuli, and R.D. Madan (2010) Selected Topics in Inorganic Chemistry,

S.Chand Publication.

3. J.E. Huheey, E.A. Keiter (2013) Inorganic chemistry principles of structure and reactivity, 16th Edn, Pearson Noida.

4. H. J. Arnikar (2007) Essential of Nuclear chemistry 4th Edition, New Age International Publishers.

Reference Books

1. U. N. Dash (2012) Nuclear Chemistry, 1st Edition.

2. F. A. Cotton and G. Wilkinson (2007) Advanced Inorganic Chemistry, Sixth edition, John

Wiley & Sons, Inc.

3. Keith F. Purcell and John C. Kotz (2012) Inorganic Chemistry, W.B.Saunders Company.

4. Gary L. Miessler, Donald A. Tarr (2013) Inorganic Chemistry, 3rd Edition, Prentice Hall.

5. A.R. West (2013) Solid State Chemistry and its applications, Wiley & Sons.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	H	S	H	S
CO2	S	S	S	M	H
CO3	S	H	M	S	S
CO4	S	S	S	S	S
CO5	S	H	M	H	M

S-Strong H-High M-Medium L-Low

Subject code: 25PCH103

Programme Code: 04		**M.Sc., Chemistry**			Skill development, Employability
Title of the paper: Core Paper 3 – Physical Chemistry I					
Batch 2025-2027	Semester I	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To make the students to comprehend knowledge on symmetry elements, symmetry operations and rate of the reactions
2. To illustrate symmetry concepts and to demonstrate the scope of the symmetry and group theory to inorganic chemistry
3. To know the principles of chemical kinetics to allow exploration of gas-phase and liquid-phase reactions.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Narrate the fundamentals of group theory
	CO2	Relate the relationship between symmetry and point groups and discuss the applications of group theory
	CO3	Experiment different theories of reaction rates and the kinetics of fast reactions
	CO4	Correlate various catalysis mechanisms with the kinetics
	CO5	Appraise the kinetics of polymerization reaction

Syllabus

UNIT – I: GROUP THEORY-I **(15 hrs)**

Symmetry elements and symmetry operations, identity element, centre of symmetry, plane of symmetry, proper and improper axes of symmetry, groups – definition, properties, types of groups- Abelian group, non-abelian group, sub group, isomorphic group – similarity transformation and classes – group multiplication table for C_{2v} and C_{3v} point groups – symmetry classification of molecules into point groups (Schoenflies symbol only), Group theory and dipole moment.

Matrices: definition of matrix, types -square, diagonal, null, unit, row, column, symmetric and skew symmetric- addition and subtraction of matrices – matrix representations of symmetry operations.

Subject code: 25PCH103

UNIT – II: GROUP THEORY-II (15 hrs)

Representation of point groups - definition, types (reducible and irreducible representations), the Great orthogonality theorem, significance and its consequences (proof not needed), character tables-construction of the character table for C_{2v} and C_{3v} point groups, reduction of reducible representations.

Application of group theory to bonding: hybridization scheme for orbital in AB_3 (planar), AB_4 (T_d), AB_5(D_{3h}) and AB_6(O_h) type of molecules.

Group theory and vibrational spectroscopy – direct product representation, vibrational modes as basis for group representation, symmetry selection rule for IR and Raman spectra (mutual exclusion principle), classification of vibrational modes.

UNIT – III: CHEMICAL KINETICS I (15 hrs)

Theories of reaction rates – Arrhenius theory, collision theory- classical collision theory - modified collision theory - weaknesses of collision theory, Absolute reaction rate or Transition state theory – Statistical mechanical derivation of rate equation - thermodynamical formulation of reaction rate - comparison of collision theory and absolute reaction rate theory.

Kinetics of fast reactions - relaxation methods - temperature jump method - flow method - pulse method - flash photolysis.

Reactions in solutions: collision in solution - Cage effect, salt effect- primary and secondary salt effects - significance of salt effect.

UNIT – IV: CHEMICAL KINETICS II (15 hrs)

Homogenous catalysis – specific and general acid - base catalysis - kinetics of acid -base catalysed reactions. Enzyme catalysis – Michaelis - Menton equation – influence of pH and temperature on enzyme catalysis.

Heterogenous catalysis: surface reactions – kinetics of surface reactions - unimolecular surface reactions - bimolecular surface reaction - Langmuir-Hinshelwood mechanism. pH-dependence of rate constant of catalyzed reactions.

Auto catalysis - oscillating reactions - mechanisms of oscillating reactions (Lotko -Volterra, Brusselator and Oregonator).

UNIT –V: POLYMER KINETICS (15 hrs)

Classification of polymers* - kinetics and mechanism of polymerization-free radical, ionic and co-ordination(Ziegler-Natta polymerization)-degree of polymerization- concept of molecular mass-Number average, weight average, Viscosity average -determination of Molecular mass –Osmometry-Light

Subject code: 25PCH103

Scattering method – Ultracentrifugation-Viscometer – kinetics of free radical chain polymerization (derivation of rate equation, kinetic chain length and degree of polymerization), Glass Transition Temperature - process of polymerization – bulk, solution, suspension and emulsion.

***** Denotes self-study

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. K. V. Raman (2004) Group Theory and its applications to chemistry, Tata McGraw Hill publishing company Ltd.
2. F. A. Cotton (2009) Chemical applications of group theory, 3rd Edition, A Wiley Interscience Publication.
3. S. Swarnalakshmi, T. Saroja, R. M. Ezhilarasi (2019) A Simple approach to group theory in chemistry, University press.
4. V. R. Gowariker & N. V. Viswanathan (2010)Polymer Science, New Age International Pvt., Ltd., publishers.
5. K. J. Laidler (2011) Chemical kinetics, 3rd Edition, Tata McGraw Hill Ltd.
6. Steinfeld, Francisco and Hase, Chemical Kinetics and Dynamics, 2ndEdition, Prentice Hall International Inc.
7. Richard I. Masel, (2011) Chemical Kinetics and Catalysis, Wiley Interscience.

Reference Books

1. Veera Reddy (2014) Symmetry and Spectroscopy of molecules, New Age International.
2. Gurdeep Raj (2014) Chemical kinetics, 6th Edition, Goel Publishing House.
3. P. W. Atkins (2009) Physical Chemistry, 8th Edition, Oxford University Press.

Subject code: 25PCH103

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	M
CO2	H	M	S	M	S
CO3	M	S	H	S	S
CO4	H	S	H	S	M
CO5	S	H	H	H	M

S-Strong H-High M-Medium L-Low

Subject code: 25PCH204

<table>
<tr><td colspan="3">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="5">Title of the paper: Core Paper 4 – Organic Chemistry II</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
II</td><td>Hours/Cycle
5</td><td>Total Hours
75</td><td>Credits
5</td></tr>
</table>

Course Objectives

1. To gain knowledge about mechanism of elimination and addition reactions.
2. To enable a comprehensive knowledge on conformational analysis and stereochemistry, concerted reactions and pericyclic reactions of organic compounds to the students.
3. To give a thorough introduction to the study of organic photochemistry and isolation, general structural elucidation of alkaloids.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Outline the essentials of addition and elimination reactions
	CO2	Identify the different types of notations in stereochemistry
	CO3	Relate correlation and FMO approach with electrocyclic, cycloaddition and Sigmatropic reactions
	CO4	Illustrate the mechanisms of various organic photochemical reactions
	CO5	Describe the structural features of some important compounds of alkaloids

Syllabus

UNIT – I: ADDITION AND ELIMINATION REACTIONS (15 hrs)

Addition to C-C and C-O multiple bonds - electrophilic, nucleophilic and free-radical additions - additions to conjugated systems - orientation - carbene addition to double bonds - Birch and Meerwein-Pondorf reduction -Hydroboration – Mannich - Wittig - Grignard reactions - Aldol - Knovenagel-Stobbe-Michael - Darzen'sglycidic ester and Benzoin condensations –Peterson alkene synthesis- hydration of olefins.

Elimination reactions - E1 and E2 mechanisms - orientations –E1CB mechanism - Hofmann and Saytzeff rules - Chaugav reaction - Hofmann degradation and Cope elimination.

Subject code: 25PCH204

UNIT – II: CONFORMATIONAL ANALYSIS AND STEREOCHEMISTRY (15 hrs)

Fischer- Newman and Sawhorse projection-R and S notation: stereochemistry of sulphur and nitrogen compounds, geometrical isomerism – E & Z configuration –Enantiotopic and diastereotopic atoms, groups and faces, Stereospecific and stereoselective syntheses - asymmetric synthesis -conformation of cyclic systems – cyclohexane derivatives (mono,di-substituted), decalins, perhydrophenanthrene, effect of conformation and reactivity in cyclic systems- conformations of biphenyls, allenes and spiranes.

UNIT – III: CONCERTED REACTIONS (15 hrs)

Conservation of orbital symmetry – Woodward-Hoffman selection rule for electrocyclic reaction, cycloaddition reaction, sigmatropic rearrangement.

Electrocyclic reactions – 1,3-diene and 1,3,5-triene, analysis of stereochemistry using correlation diagram and FMO method.

Cycloadditions: (π2s + π2s) Correlation and FMO approach, (π2s + π4s) - Diels-Alder reactions – analysis of stereochemistry by correlation diagram and FMO methods.

Sigmatropic rearrangements – analysis of sigmatropic rearrangements by FMO method-1,3&1,5-sigmatropic rearrangements – other sigmatropic shifts- Cope and Claisen rearrangements, the perturbation theory of pericyclic reactions (Basic ideas only), 1,3 dipolar addition.

UNIT – IV: ORGANIC PHOTOCHEMISTRY (15 hrs)

Laws of photochemistry* - Grothus-Draper law, Einstein's Law of photochemical equivalence, Quantum yield - physical and chemical actinometry, Jablonski diagram, photophysical processes – Fluorescence, phosphorescence, internal conversion and intersystem crossing, photosensitization, quenching, Typical photochemical reactions – Norrish type I and type II reactions, Paterno-Buchi reaction, photoreduction, photooxidation, Cis-trans isomerization, photochemistry of arenes, di-π methane rearrangement, oxa&aza - di-π methane rearrangement.

UNIT – V: ALKALOIDS (15 hrs)

Isolation and general structural methods of elucidation of alkaloids, structural elucidation and synthesis of Morphine, Reserpine, Atropine and Quinine.

*Denotes self-study portion

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Subject code: 25PCH204

Text Books

1. Jagdamba Singh, L. D. S. Yadav (2020) Organic Synthesis, 16th Edition, Pragati Prakashan Educational Publications, Meerut, India.
2. P. S. Kalsi (2022) Stereochemistry, Conformation and Mechanism, 11thEdition, New age International publishers.
3. Jagdamba Singh and Jaya Singh (2014) Photo Chemistry and Pericyclic reactions, 3rd Revised Edition, New Age International Publisher.
4. Rastogi K.K, Mukherjee (2014) Fundamentals of photochemistry, Revised edition, New age international publications.
5. O. P. Agarwal (2012) Natural product Chemistry, 21th Edition, Goel Publishing house.

Reference Books

1. Jerry March (2014) Advanced organic chemistry, 6th Edition, A Wiley Eastern limited, New Delhi.
2. D. Nasipuri (2020) Stereochemistry of organic compounds, Publisher, New Age International.
3. Ernest. L. Eliel (2014) Stereochemistry of carbon compounds, McGraw-Hill, New York.
4. I.L. Finar (2014) Organic Chemistry, Vol.I, 6th, Vol.II, 5th Edition, Addison Wesley Longman Ltd.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	M	H	M
CO2	H	S	S	M	S
CO3	H	S	M	H	H
CO4	S	H	H	H	M
CO5	H	H	M	H	M

S-Strong H-High M-Medium L-Low

Subject code: 25PCH205

<table>
<tr><td colspan="3">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="5">Title of the paper: Core Paper 5– Inorganic Chemistry II</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
II</td><td>Hours/Cycle
5</td><td>Total Hours
75</td><td>Credits
5</td></tr>
</table>

Course Objectives

1. To promote an awareness about bonding in coordination complexes to the students.
2. To gain knowledge in term symbols and electronic spectra of complexes.
3. To appraise the theories of bonding in inorganic complexes and application, substitution reaction mechanism of coordination complexes, electron transfer mechanism of coordination complexes and magnetic behavior.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Read the elemental ideas of coordination chemistry
	CO2	Cite the postulates of Crystal Field Theory and Molecular Orbital Theory
	CO3	Compute Term symbols and construct Orgel and Tanabe-Sugano diagrams of coordination complexes
	CO4	Elucidate the mechanisms of reactions of transition metal complexes and calculate their stability constants
	CO5	Compare and contrast the different types of electron transfer reactions

Syllabus

UNIT – I: CO-ORDINATION CHEMISTRY I (12 hrs)

Structure of coordination compounds with reference to the existence of various coordination numbers - complexes with coordination number two - complexes with coordination number three - complexes with coordination number four - tetrahedral and square planar complexes - complexes with coordination number five - regular trigonal bipyramidal and square pyramidal - coordination number six - distortion from perfect octahedral symmetry - trigonal prism – geometrical and optical isomerism in octahedral complexes* - coordination number seven and eight, theories of bonding - valence bond theory - principle and limitations.

Subject code: 25PCH205

UNIT – II: COORDINATION CHEMISTRY II (17 hrs)

Crystal field splitting in octahedral, square planar, tetrahedral complexes – CFSE- factors influencing the magnitude of Δ_0 – applications of CFSE, applications of CFT – Jahn-Teller distortions - limitations - LFT and MOT- applications to octahedral complexes (σ bonding and π bonding) – tetrahedral, square planar complexes – comparison of different theories.

UNIT – III: COORDINATION CHEMISTRY III (16 hrs)

Magnetic properties of tetrahedral and octahedral complexes- spin cross over rule -microstates of electron configuration in free atoms and ions –term symbols for equivalent and non-equivalent electrons- possible term symbols for given configuration – p^2 - d^2 - Electronic spectra of d^1 to d^9 complexes – selection rules - spin orbit coupling -assignment and intensities of transitions – Orgel (d^1 to d^9 octahedral and tetrahedral complexes) and Tanabe Sugano diagrams(d^2,d^6 complexes and its applications)- calculation of Δ_0 and β and Racah parameters – examples from d^3, d^7octahedral complexes- CT spectra of metal complexes.

UNIT IV: REACTION MECHANISM OF METAL COMPLEXES I (15 hrs)

Ligand substitution reactions in octahedral, square planar complexes- labile and inert complexes– dissociation, association mechanism – Mechanism of hydrolysis reactions – acid hydrolysis – base hydrolysis – anation reactions – trans effect –theories and application - Thermodynamic and kinetic stability of complexes – factors affecting stability of metal complexes – experimental determination of stability constant of complexes.

UNIT V: REACTION MECHANISM OF METAL COMPLEXES II (15 hrs)

Electron transfer reactions – one electron transfer reactions – inner sphere mechanism – outer sphere mechanism - two electron transfer reactions – complementary and non – complementary electron transfer reactions – synthesis of complexes using electron transfer reactions-metal assisted reactions – Aldol condensation – ester hydrolysis –amide hydrolysis – template effect – synthesis of macrocyclic ligands – reaction of coordinated ligand.

***** Denotes self-study

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Subject code: 25PCH205

Text Books

1. J.E. Huheey, E.A. Keiter (2013) Inorganic chemistry principles of structure and reactivity, 16thEdn, Pearson Noida.
2. Keith F. Purcell and John C. Kotz (2012) Inorganic Chemistry, W.B. Saunders Company.
3. Malik, Wahid U,Tuli G.D and Madan R.D, (2013) Selected Topics in Inorganic Chemistry, S. Chand Limited.

Reference Books

1. Basolo and Pearson, Ralph. G (2007) Mechanism of Inorganic Reactions- A study of metal complexes in solution, Wiley Eastern, New Delhi.
2. Lee J. D (2009) Concise Inorganic Chemistry, Fifth edition, ELBS.
3. F.A. Cotton and G. Wilkinson (2007) Advanced Inorganic Chemistry, Sixth edition, John Wiley & Sons, Inc.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	S	S	S
CO2	H	H	M	S	M
CO3	S	M	S	M	S
CO4	M	S	M	S	H
CO5	S	M	H	M	H

S-Strong H-High M-Medium L-Low

Subject code: 25PCH2CL

Programme Code: 04		**M.Sc., Chemistry**			Skill development, Employability
Title of the paper: Core Practical 1 – Organic Chemistry Practical I					
Batch 2025-2027	Semester I & II	Hours/Cycle 3 & 5	Total Hours 120	Credits 3	

Course Objectives

1. To make the students aware about separation of mixture of organic compounds and analyzing the unknown compounds.
2. To allow the students to know and practice the techniques of preparation of some organic compounds.
3. To know the method of recrystallization.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Describe systematic procedures for carrying out experiments
	CO2	Identify organic compounds by their characteristic reactions towards standard reagents
	CO3	Relate the principle of separation for separating two organic compounds in a given mixture
	CO4	Categorize the components present in the organic mixture and report the same
	CO5	Evaluate the crude and recrystallised form of the given organic compound

Syllabus

A. Analysis of two component organic mixtures

(Separation and characterization of individual compounds)

Note: Each student has to complete the analysis of minimum of **FIVE** Mixtures

B. Single stage Preparations (minimum 6)

1. **Hydrolysis:**

Preparation of Salicylic acid from Methyl Salicylate.

2. **Acetylation:**

Preparation of Acetanilide from Aniline.

3. **Bromination:**

Preparation of p-Bromoacetanilide from Acetanilide.

4. **Nitration:**

Preparation of m-dinitrobenzene from nitrobenzene.

Subject code: 25PCH2CL

5. **Benzoylation:**

Preparation of Benzanilide from Aniline.

6. **Oxidation:**

Preparation of Benzoic acid from Benzaldehyde.

7. Preparation of Glucose penta acetate.

8. Preparation of Diphenylhydantoin from Benzil and urea.

9. Microwave synthesis (Group Experiment, Not for ESE)

Reference books

1. Gnanaprakasam and Ramamurthy (2009) Organic Chemistry Laboratory Manual, Viswanathan, S., Printers & Publishers Pvt Ltd.

2. NK Vishnoi (2014) Advanced Practical Organic Chemistry, Vikas Publishing House.

3. R. Jagmohan (2002) Advanced Practical Organic Chemistry, Vol. I & II.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	M	H	S
CO2	S	M	H	M	S
CO3	H	S	M	S	H
CO4	S	H	M	M	H
CO5	S	M	H	S	M

S-Strong H-High M-Medium L-Low

Distribution of Marks

Internal (Maximum 40)	ESE (Maximum 60)
CIA practical exam – 25 (Exam marks 50 converted to 25) Observation note book – 10 Attendance – 5	Experiment – 45 Viva-Voce – 5 Record – 10

Subject code: 25PCH2CM

Programme Code: 04		**M.Sc., Chemistry**			Skill development, Employability
Title of the paper: Core Practical 2– Inorganic Chemistry Practical I					
Batch	Semester	Hours / Cycle	Total Hours	Credits	
2025-2027	I & II	3 &5	120	3	

Course Objectives

1. To give an idea to the students about the separation and analysis of cations from the given mixture.
2. To allow the students to know and practice the techniques in preparation of some inorganic complexes.
3. To know about the colorimetric principle in estimation of metal ions.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Read the procedure for the group separation and systematic analysis of cations
	CO2	Identify the appropriate preparation method of complexes
	CO3	Experiment the preparation of some inorganic complexes
	CO4	Analyze and report two familiar metal cations and two less familiar metal cations
	CO5	Estimate the amount of metal ions present in the whole of the given solution by colorimetric method

Syllabus

A. Semi micro Qualitative Analysis:

Analysis of mixtures of common metal cations and the following less familiar metal cations - Tungsten, Selenium, Tellurium, Molybdenum, Cerium, Thorium, Vanadium and Lithium.

Note: A minimum of **FIVE** inorganic mixtures, each containing of two common and two less familiar metal cations have to be analyzed by each student during the course.

B. Preparation of complexes

Any Five preparations selected from the following list:

Tris(thiourea)Copper(I)chloride

Potassiumtrioxalatoaluminate(III)

Potassiumtrioxalatochromate (III)

Tetramminecopper(II)sulphate

Tris(thiourea) copper(II)sulphate

Subject code: 25PCH2CM

Nickelammoniumsulphatehexahydrate

Hexaminecobalt (III) chloride

Potassiumtrioxalatoferrate (III).

C. Colorimetric Estimations (using photoelectric colorimeter)

Estimation of Copper, Iron, Nickel and Manganese

Text Books

1. V.V.Ramanajum (1971) Semimicro Qualitative Inorganic Analysis, National Publishing Co.

2. V.Venkateswaran, R.Veeraswamy and A.R. Kulandaivelu (2004) Principles of Practical Chemistry, Sultan Chand & Sons. 2nd Edition.

3. S.Giri. D.N. Bajpai and O.P. Panday (2005) Practical Chemistry Vol.I& II, S.Chand & Co.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	S	M	M
CO2	S	M	H	S	H
CO3	M	S	H	M	S
CO4	S	H	H	M	H
CO5	S	M	S	M	H

S-Strong H-High M-Medium L-Low

Distribution of Marks

Internal (Maximum 40)	ESE (Maximum 60)
CIA practical exam – 25 (Exam marks 50 converted to 25) Observation note book – 10 Attendance – 5	Experiment – 45 Viva-Voce – 5 Record – 10

Subject code: 25PCH2CN

<table>
<tr><td colspan="3">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="5">Title of the paper: Core Practical 3 – Physical Chemistry Practical I</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
I & II</td><td>Hours / Cycle
4 &5</td><td>Total Hours
135</td><td>Credits
2</td></tr>
</table>

Course Objectives

1. To promote an awareness about potentiometric titrations to the students.
2. To arm the future chemist with the knowledge of electrical conductance measurement and conductometric titrations.
3. To make the students interpret, evaluate and report upon observations and experimental results of determination of molecular weight, partition coefficient, unknown composition in Simple Eutectic System and acid-base, precipitation and redox titrations.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Recall the disciplinary regulations to be followed inside a physical chemistry lab
	CO2	Describe the determination of equilibrium constant of a reaction
	CO3	Use the principle of potentiometric titrations for estimating the strength of solutions
	CO4	Calculate the molecular weight of a compound by Rast's method
	CO5	Evaluate the properties of matter by Simple Eutectic System

Syllabus

Non-Electrical Experiments

1. **Properties of Matter**

Simple Eutectic System- determination of unknown compositions

2. **Molecular weight determination**

Determination of Molecular weight by Rast's method

3. **Partition coefficient**

Determination of Distribution Coefficient and Equilibrium Constant for the reaction

$KI + I_2 \leftrightarrow KI_3$

Subject code: 25PCH2CN

<u>Electrical Experiments</u> – Potentiometric Titrations

A. Acid-Base titrations *(using quinhydrone electrode)*

4. Titration of Strong acid against Strong base
5. Titration of Weak acid against Strong base
6. Titration of mixture of (strong & weak) acids against Strong base
7. Determination of pH (acidic solutions)
8. Determination of pKa of weak acid

B. Precipitation titrations *(using silver electrode)*

9. Titration of Potassium chloride against Silver nitrate
10. Titration of mixture of halides (chloride and iodide) against Silver nitrate

C. Redox titrations

11. Titration of Potassium Iodide against Potassium Permanganate
12. Titration of Ferrous Ammonium sulphate against Potassium dichromate

Teaching Methods

Demonstration and hands-on practicals

Reference Books

1. S.R. Palit and S.K. De (2003) Practical Physical Chemistry, Science Book Agency, Calcutta.
2. P.C. Sharma and Agarwal (1998) Practical Chemistry, Goel Publishing House, Meerut.
3. V. Venkateswaran and A.R. Kulaindaivelu (2005) Practical Physical Chemistry, S.Chand& Co.
4. J.B. Yadav (2010) Advanced Practical Physical Chemistry, Goel Publishing House, 29th edition.

Subject code: 25PCH2CN

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	H	S	M
CO2	H	H	M	S	H
CO3	H	S	H	H	M
CO4	S	H	H	S	M
CO5	S	M	M	H	H

S – Strong **H –** High **M –** Medium **L –** Low

Distribution of Marks

Internal (Maximum 40)	ESE (Maximum 60)
CIA practical exam – 25 (Exam marks 50 converted to 25) Observation note book – 10 Attendance – 5	Experiment – 45 Viva-Voce – 5 Record – 10

Subject code: 25PCH306

Programme Code: 04		**M.Sc., Chemistry**			Skill development, Employability
Title of the paper: Core Paper 6– Physical Chemistry II					
Batch 2025-2027	Semester III	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To enable a comprehensive knowledge on quantum mechanics and students will be able to remember concepts of electrochemistry and surface chemistry
2. To understand electrochemical systems of electric energy production
3. To know the electrochemical processes of surface treatment and production of materials

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Recall the elementary aspects of quantum chemistry
	CO2	Illustrate the quantum mechanical operations in solving Schrodinger wave equations
	CO3	Apply various approximation methods to Helium atom
	CO4	Outline different electrochemical theories and point out their importance
	CO5	Describe the methods of coulometry, voltametry and polarography

Syllabus

UNIT – I: QUANTUM CHEMISTRY I (15 hrs)

Success of quantum theory and the failure of classical mechanics in explaining black-body radiation, photo-electric effect and the H-atom spectrum, de Broglie's matter waves, Heisenberg's uncertainty principle. Schrodinger wave equation for particle waves, postulates of quantum mechanics, Time-dependent and Time-independent Schrodinger equations. Wave function (ψ) and its physical meaning, Conditions for acceptable wave function. Operators- algebra of operators, commutator, linear, Hermitian, Hamiltonian and angular momentum- Eigen functions and Eigen values, correspondence between physical quantities in classical mechanics and operators in quantum mechanics.

UNIT – II: QUANTUM CHEMISTRY II (15 hrs)

Particle in a 1-D box with infinite potential barrier - quantization of energy, normality and orthogonality of wave function. Particle in a 3-D box – a cubical box: a case of degeneracy. 1-D Harmonic

Subject code: 25PCH306

oscillator – classical and quantum mechanical treatment - solving of Schrodinger equation – complete eigen functions and eigen values – comparison of classical and quantum results. Rigid rotor model of a diatomic molecule – planar rigid rotor (or particle on a ring), the Phi-equation and its solution - non planar rigid rotator (or particle on a sphere) - complete wave function (spherical harmonics).

UNIT – III: QUANTUM CHEMISTRY III (15 hrs)

Schrodinger equation for H atom (H – like atoms) - separation of variables (solving of radial equation is not needed but nature of solution is given). Approximation methods - variation method - application of variation method to He atom, perturbation theory (first order only) - application of perturbation method to He atom, symmetric and antisymmetric wave functions, electron spin, Pauli principle of antisymmetric wave functions, Slater determinants, Approximate wave function of many electron atoms- Born – Oppenheimer approximation, Hartree self-consistent field theory.

UNIT – IV: ELECTROCHEMISTRY-I (15 hrs)

Interionic attraction theory, Debye-Huckel-Onsager equation, derivation, verification and validity of DHO equation, Falkenhagen effect, Wien effect, activity and activity co-efficient, ionic strength, Debye-Huckel limiting law and its applications.

Electrokinetic phenomena: theories of double layer - Helmholtz-Perrin, Gouy-Chapmann & Stern theories - Butler-Volmer equation.

UNIT – V: ELECTROCHEMISTRY-II (15 hrs)

Electrolytic oxidation and reduction, voltametry, cyclic voltametry and polarography, current-voltage relationship, dropping mercury electrode, diffusion current, factors affecting diffusion current, Ilkovic equation (derivation not necessary), half-wave potentials, applications of polarography, amperometric titrations.

Fundamental principles of coulometric methods, constant current and controlled – potential methods, primary and secondary titrations – simple applications.

Solar cells***** – introduction, principle and working.

***** Denotes self-study

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Subject code: 25PCH306

Note: Question paper will contain not more than 20 % of problems covering the entire syllabus.

Text Books

1. R. K. Prasad (2006) Quantum Chemistry, New Age International Publishers.
2. A.K. Chandra (2002) Quantum chemistry, 4th edition, Tata McGraw-Hill.
3. B.R. Puri & L R. Sharma (2013) Advanced Physical Chemistry, Milestone Publishers & Distributors.
4. F.L. Pilar (2006) Elementary Quantum Chemistry, McGraw-Hill.
5. S. Glasstone (2005) Introduction to electrochemistry, 10th Edition, East West Press Private Ltd.

Reference Books

1. Ira. N. Levine (2016) Quantum Chemistry, Prentice Hall; 7th edition.
2. P. W. Atkins (2018) Physical Chemistry, 11th Edition, Oxford University Press.
3. L. I. Andropov (2009) Theoretical Electrochemistry, Mir Publishers, Moscow.
4. Horia Metiu (2006) Physical Chemistry –Quantum Mechanics, Taylor& Francis.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	S	M	M
CO2	S	M	H	M	H
CO3	H	S	H	H	S
CO4	S	H	S	S	M
CO5	H	S	M	H	M

S-Strong H-High M-Medium L-Low

Subject code: 25PCH307

<table>
<tr><td colspan="3">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="5">Title of the paper: Core Paper 7– Organic Chemistry III</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
III</td><td>Hours/Cycle
5</td><td>Total Hours
75</td><td>Credits
5</td></tr>
</table>

Course Objectives

1. To foster an awareness in the student the ideas of molecular rearrangement and oxidation and reduction reactions of organic compounds.
2. To introduce steroids and to enable the students to elucidate their structures.
3. To gain knowledge about the classification, characterization of proteins, vitamins and some heterocyclic compounds.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Discuss the synthetic utility of different reagents in oxidation and reduction reactions
	CO2	Appraise the chemistry of reagents for organic synthesis
	CO3	Enumerate the mechanisms of various molecular rearrangements
	CO4	Sketch and elucidate the structure of selected steroids
	CO5	Classify proteins and vitamins; examine their structures and biological importance

Syllabus

UNIT – I: REAGENTS FOR OXIDATION AND REDUCTION (15 hrs)

Oxidation: Selenium dioxide, periodic acid, aluminium-t-butoxide, peroxides and peroxyacids, PCC (Corey's reagent), MnO_2, OsO_4, Jones reagent, Copper chromite, Ozonolysis, Oppenauer oxidation, Sharpless asymmetric epoxidation, Lead tetraacetate, Mercuric acetate, Thallium acetate, DMSO.

Reduction: Complex metal hydrides such as $LiAlH_4$, $NaBH_4$, $NaCNBH_3$, DIBAL-H and trialkyl tin hydride, Dissolving metal reduction – Sodium-alochol, Zinc-Hydrocholoric acid (Clemenson), Reduction by hydrazine (Wolff-Kishner reduction), stannous chloride (Stephen reaction).

Subject code: 25PCH307

UNIT – II: REAGENTS FOR ORGANIC SYNTHESIS (15 hrs)

Reagents: Gilman`s reagent, lithium diisopropylamide (LDA), dicyclohexylcarbodiimide (DCC), 1, 3-Dithiane, Woodward and Prevost hydroxylation, DDQ, DBU, PPA, NBS, m-chloroperbenzoic acid, Baker's yeast, Wittig reagent, Grignard reagent, organolithium compounds and organosilicon compounds.

UNIT – III: MOLECULAR REARRANGEMENTS (15 hrs)

Introduction, nucleophilic, free radical and electrophilic rearrangements, 1, 2 – rearrangement - Wagner Meerwein, Acid catalysed rearrangement - Arndt-Eistert synthesis, Benzidine rearrangement, Wolff rearrangement - Base catalysed rearrangement – Favorskii, Quasi-Favorskii, Carbon to Carbon migration of other groups - Neber rearrangement Sommelet-Hauser rearrangement. Carbon to Nitrogen migration - Hofmann rearrangement, Curtius rearrangement, Lossen rearrangement, Schmidt rearrangement, Beckmann rearrangement. Nitrogen to carbon - Stevens rearrangement. Oxygen to carbon - Wittig rearrangement, Fries and Photo Fries rearrangement. Rearrangements to electron deficient oxygen- Dakin rearrangement.

UNIT – IV: STEROIDS (15 hrs)

Introduction, structural elucidation of Cholesterol (synthesis not necessary), structural elucidation and synthesis of Estrone (Anner-Miescher synthesis), Testosterone and Progesterone (synthesis from Cholesterol), introduction and structures of Bile acids, biosynthesis of steroids (General principles only).

UNIT– V: PROTEINS AND VITAMINS (15 hrs)

Classification and characteristics of proteins – General methods of synthesis of polypeptides (any two), solid phase peptide synthesis, structure and their biological importance of nucleic acids-RNA and DNA.

Vitamins-Introduction-structure, sources, functions and deficiency diseases*, Structural elucidation of Vitamins- A and B12.

*Denotes self-study portion

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Subject code: 25PCH307

Text Books

1. V.K.Ahluwalia and Rakesh kumar Parashar (2016) Organic reaction mechanisms, 3rdEdition, Narosa publishing house.
2. Jagdamba Singh, L. D. S. Yadav (2021) Advanced Organic Chemistry, 19th Edition, Pragati Prakashan Educational publications, Meerut, India.
3. I. L Finar (2014) Organic Chemistry Vol. I 6th, Vol. II 5th edition, Pearson education, Ltd.
4. O. P. Agarwal (2010) Organic Chemistry- Natural products Vol II, 38th Edition, Goel Publishing house.
5. R K Bansal (2016) Heterocyclic Chemistry, 3rdEdition New age international (P.) Ltd.

Reference Books

1. O.P.Agarwal (2014) Organic Chemistry Reaction and Reagents, 51stedition, Goel Pub. House.
2. Jerry March (2016) Advanced Organic Chemistry, Wiley eastern limited, 6th edition, New Delhi.
3. F.A.Carey (2014) Organic Chemistry-Part-B-Reactions and synthesis, Springer, 5th edition.

Mapping

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CO3	H	M	H	M	H
CO4	S	S	M	H	S
CO5	S	H	M	H	M

S-Strong H-High M-Medium L-Low

Subject code: 25PCH308

Programme Code: 04		**M.Sc., Chemistry**			Skill development, Employability
Title of the paper: Core Paper 8– Inorganic Chemistry III					
Batch 2025-2027	Semester III	Hours/Cycle 4	Total Hours 60	Credits 5	

Course Objectives

1. To create an awareness in the student the fundamental concepts of inorganic photochemistry and bioinorganic chemistry.
2. To allow the students to get introduced to the study of organometallic complexes and their applications as catalysts for chemical reactions.
3. To impart knowledge on the preparation and properties of metal carbonyl complexes, photochemistry of metal complexes and various applications and the role metals in biological systems.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Record the essentials of organometallic chemistry
	CO2	Explain the structure, reactions and bonding in several organometallic compounds
	CO3	Illustrate the role of organometallic compounds in catalysis
	CO4	Discover the chemistry and significance of bioinorganic compounds
	CO5	Explore the applications of metals in medicine

Syllabus

UNIT – I: ORGANOMETALLIC CHEMISTRY I (12 hrs)

Hapticity, 18 electron rule* – EAN rule– classification of organometallic compound – the metal carbon bond types – ionic bond – sigma covalent bond – electron deficient bond – dative bond. Metal carbonyls - methods of preparation, structure, reactions- metal carbonyl bonding- IR spectroscopy of metal carbonyls. Carbonylate ions, carbonyl hydrides, carbonyl halides, Vaska's complex.

UNIT – II: ORGANOMETALLIC CHEMISTRY II (12 hrs)

Synthesis, reactions, bonding and structure in metal alkyl, alkene, alkyne, allyl and dienyls complexes. Carbene, carbyne and carbido complexes, bonding and structure of cyclopentadienyl complexes

Subject code: 25PCH308

- Ferrocene - structure and bonding, arene complexes, complexes formed by 7 and 8 membered aromatic rings.

UNIT – III: ORGANOMETALLIC CHEMISTRY III (12 hrs)

Organometallic compounds in catalysis – coordinative unsaturation – acid base behaviour reaction – migration of atoms or groups from metal to ligand – insertion reaction – Olefin metathesis– isomerisation of alkenes – hydrogenation (Wilkinson's catalyst) – hydroformylation (Oxo process) and hydrosylation of alkenes – Wacker process-carbonylation of methanol and methyl acetate (Monsonto acetic acid process), Zeigler-Natta catalyst, Synthesis gas.

UNIT – IV: BIOINORGANIC CHEMISTRY I (12 hrs)

Iron containing proteins: Metalloporphyrins - Haemoglobin and myoglobin – Structures and work functions – Cytochromes – structure and work functions, Non-heme oxygen carriers – Electron carrier proteins – Iron sulphur proteins – Ferridoxins and Rubredoxins – structure and functions, Magnesium containing proteins: Chlorophyll – structure, Copper containing proteins: Classification – Blue Copper Proteins – structure of blue copper electron transferases – copper protein as oxidases – cytochrome c oxidase – mechanistic studies of cytochrome c oxidase.

UNIT – V: BIOINORGANIC CHEMISTRY II (12 hrs)

Metalloenzymes: Carboxy peptidase A, Carbonic anhydrase – structure and functions, Superoxide dismutase, Molybdenum oxatransferase, Xanthine oxidase structure and functions, Corrin ring system – Vitamin B12 (cyanocobalamin) and B12 coenzymes – In vivo and In vitro nitrogen fixation, Essentials of trace elements and chemical toxicology: Trace elements in biological system, Metal ion toxicity - classes of toxic metal compounds – detoxification, Metals in medicine: Anti arthritis drugs – Au and Cu in rheumatoid arthritis – Li in psychiatry – Pt, Au and metallocenes in anti-cancer drugs, metals in radiodiagnosis and magnetic resonance imaging. Transport and storage of metals: Mechanism – Fe and Cu storage and transport – sodium and potassium ion pumps.

***** Denotes self-study

Teaching methodology

Smart Class Room/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Subject code: 25PCH308

Text Books

1. J.E. Huheey (2009) Inorganic chemistry, 4th Edition, Pearson Education.
2. Manfred Bochmann (2008) Organometallics 1 – Complexes with transition metal-carbon σ-bonds, Oxford University Press.
3. Asim K. Dass (2017) Bioinorganic Chemistry, Books and Allied (P) Limited.

Reference Books

1. J. D. Lee (2009) Concise Inorganic Chemistry, Fifth edition, Chapman & Hall Ltd.
2. D.F. Shriver, P.W. Atkins and C.H. Longford (2010) Inorganic chemistry, 5th edition, Oxford University Press.
3. I. Bertini, H.B.Gray, S.J. Lippard and J.S. Nalentine, (2010) Bioinorganic Chemistry; University Science Books.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	H	S
CO2	H	S	H	S	M
CO3	S	H	S	H	S
CO4	S	S	M	S	H
CO5	S	H	M	S	M

S-Strong H-High M-Medium L-Low

Subject code: 25PCH3CO

<table>
<tr><td colspan="3">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="5">Title of the paper: Core Practical 4 –Physical Chemistry Practical II</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
III</td><td>Hours/Cycle
4</td><td>Total Hours
60</td><td>Credits
2</td></tr>
</table>

Course Objectives

1. To arm the future chemist with the knowledge of electrical conductance measurements and conductometric titrations.
2. To gain understanding in making and recording observations in conductometric titrations.
3. To inculcate knowledge on the kinetics of reactions.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Read the various laws used for measuring electrical conductance
	CO2	Relate the principle of conductometric titrations to the estimation of the strengths of solutions
	CO3	Apply Freundlich adsorption isotherm for the adsorption of oxalic acid on charcoal
	CO4	Examine the reaction kinetics of two different solutions
	CO5	Evaluate the electrical properties of solution and estimate the strength of the given solution

Syllabus

Electrical Conductance measurements

1. Determination of cell constant & Verification of Ostwald's dilution law
2. Verification of Kohlrausch's law

Conductometric Titrations

3. $BaCl_2$Vs $MgSO_4$
4. Buffer Vs Strong acid

Chemical Kinetics

5. Acid hydrolysis of an ester – Relative strength of acids
6. Reaction kinetics of KI and $K_2S_2O_8$
7. Iodination of acetone

Subject code: 25PCH3CO

Adsorption

8. Adsorption of oxalic acid on charcoal

Reference Books

1. S.R. Palit and S.K. De (2003) Practical Physical Chemistry, Science Book Agency, Calcutta.
2. P.C. Sharma and Agarwal (1998) Practical Chemistry, Goel Publishing House, Meerut.
3. V. Venkateswaran and A.R. Kulaindaivelu (2005) Practical Physical Chemistry, S.Chand & Co.,.
4. J.B.Yadav (2010) Advanced Practical Physical Chemistry, Goel Publishing House, 29th edition.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	S	S	H
CO2	M	H	S	H	M
CO3	H	M	H	S	M
CO4	S	H	S	H	M
CO5	S	M	H	S	H

S-Strong H-High M-Medium L-Low

Distribution of Marks

Internal (Maximum 40)	ESE (Maximum 60)
CIA practical exam – 25 (Exam marks 50 converted to 25) Observation note book – 10 Attendance – 5	Experiment – 45 Viva-Voce – 5 Record – 10

Subject code: 25PCH409

Programme Code: 04		**M.Sc., Chemistry**			Skill development, Employability
Title of the paper: Core Paper 9–Physical Chemistry III					
Batch 2025-2027	Semester IV	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To enable a complete knowledge on chemical and statistical thermodynamics
2. To make the students understand the third law of thermodynamics, probability theorems, distribution laws, partition functions
3. To foster an awareness in the student the fundamental concepts of photochemistry

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Define the vitals of chemical thermodynamics and irreversible thermodynamics
	CO2	Discuss the third law of thermodynamics, theories of probability and thermodynamic probability
	CO3	Apply the principles of statistical thermodynamics to derive distribution laws
	CO4	Derive the expressions for the partition functions of molecules
	CO5	Summarize various photophysical processes taking place in excited molecules

Syllabus

UNIT – I: CHEMICAL THERMODYNAMICS I

SECOND LAW OF THERMODYNAMICS (15 hrs)

Second law of thermodynamics- Concept of entropy, entropy change in reversible and irreversible processes, work and free energy functions, Maxwell's relations, Criteria for reversible and irreversible process. Fugacity and Activity- Determination of fugacity of gas in a gaseous mixture, Concept of activity, activity co-efficient, Standard states and experimental determination of activity and activity coefficient of electrolytes.

Subject code: 25PCH409

IRREVERSIBLE THERMODYNAMICS

Phenomenological Laws and Onsager's Reciprocal Relations- Verification of the Onsager relations, The principle of Microscopic Reversibility, Electrokinetic Effects, Non-linear Thermodynamics of Irreversible Processes, Application of Irreversible Thermodynamics to Biological systems.

UNIT – II: CHEMICAL THERMODYNAMICS II (15 hrs)

THIRD LAW OF THERMODYNAMICS

Third law of thermodynamics, probability and third law, Nernst heat theorem and other forms stating third law, thermodynamic quantities at absolute zero, statistical meaning of third law and apparent exceptions.

PROBABILITY

Theories of probability, theories of permutations and combinations, thermodynamic probability, thermodynamic probabilities of systems in equilibrium, Boltzmann expression for entropy, Stirling's approximation, States of maximum thermodynamic probability, thermodynamic probabilities of systems involving energy levels.

UNIT – III: STATISTICAL THERMODYNAMICS I (15 hrs)

Quantum statistics: Distribution laws - Maxwell-Boltzmann distribution law - Evaluation of alpha and beta in M.B. distribution law, Bose-Einstein distribution law, Entropy of Bose-Einstein gas, Bose-Einstein Condensation, Fermi-Dirac distribution law, Entropy of a Fermi-Dirac gas, Plank distribution law for black-body radiation, Heat capacities of solids - Einstein's and Debye's theories of heat capacities of solids.

UNIT – IV: STATISTICAL THERMODYNAMICS II (15 hrs)

Partition function – definition, Translational partition function, Rotational partition function – effect of molecular symmetry on rotational partition function- ortho and para hydrogen, Vibrational partition function and Electronic partition function, Evaluation of thermodynamic properties E, H, S, A, G, $C_p$and C_v from monoatomic and diatomic ideal gas molecule partition functions, Equipartition principle, relation between molecular partition function and canonical partition functions, relation between the total partition function of a molecule and the separate partition function.

UNIT – V: PHYSICAL PHOTOCHEMISTRY (15 hrs)

Physical properties of the electronically excited molecules-Excited state acidity constants- pK* values-Geometry of some electronically excited molecules-Types of photophysical pathways-Fluorescence emission-Phosphorescence- Photophysical kinetics of unimolecular processes- Stern-Volmer equation-

Subject code: 25PCH409

Quenching - Delayed fluorescence -study of excited states –Flash photolysis- chemiluminescence*, Photosynthesis – PS I and PS II.

***** Denotes self-study

Note: Question paper will contain not more than 20 % of problems covering the entire syllabus.

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. Puri, Sharma, Pathania (2020) Principles of physical chemistry, 47th Edition, Vishal Publishing Co.
2. Rajaram, Kuriacose (2006) Thermodynamics, Shobanlal & Co, 4th edition.
3. K.K. Rohatgi, Mukherjee (2006) Fundamentals of Photochemistry, New Age International.
4. Nicholas J. Turro (2013) Modern Molecular Photochemistry, 2ndEdition, University Science Books.

Reference Books

1. Glasstone (2013) Thermodynamics for chemists, Van Nostrands.
2. M.C. Gupta (2013) Statistical thermodynamics, New Age International.
3. Gurdeep Raj (2016) 4th Edition, Advanced Physical Chemistry, Goel Publishing House.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	H	M	M
CO2	S	M	S	M	S
CO3	H	S	H	S	H
CO4	M	S	S	S	M
CO5	S	M	H	M	H

S-Strong H-High M-Medium L-Low

Subject code: 25PCH410

<table>
<tr><td colspan="3">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="5">Title of the paper: Core Paper 10– Spectroscopy</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
IV</td><td>Hours/Cycle
5</td><td>Total Hours
75</td><td>Credits
5</td></tr>
</table>

Course Objectives

1. To understand the principles and instrumentation of various spectroscopic techniques.
2. To gain knowledge of the applications of IR, UV and NMR spectra.
3. To identify the structure of compounds using various spectral techniques.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	List the fundamental concepts of IR spectroscopic technique
	CO2	Discuss the theories and rules for solving UV spectrum of a compound
	CO3	Interpret the fragmentation pattern in a mass spectrum and determine the structural features of some compounds
	CO4	Elucidate the ^{1}H spectra of simple organic molecules
	CO5	Solve the ^{13}C NMR spectra of organic compounds

Syllabus

UNIT - I: IR SPECTROSCOPY (15 hrs)

The vibrating diatomic molecule-the simple harmonic oscillator- selection rules-the diatomic rotator-vibration of polyatomic molecule (fundamental vibrations and their symmetry)-overtone and combination frequencies - Molecular vibrations -factors influencing vibrational frequencies - force constant-identification of functional groups, hydrogen bonding and IR spectra, finger print region - Fermi Resonance -applications of infrared to organic compounds.

UNIT – II: UV-VISIBLE SPECTROSCOPY (15 hrs)

Theory- Beer-Lambert's law of photochemistry - principle- electronic spectra of diatomic molecules-Born-Oppenheimer approximation- intensity of vibrational electronic spectra– Franck-Condon principle-selection rules–dissociation energy- Fortrat diagram- predissociation-types of transition*-auxochromes and

Subject code: 25PCH410

chromophores, Woodward-Fieser rules for calculating absorption maxima of dienes, polyenes and α, β-unsaturated ketones, Applications to organic compounds.

UNIT – III: MASS SPECTROMETRY (15 hrs)

Presentation of mass spectrum-instrumentation-double focusing mass spectrometer-ion source-mass analyzers-ion detectors, types of ions-molecular ion, fragment ion, rearrangement ion, metastable ion, odd and even electron ions, molecular ion peak, base peak and metastable ion peak, determination of molecular formula-Nitrogen Rule, isotopic abundance, Retro-Diels Alder Reaction, McLafferty rearrangement, Ortho elimination- double hydrogen rearrangement, double bond and ring equivalence.

Fragmentation associated with functional groups (aliphatic and aromatic) – hydrocarbons, unsaturated hydrocarbons, aldehydes, ketones, carboxylic acids, esters, amides, alcohols, thiols, amines, ethers.

UNIT – IV: NUCLEAR MAGNETIC RESONANCE-^{1}HNMR (15 hrs)

Magnetic properties of nuclei – theory of nuclear resonance, Instrumentation, Relaxation mechanisms(spin-spin & spin-lattice)- Chemical shifts- Electronegative effect, shielding and deshielding effects, Hydrogen bonding effect, Anisotropy, spin-spin coupling, geminal, vicinal, Long range, deuterium exchange – solvents used in NMR, First order and non-first order NMR spectra- AB, ABC, A_2B_2, and ABX spectra, simplification of complex spectra- chemical shift reagents, double resonance –INDOR- Spin tickling- magnetic field strength, Nuclear Overhauser Effect (NOE), dynamic NMR, Applications of NMR to organic compounds.

UNIT – V: ^{13}C NMR (15 hrs)

Sensitivity, differences between ^{13}C NMR and ^{1}H NMR, measurement of ^{13}C NMR spectra, solvents, Types of ^{13}C NMR spectra - fully coupled, proton noise decoupled (fully decoupled), off resonance decoupled spectrum, DEPT, intensity of signals, carbon chemical shift- inductive effect, resonance effect, hydrogen bonding, heavy atom effect, substituent effects γ-gauche effect, γ-Anti effect.

2D NMR spectroscopy: Theory, basic components of two-dimensional experiment, Homonuclear Correlation Spectroscopy (H, H-COSY), Heteronuclear correlation (C, H-COSY) spectrum.

Solving problems using IR, UV, NMR and mass spectra for simple organic molecules not exceeding C_{12} units.

***** Denotes self-study

Note: Question paper will contain not more than 20 % of problems covering the entire syllabus.

Subject code: 25PCH410

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. Jagmohan (2013) Organic Spectroscopy, Principles and Applications, second edition, Narosa publishing house.

2. Y.R.Sharma (2013) Elementary Organic Spectroscopy, 5th Edition, S. Chand & Co. Ltd.

3. W. Kemp (2022) Organic Spectroscopy, 3rd Edition, McMillan Press Ltd.

4. C.N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, (2008), Tata McGraw-Hill.

Reference Books

1. D.L. Pavia, G.M. Lampman, George S. Kriz (2009) Introduction to spectroscopy, Brooks Cole; 4th Edition.

2. Silverstien, Bassler and Morril (2014) Spectrometric identification of organic compounds, 8th Edition, John Wiley and Sons.

3. P.S. Kalsi (2014) Spectroscopy of organic compounds, 6th edition, Wiley Eastern Ltd.,

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	H	S	H
CO2	H	H	S	M	S
CO3	S	M	H	H	M
CO4	H	S	M	S	S
CO5	S	H	M	H	M

S-Strong H-High M-Medium L-Low

Subject code: 25PCH4CP

Programme Code: 04		**M.Sc., Chemistry**			Skill development, Employability
Title of the paper: Core Practical 5 - Organic Chemistry Practical- II					
Batch	Semester	Hours/Cycle	Total Hours	Credits	
2025-2027	III & IV	3 &5	120	3	

Course Objectives

1. To attain knowledge in estimating organic compounds quantitatively.
2. To learn and practice the methods of preparation of some organic compounds.
3. To acquire expertise in the preparation of some important drugs.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Define clearly, the procedures of quantitative estimations
	CO2	Report the significance of the preparation of Aspirin and Paracetamol drugs
	CO3	Apply the principle involved in double stage preparation of some organic compounds and prepare the compounds
	CO4	Analyze Reichert-Meisel value, saponification value and iodine value in the given oil or fat
	CO5	Evaluate quantitatively the amount of organic compounds present in the whole of the given solution

Syllabus

A. Quantitative estimations:

Estimation of phenol, aniline, ethyl methyl ketone, Glucose (Fehling's method and Bertrand's method), Ascorbic acid.

B. Two stage Preparations:

1. Preparation of Drugs: Aspirin, Paracetamol

2.Preparation of Benzanilide from benzophenone

2. Preparation of m- nirtrobenzoic acid from methyl benzoate

4. Preparation of p- nitroaniline from acetanilide

5. Preparation of p-bromo acetanilide from aniline

C. Extraction and estimations: (Not for ESE examination**)**

1. Lactose from milk

2. Caffeine from tea

Subject code: 25PCH4CP

3. Nicotine from tobacco extract

4. Citric acid or ascorbic acid from a tablet or from a natural source.

D. Analysis of oil: (Not for ESE examination)

Reichart – Meisel value, saponification value and iodine value.

Text Books

1. Gnanprakasam and Ramamurthy (2000) Organic Chemistry Laboratory Manual, Anand Book Depot, Chennai.

2. R. Jagmohan (2002) Advanced Practical Organic Chemistry, Vol. I & II.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	S	M	M
CO2	S	S	H	S	S
CO3	H	M	S	H	S
CO4	S	H	H	S	M
CO5	S	H	S	M	H

S-Strong H-High M-Medium L-Low

Distribution of Marks

Internal (Maximum 40)	ESE (Maximum 60)
CIA practical exam – 25 (Exam marks 50 converted to 25) Observation note book – 10 Attendance – 5	Experiment – 45 Viva-Voce – 5 Record – 10

Subject code: 25PCH4CQ

<table>
<tr><td colspan="3">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="5">Title of the paper: Core Practical 6 – Inorganic Chemistry Practical II</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
III & IV</td><td>Hours/Cycle
3 &5</td><td>Total Hours
120</td><td>Credits
3</td></tr>
</table>

Course Objectives

1. To make the students aware about separation of mixture of inorganic compounds and quantifying them using volumetric and gravimetric principles
2. To know and apply the principle of UV-Visible Spectral studies
3. To learn about the preparation and analyse the properties of inorganic complexes

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Recall the principles of Gravimetry
	CO2	Demonstrate the chromatographic separation techniques for the prepared compounds
	CO3	Apply the principle of UV-Visible Spectroscopy to solve the structures of complexes
	CO4	Comment on the physical properties such as melting point, etc., of the prepared inorganic complexes
	CO5	Estimate the amount of cations present in a solution mixture

Syllabus

A. UV-Visible spectral studies: Recording UV-Visible spectrum of five coordination complexes and interpretation of the spectra. (Group Experiment, Not for ESE practicals)

B. Chromatography: Column, Paper and Thin layer chromatographic techniques

(Group Experiments, Not for ESE practicals)

C. Preparation:

Single stage preparation, analysis and study of the properties of at least five coordination complexes.

HexathioureaLead(II)nitrate, Potassiumtrioxalatoferrate(III), Pentathioureadicopper(I)nitrate, Potassiumtrioxalatochromate(III), Tris(thiourea)copper(I)chloride, Bis(glycinato)copper(II)monohydrate, Bis(acetyl acetanato) copper (II) monohydrate.

Subject code: 25PCH4CQ

D. Quantitative estimation:

Mixture of cations involving volumetric and gravimetric estimation:

Copper & Nickel, Iron & Nickel, Iron & Magnesium and Calcium & Barium

Reference books

1. V.Venkateswaran, R.Veeraswamy and A.R. Kulandaivelu (2004) Principles of Practical Chemistry, Sultan Chand & Sons, 2nd Edition.

2. Giri. S,Bajpai. D.N. and O.P Panday (1972) Practical Chemistry Vol.I& II, S.Chand& Co.

3. J. Bassart, R.C. Dennay, G.H. Jeffery and Mendham (2000) Vogel's text book of qualitative Inorganic Analysis, 6thEdn. Pearson Education.

Distribution of marks

Internal (Maximum 40)	ESE (Maximum 60)
CIA practical exam – 25 (Exam marks 50 converted to 25) Observation note book – 10 Attendance – 5	Experiment – 45 Viva-Voce – 5 Record – 10

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	M	S	H
CO2	S	M	S	H	S
CO3	H	S	M	S	S
CO4	S	H	M	H	S
CO5	S	M	S	H	M

S-Strong H-High M-Medium L-Low

Subject code: 25PCH4Z1

<table>
<tr><td colspan="2">Programme Code: 04</td><td>M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="3">Title of the paper: Project &viva-voce</td></tr>
<tr><td>Batch
2025-2027</td><td>Semester
IV</td><td>Credits
4</td></tr>
</table>

Course Objectives

1. To make the students acquire the basic tools needed to carry out independent chemical research.
2. To facilitate self-paced learning among students, making them solve research-oriented problems.
3. To foster the quality of learning through collaborative learning and teacher-student interactions.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Choose scrupulously, an appropriate research topic
	CO2	Summarize the findings of a thorough literature review
	CO3	State exactly, the problem of the experimental study/ research undertaken
	CO4	Interpret the results of the research using some basic tools
	CO5	Evaluate the research outcomes and present them in written and oral

COMPONENT FOR PROJECT

CIA / ESE	Particulars	Project Out of 100 Marks
CIA	Project Review	15
	Regularity	5
	Total Internal Marks	**20**
***ESE**	Project Report	60
	Viva Voce	20
	Total External Marks	**80**
Total Marks (CIA+ESE)		**100**

Note: The Project dissertation evaluation and viva-voce examination will be conducted jointly by the Internal and External Examiners

Subject code: 25PCH4Z1

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	S	M	S	S
CO2	S	M	S	H	H
CO3	S	S	M	H	S
CO4	S	H	M	H	H
CO5	S	H	H	S	M

S-Strong H-High M-Medium L-Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Major Elective–Analytical Chemistry				
Batch 2025-2027	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To introduce the ideas of error analysis to the students.
2. To enable the students to attain knowledge on various chromatographic techniques and thermoanalytical methods.
3. To gain knowledge in ESR and Mossbauer spectroscopy, AAS and polarimetry.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Define the ideas of error analysis
	CO2	Discuss the principles and instrumentation of several chromatographic methods
	CO3	Discover the principles, instrumentation and applications of various thermo analytical techniques
	CO4	Interpret ESR and Mossbauer spectra of several metal complexes
	CO5	Assess the principle and applications of AAS, ORD and CD

Syllabus

UNIT – I: ERROR ANALYSIS (15 hrs)

Errors – determinate and indeterminate errors, accuracy and precision, mean, median, average deviation, standard deviation, relative standard deviation, standard deviation for 'Sample' and 'Population of data'-rejection of measurements- Quotient test -confidence limits, confidence interval, tests of significance - t-test and f-test -minimization of errors* - significant figures, rounding off the numerical expressions, reporting of analytical data.

UNIT– II: CHROMATOGRAPHIC METHODS (15 hrs)

Basic principles, theories, instrumentation, experimental procedures and application of following chromatographic techniques – Paper (PC), Thin Layer (TLC), Column (CC), Gel Permeation (GPC), Gas (GC) and High-Performance Liquid Chromatography (HPLC), Ion-exchange chromatography.

UNIT – III: THERMAL ANALYSIS (15 hrs)

Introduction - different types of thermo analytical methods. Thermo gravimetric analysis (TGA) - principle – factors influencing thermograms. Derivative thermogravimetry (DTG) - principle – factors influencing thermograms. TGA instruments – precautions in the use of thermo balance. Differential thermal analysis (DTA) – principle – instrumentation – applications – thermometric titrations-principle-instrumentation and applications. Differential scanning calorimetry (DSC) - principle - instrumentation and applications.

UNIT –IV: ESR & MOSSBAUER (15 hrs)

Electron spin resonance - Theory – derivative curves - 'g' values, Kramer's degeneracy-zero field splitting – hyperfine splitting – isotropic and anisotropic systems – identification of free radicals – applications to copper complexes.

Mossbauer spectroscopy-Principle and theory-Isomer shift – quadruple interactions – magnetic interactions – applications to Iron complexes

UNIT– V: ATOMIC ABSORPTION SPECTROMETRY& POLARIMETRY (15 hrs)

AAS-Principle- instrumentation – detection of metals & non-metals, interference, detection limit & sensitivity and applications. Flame Emission spectrometry- Principle, instrumentation, methodology and applications. Comparison between AAS and FES.

Polarimetry – Plane polarized light – optical activity of molecules – polarimeter and its uses. ORD and CD spectrometry, circular birefringence, circular dichroism, optical rotatory dispersion, Plain curves, anomalous curves - cotton effect – axial haloketone rule and octant rule – application.

***** Denotes self-study portion

Note: Question paper will contain not more than 20 % of problems covering the entire syllabus.

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. B. K. Sharma (2013) Instrumental methods of Chemical analysis, Goel Publishing house, 29th edition.
2. V K Srivastava and K K Srivastava (2013) Introduction to chromatography-Theory and Practice, S.Chand & Company LTD, 2nd edition.
3. R.S. Drago (1996) Physical methods in Inorganic chemistry, 1st Edition, W. B. Saunders Company.

4. H. Kaur (2013) Instrumental methods of chemical analysis, PragathiPrakashan Publishers, 9th edition.

Reference Books

1. Gurdeep R. Chatwal& S.K. Anand (2014) Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
2. Gary D. Christian (2014) Analytical Chemistry**,** 6th edition, John Wiley & Sons, Inc.
3. D.A. Skoog, D.M. West, F.J. Holder and S.R. Grouch (2014) Analytical chemistry an Introduction 9th Edition, Saunders College publishing.

Mapping

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CO5	H	H	S	H	M

S-Strong H-High M-Medium L-Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Major Elective–Green and Nanochemistry				
Batch 2025-2027	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To gain knowledge on principles of green chemistry, microwave assisted reactions and ultrasound assisted reactions.
2. To stimulate the students to know about green synthesis.
3. To acquire a clear idea about various synthesis of nanomaterials and techniques.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	List the basic principles of green chemistry
	CO2	Relate the twelve principles of green chemistry with several green syntheses
	CO3	Discover the microwave and ultra sound assisted syntheses
	CO4	Elucidate the chemistry of nanomaterials and their synthetic methods
	CO5	Describe various characterization techniques for nanomaterials; summarize the applications of nanomaterials

Syllabus

UNIT – I: GREEN CHEMISTRY I (15 hrs)

Definition, need for green chemistry, twelve basic principles of green chemistry-planning a green synthesis in a chemical laboratory - concept of atom economy – rearrangement reaction– addition reaction – substitution reaction – elimination reaction - concept of selectivity – chemo selectivity - regio selectivity – enantioselectivity – diastereoselectivity

UNIT – II: GREEN CHEMISTRY II (15 hrs)

Green solvents – super critical carbondioxide, Water as greener solvent- reactions in ionic-liquid, solvent free reaction- solid supported organic synthesis, phase transfer catalyst (PTC), Synthesis involving basic principles of green chemistry – synthesis of adipic acid, catechol, BHT, citral, Ibuprofen and paracetamol.

UNIT – III: GREEN CHEMISTRY III (15 hrs)

Microwave assisted reactions – introduction- reactions in water – Hofmann elimination – Hydrolysis reactions – oxidation reactions – reactions in organic solvents – Esterification –Claisen rearrangement – Diels Alder reaction – Decarboxylation – solvent free reactions – deprotections – saponification. Ultrasound assisted reactions – Esterification – saponification – Cannizaro reaction – Strecker synthesis – Reformatsky reaction, Future trends in green chemistry, green chemistry in sustainable development.

UNIT – IV: NANOCHEMISTRY I (15 hrs)

Introduction- definition of nanoscience, nanotechnology, nanochemistry, nanomaterials, nanoscale, Classification of nanomaterials – 0D, 1D, 2D and 3D nanomaterials, quantum dots, fullerenes, carbon nanotubes - types, nanocomposites - types, Properties of nanomaterials – electrical, magnetic, optical and mechanical properties, Bottom-up and Top-down approaches, Physical methods of preparation of nanomaterials – plasma arcing, chemical vapour deposition, electrodeposition, sol-gel synthesis, ball-milling.

UNIT –V: NANOCHEMISTRY II (15 hrs)

Chemical methods of preparation of nanomaterials – Chemical reduction – borohydride, citrate and polyol reduction, co-precipitation, high temperature thermal decomposition, liquid-liquid interface reaction, Characterization Techniques – principle, instrumentation and applications of - Scanning Electron Microscopy (SEM), Scanning Tunnelling Microscope (STM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Powder X-Ray Diffraction (XRD), Applications of Nanomaterials - catalysis, environmental and biomedical (drug delivery) applications, Environmental hazards of nanomaterials*.

*Denotes self-study portion

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. V. Kumar (2010) An Introduction to Green Chemistry, Vishal Publishing Co.
2. V S. Muralidharan, A. Subramania (2010) Nanoscience and technology, Ane books pvt. Ltd.,

Reference Books

1. V.K. Ahluwalia (2013) Green Chemistry, Ane Books Pvt. Ltd.

2. B.S. Murty, P. Shankar, Baldev Raj, B.B. Rath, James Murday (2013) Text book of nanoscience and nanotechnology, Universities Press.

3. S. Shanmugam (2010) Nanotechnology, MJP Publishers.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	M
CO2	S	H	S	S	S
CO3	H	S	H	M	S
CO4	S	M	H	S	M
CO5	H	S	H	S	M

S-Strong H-High M-Medium L-Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Major Elective–Bioinorganic Chemistry				
Batch 2025-2027	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To introduce the role of metal ions in biological systems.
2. To enable the students to know the structure, function and physiology of Haemoglobin and myoglobin.
3. To recognize electron transfer, respiration, photosynthesis, function of metalloenzymes and the applications of metals in medicine.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Revive the role of metal ions in biological systems
	CO2	Understand the physiology and functions of haemoglobin and myoglobin
	CO3	Analyze the electron transfer reactions in biological systems
	CO4	Integrate the structure and functions of metalloenzymes
	CO5	Study the functions and applications of metals in medicine; Examine the toxicity of metals in biological systems

Syllabus

UNIT –I: METAL STORAGE, TRANSPORT AND BIOMINERALISATION (15 hrs)

Metals in biological systems-trace and ultra trace metals - the roles of metal ions in biological systems- the entatic state- iron storage - ferritin- haemosiderin - iron transport- transferrin- siderophores, hemerythrin, hemocyanin.

UNIT– II: DIOXYGEN MANAGEMENT (15 hrs)

Hemoglobin and myoglobin – dioxygen binding, transport and utilization – the binding of dioxygen to myoglobin – the physiology of myoglobin and hemoglobin – structure and functions of hemoglobin – other biological dismutases – oxidases and oxygenases – tyrosinase – methane monooxygenase – dioxygenases.

UNIT –III: ELECTRON TRANSFER, RESPIRATION AND PHOTOSYNTHESIS (15 hrs)

Ferredoxins – rubredoxins – synthetic models e-s proteins – blue copper proteins – cytochromes – photosynthesis – chlorophyll and photosynthetic reaction center – photosynthetic pathway – manganese and photosystem II.

UNIT –IV: METALLOENZYMES (15 hrs)

Enzymes – structure and function – zinc enzyme – carboxypeptiase and carbonic anhydrase – iron enzymes – catalase, peroxidase and cytochrome P-450 – copper enzymes – Enzymes – structure and function – zinc enzyme – carboxypeptiase and carbonic anhydrase – iron enzymes – catalase, peroxidase and cytochrome P-450 – copper enzymes – superoxide dismutase – molybdenum oxatransferase enzymes – xanthine oxidase – vitamin B_{12} and the coenzyme – nitrogenase.

UNIT– V: METALS IN MEDICINE (15 hrs)

Metal deficiency and disease – metals used for diagnosis and chemotherapy with reference to anticancer drugs – toxic effects of metals* – function and toxicity of the elements in biological systems – antibiotics and related compounds – chelate therapy – metal complexes as probes of nucleic acids.

***** Denotes self-study portion

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. Dr.Asim K. Dass (2009) Bioinorganic Chemistry, Books and Allied (P) Limited.
2. J.E.Huheey, E.A.Kieter, R.L.Keiter (2009) Inorganic Chemistry 4th Edition, Addision Wesely Publishing Company.

Reference Books

1. Bertini, H.B.Gray, S.J. Lippard and J.S. Nalentine (2011) Bioinorganic Chemistry; University Science Books.

2. P.S. Kalsi and J.P. Kalsi (2011) Bioorganic, Bioinorganic and Supramolecular chemistry, New Age International Publishers.

3. K. Hussain Reddy (2007) Bioinorganic Chemistry, New Age International.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	M
CO2	S	H	S	M	S
CO3	S	S	H	M	H
CO4	S	M	S	S	S
CO5	H	S	M	M	H

S-Strong H-High M-Medium L-Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Major Elective–Drugs and their development				
Batch 2025-2027	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To create awareness among the students about various drugs used for therapeutic purposes.
2. To enable the students to know the principle of drug designing and drug targeting.
3. To realize the importance of various drugs, their design and development.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Recall the Indian Knowledge System, describe the chemistry of drugs and their action as therapeutics
	CO2	Discuss the action mechanism of drugs
	CO3	Examine the physicochemical properties of drugs
	CO4	Outline the Structure Activity Relation of several therapeutic agents
	CO5	Assess drug design and drug target interaction

Syllabus

UNIT– I: INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM AND DRUG CHEMISTRY (15 hrs)

Introduction to Indian Knowledge System **–** Metals used as medicine in Vedic age – Bhasmas for various ailments – Gold, Silver, Copper and Lead bhasmas – Introduction to Flower medicine.

Introduction to drugs, definition of drugs, requisites of a good drug*, classification of drugs, development of various classes of drugs – revolutions in drug discovery.

Some common drugs – anaesthetics, antiseptics, analgesics, antipyretics, cell structure - types of molecules in the cell affected by drugs - protein binding.

UNIT– II: DRUG ACTION (15 hrs)

Characteristics of different routes to drug administration, sites of drug action, mode of drug action, mechanism of drug action, drug receptors – drug-receptor complex nomenclature, chemical nature, types, drug receptor interactions – covalent, ionic, hydrogen bonding, Vander Waals and hydrophobic interactions, receptor site theories – occupation, rate and induced-fit theories.

UNIT– III: PHYSICOCHEMICAL PROPERTIES OF DRUGS (15 hrs)

Introduction-physical properties-solubility, partition coefficient, ionization and pka values-hydrogen bonding-surface activity-applications-complexation-redox potential-steric features of drug-conformational isomers-optical isomers-bioisosterism-classical bioisosterers- nonclassical bioisosterers.

UNIT – IV: THERAPEUTIC AGENTS (15 hrs)

Structure Activity Relation (SAR) of antibiotics – cephalosporins, streptomycin, tetracycline, erithromysin and chloramphenicol, SAR of antimalarial drug cinchonine, SAR of anticancer drug cisplatin, cardiovascular drugs – definition and categories, synthesis and use of diuretic drug – chloemerodrin Hg^{197}, antiparkinsonism drug – biperiden hydrochloride, antipsychotics, antithyroid drugs, drugs to combat aids, antiviral drugs, vaccines and their action mechanism.

UNIT – V: DRUG DESIGN AND DRUG-TARGET INTERACTION (15 hrs)

Drug design – Fundamentals and objectives of QSAR, variation of substituents – alkyl and aromatic substituents, extension of the structure, chain extensions/contractions, ring expansions/contractions, ring variations, ring fusions, isosterers, simplification and rigidification of the structure, conformation blockers, X-ray crystallographic studies, molecular modeling studies, drug design by nuclear magnetic resonance, a case study, oxaminquine.

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. Rama RaoNadendla (2007) Medicinal chemistry, Pharmamid press.
2. K.Illango, P.Valentina (2007) Text book of medicinal chemistry-Volume I &II- First edition, Keerthi publishers.
3. Ashutoshkar (2006) Medicinal chemistry-4th edition- New age international publishers.

Reference Books

1. JayashreeGhosh (2008) A Text Book of Pharmaceutical Chemistry 3rdEdn, S.Chand & Co Ltd.
2. L.M.Atherden (1995) Text Book of Pharmaceutical Chemistry, 8thEdn, Oxford University Press.
3. C.R.Chatwal (2007) Pharmaceutical Chemistry Vol. I & II, III Edn, Himalaya Publishing House.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	M
CO2	S	H	S	M	S
CO3	S	S	H	M	H
CO4	S	M	S	S	S
CO5	H	S	H	M	H

S-Strong H-High M-Medium L-Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Major Elective–Medicinal Chemistry				
Batch 2025-2027	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To study the chemistry behind the development of pharmaceutical materials.
2. To gain knowledge on mechanism and action of drugs.
3. To understand the need of antibiotics and usage of drugs.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Recall the basic concepts of medicinal chemistry.
	CO2	Understand the mode of action of antibiotics.
	CO3	Illustrate the classification of anti-hypertensive agents and diuretics.
	CO4	Appraise the importance of antimalarial drugs.
	CO5	Assess the functions of anti-tubercular, antiviral and antifungal agents

Syllabus

UNIT-I: Antibiotics **(15 hrs)**

Historical background, Nomenclature, Stereochemistry, Structure activity relationship, Chemical degradation classification and important products of the following classes. β-Lactam antibiotics: Penicillin, Cepholosporins, β- Lactamase inhibitors, Monobactams Aminoglycosides: Streptomycin, Neomycin, Kanamycin, Tetracyclines: Tetracycline, Oxytetracycline, Macrolide: Erythromycin, Clarithromycin, Azithromycin.

UNIT-II: Analgesics, Antipyretics and Anti-inflammatory Drugs **(15 hrs)**

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.

UNIT-III: Antihypertensive agents and diuretics **(15 hrs)**

Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.

UNIT-IV: Antimalarials **(15 hrs)**

Etiology of malaria, Quinolines: SAR, Quinine sulphate, Chloroquine, Amodiaquine, Primaquine phosphate, Pamaquine, Quinacrine hydrochloride, Mefloquine. Biguanides and dihydrotriazines: Cycloguanilpamoate, Proguanil. Miscellaneous: Pyrimethamine, Artesunete, Artemether, Atovoquone.

UNIT-V: Anti-tubercular, antiviral and antifungal agents **(15 hrs)**

Anti-tubercular Agents- Synthetic anti tubercular agents: Isoniozid, Ethionamide, Ethambutol, Pyrazinamide, Para amino salicylic acid.

Antiviral agents- Amantadine hydrochloride, Rimantadine hydrochloride, Idoxuridinetrifluoride, Acyclovir, Gancyclovir, Zidovudine, Didanosine, Zalcitabine.

Antifungal agents- Clotrimazole, Econazole, Butoconazole, OxiconazoleTioconozole, Miconazole, Ketoconazole, Terconazole, Itraconazole.

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. Rama Rao Nadendla (2007) Medicinal chemistry, Pharmamid press.
2. K.Illango, P.Valentina (2007) Text book of medicinal chemistry-Volume I &II- First edition, Keerthi publishers.
3. Ashutoshkar (2006) Medicinal chemistry-4th edition- New age international publishers.

Reference Books

1. Jayashree Ghosh (2008) A Text Book of Pharmaceutical Chemistry 3rd Edn, S.Chand& Co Ltd.
2. L.M.Atherden (1995) Text Book of Pharmaceutical Chemistry, 8thEdn, Oxford University Press.
3. C.R.Chatwal (2007) Pharmaceutical Chemistry Vol. I & II, III Edn, Himalaya Publishing House.

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CO3	H	M	L	H	S
CO4	S	M	H	M	M
CO5	S	H	M	S	L

S-Strong H-High M-Medium L-Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Major Elective–Polymer Chemistry				
Batch 2025-2027	Hours/Cycle 5	Total Hours 75	Credits 5	

Course Objectives

1. To gain knowledge in polymer chemistry.
2. To explore the structure, properties and uses of various polymers, fibres and elastomer
3. To understand about various properties of polymers, fibres, elastomers and their applications in industries

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	CO1	Remember the preparation and properties of some important polymers
	CO2	Empathize the process of fabrication
	CO3	Realize the technology and applications of fibres
	CO4	Appraise elastomer technology in industries
	CO5	Explore the chemistry of elastomers

Syllabus

UNIT–I: POLYMER (15 hrs)

Introduction- Definitions- Industrial Polymers- Plastics- Fibers- Rubber- Coatings and adhesives- Chemical structure and properties of polymers- Glass Transition Temperature (T_g) Stereochemistry- crystallinity- Mechanical properties-thermal Stability-Flammability and Flame resistance-Chemical resistance- Degradability-Electrical Conductivity-Nonlinear Optic Properties. Degrading agencies and mechanism of degradation: Thermal, mechanical, ultrasonic degradation, degradation by high-energy radiation, photo degradation, oxidative and hydrolytic degradation.

UNIT–II: INDIVIDUAL POLYMERS (15hrs)

Production, properties and uses of ethenic polymers– polythene (HDPE&LDPE), polypropylene, polystyrene, PVC*, polyvinylacetate, polyvinylalcohol, polymethylmethacrylate and polyacrylonitrile, Production-properties and uses of polycondensation polymers – phenol- formaldehyde, urea-formaldehyde and epoxyresins. Polymer additives: Fillers, Antioxidants, thermal and UV-stabilizers, lubricants, colorants, flame retardants, blowing agents and Plasticizers– effect of plasticizers on T_g.

UNIT–III: FABRICATION PROCESS (15 hrs)

One-dimensional processes – application of coatings and adhesives, Two-dimensional processes – Casting (Die casting, rotational and film casting), Clandering, Lamination and Extrusion (flat film and Blown film extrusion) processes. Three-dimensional processes– Moulding (Compression, Injection, Reaction injection, Blow, Transfer, and Rotational moulding) processes, Forming (atmosphere pressure and Fluid pressure forming) processes and Foaming process.

UNIT–IV: FIBRE TECHNOLOGY (15 hrs)

Production, properties and uses of natural and synthetic fibres, cellulosic fibre, polyamide fibre, polyester fibres and acrylic fibres. Classification and properties of textile fibres – criteria for fibre formation, orientation of molecules on drawing. Spinning processes–melt spinning, dry spinning and wet spinning. Treatment of fibres– sizing, dyeing, finishing, scouring and lubrication.

UNIT– V: ELASTOMER TECHNOLOGY (15 hrs)

Structure and properties of elastomers – vulcanization – Chemistry of vulcanization –sulphur and non-sulphur – types of vulcanization–Elastomer properties and compounding. Synthetic rubbers–GRS(Buna-S), N-butyl rubber, nitrile rubber, sulphide rubber, urethane rubber and silicone rubber. Applications of Polymers in Industry: Membrane applications of polymericmaterials-Biomedicalapplications-Drugdelivery-artificialorgans-Electronicapplications-Conductingpolymers.

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text books

1. V.R. Gowariker, Polymer Science, Wiley Eastern,2019.
2. G.S. Misra, Introductory Polymer Chemistry, New Age International (Pvt) Limited,2021.
3. M.S. Bhatnagar, A Text Book of Polymers, vol-I & II, S.Chand& Company, New Delhi, 2004.

Reference books

1. F. N. Billmeyer, Textbook of Polymer Science, Wiley Interscience,2007.
2. A. Kumar and S. K. Gupta, Fundamentals and Polymer Science and Engineering, Tata McGraw-Hill, 1978.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	S	M	M
CO2	S	H	S	S	H
CO3	H	S	M	M	S
CO4	S	H	S	H	S

S-Strong H-High M-Medium L-Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Non Major Elective–Environmental science				
Batch 2025-2027	Hours/Cycle 4	Total Hours 60	Credits 4	

Course Objectives

1. To create awareness among the students about various environmental issues like pollution of air, water and soil which threaten the mankind.
2. To allow students grasp the sources and effects of various pollutions.
3. To motivate the students to know the measures to prevent and control pollution.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Enumerate the different sources of air pollutants and their effects
	CO2	Classify water pollutants; Report their sources and harmful effects
	CO3	Identifydifferent sources of soil pollution, their effects and control measures
	CO4	Discover the types and consequences of radioactive pollutants
	CO5	Assess the causes and harmful effects of thermal and noise pollution

Syllabus

UNIT– I : AIR POLLUTION (12hrs)

Composition of air, Classification of pollutants-monitoring and control of air pollution-CO sensor-Greenhouse effect-definition-major sources of greenhouse gases* – consequences of greenhouse effect, Global warming*- Ozone layer depletion – mechanism – Chlorofluoro carbons (CFC), Smog-photochemical smog, Acid rain-theory of acid rain-effects of acid rain-prevention and control.

UNIT – II: WATER POLLUTION (12 hrs)

Sources of water pollution sewage & domestic wastes, industrial effluents, agricultural discharges, fertilizers, detergents, toxic metals, siltation, thermal and radioactive materials, Types of water pollution - ground water, surface water, lake water, river water and sea water pollution and their harmful effects, Effects of oil pollution in marine water, Eutrophication –types, effects and its control measures, Control measures of water pollution.

UNIT – III : SOIL POLLUTION (12hrs)

Types of soil and their characteristics. Sources of soil pollutants and their deterimental effects-industrial, urban wastes, radioactive materials, agricultural products, chemical & metallic wastes and biological agents. Diseases caused by soil pollution*. Remedial measures for soil pollution.

UNIT – IV: RADIOACTIVE POLLUTION (12 hrs)

Radio activity and kinds of radiation, Natural and anthropogenic sources of radiation, harmful biological effects of ionizing and non-ionizing radiations (unit of measurement REM), micro waves, radio frequency, x-ray, disposal methods of radioactive wastes from nuclear power plants, low level and high-level nuclear waste - biomedical waste.

UNIT – V: THERMAL AND NOISE POLLUTION (12 hrs)

Thermal Pollution – definition-sources-nuclear power plants, thermal power plants, industrial effluents, domestic & municipal sewage, harmful effects of thermal pollution.

***Noise Pollution** – definition, sources, effects and control, Units of sound-dB.

*Denotes self-study portion

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. B.K.Sharma (2014)Environmental Chemistry, GOEL Publishing Company.
2. A.K De (2016) Environmental Chemistry, New Age International,1st Edition.

Reference Books

1. G.S.Sodhi (2009)Fundamentals of Environmental Chemistry, Alpha science.
2. E. Lichtfouse, J. S. Bauer, D. Robert (2009) Environmental Chemistry, Springer.
3. BalramPani (2007) Text book of environmental chemistry, I.K. International Pvt., Ltd.

Mapping

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CO2	H	S	S	M	H
CO3	S	H	H	M	H
CO4	H	H	H	S	S
CO5	S	H	S	H	M

S – Strong **H –** High **M –** Medium **L –** Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Non Major Elective–Scientific Thesis Writing				
Batch 2025-2027	Hours/Cycle 4	Total Hours 60	Credits 4	

Course Objectives

1. To introduce students the research prospectus and thesis/dissertation writing process with the focus on both the rhetorical framework and grammatical patterns germane to these tasks and the purpose of the research project.
2. To focus on the communication problems encountered in research and writing a thesis.
3. To train the students on writing a thesis or dissertation with the aid of MS Office and some software like Chemdraw.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Discover the ways to write the 'Introduction'
	CO2	Discuss the guidelines for writing 'Materials and Methods' chapter of a thesis
	CO3	Explain the strategies adopted for writing 'Discussion', 'Abstract', and 'Synopsis' sections of a thesis
	CO4	Elucidate the different types of reference citation in a thesis
	CO5	Distinguish between oral and poster presentation; Compare various article types in journal publication

Syllabus

UNIT – I: INTRODUCTION (12 hrs)

Writing introduction of thesis- General introduction and chapter introduction - example of organization of the thesis in general introduction – example of statement if aims and objectives in a general introduction – introduction of a chapter in a thesis.

Writing review of literature – need for review of literature* – review process and bibliography – locating literature – publications – reading the literature – placement of review of literature in a thesis – organizing and writing literature review – time period covered in the review – contents of a review — use of tabular format in review – focus of the organization – revision of the draft.

UNIT – II:MATERIALS AND METHODS (12 hrs)

Writing materials and methods – General guidelines – details required about the chemical material. Writing results – voice, tense and style – topical sentence – sequence – structure – content.

Preparation of table – tabular form – introduction and placement of a table – table format – numbering of table – title of the table – the stub – box heading – unit of measurements – footnotes. Preparation of figures – introduction – introduction and placement of figures – numbering of figures – caption of figures – preparation of statistical diagrams – preparation of photographs and microphotographs.

UNIT – III: DISCUSSION (12 hrs)

Writing discussion – style of writing discussion – sequence of discussion – structure and content of discussion – key findings and interpretation – discussion of methodology – comparison of results – discussion of the significance of the result – discussion of unexpected result – discussion of unexpected result – discussion in the absence of pertinent literature – conclusion of discussion – structured format of discussion – an example of discussion.

Writing abstract, keywords, summary and synopsis of thesis.

UNIT – IV: FORMATTING (12hrs)

References citing and listing – introduction – different systems of reference citation – name year system – citation in the text – listing references- citation sequence system – alphabet number system.

Formatting and typing thesis – introduction – paper – margins – paragraph indentations – widow and orphan lines – spacing – alignment – hyphenation – fonts – pagination – format of a thesis.

UNIT – V: MANUSCRIPT PREPARATION (12hrs)

Preparing manuscript for presentation – poster presentation – poster size – poster Vs. oral presentation – preparation of poster – poster printing – displaying the poster – presenting the poster. Preparing for oral presentation – preparation of the script – timings – using visual aids – presentation style.

Journal article – types – original research paper, Short communications, Review articles, case studies - peer review - impact factor of journals - h-index - ISSN.

Working knowledge in MS Word and MS power point.

Working knowledge in software-Origin, Chemdraw.

*Denotes self-study portion

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text Books

1. N. Gurumani (2010) Scientific thesis writing and paper presentation, MJP publishers.

Reference Books

1. Hans FridrichEbel, Claus Bliefert, Willaim E. Russey (2012) The art of scientific writing, Wiley, VCH.
2. Martha Davis, Kaaron Davis (2012) Scientific papers and presentation, 3rd edition, Elsevier.

Mapping

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CO1	M	H	S	S	H
CO2	H	M	H	H	H
CO3	H	S	H	H	M
CO4	M	H	S	S	S
CO5	S	H	S	S	M

S – Strong H – High M – Medium L – Low

Programme Code: 04		**M.Sc., Chemistry**		Skill development, Employability
Title of the paper: Non Major Elective–Textile and dye chemistry				
Batch 2025-2027	Hours/Cycle 4	Total Hours 60	Credits 4	

Course Objectives

1. To understand the classification, structure, properties of various textile fibres.
2. To enable the students to attain knowledge to understand the interaction between dye and textile fibres.
3. To learn about types of fibres and dyeing processes and after treatment techniques.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Examine the chemistry of fibres and dyes
	CO2	Explain the manufacture and processing of fibres
	CO3	Illustrate various theories of colour and dye-fibre interactions
	CO4	Analyze the principle of dyeing
	CO5	Evaluate several treatment processes involved in dyeing

Syllabus

UNIT–I STRUCTURE OF FIBRES (12 hrs)

Introduction -General properties of textile fibres, Classification of fibres*: (natural, synthetic and Semi synthetic fibres), Differences between cellulose and synthetic fibres, Structure of textile fibres: Cotton, wool, silk, nylon, polyester, polyacrylamide, and Hydrophilic and hydrophobic fibres, Physical, chemical and biological properties and uses of cellulose fibre (cotton), protein fibre (silk and wool) and synthetic fibres (nylon and polyester).

UNIT–II MANUFACTURE AND PROCESSING OF FIBRES (12 hrs)

Semi synthetic fibres: Rayon -manufacture of viscose rayon, cuprammonium rayon and Acetate rayon, Synthetic fibres: Preparation, properties and Uses of Nylon 6, Nylon 66, Polyester, and poly acryl amide, Mercerization-Manufacture of mercerized cotton and their applications.

UNIT–III DYES (12 hrs)

Dyes –Requisites of a dye* –Theories of colour -Witt Theory and Modern theory, Classification of dyes with examples –according to application and structure - methyl orange, bismark brown, congo red, Malachite green, crystal violet, Phenolphthalein, Fluorescein, sulphur dyes, Phthalocyanines, Cyanine dyes,

Dye-Fibre interactions: Ionic, Covalent, Vander Waals, H-bonding interactions, Dyeing assisting agents: NaOH, Na_2CO_3, aluminium sulphate, chromic sulphate.

UNIT–IV PRINCIPLES OF DYEING PROCESSES (12hrs)

General concept of dyeing process: affinity of a dye, conditions for dyeing, selection of dye stuff, Dyeing methods –Direct dyeing, Top dyeing, Stock dyeing, Yarn dyeing, piece dyeing and garment dyeing, Silk dyeing.

UNIT–V TREATMENT PROCESSES (12hrs)

After treatment processes: Stripping of dyes, low temperature dyeing, Sizing: sizing agents and applications, Bleaching: Types of bleaching, Reductive bleaching, oxidative bleaching agents, Brightening: -Optical brightening agents-Types and uses.

*Denotes self-study portion

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

TEXT BOOKS

1. B.K. Sharma, Industrial Chemistry, (2011) Goel Publishing Co.,

2. Jain and Jain, Engineering Chemistry, (2015) DhanpatRai& Sons.

REFERENCE BOOKS

1. K.Venkataraman, The Chemistry of Synthetic Dyes, (2009) Vol.I, II, III & IV, Academic Press, N.Y.

2. I.L Finar, Organic Chemistry, (2009) Vol II, ELBS.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	H	S	S
CO2	H	H	H	M	S
CO3	S	M	M	H	S
CO4	S	H	H	M	H
CO5	H	M	S	H	M

S – Strong H – High M – Medium L – Low

Subject code: 25PGI4N2

Programme Code: 04		**M.Sc., Chemistry**		
Course Code: 25PGI4N2		**Non Major Elective – Information Security**		
Batch 2025-2027	Semester IV	Hours/Cycle 4	Total Hours 60	Credits 4

Course Objectives

1. Students will identify the core concepts of Information security.
2. To examine the concepts of Information Security.
3. To design and implement the security features for IT and Industrial sectors.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	To Learn the principles and fundamentals of information security.
	CO2	To Demonstrate the knowledge of Information security concepts
	CO3	To Understand about Information Security Architecture.
	CO4	To Analyze the various streams of security in IT and Industrial sector.
	CO5	To know about Cyber Laws and Regulations.

Syllabus

UNIT I (**12 Hours)**

Information Security basics: Definition of Information Security - History of Information Security - Characteristics of Information Security - Components of Information Security - Security System Development Life Cycle (SDLC).

Information Security for technical administrators: Server Security – Network security- Social Media Security.

UNIT II **(12 Hours)**

Cryptography: Basic concepts - plain text - Cipher text - Encryption Principles - CRYPT Analysis - Cryptographic Algorithms - Cryptographic Tools – Authentication -Biometrics* - passwords - Access Control Devices - Physical Security - Security and Personnel. Language-based Security: Analysis of code for security errors, Safe language and sandboxing techniques.

Subject code: 25PGI4N2

UNIT III **(12 Hours)**

Firewalls, Viruses & Worms & Digital Rights Management: Viruses and Worms-Worms - Digital Rights Management – Firewalls - Application and Circuit Proxies - Stateful Inspection - Design Principles of Firewalls.Logical Design: Access Control Devices- Physical Security-Security and Personnel - NIST Models-VISA International Security Model- Design of Security Architecture-Planning for Continuity.

UNIT IV **(12 Hours)**

Hacking: Introduction – Hacker Hierarchy – Password cracking – Phishing - Network Hacking - Wireless Hacking - Windows Hacking - Web Hacking*- Ethical Hacking. Security Investigation: Need for Security- Business Needs-Threats- Attacks- IP Addressing and Routing - Social media.

UNIT V **(12 Hours)**

Cyber Laws: What is Cyber Law? - Need for Cyber laws - Common Cyber Crimes and Applicable Legal Provisions: A Snapshot - Cyber Law (IT Law) in India – The Information Technology Act of India 2000 - Cyber Law and Punishments in India - Cyber Crime Prevention guide to users – Regulatory Authorities.

***Self-study** (Questions for examination may be taken from the self-study portions also)

Teaching methodology

Chalk and Talk, Power point presentation, Seminar, Brainstorming, Assignment, Google Classroom.

Text Book:

Information Security –Textbook prepared by Kongunadu Arts and Science College, Coimbatore -29, 2022.

Reference Books:

1. Charles P Pfleeger and Shai Lawrence Pfleeger, “Security in Computing”, Fourth & Third Edition, Prentice Hall, 2007 & 2011.
2. Ross J. Anderson and Ross Anderson, “Security Engineering: A guide to building Dependable Distributed System”, Wiley, 2009.
3. Thomas R. Peltier, Justin Peltier and John Bleckley, “Information Security Fundamentals”, 2nd Edition, Prentice Hall 1996.

Subject code: 25PGI4N2

4. Gettier, Urs E. “Information Security: Strategies for Understanding and Reducing Risks”, John Wiley & Sons, 2011.
5. “Principles of information security”. Michael Whiteman and Herbert J. Mattord, 2012.
6. Information security -Marie wright and John kakalik, 2007.
7. Information security Fundamentals- Thomas R. Peltier, Justin Peltier and John Blackley-2005.
8. Information Security theory and practical PHI publication, Dhiren R. Patel-2008.
9. Debby Russell and Sr. G.T. Gangemi, “Computer Security Basics”, 2nd edition, O’Reilly Media, 2006.

MAPPING

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	H	S	S
CO2	M	H	H	S	H
CO3	H	S	S	M	S
CO4	H	M	H	S	H
CO5	H	S	H	S	H

S–Strong **H** –High **M**– Medium **L**–Low

Subject code: 25PGI4N2

Question Paper Pattern

Duration: 3 hrs **Max: 75 marks**

Section - A (10x1=10)

Choose the correct answer

Section - B (5x5=25)

Short answer questions, either or type, one question from each unit.

Section - C (5x8=40)

Essay answer questions, either or type, one question from each unit.

CIA EXAMINATION MARK BREAKUP

S. NO	DISTRIBUTION COMPONENT	MARKS
1.	CIA I – 75 Marks Converted to 30	**30**
2.	CIA II – 75 Marks Converted to 30	**30**
3.	Assignment I	**10**
4.	Assignment II	**10**
5.	Attendance	**05**
6.	Any Case Study related to Information Security	**15**
	Total	**100**

Subject code: 25PCH3X1

Programme Code: 04		**All PG Programmes**
Course Code :25PCH3X1		**Extra Departmental Course** **EDC Paper 1 – Food Science**
Batch 2025-2027	Hours/Cycle 2	Credits 2

Course Objectives

1. To understand the functions, chemical composition and nutritive value of some common food stuffs.
2. To enable the students, attain knowledge on various nutrients and food additives.
3. To create awareness on food adulteration and the important food standards.

Course Outcomes (CO)

On successful completion of the course, the students will be able to

K1 to K5	**CO1**	Examine the basic food groups and their chemical composition
	CO2	Identify the sources and functions of nutrients like carbohydrates, proteins, etc.,
	CO3	Illustrate the role of food additives in the food industries
	CO4	Analyse the adulterated food products in the market
	CO5	Assess several laws and standards of foods, and the future foods

Syllabus

UNIT – I: FOOD AND ITS GROUPS (6 hrs)

Food – definition, functions, basic food groups, chemical composition and nutritive value of some common food stuffs – cereals (rice, wheat), pulses (legumes), vegetables and fruits, eggs, milk and meat.

UNIT – II: NUTRIENTS IN FOOD (6 hrs)

Nutrients – definition, sources and functions of some important nutrients –carbohydrates, proteins, fats, vitamins, minerals and water.

UNIT – III: FOOD ADDITIVES (6 hrs)

Some important food additives–antioxidants, chelating agents, colouring agents, flavouring agents, curating agents, emulsifiers, leavening agents, anticaking agents, humectants, non-nutritive sweeteners, thickeners, stabilizers, preservatives.

Subject code: 25PCH3X1

UNIT – IV: FOOD ADULTERATION (6 hrs)

Adulteration – definition, types of adulterants – intentional and incidental adulterants, metallic contaminants, adulterants in common food stuffs – coffee, sugar, milk, turmeric powder, chilli powder, ghee, honey, edible oils.

UNIT – V: FOOD STANDARDS AND FUTURE FOODS (6 hrs)

Food safety – general principles, FSSAI, BIS, AGMARK, ISO, Codex Alimentarius, HACCP, Organic foods, low-cost nutrient supplement, packaging of foods, nutrition labeling, nutraceuticals.

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

TEXT BOOK

1. B. Srilakshmi (2015) Food science, New Age International, VI edition.

REFERENCE BOOKS

1. Lillian H. Meyer (2004) Food chemistry, CBS publishers and distributors.

2. SeemaYadav (2006) Food chemistry, Anmol publishers.

Subject code: 25PCH3X1

Question Paper Pattern

Duration: 3 hrs **Max: 75 marks**

Section - A (10x1=10)

Choose the correct answer

Section - B (5x5=25)

Short answer questions, either or type, one question from each unit.

Section - C (5x8=40)

Essay answer questions, either or type, one question from each unit.

CIA EXAMINATION MARK BREAKUP

S. NO	DISTRIBUTION COMPONENT	MARKS
1.	CIA I – 75 Marks Converted to 40	**40**
2.	CIA II – 75 Marks Converted to 40	**40**
3.	Assignment I	**05**
4.	Assignment II	**05**
5.	Attendance	**05**
6.	Others (Seminar, Group Discussion, Flipped Class room, etc.,)	**05**
	Total	**100**

Subject code: 25PCH0J1

JOB ORIENTED COURSE

<table>
<tr><td colspan="2">Programme Code: 04</td><td colspan="2">M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="4">Title of the paper: Job Oriented Course – Pharmaceutical chemistry</td></tr>
<tr><td>Batch
2025-2027</td><td>Hours/Cycle
2</td><td>Total Hours
30
(Out of class hours)</td><td>Credits
2</td></tr>
</table>

Course Outcomes

1. To give the students a thorough introduction to the study of drugs.
2. To educate the students and to create an awareness about first aid.
3. On successful completion of the syllabus, the students should have been aware of the causes, treatment and prevention of some common diseases, biological role of some elements, the structure, uses and adverse effects of analgesics, antiseptics and disinfectants.

UNIT –I: THE NATURE AND SOURCES OF DRUGS (6 hrs)

Terminologies used in pharmaceutical chemistry-pharmacy, pharmacology, bacteria, virus, fungi, chemotherapy, pharmacopeia and toxicology, biological and chemical classification of drugs, metabolism of drugs-biotransformation-oxidative reaction-hydroxylation, oxidative dealkylation, oxidative deamination and hydrolytic (hydrolysis) reactions, conjugation reactions- glucuronide conjugation, aminoacid conjugation, sulphate conjugation, methylation and N-acetylation, routes of administration and the process of adsorption of drugs.

UNIT –II: FIRST AID FOR ACCIDENTS (6 hrs)

Aims and rules of first aid, first aid treatment for cuts/abrasions/ bruises, bleeding, fracture, burns, fainting and poisonous bites, clinical symptoms of poisoning and basic therapeutic treatment, common poisons and their antidotes-acid, alkali, disinfectants, hallucinogens, alcohol, mercury and salicylate poisoning, articles to be kept in a standard first aid box.

UNIT –III: COMMON DISEASES (6 hrs)

Some common diseases: Causes, treatment and prevention of malaria, filarasis, plague, diphtheria, whooping cough, influenza, measles, mumps, common cold, tuberculosis (T.B), cholera, typhoid, dysentery, jaundice, asthma, epilepsy, piles and leprosy.

Biological role of following elements and their compounds: potassium, calcium, iodine, copper and zinc.

Subject code: 25PCH0J1

UNIT – IV: BLOOD AND DIABETES (6 hrs)

Composition of Blood: Plasma, RBC, WBC, platelets (thrombocytes)-their functions.

Blood pressure: Primary and secondary hypertension-hypotension-measurement of blood pressure.

Anaemia: Causes and control-sign, symptoms & types-antianemic drugs.

Diabetes: Types-diabetes insipdus and diabetes mellitus-juvenile & adult, control of diabetes-insulin structure and sources, oral hypoglycemic drugs - tolbutamide, chlorpropamide, glibenclamide, bigunides (penformin and metformin).

UNIT – V: THERAPEUTIC AGENTS (6 hrs)

Structure, uses and adverse effects of Analgesics agents: morphine, pethidine and methadone. Antipyretic-anti-inflammatory agents: aspirin, methyl salicylate, paraacetamolphenacetin, analgin, indomethacin & ibuprofen. Antiseptic and disinfectants: distinction between disinfectants and antiseptics, standardization of disinfectants and antiseptics, source, structure and uses of the following compounds-cresols, thymol, chloroxylenol, chloramines-T, crystal violet, methylene blue, nitromersol, dequalinium chloride and formalin.

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Reference Books

1. JayashreeGhosh (2008) A Text Book of Pharmaceutical Chemistry 3rdEdn, S.Chand& Co Ltd.
2. L.M.Atherden (1995)Text Book of Pharmaceutical Chemistry, 8thEdn, Oxford University Press.
3. C.R.Chatwal (2007)Pharmaceutical Chemistry Vol. I & II, IIIEdn, Himalaya Publishing House.

Subject code: 25PCH0D1

<table>
<tr><td colspan="2">Programme Code: 04</td><td>M.Sc., Chemistry</td><td rowspan="3">Skill development, Employability</td></tr>
<tr><td colspan="3">Title of the paper: Advanced Learners Course – 1 Chemistry of Corrosion</td></tr>
<tr><td>Batch
2025-2027</td><td colspan="2">Credits
2</td></tr>
</table>

Syllabus

UNIT – I: INTRODUCTION TO CORROSION

Definition of corrosion cost of corrosion, importance of corrosion studies – classification of corrosion– expressions for corrosion rate – corrosion principles – electrochemical principles of corrosion – Faradays Laws, types of electrochemical cells, concentration cells, Thermodynamic principles of corrosion – Standard electrode potentials and thermodynamic corrosion theory – Galvanic series of metals and alloys.

UNIT – II: KINETICS

Kinetics of electrochemical corrosion – importance of kinetics, graphical presentation of kinetic data, exchange current density, polarization of electrodes, concentration polarization, activation polarization and resistance polarization, Mixed potential theory, Applications of electrodes kinetics to experimental observation.

UNIT-III: PASSIVITY

Kinetics of passivity – introduction – electrochemical behavior of active / passive metals, flade reactivation potential, criteria for selecting a metal exhibiting passivity, factors influencing electrochemical behavior and corrosion rate of metals exhibiting passivity, theories of passivity.

UNIT – IV: FORMS OF CORROSION

Different form of corrosion and the factors influencing atmospheric, intergranular, pitting, galvanic, crevice, stress, soil), Protection against corrosion - design improvement, changes of metal, change of environment, change of metal potential, use of coatings.

Subject code: 25PCH0D1

UNIT – V: MONITORING TECHNIQUES

Interpretation and measurement of corrosion – potential measurements, corrosion current measurements using rotating disc electrode, polarization measurements (polarization break, Tafel and linear)-two electrode system, three electrode system, advantages, disadvantages and precautions in usage, Corrosion behavior diagram.

Reference Book

1. Raj Narayan (1983) An introduction to metallic corrosion and its prevention, Oxford and IBH Publishing Co.

Subject code: 25PCH0D2

Programme Code: 04	**M.Sc., Chemistry**	Skill development, Employability
Title of the paper: Advanced Learners Course-2 Industrial Chemistry		
Batch 2025-2027	Credits 2	

Syllabus

UNIT –I: GLASS

Physical and chemical properties of glass, Raw materials used in the manufacture, Steps used for the manufacture-formation of batch materials, melting, shaping, annealing and finishing, Chemical reactions in the furnace, Pot furnace and tank furnace, Regenerative and recuperation types, Varieties of glasses-silica, optical, borosilicate, lead, safety, pyrex, alkali silicate, photochromic and glass wool.

UNIT –II: CEMENT

Types of cement, Types of Portland cement, Raw materials-manufacturing process – wet and dry process-types of kiln and reactions in kiln- composition of clinker-additives added during grinding-setting, curing and hardening of cement-physiochemical transformations, Properties of cement Mortars and concrete-RCC.

UNIT –III: FERTILIZERS

Plant nutrients-primary, secondary and micro nutrients, Need for fertilizers-classification of fertilizers, Source of fertilizers-natural and artificial, Nitrogenous fertilizers-ammonium nitrate, ammonium sulphate and urea, Phosphate fertilizers-phosphate rocks-normal super phosphate-triple super phosphate, Potassium fertilizers-NPK fertilizers.

UNIT –IV: PAINTS AND PIGMENTS

Paints:- Definition-classification-constituents-manufacture-requirements of a good paint, Paint failure, Types of paints-emulsion paints-latex-luminescent-fire retardant-heat resistant, Methods of applying paint, Paint removers, Varnishes - types and classes, Lacquers, solvents, thinners and oils, Pigments:-white pigments- manufacture-white lead (electrolytic method)-zinc oxide (French process) – titanium dioxide (chlorine method), Blue pigment-ultramarine, Red pigment-red lead, Green pigment-chrome green, Yellow pigment-chrome yellow.

Subject code: 25PCH0D2

UNIT –V: RUBBER AND ALLIED PRODUCTS

Natural rubber-types and classification-latex-coagulation-refining of crude rubber-vulcanization (sulphur and non-sulphur)-properties of vulcanized rubber, Synthetic rubber-manufacture and uses of-Buna-S (from petroleum), Neoprene, Butyl rubber, silicone rubber and poly urethane.

Reference Books

1. B.K.Sharma (1991) Industrial Chemistry, GOEL Publishing Company, 4thEdn.
2. B.N. Chakarabarthy (1991) Industrial Chemistry, Oxford and IBH publishing house.
3. H. L. White (2008) Introduction to Industrial Chemistry, John Wiley & sons.
4. Vermani O.P. (2008) Industrial chemistry, Galgotia Publications Pvt. Ltd.

Subject code: 25PCH0D3

<table>
<tr><td colspan="2">Programme Code: 04</td><td>M.Sc., Chemistry</td><td rowspan="3">Skill development,
Employability</td></tr>
<tr><td colspan="3">Title of the paper: Advanced Learners Course – 3
Advanced Functional Materials</td></tr>
<tr><td>Batch
2025-2027</td><td colspan="2">Credits
2</td></tr>
</table>

Syllabus

UNIT – I: MOLECULAR-LEVEL DEVICES AND MACHINES

Molecular machines: Pseudorotaxanes, rotaxanes and catenanes – Systems featuring charge-transfer interactions –systems featuring hydrogen bonding interactions. Devices based on Electronic and Nuclear motion: Plug/socket and related systems – electrochemically controlled systems.

UNIT – II: PAMAM DENDRIMER-BASED MULTIFUNCTIONAL NANOPARTICLES

Poly(Amidoamine) Dendrimers: Structure and biological properties – Synthesis and characterization, PAMAM dendrimers as a vehicle for molecular delivery into cells – PAMAM dendrimers as MRI contrast agents.

UNIT III - ADVANCED FUNCTIONAL OXIDE MATERIALS AND THEIR APPLICATIONS

High temperature superconductors: Cuprate Materials, Electrical and Magnetic properties - Magnetic oxide materials: Ferromagnetic oxide materials, Ferrites materials – Multiferroic Materials: Origin of magnetic ordering in the oxide materials.

UNIT IV - BIODEGRADABLE POLYMERS BIODEGRADABLE POLYMERS

Polyε-caprolactone- modified poly ε-caprolactone copolymer with ester, amide and urethane linkages, polyglycolate, polymandelic acid - biodegradable polyamides – polyester urea – polyamide urethane.

UNIT V - SMART POLYMERS SUPRAMOLECULAR POLYMERS

Main chain supramolecular polymers, side-chain supramolecular polymers, examples of stimuli responsive supramolecular polymers, self-healing polymers.

Subject code: 25PCH0D3

Reference Books

1. Fritz Vögtle, J. Fraser Stoddart and Masakatsu Shibasaki, (2000) Molecular-Level Devices and Machines, In Stimulating Concepts in Chemistry, Ed., pp 255-266, Wiley-VCH Verlag GmbH, Weinheim.

2. Chad A. Mirkin and Christ of M. Niemeyer (2007) Poly(amidoamine) Dendrimer-Based Multifunctional Nanoparticles, In Nanobiotechnology II, Ed: Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim.

3. J. W. Lynn (1990), High Temperature Superconductivity, Springer- Verlag.

4. J. Guillet (1973) Polymers and Ecological problems, Ed., Plenum Press, New York.

5. W. Schnabel (1981), Polymer Degradation – Principles and Practical Applications, Hanser International.

6. Wolfgang H. Binder (2013), Self-Healing Polymers via Supramolecular, Hydrogen-Bonded Networks, in Self-healing Polymers: From principles to applications, Ed: Wiley VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.

KONGUNADU ARTS AND SCIENCE COLLEGE

(Autonomous)
Re-accredited by NAAC with 'A^{+}' Grade (4th Cycle)
Affiliated to Bharathiar University
College of Excellence (UGC)
G.N.Mills Post, Coimbatore - 641029, Tamilnadu, INDIA

PG & RESEARCH DEPARTMENT OF CHEMISTRY

CERTIFICATE PROGRAMME IN CHEMICAL ANALYSIS AND LABORATORY TECHNIQUES

CURRICULUM AND SCHEME OF EXAMINATIONS (CBCS)

(2025 – 2026 ONWARDS)

KONGUNADU ARTS AND SCIENCE COLLEGE (AUTONOMOUS)

COIMBATORE – 641 029

PROGRAMME NAME: Certificate Programme in Chemical Analysis and Laboratory Techniques

Curriculum and Scheme of Examination under CBCS

(Applicable to students admitted during the academic year 2025-2026)

Subject Code	Title of the paper	Instruction hours/cycle	Exam Marks			Duration of Exam (Hrs)	Credits
			CIA	ESE	Total		
25CAL101	Core Paper 1- Basic Laboratory Concepts	2	25	75	100	3	2
25CAL1CL	Core Practical 1 - Essential Chemical Laboratory Techniques	3	40	60	100	3	2
25CAL1CM	Core Practical 2 –Application Oriented Practical	3	40	60	100	3	2
	Total	8	-	-	300	-	6

Note :

CBCS – Choice Based Credit System,

CIA – Continuous Internal Assessment

ESE – End of Semester Examinations

Tally Table

Subject	No. of Subjects	Total Marks	Credits
Core – Theory	1	100	2
Core – Practical	2	200	4
Grand Total		**300**	**6**

Components of Continuous Internal Assessment

Components		Marks	Total
Theory			
CIA I	75	(75+75 = 150/10) 15	25
CIA II	75		
Assignment/Seminar		5	
Attendance		5	
Practical			
CIA Practical		25	40
Observation Notebook		10	
Attendance		5	

BLOOM'S TAXONOMY BASED ASSESSMENT PATTERN

K1-Remembering; **K2**-Understanding; **K3**-Applying; **K4**-Analyzing; **K5**-Evaluating

1. Theory Examination

CIA I & II and ESE: 75 Marks

Knowledge Level	Section	Marks	Description	Total
K1 – K2 Q1 to 10	A (Answer all)	10 x 1 = 10	MCQ	75
K1 – K5 Q11 to 15	B (Either or pattern)	5 x 5 = 25	Short Answers	
K2 – K5 Q16 to 20	C (Either or pattern)	5 x 8 = 40	Descriptive / Detailed	

2. Practical Examination:

Knowledge Level	Section	Marks	Total
K3	Experiments	50	60
K4	Record Work	10	
K5			

Subject code: 25CAL101

Certificate Programme in Chemical Analysis and Laboratory Techniques			
Title of the paper: Core Paper 1 – Basic Laboratory Concepts			
Year	Hours / Cycle	Total Hours	Credits
2025-2026	2	30	2

Course Objectives

1. To motivate the students to comprehend a knowledge on some basic laboratory ideas and concepts.
2. To impart understanding in laboratory hygiene and safety.
3. To enable the students to learn different separation techniques.

Course Outcomes (CO)

K1 to K5	**CO1**	Recall the concepts of laboratory hygiene and safety
	CO2	Review the working of Weighing and Analytical balance
	CO3	Describe the cleaning methods of laboratory glassware
	CO4	Enumerate the fundamentals of titrations and indicators
	CO5	Appraise various separation techniques for separation of compounds

Syllabus

Unit I: Laboratory Hygiene and safety (6 hours)

Storage and Handling of Chemicals, Carcinogenic chemicals, Handling of ethers, Toxic and Poisonous chemicals, Waste disposal, General precautions for avoiding accidents, Poisoning-rules to avoid poisoning, treatment for specific poisons, Laboratory safety measures.

Unit II: Weighing and Analytical balance (6 hours)

Double pan balance – care and use, weighing process, calibration of weights, errors in weighing, requirements of a good balance, Single pan balance – weighing in single pan balance, rules for use, Electronic balance – weighing bottles.

Unit III: Laboratory glassware (6 hours)

Cleaning methods and cleansing agents –cleaning and maintenance of burette, calibration of pipette, calibration of burette, calibration of volumetric flask.

Subject code: 25CAL101

Unit IV: Titrations **(6 hours)**

Standardization, experimental requirements for volumetric analysis, concentration units, Types of titrations – Acid-base titrations, redox titrations, precipitation titrations, Types of indicators – indicators for acid-base titrations, self-indicators, external indicators.

Unit V: Separation techniques **(6 hours)**

Precipitation, Solvent extraction, Chromatography – types, principles and applications – Column chromatography, Paper Chromatography, Thin Layer Chromatography.

Teaching methodology

Smart ClassRoom/Powerpoint presentation/Seminar/Quiz/Discussion/Flipped Class

Text book:

1. R. Gopalan, P.S. Subramanian, K. Rengarajan, Elements of Analytical Chemistry, Sultan Chand & Sons, Third Edition, 2003.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	H	S	H	S
CO2	S	S	S	M	H
CO3	S	H	M	S	S
CO4	S	S	S	S	S
CO5	S	H	M	H	M

Subject code: 25CAL1CL

Certificate Programme in Chemical Analysis and Laboratory Techniques			
Title of the paper: Core Practical 1 – Essential Chemical Laboratory Techniques			
Year	Hours / Cycle	Total Hours	Credits
2025-2026	3	45	2

Course Objectives

1. To make the students aware about preparation of standard solutions.
2. To allow the students to know and practice the techniques of performing titrations.

Course Outcomes (CO)

K1 to K5	**CO1**	Describe systematic procedures for preparation of standard solutions, indicators and some reagents
	CO2	Understand the concept of acid-base titrations and perform them effectively
	CO3	Determine the boiling points and melting points of some important organic compounds
	CO4	Prepare buffer solutions and determining their pH values
	CO5	Prepare and evaluate the crude and recrystallised form of Aspirin and Methyl Orange

Syllabus

I. Preparation of standard solutions, indicators and reagents

II. Acidimetry – Alkalimetry

1. Estimation of Na_2CO_3
2. Estimation of HCl

III. Determination of boiling point

IV. Determination of melting point

V. Preparation of buffer solutions and determination of their pH values

VI. Preparation of drug – Aspirin

VII. Preparation of dye – Methyl Orange

Subject code: 25CAL1CL

Teaching Methods

Demonstration and hands-on practicals

Reference books:

1. N.S. Gnanaprakasam and G. Ramamurthy, Organic Chemistry Laboratory Manual, Anand Book Depot, Chennai, **2006**.

2. V. Venkateswaran, R. Veeraswamy and A.R. Kulandaivelu, Principles of Practical Chemistry, Sultan Chand & Sons, 2nd Edition, **2012**.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	H	S	S	M
CO2	S	M	H	S	H
CO3	M	S	H	H	S
CO4	S	H	H	M	H
CO5	S	M	S	M	H

S-Strong H-High M-Medium L-Low

Subject code: 25CAL1CM

Certificate Programme in Chemical Analysis and Laboratory Techniques			
Title of the paper: Core Practical 2 – Application Oriented Practical			
Year	Hours / Cycle	Total Hours	Credits
2025-2026	3	45	2

Course Objectives

1. To make the students determine pH and conductance of solutions.
2. To inculcate the knowledge of isolation techniques.
3. To train the students prepare liquid soap and phenyl, thereby improving their entrepreneur skills.

Course Outcomes (CO)

K1 to K5	**CO1**	Estimate hardness of various water samples
	CO2	Determine the BOD and COD of water samples
	CO3	Isolate citric acid from lemon
	CO4	Extract lactose from milk
	CO5	Prepare liquid soap and phenyl using appropriate starting materials

Syllabus

I. Estimation of hardness of water

II. Determination of Biological Oxygen Demand (BOD)

III. Determination of Dissolved Oxygen (DO)

IV. Isolation of citric acid from lemon

V. Isolation of lactose from milk

VI. Preparation of liquid soap

VII. Preparation of phenyl

Teaching Methods

Demonstration and hands-on practicals

Subject code: 25CAL1CM

Reference books:

1. N.S. Gnanaprakasam and G. Ramamurthy, Organic Chemistry Laboratory Manual, Anand Book Depot, Chennai, **2006**.

2. V.Venkateswaran, R.Veeraswamy and A.R. Kulandaivelu, Principles of Practical Chemistry, Sultan Chand & Sons, 2nd Edition, **2012**.

Mapping

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	H	S	M
CO2	H	H	M	S	H
CO3	H	S	H	H	M
CO4	S	H	H	S	M
CO5	S	M	M	H	H

S – Strong **H –** High **M –** Medium **L –** Low