PSGR Krishnammal College for Women

MASTER OF SCIENCE IN CHEMISTRY

PROGRAMME CODE: MCE

CHOICE BASED CREDIT SYSTEM (CBCS) &

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK (LOCF)

SCHEME OF EXAMINATION & SYLLABUS

(w.e.f 2026 - 27 onwards)

REGULATIONS 2026

POSTGRADUATE PROGRAMMES

(a) Qualification Descriptor

Aligned with NHEQF Level 9 (Master's Degree Level).

A Master's Degree signifies that a learner has acquired:

- Advanced theoretical and practical knowledge in a specialized discipline
- Ability to conduct independent research and contribute to knowledge
- Competence to solve complex professional or societal problems
- Skills to communicate research findings effectively
- Capacity for autonomous decision making and leadership
- Preparation for doctoral research, policy roles, entrepreneurship or advanced careers

PG Graduate Attributes

GA Code	Graduate Attribute (PG Level Meaning)
GA1	Advanced Disciplinary Expertise
GA2	Scholarly & Professional Communication
GA3	Critical & Evaluative Thinking
GA4	Complex Problem Solving
GA5	Advanced Analytical & Quantitative Reasoning
GA6	Independent Research & Innovation
GA7	Professional Collaboration
GA8	Evidence-Based Scientific Reasoning
GA9	Reflective & Meta-Cognitive Ability
GA10	Advanced Digital & Data Competence
GA11	Self-determined Learning
GA12	Global & Multicultural Perspective
GA13	Research Ethics & Professional Integrity
GA14	Academic & Professional Leadership
GA15	Lifelong Learning & Scholarly Growth

GAs – Written Measured

These attributes can be directly assessed through advanced written examinations, analytical assignments, and research documentation.

GA	Attribute	Measure	Assessment Method
GA1	Advanced Disciplinary Expertise	Strongly	Advanced theory examinations, domain-specific problem solving
GA3	Critical & Evaluative Thinking	Strongly	Critical essays, analytical case evaluations
GA4	Complex Problem Solving	Strongly	Multi-layered case studies, applied domain challenges

GA5	Advanced Analytical & Quantitative Reasoning	Strongly	Statistical analysis, modelling, advanced data interpretation
GA6	Independent Research & Innovation	Strongly	Dissertation, research publications, project reports
GA8	Evidence-Based Scientific Reasoning	Strongly	Research justification, hypothesis testing, empirical argumentation
GA9	Reflective & Meta-Cognitive Ability	Partially	Research reflection reports, learning journals
GA10	Advanced Digital & Data Competence	Partially	Data analytics assignments, software-based problem tasks

PG GAs – Performance Based

These require demonstration through professional engagement, leadership roles, applied practice, and real-world interaction.

GA	Attribute	Measure	How Measured
GA2	Scholarly & Professional Communication	Strongly	Research presentations, conference papers, viva voce
GA7	Professional Collaboration	Strongly	Team research projects, interdisciplinary assignments
GA11	Self-determined Learning	Limited	Independent coursework, self-designed research components
GA12	Global & Multicultural Perspective	Partially	International seminars, cross-cultural academic discussions
GA13	Research Ethics & Professional Integrity	Strongly	Ethics-based case analysis, plagiarism checks, research compliance documentation
GA14	Academic & Professional Leadership	Limited	Project leadership, event coordination, mentoring roles
GA15	Lifelong Learning & Scholarly Growth	Limited	Online courses completion, publication engagement, academic memberships

Department of Chemistry

Vision

- To excel in education and research, fostering innovation, interdisciplinary collaboration and global standards of learning, aspiring to empower students with knowledge, confidence and values that enable them to contribute towards scientific progress, development of equitable and sustainable society.

Mission

- Provide equitable access to quality education that nurtures curiosity, creativity, and lifelong learning.
- Deliver undergraduate, postgraduate, and doctoral programs of global relevance, blending fundamental and applied sciences.
- Integrate modern technological tools and contemporary teaching–learning practices to enhance academic growth.
- Encourage students to excel in competitive examinations and research pursuits, transforming them into scientists, educators, entrepreneurs, and innovators.
- Strengthen research through vibrant collaborations, cutting-edge facilities, and impactful publications.
- Promote ethical values, cultural sensitivity, and social responsibility alongside scientific temper.
- Serve society by advancing knowledge, preserving heritage, and addressing regional, national, and global challenges.

Master of Science in Chemistry

Programme Objectives, Outcomes and Mapping

Programme Educational Objectives (PEOs)

(Expected career and professional achievements of graduates within three to five years of completing the programme)

PEO1: Establish successful profession in chemical sciences and related interdisciplinary fields by applying gained knowledge, analytical ability, and contemporary scientific methods.

PEO2: Demonstrate leadership readiness, critical thinking, analytical reasoning, and team work towards personal and socio - economic development.

PEO3: Promote significant societal contributions through equity, inclusivity, diversity, environmental stewardship towards sustainable development.

PEO4: Uphold the ethical practices and professional responsibilities towards technological development in academia and industry.

PEO5: Engage in lifelong learning and exhibit skills relevant to subject oriented employability.

Programme Learning Outcomes (PLOs)

(Specific abilities, knowledge, and skills that graduates are expected to demonstrate upon Graduation)

PLO1: Apply advanced concepts, theories and principles in domains of chemistry to solve scientific problems.

PLO2: Execute sophisticated laboratory and instrumental techniques with precision for chemical analyses.

PLO3: Interpret experimental data using literature to validate chemical hypotheses.

PLO4: Design and progress independent research / innovative chemical syntheses to bridge contemporary scientific gaps.

PLO5: Utilize advanced digital tools, computational softwares and chemometrics for modeling and interpretation of data.

PLO6: Present research findings effectively as written, oral and digital formats in academic and professional forums.

PLO7: Demonstrate leadership, responsibility and effective professional interaction in a multidisciplinary fashion.

PLO8: Reflect on learning experiences and develop self-directed strategies towards holistic excellence.

PLO9: Implement ethical research practices, laboratory safety protocols and green chemistry pathways in chemical research and industrial applications.

PLO10: Engage in continuous professional development and scholarly activities, evolving scientific knowledge and technological advancements.

PLOs with Bloom's Levels, Assessment Methods, and Graduate Attribute Mapping

PLO No	Programme Learning Outcome	Bloom's Level	Assessment Methods	Mapped Gas
PLO1	Apply advanced concepts, theories and principles in domains of chemistry to solve scientific problems.	K3	CIA, ESE, Practical, Viva	GA1, GA4,
PLO2	Execute sophisticated laboratory and instrumental techniques with precision for chemical analyses.	K3	Practical, Internship	GA1, GA5
PLO3	Interpret experimental data using literature to validate chemical hypotheses.	K5	Seminar, Case Study	GA3, GA8
PLO4	Design and progress independent research / innovative chemical syntheses to bridge contemporary scientific gaps.	K6	Project, Dissertation	GA6, GA11
PLO5	Utilize advanced digital tools, computational softwares and chemometrics for modeling and interpretation of data.	K3	Practical, CIA	GA5, GA10
PLO6	Present research findings effectively as written, oral and digital formats in academic and professional forums.	K3	Seminar, Viva, Project Report, CIA	GA2, GA10
PLO7	Demonstrate leadership, responsibility and effective professional interaction in a multidisciplinary fashion.	K3	Project, Internship, Seminar, Viva	GA7, GA14
PLO8	Reflect on learning experiences and develop self-directed strategies towards holistic excellence.	K5	Seminar, Viva	GA9, GA11
PLO9	Implement ethical research practices, laboratory safety protocols and green chemistry pathways in chemical research and industrial applications.	K3	Practical, Case Study, Viva, Field Work	GA12, GA13
PLO10	Engage in continuous professional development and scholarly activities, evolving scientific knowledge and technological advancements.	K4	Internship	GA14, GA15

Programme Specific Outcomes (PSOs)

(Expected knowledge, skills, and competencies that graduates will acquire by the end of the programme)

PSO1: Integrate concepts of inorganic and solid-state chemistry, explain coordination behavior, bonding, reactivity, and structural characteristics of advanced inorganic clusters and organometallic systems.

PSO2: Elucidate reaction pathways and structural transformations of organic molecules using mechanistic principles, stereochemical analysis, and synthetic strategies.

PSO3: Apply thermodynamic, quantum mechanical, and kinetic principles to analyze molecular behavior, reaction feasibility, and energy transformations in chemical systems.

PSO4: Attain indepth knowledge in analytical/spectroscopic methods and acquire skill to identify, characterize and quantify compounds with scientific accuracy.

PSO5: Implement sustainable and interdisciplinary chemical approaches in research and industrial applications using polymer, green and nanochemistry

PSO6: Formulate research problems with appropriate experimental methods, interpretation of results and scientific report writings

PSO Alignment with Core Courses and Skill Competencies

PSO No	Programme Specific Outcome	Supporting Core Courses	Skill Competency
PSO1	Integrate concepts of inorganic and solid-state chemistry, explain coordination behavior, bonding, reactivity and structural characteristics of advanced inorganic clusters and organometallic systems.	Inorganic Chemistry I (Inorganic and Solid State Chemistry); Coordination and Organometallic Chemistry; Nano Chemistry and Bioinorganic Chemistry	Acquire fundamentals of inorganic chemistry, coordination chemistry, advanced nano/bioinorganic applications.
PSO2	Elucidate reaction pathways and structural transformations of organic molecules using mechanistic principles, stereochemical analysis and synthetic strategies.	Organic Chemistry I (Reaction Mechanism & Stereochemistry); Organic Chemistry II (Reagents, Rearrangements, Pericyclic Reactions); Organic Chemistry III (Chemistry of Natural Products); Spectroscopy	Earn ideas about basic reaction mechanisms advanced synthetic transformations, natural product chemistry and structural identification.
PSO3	Apply thermodynamic, quantum mechanical, and kinetic principles to analyze molecular behavior, reaction feasibility and energy transformations in chemical systems.	Physical Chemistry I (Thermodynamics); Physical Chemistry II (Group Theory and Quantum Chemistry); Physical Chemistry III (Reaction Kinetics and Electrochemistry); Advanced Physical Chemistry	Achieve rudiments on thermodynamics , quantum chemistry, kinetics/electrochemistry, advanced theoretical analysis.
PSO4	Attain indepth knowledge in analytical/spectroscopic methods and acquire skill to identify, characterize and quantify compounds with scientific accuracy.	Analytical Techniques in Chemistry; Spectroscopy; Organic Chemistry Practical I & II; Inorganic Chemistry Practical I & II; Physical Chemistry Practical I & II	Integrate instrumental methods with laboratory applications, emphasizing data accuracy and interpretation.
PSO5	Implement sustainable and interdisciplinary chemical approaches in research and industrial applications using polymer, green and nanochemistry	Green Chemistry; Chemistry and Technology of Polymers / Applied Chemistry; Nano Chemistry and Bioinorganic	Achieve industry relevance and sustainability focus, aiming towards green chemistry principles and applied technologies.

		Chemistry; Industrial Chemistry	
PSO6	Formulate research problems with appropriate experimental methods, interpretation of results and scientific report writings	Research Methodology; Cheminformatics / Project and Viva Voce; Comprehensive Examination	Develop research competency, integrating methodology, digital tools, and project-based investigation.

Scheme of Examination

Sem	Course Code	Course Title	Course Type	Hrs / Week	Credit	Examination			
						Duration in Hours	Maximum Marks		
							CA	ESE	TOTAL
I	MCE2601	Core I: Inorganic Chemistry I (Inorganic and Solid State Chemistry)	DSC	4	4	3	25	75	100
	MCE2602	Core II: Organic Chemistry I (Organic Reaction Mechanism and Stereochemistry)	DSC	5	5	3	25	75	100
	MCE2603	Core III: Physical Chemistry I (Classical and Statistical Thermodynamics)	DSC	5	5	3	25	75	100
	MCE2604	Core IV: Analytical Techniques in Chemistry	DSC	4	4	3	25	75	100
	MCE26P1	Core Practical I: Organic Chemistry Practical I	DSC	4					
	MCE26P2	Core Practical II: Inorganic Chemistry Practical I	DSC	4					
	MCE26P3	Core Practical III: Physical Chemistry Practical I	DSC	4					
I - III	26MONL1	Online Course	ACC						
Semester I Total				**30**	**18**				**400**
II	MCE2605	Core V: Organic Chemistry-II (Reagents, Rearrangements, Pericyclic Reactions and Photochemistry)	DSC	4	4	3	25	75	100
	MCE2606	Core VI: Physical Chemistry-II (Group Theory and Quantum Chemistry)	DSC	4	4	3	25	75	100

	MCE2607	Core VII: Spectroscopy	DSC	3	3	3	25	75	100
	MCE2608CE	Core VIII: Advanced Physical Chemistry	SEC	3	3		100*		100
	MCE26P1	Core Practical I: Organic Chemistry Practical I	DSC	4	4	6	25	75	100
	MCE26P2	Core Practical II: Inorganic Chemistry Practical I	DSC	4	4	6	25	75	100
	MCE26P3	Core Practical III: Physical Chemistry Practical I	DSC	4	4	6	25	75	100
	MCB26A1	Clinical Microbiology and Biochemistry	MDC	4	4	3		100@	100
I - III	26MONL1	Online Course	ACC						
Semester II Total				**30**	**30**				**800**
III	MCE2609	Core IX: Coordination and Organometallic Chemistry	DSC	4	4	3	25	75	100
	MCE2610	Core X: Organic Chemistry III (Chemistry of Natural Products)	DSC	5	5	3	25	75	100
	MCE26E01	Elective I : Physical Chemistry III (Reaction Kinetics and Electrochemistry) (OR)	DSE	4	4	3	25	75	100
	MCE26E02	Elective I : Medicinal Chemistry							
	MCE26P4	Core Practical IV: Organic Chemistry Practical II	DSC	4	4	6	25	75	100
	MCE26P5	Core Practical V: Inorganic Chemistry Practical II	DSC	4	4	6	25	75	100
	MCE26P6	Core Practical VI: Physical Chemistry Practical II	DSC	5	4	6	25	75	100
	MCE26S1	Research Methodology	DSE	2	2	3		100@	100

	MNM26CS2	Cyber Security II	VAC	2	Gr.		100*		100£
	MCE26COM	Comprehensive Examination	DSC		Gr.		100*		100£
I - III	26MONL1	Online Course	ACC		Cr. / St.				
Semester III Total				**30**	**27**				**700**
IV	MCE2611	Core XI: Green Chemistry	DSC	3	3	3	25	75	100
	MCE2612	Core XII : Nano Chemistry and Bioinorganic Chemistry	DSC	3	3	3	25#	75	100
	MCE26E03	Elective II: Chemistry and Technology of Polymers (OR)	DSE	4	4	3	25	75	100
	MCE26E04	Elective II: Applied Chemistry							
	MCE26AC1	Advance Learner Course I : Cheminformatics (or)	ACC	SS	5^	3	25	75	100
	MCE26AC2	Advance Learner Course I : Industrial Chemistry							
	MCE26PROJ	Project and Viva voce	DSE	20	5		25	75	100
Semester IV Total				**30**	**15**				**400**
		Total			**90+ Additional Credits**				**2300 + Marks for Additional Credit Courses**

Hours of Instructions is inclusive of lectures, seminars, presentations, case-studies, etc

List of Interdisciplinary Course offered to other Programmes

Semester	Course Type	Course Code	Course Title	Programmes
II	MDC	MCB26A1	Clinical Microbiology and Biochemistry	M.Sc Botany

Symbols and Notations

Symbols	Notations
*	Course assessed through Internal Assessment (CIA) only
Gr.	Grade awarded based on CBCS grading system
St.	Course Status (Completed/Not Completed)
^	Advanced Learner Course, Online Courses – Additional Credit Courses
@	Course assessed through End Semester Examination (ESE) only
#	Open Book Examination
$	Evaluation Pattern converted from 25:75:100 to 20:55:75 (CIA:ESE:Total) structure
$$	Evaluation Pattern converted from 25:75:100 to 15:35:50 (CIA:ESE:Total) structure
€	Hours per Week Outside Class Hours
£	Marks not considered for total; grade will be awarded.

Abbreviation	Course Type
DSC	Discipline Specific Core Courses
DSE	Discipline Specific Elective Courses
MDC	Multidisciplinary Courses
AEC	Ability Enhancement Course
SEC	Skill Enhancement Course
VAC	Value Added Courses
ACC	Additional Credits Courses

Assessment and Evaluation Framework

Continuous Internal Assessment (CIA) – 25%

Component	Activities Included
Internal Tests	Periodic written tests
Assignments / Case Studies	• Written assignments • Case analysis reports • Article reviews • Literature review tasks • Data interpretation exercises • Policy analysis (Arts & Humanities) • Business case studies (Commerce & Management) • Lab-based analytical reports (Science)
Seminars / Presentations	• PowerPoint presentations • Poster presentations • Panel discussions • Group seminars • Viva voce • Digital presentations using multimedia tools • Peer evaluation rubrics
ICT-based Tasks	• Spreadsheet analysis • Accounting software / statistical software • Online quizzes • Simulation tools • E-content creation • Coding platforms (for relevant disciplines)
Projects / Field Reports	• Field surveys • Industry visits • Internship reports • Mini-projects • Laboratory experiments • Community-based research • Data collection & statistical analysis • Reflective journals

End Semester Examination (ESE) – 75%

Component	Description
Written Examination	3-hour written examination covering all CLOs
Cognitive Levels	Questions aligned with multiple Bloom's Taxonomy (K-levels)
Professional Conduct	Ethical and professional conduct during examination
Academic Compliance	Timely submission and participation as per regulations

Assessment Components Aligned with Blooms Levels

EXAMINATION SYSTEM

Semester system will be followed. A semester consists of a minimum of 90 working days excluding the days of conduct of ESE. There will be Continuous Internal Assessment (CA) to evaluate the performance of students in each course and the End Semester Examination will be held at the end of every semester. Marks for ESE and CA with reference to the maximum marks for the courses will be as follows:

Max. Marks	CA	ESE
100	25	75
75	20	55
50	15	35

A. Bloom's levels are followed in question papers and aligned with CLOs and CA components.

Remember - K1

Understand - K2

Apply - K3

Analyze - K4

Evaluate - K5

Create - K6

B. Continuous Internal Assessment CA

The weightage assigned to various components of the CA is as follows

<u>Postgraduate Programme</u>

a. Core and Elective (Including Course with Open Book Examination)

CA Components	Marks	K Level
CIA Test	5 Marks (conducted for 45 marks after 50 days – 3 units)	K2 to K6 as per QP Pattern
Model Exam	7 Marks (Conducted for 75 marks after 85 days) (Each Unit 15 Marks)	
Seminar	4 Marks	K6
Assignment	4 Marks	K5
ICT (Quiz)	2 Marks	K2
Attendance	3 Marks (Attendance 75% - 80% - 1 Mark, 81% - 90 % - 2 Marks, 91% - 100% - 3 Marks)	
Total	**25 Marks**	

b. Coursera in combination with Core Course:

CA Components	Marks	K Level
Coursera	25 Marks (100 marks from Coursera converted to 25 marks)	K4
CIA Test	25 Marks (conducted for 45 marks from Coursera converted to 25 marks)	K2 to K6 as per QP Pattern
Model Exam	30 Marks (conducted for 75 marks from Coursera converted to 30 marks)	
Assignment	10 Marks	K5
Seminar	10 Marks	K6
Total	**100 Marks**	

c. Practical

CA Components	Marks	K Level
Lab Performance	7 Marks	K4
Internal Viva-Voce	5 Marks	K4
Model Exam	10 Marks	K5
Attendance	3 Marks	
Total	**25 Marks**	

For practical courses with 50 marks as ESE, the split-up is 15 marks as internal and 35 as external. Internal conducted for 25 and converted to 15 marks and external conducted for 75 and converted to 35 marks.

d. Cyber Security II

CA Components	Marks	K Level
ICT (Quiz)	50 Marks	K2
Assignment	25 Marks	K5
Project / Case Study / Poster	25 Marks	K6
Total	**100 Marks**	

e. Advance Learner Course

CA Components	Marks	K Level
Test 1	10 Marks (conducted for 45 marks after 50 days – 3 units)	K2 to K6 as per QP Pattern
Model Exam	15 Marks (Conducted for 75 marks after 85 days (Each Unit 15 Marks)	
Total	**25 Marks**	

f. Comprehensive Examination

Course Title	Marks	K level
Comprehensive Examination	100	K3

g. Project and Viva voce

Components	Marks	K level
Continuous Internal Assessment (CA)	25 Marks	K3, K4, K6
End Semester Examination	75 Marks	K5, K6
Total	**100 Marks**	

Continuous Internal Assessment (CA)

CA Components	Marks	K Level
I Review - Project Proposal Presentation	5 Marks	K3
II Review - Periodic Review-Progress Evaluation	10 Marks	K4
III Review - Project Report Draft Submission	10 Marks	K6
Total	**25 Marks**	

End Semester Examination

Components	Marks	K level
Evaluation of the Project Report	25 Marks	K6
Viva Voce	50 Marks	K5
Total	**75 Marks**	

h. *Summer Internship* / Field Work / Institutional Training

CA Components	Marks	K Level
Work diary	15 Marks	K3
Report	50 Marks	K6
Viva Voce	25 Marks	K5
Attendance	10 Marks	
Total	**100 Marks**	

C. Schedule for CA Tests

One test for Continuous Assessment (3 Units) will be conducted on pre-determined date i.e., commencing on the 50th day from the date of reopening. The model exam (5 units) will be conducted after completing 85th working day.

D. Question Paper Pattern and Distribution of Marks for CA

Core, Elective & ALC - (First 3 Units)

Description	Marks	Number of questions in K level					
Questions from each unit comprising of		**K1**	**K2**	**K3**	**K4**	**K5**	**K6**
One question with a weightage of 2 Marks	3 X 2 = 6		3				
One question with a weightage of 5 Marks (Internal Choice at the same CLO level)	3 X 5 = 15			1	1	1	
One question with a weightage of 8 Marks (Internal Choice at the same CLO level)	3 X 8 = 24			1	1		1
Total	**45 Marks**						

E. Model /End Semester Examination – Question Paper Pattern and Distribution of Marks

Core, Elective & ALC

Description	Marks	Number of questions in K level					
Questions from each unit comprising of		**K1**	**K2**	**K3**	**K4**	**K5**	**K6**
One question with a weightage of 2 Marks	5 x 2 = 10		5				
One question with a weightage of 5 Marks (Internal Choice at the same CLO level)	5 x 5 =25			2	2	1	
One question with a weightage of 8 Marks (Internal Choice at the same CLO level)	5 x 8 =40			2	1	1	1
Total	**75 Marks**						

PG - IDC and Special Course (Research Methodology):

Description	Marks	Number of questions in K level					
Questions from each unit comprising of		**K1**	**K2**	**K3**	**K4**	**K5**	**K6**
One question with a weightage of 5 Marks (Internal Choice at the same CLO level)	5 x 5 =25		2	1	1	1	
One question with a weightage of 15 Marks (Internal Choice at the same CLO level)	5 x 15 =75			2	1	1	1
Total	**100 Marks**						

ESE Practical Pattern

The End Semester Examination will be conducted for a maximum of 75 marks with a maximum 15 marks for the record and other submissions if any.

Practical Components	Marks	K level
Practical Execution	60 Marks	K5
Record	15 Marks	K2
Total	**75 Marks**	

Submission of Record note books for Practical Examinations

Submission of bonafide record note books is mandatory to appear for the practical examination. If a candidate is unable to submit the record note book on valid grounds, she may be permitted to appear for the practical examinations, provided the head of the department certifies that the candidate has performed the experiments prescribed for the course and she will be awarded zero (0) marks for record note book.

Rubrics for Assessments

Rubrics for Assessment

Standard 4-Level Performance Scale

Level	Descriptor	Score Range (Illustrative)
Level 4	Excellent	80–100% of component marks
Level 3	Good	60–79%
Level 2	Satisfactory	40–59%
Level 1	Needs Improvement	Below 40%

1. Theory

End Semester Examination (ESE)

Section	K-Level	Criteria	Level 4 (Excellent)	Level 3 (Good)	Level 2 (Satisfactory)	Level 1 (Needs Improvement)
SEC A (Theory / Knowledge)	K1–K2	Knowledge recall & understanding	Thorough understanding across all required cognitive levels	Good understanding, minor gaps	Basic understanding, limited depth	Inadequate or incorrect understanding
SEC B (Application & Analysis)	K3–K5	Problem-solving, application of concepts, analytical reasoning	Accurately applies concepts, strong logical reasoning, handles problems independently	Mostly correct application, minor errors, reasonable reasoning	Partial application, procedural errors, limited reasoning	Unable to apply concepts, incorrect, poor reasoning
SEC C (Comprehensive / Higher-Order Tasks)	K3–K6	Analytical reasoning, creation, problem-solving, innovation	Clear logical reasoning, structured solutions, innovative or optimized solutions	Reasonable logic with minor gaps, mostly correct solutions	Limited reasoning, basic attempt at solution	Poor or no reasoning, incorrect or missing solutions

Continuous Internal Assessment (CIA)

Section	K-Level	Criteria	Level 4 (Excellent)	Level 3 (Good)	Level 2 (Satisfactory)	Level 1 (Needs Improvement)
SEC A (Theory / Knowledge)	K1–K2	Knowledge recall & understanding	Thorough understanding across all required cognitive levels	Good understanding, minor gaps	Basic understanding, limited depth	Inadequate or incorrect understanding
SEC B (Application & Analysis)	K3–K5	Problem-solving, application of concepts, analytical reasoning	Accurately applies concepts, strong logical reasoning, handles problems independently	Mostly correct application, minor errors, reasonable reasoning	Partial application, procedural errors, limited reasoning	Unable to apply concepts, incorrect, poor reasoning
SEC C (Comprehensive / Higher-Order Tasks)	K3, K4, K6	Analytical reasoning, creation, problem-solving, innovation	Clear logical reasoning, structured solutions, innovative or optimized solutions	Reasonable logic with minor gaps, mostly correct solutions	Limited reasoning, basic attempt at solution	Poor or no reasoning, incorrect or missing solutions

2. Internal Components – Other Activities

Component	K-Level	Criteria	Level 4	Level 3	Level 2	Level 1
Assignment	K5	Application & Problem Solving	Strong solutions, accurate	Mostly correct	Partial	Incorrect / missing
Seminar / Presentation	K6	Creation, Communication & Analysis	Insightful, professional, confident	Good, minor gaps	Basic	Poor / incomplete
ICT Quiz	K2	Knowledge & Application	Accurate & confident	Mostly correct	Basic	Incorrect
Attendance	—	Participation & Punctuality	Full attendance, punctual	Mostly present	Occasional	Poor / frequently absent

3. Practical

Continuous Internal Assessment (CIA)

Component	Bloom's Level	Level 4 (Excellent)	Level 3 (Good)	Level 2 (Satisfactory)	Level 1 (Needs Improvement)
Model Practical (Converted to 10)	K5	Independent execution, accurate results, strong analysis, handles unexpected issues confidently	Minor errors, mostly accurate, guided problem-solving	Performs with guidance, partial understanding, limited analysis	Unable to perform, inaccurate results, no reasoning
Internal Viva	K4	Strong conceptual knowledge, clear reasoning, confident troubleshooting	Good understanding, minor gaps, can handle problems with guidance	Basic understanding, limited problem-solving	Weak knowledge, unable to respond or reason
Lab Performance	K4	Active participation, consistent improvement, skillfully applies concepts	Mostly regular participation, moderate improvement	Irregular, minimal improvement	Rarely participates, no skill growth
Attendance	—	Full attendance, punctual	Mostly present	Occasionally absent	Frequently absent

End Semester Practical Examination (ESE)

Component	Bloom's Level	Level 4 (Excellent)	Level 3 (Good)	Level 2 (Satisfactory)	Level 1 (Needs Improvement)
Practical Execution	K5	Accurate execution, proper procedure, precise results, handles unexpected issues confidently	Minor errors, mostly correct, can handle problems with help	Multiple errors, partial results, limited troubleshooting	Incorrect procedure, unable to execute, fails completely
Record Verification	K2	Complete experiments, accurate results, correct interpretation, neat & structured	Minor omissions, minor errors, mostly clear	Incomplete, errors present, basic clarity	Very incomplete, incorrect, untidy
External Viva	K4	Strong theoretical knowledge, clear understanding & application, confident reasoning	Good understanding, minor gaps, partial application	Basic knowledge, limited linkage to experiment	Weak knowledge, unable to explain or apply concepts

4. Projects

Continuous Internal Assessment (CIA)

Component	Bloom's Level	Level 4 (Excellent)	Level 3 (Good)	Level 2 (Satisfactory)	Level 1 (Needs Improvement)
Project Proposal Presentation	K3	Clear, focused problem definition; well-defined objectives; feasible plan; confident presentation	Minor gaps in clarity or planning; mostly clear	Broad or partially defined problem; basic objectives; basic presentation	Vague/unclear problem; objectives missing; poor presentation
Periodic Review / Progress Evaluation	K4	Consistent, timely progress; correct application; identifies & resolves issues independently; systematic documentation; proactive	Minor delays, minor guidance needed, mostly updated documentation; moderately proactive	Irregular progress, partial application, needs support, basic documentation	Very limited progress, incorrect application, passive, poor documentation
Project Report Draft Submission	K6	Well-structured report; accurate understanding; adequate data; logical analysis; proper referencing & presentation	Minor structural or conceptual gaps; minor data issues; reasonable analysis; minor formatting issues	Basic structure; partial understanding; limited data; basic analysis; basic formatting	Poorly organized; incorrect understanding; insufficient data; no analysis; poor presentation

End Semester Examination (ESE)

Component	Bloom's Level	Level 4 (Excellent)	Level 3 (Good)	Level 2 (Satisfactory)	Level 1 (Needs Improvement)
Final Project Report Evaluation (External)	K6	Topic relevant & meaningful; accurate application of concepts; adequate & relevant data; logical analysis; effective problem-solving; professional formatting	Mostly relevant; minor conceptual errors; minor gaps in data; mostly logical; reasonable solutions; minor formatting issues	Moderately relevant; basic application; limited data; basic analysis; basic problem-solving; basic formatting	Poor relevance; incorrect application; insufficient data; weak analysis; no solution; poor formatting
External Viva Voce	K5	Thorough understanding; strong linkage to project; logical reasoning; confident & accurate responses; professional communication	Minor gaps in understanding or reasoning; mostly correct answers; acceptable communication	Basic understanding; limited linkage; basic reasoning; limited answers; basic communication	Weak understanding; no linkage; no reasoning; unable to respond; poor communication

SYLLABUS
FIRST SEMESTER

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCE2601	Core I: Inorganic Chemistry I (Inorganic Chemistry and Solid State Chemistry)	60	55	5	4

Preamble

- Introduces advanced concepts in inorganic polymers and solid-state chemistry, which are fundamental to modern inorganic materials research.
- Focuses on the synthesis, structure and properties of borazines, phosphazenes, sulphur nitrides and silicones.
- Underscores the erudition of isopoly and heteropoly acids and anions, highlighting their structural diversity and chemical behaviour.
- Provides a comprehensive understanding about ionic/crystalline solids, structures and their defects.
- Familiarizes about X-ray diffraction techniques necessitated for structural characterization of inorganic materials.

Prerequisite

- To possess prior knowledge of basic inorganic chemistry, chemical bonding and molecular structure, fundamentals of solid-state chemistry

Course Learning Outcomes (CLOs)

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

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Recall the fundamental concepts of inorganic polymers, polyoxometalates, crystal structures, and lattice defects in solid-state chemistry.	K1
CLO2	Explain the preparation, structure, and properties of borazines, phosphazenes, sulphur nitrides, silicones, and polyoxometalate systems.	K2
CLO3	Apply principles of solid state such as coordination number, radius ratio rules, and lattice concepts to predict structures of ionic solids.	K3
CLO4	Analyze the formation, structural variations and bonding patterns in inorganic polymers, isopoly and heteropoly acids and crystalline solids.	K4
CLO5	Evaluate structural stability and defect behavior in crystalline materials using concepts from solid-state chemistry and diffraction methods.	K5

CLO6	Formulate structural models or conceptual frameworks to explain structure–property relationships in inorganic polymers and crystalline materials using theoretical models.	K6
K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Unit	Coverage	Mapped CLOs
I	Inorganic polymers	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
II	inorganic polymers, sulphur nitrides, (SN)x conductors, silicon-based polymers and silicones	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
III	Isopoly and heteropoly acids and anions	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
IV	Types of solids	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
V	Ionic crystal structures	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO 10
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	3	1	2	1	1	1	1	1	1	1
CLO3	3	1	2	1	1	1	1	1	1	1
CLO4	3	1	3	1	1	1	1	1	1	1
CLO5	3	1	3	1	1	1	1	1	1	1
CLO6	2	1	1	3	1	1	1	1	1	1

INORGANIC CHEMISTRY I (MCE2601)
(Inorganic Chemistry and Solid State Chemistry) (55 Hrs)

Unit – I **(11 Hrs)**

Inorganic Polymers- I

Chain – Catenation, Heterocatenation - Silicate minerals, orthosilicates, pyrosilicates, zeolites- Intercalationcompounds-preparation and properties.

Rings- Borazines- Preparation, properties and structure, Phosphazenes – Preparation, properties and structure.

Cages- PS cages, PO cages.

Unit – II **(11 Hrs)**

Inorganic Polymers- II

Introduction, general properties, glass transition temperature, classification. One dimensional conductors- Nitrides of sulphur - S4N4 - Preparation and structure, $S4N_3^+$ - Preparation and structure, $(SN)_x$ -Preparation and structure. Silicon based polymers – Preparation, properties and types of silicones.

Unit – III **(11 Hrs)**

Isopoly and Heteropoly Acids and Anions

Introduction, polymerization of CrO_4^{2-} anion, polymerization of molybdates, tungstates, vanadates, niobates and tantalates. Isopoly anions and isopoly acids of Mo^{6+} and W^{6+}, isopolyvanadates, isopolyniobates and isopolytantalates. Heteropoly anions and heteropoly acids- different types, important reactions of iso and heteropoly anions.

Unit – IV **(11 Hrs)**

Solid State Chemistry – I

Structure- Types and classification of solids, distinction between crystalline and amorphous solids. Unit cell, Bravais lattice, classification of crystals based on bond type and packing in crystals. Imperfections in crystals - Types of defects, stoichiometric defects - Schottky and Frenkel. Non-stoichiometric defects – Metal excess and metal deficient, consequences of metal deficiency defects.

Unit – V **(11Hrs)**

Solid State Chemistry – II

Inorganic crystals - Coordination number, radius ratio rule and shapes of ionic crystals. Structures of ionic crystals - AX type: CsCl, ZnS (Zinc blende, Wurtzite), AX_2 type: CaF_2, TiO_2, CdI_2. X - ray diffraction- Powder Method, Single crystal methods, High temperature powder diffraction- Principle and uses.

*** Course Alignment with SDGs: 4, 9, 12**

Text Books:

S.No	Authors	Title	Publishers	Year & Edition
1	SatyaPrakash, G.D. Tuli, S.K. Basu, R.D.Madan	Advanced Inorganic Chemistry – Vol. I	S.Chand& Co.Ltd.	2012
2	Gurdeep Raj	Advanced Inorganic Chemistry – Volume I	Krishna Prakasam Media (P) Ltd.	1999 25 Edn
3	B.R. Puri, L.R. Sharma, K.C. Khalia	Principles of Inorganic Chemistry	MilestonePublisher	2007-2008
4	James E. Huheey,Ellen A. Keiter	Inorganic Chemistry	Pearson	2006 4 Edn

Reference Books:

S.No	Authors	Title	Publishers	Year & Edition
1	F. Albert Cotton and Geoffrey Wilkinson	Advanced Inorganic Chemistry	Wiley Interscience	1999 6 Edn
2	Anthony R. West	Solid State Chemistry and its Application	Wiley India	2011
3	J.D. Lee	Concise Inorganic Chemistry	Wiley India	2010

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture - Chalk and Talk
- PowerPoint presentations
- E-content
- Simulation
- Group discussions
- Assignments
- Quizzes
- Student seminars

Course Designers & Teaching–Learning Strategies

Course Code & Title	**MCE2601 & Inorganic Chemistry I (Inorganic and Solid State Chemistry)**
Course Designers	Dr. N. Muthulakshmi Andal Dr. G. Subashini
Teaching–Learning Strategies	Participatory Learning : 35 %
	Experiential Learning : 27 %
	Problem-based Learning : 38 %

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCE2602	**Core II: Organic Chemistry I (Organic Reaction Mechanism and Stereochemistry)**	**75**	**70**	**5**	**5**

Preamble

- Organic reaction mechanisms and stereochemistry constitute the conceptual foundation for advanced organic synthesis and modern chemical research.
- Provides an in-depth understanding of aromaticity, reaction mechanisms, nucleophilic and electrophilic substitution reactions, elimination reactions and stereochemical principles governing organic transformations.
- Emphases mechanistic interpretation using kinetic and thermodynamic concepts, stereochemical outcomes of reactions and structure–reactivity relationships.
- Equips students with the theoretical framework required to rationalize complex organic reactions and to design stereoselective synthetic strategies relevant to pharmaceuticals, materials science and biochemical systems.

Prerequisite

- Fundamental knowledge of undergraduate organic chemistry including reaction mechanisms, aromaticity, stereochemistry and basic physical organic chemistry concepts such as kinetics and thermodynamics.

Course Learning Outcomes (CLOs)

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

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Recall the fundamental concepts of aromaticity including the criteria for aromatic systems, nucleophilic and electrophilic substitution reactions, elimination reactions and stereochemistry of organic compounds	K1
CLO2	Explain aromaticity in ring systems, mechanisms of aliphatic and aromatic nucleophilic substitution (including neighbouring group participation and anchimeric assistance), orientation and reactivity in electrophilic substitution, structural and stereochemical factors in elimination reactions, and assignment of absolute configuration.	K2
CLO3	Apply mechanistic and stereochemical principles to determine aromatic stability, identify aromatic/non-aromatic/anti-aromatic systems and predict products, regioselectivity and stereochemical outcomes in nucleophilic substitution, electrophilic substitution and elimination reactions.	K3

CLO4	Analyze the kinetic and isotopic effects of organic reaction mechanisms, factors influencing the nucleophilic & electrophilic substitution, elimination reactions and various types of chirality & conformations in cyclic systems.	K4
CLO5	Evaluate the organic reaction mechanisms by applying relevant postulates and assess mechanistic pathways in nucleophilic substitution (SNAr mechanism, Benzyne mechanism, SRN1 mechanism), electrophilic substitution, elimination reactions and stereochemical aspects in asymmetric synthesis using Cram's rule, Prelog's rule and Felkin–Ahn model.	K5
CLO6	Assess structure–reactivity relationships using mechanistic evidence, kinetic analysis and stereochemical data.	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Unit	**Coverage**	**Mapped CLOs**
Unit I	Aromaticity and fundamental reaction mechanisms	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit II	Aliphatic and Aromatic Nucleophilic Substitution reactions	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit III	Aliphatic and Aromatic Electrophilic Substitution reactions	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit IV	Elimination reactions and mechanistic competition	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit V	Stereochemistry and asymmetric synthesis	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO 10**
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	3	1	2	1	1	1	1	1	1	1
CLO3	3	1	2	1	1	1	1	1	1	1
CLO4	2	1	3	1	1	1	1	1	1	1
CLO5	2	1	3	2	1	1	1	1	1	1
CLO6	2	1	3	2	1	1	1	1	1	1

CORE II: ORGANIC CHEMISTRY I MCE2602

(Organic Reaction Mechanism and Stereochemistry) (70 Hrs)

Unit I **(14Hrs)**

Aromaticity

Criteria - Huckel's rule – Aromatic character in benzene, four, five, seven, eight membered rings- Aromaticity of benzenoid and heterocyclic compounds. Non-benzenoid aromatics- azulene, ferrocene, tropolone, sydnones and annulenes (synthesis not required) - Non aromatic and anti-aromatic systems. Aromatic compounds in biochemistry – phenyl alanine, tyrosine, tryptophan, purine, pyrimidine.

Reaction Mechanism

Types of reactions and mechanisms, Non kinetic methods- Product analysis, intermediate criteria (isolation, trapping and detection)- Isotopic labeling and cross over experiments- Stereochemical evidence. Kinetic methods- Mechanistic implications of rate law- Isotope effects. Kinetic and thermodynamic control of reactions - Hammonds postulates, Curtin Hammett Principle, linear free energy relationship- Hammett and Taft equations.

Unit II **(14 Hrs)**

Aliphatic Nucleophilic Substitution

The S_N1, S_N2 & S_Ni mechanisms. The neighbouring group mechanism, neighbouring group participation by π & σ bonds, anchimeric assistance. Nucleophilic substitution at an allylic, aliphatic, trigonal and vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis, ambident nucleophiles and ambident substrates. Oxygen nucleophiles - Williamson reaction

Aromatic Nucleophilic Substitution

The S_NAr, S_N1, Benzyne and SR_N1 Mechanisms. Reactivity – Effect of substrate structure, leaving group and attacking nucleophile. O & S nucleophiles - Bucherer reaction, Rosenmund reaction, Von Richter rearrangement.

Unit III **(14 Hrs)**

Aliphatic Electrophilic Substitution

Bimolecular mechanisms – S_E2 (front), S_E2 (back) and S_E^i. Unimolecular mechanism- S_E1 mechanism, Substitution accompanied by double bond shifts. Hydrogen electrophiles- hydro-dehydrogenation, Halogen electrophiles - Halogenation of aldehydes, ketones and carboxylic acids, Nitrogen electrophiles - aliphatic diazonium coupling, Stork-enamine reaction, Sulphur electrophiles – sulphonation, Carbon electrophiles - acylation, alkylation.

Aromatic Electrophilic Substitution

Mechanism, orientation and reactivity, the ortho/para ratio. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling, ipso substitution. Sulphur electrophiles: Sulphonation, Jacobsen rearrangement. Carbon electrophiles: Alkylation, acylation, arylation reactions - Scholl reaction,

Gattermann reaction, Gattermann-Koch reaction, Reimer- Tiemann reaction, Kolbe- Schmidt reaction, Houben- Hoesch reaction, Vilsmeier- Haack reaction, Hoffmann-Martius reactions.

Unit IV **(14 Hrs)**

Elimination Reactions

E1, E2 and E1cB mechanism, orientation of double bond- structural and stereochemical factors

governing eliminations - Hoffmann and Saytzeff rules, Bredt's rule. Effect of changes in the substrate, base, leaving group and medium in E1, E2 and E1cB reactions, syn-anti dichotomy, E1-E2-E1cB spectrum, Elimination vs substitution. Pyrolytic elimination- Chugaev reaction, Hoffmann degradation, Cope elimination.

Unit V **(14 Hrs)**

Stereochemistry

Optical isomerism: Concept of chirality, R, S - nomenclature of compounds having more than one chiral centres.

Topicity and Prochirality: Identification of Homotopic, Enantiotopic, Diastereotopic Ligands and Faces. Prochirality – pro R, pro S, Re and Si faces.

Asymmetric Synthesis - Cram's and Prelog's Rules, Felkin-Ahn modification, Chiral Auxiliaries - Evan Aldol Reaction, Chiral Reagents - Epoxidation (Sharpless' Reaction). Stereospecific and Stereoselective Reactions

Axial chirality - Optical isomerism of biphenyl, allenes and spirens. Planar chirality - Optical isomerism of ansa compounds and cyclophanes. Helicity - Optical isomerism of over- crowded molecules. Stereochemistry of sulphur and nitrogen compounds.

Geometrical Isomerism: Stereoisomerism of cyclic compounds (upto six membered ring) - Aldoximes and ketoximes.

Conformational Analysis: Configuration and conformation. Conformation of cyclic compounds - cyclohexane, decalins, perhydrophenanthrenes. Effect of conformation on reactivity.

*** Course Alignment with SDGs: 4, 9**

Text Books:

S.No	Authors	Title	Publishers	Year & Edition
1	I.L. Finar	Organic Chemistry Vol I	Pearson Education	2009 6 Edn
2	I.L. Finar	Organic Chemistry Vol II	Pearson Education	2011 5 Edn
3	Jagdamba Singh and Yadav	Advanced Organic Chemistry	Pragati Prakasham	2010 6 Edn
4	Jerry March	Advanced Organic Chemistry	Wiley Publications	2010 4 Edn
5	E. L Eliel	Stereochemistry of Carbon Compounds	Tata McGraw Hill	2004 30 Edn
6	T.W. Graham Solomons, Craig B. Fryhle	Organic Chemistry	Wiley Publications	2008 9 Edn

Reference Books:

S.No	Authors	Title	Publishers	Year & Edition
1	R.K. Bansal	Organic Reaction Mechanism	Tata McGrawHill Publications	2006 3 Edn

2	F. A. Carey and Sundberg	Advanced Organic Chemistry-Part A	Springer	2010 2 Edn
3	F.A. Carey and Sundberg	Advanced Organic Chemistry-Part B	Springer	2007 2 Edn
4	D. Nasipuri	Stereochemistry of Organic Compounds	New AgePublishers	2008 2 Edn
5	Stanely H. Pine	Organic Chemistry	Tata MC GrawHill	2007 5 Edn

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture - Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Numerical problem-solving exercises
- Group discussions
- Assignments
- Quizzes
- Peer learning activities
- Student seminars

Course Designers & Teaching–Learning Strategies

Name of the course	**Organic Chemistry I**
Name of the Faculty	Dr. N. Shymaladevi, Dr. P. Amutha Dr. G. Sathya Priyadarshini Dr. Sowmya Ramkumar Dr. R Revathi
Participatory Learning	35%
Experiential Learning	30%
Problem-based Learning	35%

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCE2603	**Core III: Physical Chemistry I** (Classical and Statistical Thermodynamics)	**75**	**70**	**5**	**5**

Preamble

- Introduces thermodynamic parameters, advanced theoretical knowledge of statistical mechanics for understanding molecular systems.
- Explores statistical treatment of molecular energy distribution through Maxwell–Boltzmann statistics and partition functions
- Conceptual understanding and analytical interpretation of chromatographic, spectroscopic, thermoanalytical, and atomic spectroscopic techniques.
- Concepts of ensembles and thermodynamic probability are discussed to connect microscopic states with macroscopic thermodynamic properties.
- Highights quantum statistics including Bose-Einstein and Fermi - Dirac distributions and their significance.

Prerequisite

- Students should have prior knowledge of thermodynamics, quantum mechanics and elementary probability concepts in chemistry.

Course Learning Outcomes (CLOs)

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

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Understand fundamental thermodynamic parameters such as chemical potential, fugacity, activity, and standard states, third law of thermodynamics, classical and quantum statistics, partition function	K1
CLO2	Describe the concepts of thermodynamic probability, microstates, macrostates, statistical ensembles, chemical potential, partition functions, quantum statistics	K2
CLO3	Utilize statistical distribution laws and partition functions to determine thermodynamic properties of gases; Stirling's approximation and molecular velocities	K3

CLO4	apply thermodynamic concepts to evaluate the relationship between thermodynamic properties, translational, rotational, vibrational and electronic partition functions.	K4
CLO5	evaluate statistical thermodynamics to the properties of identical indistinguishable particles like bosons and fermions	K5
CLO6	Develop theoretical approaches integrating thermodynamics and statistical and quantum mechanics to explain molecular systems.	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Unit	**Coverage**	**Mapped CLOs**
Unit I	Chemical potential, Gibbs–Duhem equation, fugacity and activity	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit II	Third law of thermodynamics, probability and ensembles	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit III	Maxwell–Boltzmann statistics and velocity distribution	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit IV	Equipartition principle and partition functions	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit V	Quantum statistics – Bose–Einstein and Fermi–Dirac theories	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low.

CLO \ PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO 10**
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	3	1	2	1	1	1	1	1	1	1
CLO3	3	2	2	1	2	1	1	1	1	1
CLO4	3	1	3	1	1	1	1	1	1	1
CLO5	2	1	3	1	2	1	1	1	1	1
CLO6	2	1	2	3	2	1	1	1	1	1

CORE IV: PHYSICAL CHEMISTRY I (MCE2603) (70Hrs)

(Classical and Statistical Thermodynamics)

Unit I **(14Hrs)**

Classical Thermodynamics

Chemical potential - Gibbs - Duhem equation - determination of partial molar quantities. Clausius - Clapeyron equation and its applications. Fugacity - definition - determination of fugacity of gases by graphical method, from equation of state, approximation method and generalized method - variation of fugacity with temperature. Fugacity and the standard state for non-ideal gases - fugacity coefficient, fugacity of mixture of non- ideal gases.

Activity and activity coefficient. Standard states - activity of solutions.

Unit II **(14Hrs)**

Third Law of Thermodynamics

Nernst heat theorem, third law of thermodynamics - need for third law, different forms of stating third law, thermodynamic quantities at absolute zero, probability and third law, statistical meaning of third law and apparent exceptions, negative absolute temperature.

Probability and Ensembles

Theorems of permutations, combinations and probability. Thermodynamic probability to molecular systems - states of maximum thermodynamic probability of systems involving energy levels.

Distinguishable and indistinguishable particles. Microstates and macrostates. Ensembles – definition - microcannonical, cannonical, grand cannonical and average ensembles.

Unit III **(14 Hrs)**

Maxwell Boltzmann Statistics

Stirling's approximation formula, Maxwell Boltzmann distribution law – assumptions, derivation for the system having non - degenerate and degenerate energy levels. Experimental verification of Maxwell's distribution of molecular velocities by Stern method. Limitations of Maxwell Boltzmann distribution law.

2D Velocity Distribution Law

Phase space, Maxwell's distribution law of molecular velocities, evaluation of alpha and beta in Boltzmann statistics. Evaluation of average velocity, root mean square velocity and most probable velocity from distribution law of molecular velocities, molecular velocities and energies of an ideal gas.

Unit IV **(14Hrs)**

Equipartition of Principle of Energy

Calculation of heat capacities of ideal gases - limitations.

Partition Functions Definition - explanation - molecular partition function - molar partition function - relationship between partition function and thermodynamic properties E, H, S, A, G, C_V and C_P. Translational partition functions - Sackur tetrode equation. Rotational partition functions – ortho/para hydrogen - vibrational partition functions - electronic partition functions. Evaluation of thermodynamic properties for mono and diatomic ideal gas molecules from partition functions.

Unit V **(14 Hrs)**

Quantum Statistics

Bose Einstein distribution law - derivation - entropy of boson - applications. Derivation of Planck's black body radiation law. Bose Einstein condensation. Helium at low temperature. Fermi - Dirac distribution law - derivation, entropy of fermions, applications - electron gas, fermi energy of free electrons at absolute zero. Heat capacity of free electrons in metals. Heat capacity - Einstein theory and Debye theory, Debye T-cube law, comparison of Maxwell Boltzmann, Bose Einstein, Fermi - Dirac statistics.

*** Course Alignment with SDGs: 4, 9**

Text Books

S.No.	Authors	Title	Publisher	Year & Edition
1	Samuel Glassstone	Thermodynamics for Chemists	East West Press	2002, reprint
2	M.C. Gupta	Statistical Thermodynamics	Wiley Eastern Publications	1990 1 Edn
3	Ashley	Classical and Statistical Thermodynamics	Pearson Education	2012

Reference Books

S.No.	Authors	Title	Publisher	Year & Edition
1	P.W. Aktins	Physical Chemistry	Oxford University	1978, 1 Edn
2	Gurdeep Raj	Advanced Physical Chemistry	GOEL Publishing House	2002, 27 Edn

3	Peter Atkins Julio de Paula	Elements of Physical Chemistry	Oxford University	2014, 5 Edn
4	F.W. Sears G.L. Salinger	Thermodynamics, Kinetic & Statistical thermodynamics	Narosa Publishing House	2013, Reprints
5	Frederick.T. Wall	Chemical Thermodynamics	W.H. Freeman & Company	1974, 3 Edn

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture - Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Numerical problem-solving exercises
- Group discussions
- Assignments
- Quizzes
- Peer learning activities
- Student seminars

Course Designers & Teaching–Learning Strategies

Course Code & Title	**MCE2603, PHYSICAL CHEMISTRY I**
Course Designers	Dr. D. Nalini, Dr.G.Selvi Dr. R. Revathi, Dr. Sowmya Ramkumar Dr.G. Subashini, Dr. V.S. Angulakshmi
Teaching–Learning Strategies	Participatory Learning : 30 %
	Experiential Learning : 30 %
	Problem-based Learning : 40 %

Course Code	Course Title	Hours			Credits
		Total	Lecture	Examination	
MCE2604	**Core IV: Analytical Techniques in Chemistry**	**60**	**55**	**5**	**4**

Preamble

- It focuses on the fundamental principles, instrumentation, and operational aspects of major analytical techniques used in chemical and materials analysis
- The course explores advanced instrumental methods such as chromatography, chiroptical spectroscopy, thermoanalytical techniques, electron spectroscopy, and atomic spectroscopy.
- The course enhances analytical reasoning and instrumental interpretation skills required for advanced chemical investigations.
- The course enables the application of modern analytical tools to solve complex problems in chemical research and industrial applications

Prerequisite

Fundamental knowledge in analytical chemistry, spectroscopy and thermodynamics.

Course Learning Outcomes (CLOs)

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

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Outline the principles, components, and terminology of chromatographic, chiroptical, thermoanalytical, electron, and atomic spectroscopic techniques	K1
CLO2	Explain the working principles, instrumentation and operational features of advanced analytical techniques used in chemical analysis.	K2
CLO3	Apply chromatographic, thermoanalytical and atomic spectroscopic methods for solving qualitative and quantitative chemical analysis problems.	K3
CLO4	Analyze chromatograms, thermograms and spectroscopic data to determine structural, compositional and surface chemical information.	K4

CLO5	Evaluate the suitability, accuracy and limitations of different analytical techniques for specific chemical and industrial applications.	K5
CLO6	Formulate advanced analytical strategies by integrating suitable instrumental techniques—such as HPLC, GC, SFC, ORD, CD, TGA, DTA, DSC, XPS, PES, UPS, and AAS—for the systematic investigation of complex chemical systems	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Unit	**Coverage**	**Mapped CLOs**
Unit I	Chromatography – HPLC, GC, SFC and chromatogram interpretation	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit II	Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD)	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit III	Thermoanalytical methods – TGA, DTA, DSC	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit IV	Electron spectroscopy – PES, XPS, UPS, AES and surface chemical interpretation	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
Unit V	Atomic spectroscopy – AAS, FES	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	3	2	1	1	1	1	1	1	1	1
CLO3	2	3	2	1	1	1	1	1	1	1
CLO4	2	1	3	1	2	1	1	1	1	1
CLO5	2	1	3	1	1	1	1	1	1	1
CLO6	2	2	2	3	1	1	1	1	1	1

CORE IV: ANALYTICAL TECHNIQUES IN CHEMISTRY (MCE2604) (55Hrs)

Unit I **(11Hrs)**

Chromatography

High Pressure Liquid Chromatography (HPLC) - Introduction, characteristic features of HPLC, principle,column processes & band broadening, instrumentation and application.

Gas Chromatography (GC) - Introduction, principle, theory, instrumentation, evaluation of gaschromatogram, identification of chromatogram, plate theory and applications.

Super Critical Fluid Chromatography (SFC) - Characteristics of super critical fluids, comparison of SFC with HPLC & GLC and applications.

**Interpretation of chromatogram using caffeine, mixture of aminoacids, aflatoxin in milk, separation of phyto constituents.

Unit II **(11 Hrs)**

Optical Rotatory Dispersion & Circular Dichorism : Introduction, polarised light &chiroptical properties - linearly & circularly polarized light, circular birefringence & circular dichroism. Instrumentation – Automatic recording spectropolarimeters (ORD), Circular dichrometer. ORD and CD curves – plain curves, cotton effect curves. Empirical &Semi empirical rules - Axial haloketone rule, Octant rule, Helicity rule, Lowe's rule. Application of Axial haloketone rule & Octant rule for ketones – absolute configuration, position of functional group, conformation, conformational mobility; Helicity in dienes, Lowe's rule for the configuration of allenes.

Unit III **(11Hrs)**

Thermoanalytical Methods

Thermogravimetric analysis & differential thermal analysis – Principle, various components with block diagram - TGA & DTA curves of $CuSO_4.5H_2O$, $MgC_2O_4.H_2O$ & $Ca(OOCCH_3)_2.H_2O$ Simultaneous DTA-TGA curves of $SrCO_3$ in air & $CaC_2O_4.H_2O$ in air & CO_2. Factors affecting TGA & DTA curves. DSC - Principle, Instrumentation – Power compensated, Heat-flux, Modulated DSC instruments. Applications: glass transition temperatures, reaction kinetics, crystallinity and crystallization rate.

**Interpretation of thermogram using TGDTA (Tris(thiourea)copper (II) chloride, Potassiumtris(oxalato)ferrate(III))

Unit – IV **(11 Hrs)**

Electron-Ion Spectroscopy

Introduction – general techniques in surface spectroscopy. Basic principles of electron spectroscopy – photoelectric effect and photoelectron spectroscopy (PES). Phototelelectron spectroscopy and Koopman's theorem. X-ray photoelectron spectroscopy – instrumentation & applications. Principles of Ultraviolet Photoelectron spectroscopy (UPS) and Auger Electron spectroscopy (AES).

**Interpretation of XPS of metal oxides (MnO_2, Co_3O_4 and NiO), metal hydroxides ($Co(OH)_2$, $Ni(OH)_2$) and organic compounds (graphenes and carbon nitrides).

Unit – V **(11 Hrs)**

Atomic Spectroscopy

Atomic Absorption Spectroscopy (AAS) – introduction, principle, procedure, preparation of samples, measurement of atomic absorption, sensitivity, calibration – methods, advantages and disadvantages of atomic absorption, precision and accuracy. Flame Emission – relationship between atomic absorption and Flame Emission Spectroscopy (FES) – advantages of atomic absorption over flame emission. Line widths – instrumentation – sources – monochromators – filters – optical system and detectors - indicators. Flame – profiles – flame atomization – oxidants. Fuels – types of burners, interferences – cation and anion interferences, analytical applications.

**Determination of trace metal ions using AAS from industrial effluents (electroplating, paint and textile industries)

** Not for examination

*** Course Alignment with SDGs: 4, 9, 12**

Text Books

S.No.	Authors	Title	Publisher	Year & Edition
1	E.L Eliel	Stereochemistry of Carbon Compounds	Tata McGrawHill	2004 30 Edn.
2	Dr. H. Kaur	Instrumental Methods of Chemical Analysis	Pragati Prakashan	2008 4 Edn
3	Mahinder Singh	Analytical Chemistry-InstrumentalTechniques	Dominant Publishers & Distributors New Delhi	2003 1 Edn.
4	B. K Sharma	Instrumental Methods of ChemicalAnalysis	Goel Publications	2012 28 Edn.
5	H. H Willard, L. L Merritt, J. A Dean, F.A. Settle	Instrumental Methods of Analysis	CBS Publishers& Distributors	1986 7 Edn.
6	D.A. Skoog, F.J. Holler and S.R. Crouch	Instrumental Analysis	Cengage Learning	2010

Reference Books

S.No.	Authors	Title	Publisher	Year & Edition
1	S. M. Khopkar	Basic Concepts of Analytical Chemistry	Wiley EasternLtd	1884 1 Edn.
2	D. A Skoog, F.J. Holler and D. MWest	Analytical Chemistry-An Introduction	Saunders College Publications	1994 & 6 Edn.
3	M.S. Yadav	Instrumental Methods of Chemical Analysis	Campus Book	2006 & 1 Edn.

Related Online References

- https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Instrumental_Analysis_(LibreTexts)/26%3A_Chromatographic_Methods.
- https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Stereochemistry/Circular_Dichroism
- https://www.thermofisher.com/in/en/home/materials-science/learning-center/techniques/xps.html
- https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Instrumental_Analysis_(LibreTexts)/20%3A_Atomic_Absorption_Spectroscopy

Pedagogy

The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Lecture - Chalk and Talk
- PowerPoint presentations
- E-content and digital learning resources
- Numerical problem-solving exercises
- Group discussions
- Assignments
- Quizzes
- Peer learning activities
- Student seminar

Course Designers & Teaching–Learning Strategies

Course Code & Title	**MCE2604, Analytical Techniques in Chemistry**
Course Designers	Dr. E. Kayalvizhy Dr. C. Nithya Dr. G. Sathya Priyadarshini Dr. S. Charulatha
Teaching–Learning Strategies	Participatory Learning : 30 %
	Experiential Learning : 30 %
	Problem-based Learning : 40 %

Course Code	Course Title	Hours			Credits
		Total	Practical	Examination	
MCE26P1	**Core Practical I : Organic Chemistry Practical I**	**120**	**114**	**6**	**4**

Preamble

- Emphasis on systematic separation and identification of organic compounds from mixtures and preparation of functional derivatives.
- Exposure in the systematic synthesis and purification of organic compounds.
- Introduces the application of spectroscopic and chromatographic tools for the characterization and identification of functional groups.
- Develops laboratory skills, analytical thinking, and safe laboratory practices for organic analysis.
- Integrates theoretical knowledge and laboratory practice, for industrial and academic research.

Prerequisite

- A foundational understanding of organic chemistry, including functional groups, reaction mechanisms, purification techniques, and laboratory procedures.

Course Learning Outcomes (CLOs)

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

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Recall the principles of organic qualitative analysis and the chemical properties of reagents used in organic synthesis.	K1
CLO2	Explain the theoretical principles behind separation techniques for binary mixtures, concepts of named organic preparations and characterization tools.	K2
CLO3	Perform separation of organic mixtures, synthesize selected organic compounds, and purify them using appropriate laboratory techniques.	K3

CLO4	Analyze experimental observations and spectral data (FTIR & HPLC) to identify functional groups and determine the purity of chemical / food samples.	K4
CLO5	Evaluate the purity, yield, and experimental reproducibility of synthesized compounds using melting point.	K5
CLO6	Design systematic experimental procedures for organic mixture analysis and synthesis while adhering to laboratory safety and green chemistry practices.	K6
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Experiment No.	**Coverage**	**Mapped CLOs**
1.	Qualitative analysis of two component mixtures:	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
2.	preparations of organic compounds	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
3.	IR spectroscopy	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
4.	HPLC (Group experiment)	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	3	1	2	1	1	1	1	1	1	1
CLO3	2	3	1	1	1	1	1	1	2	1
CLO4	2	1	3	1	2	1	1	1	1	1
CLO5	2	1	3	1	1	1	1	1	1	1
CLO6	1	2	1	3	1	1	1	1	3	1

Core Practical I: ORGANIC CHEMISTRY PRACTICAL I MCE26P1

(114 Hrs)

1. **Qualitative Analysis:**

Analysis of two component mixtures – Separation, identification of components and determination of melting point/ boiling point of the components.

Note: A minimum of five organic mixtures should be done by each student.

2. **One stage preparations and purification by recrystallization technique**

(i) m-dinitrobenzene from Nitrobenzene

(ii) Resacetophenone from Resorcinol

(iii) Tribromoaniline from Aniline

(iv) Diazoaminobenzene from Aniline

(v) Anthranilic acid from Pthalimide

(vi) Methyl orange from sulphanilic acid

3. **Characterization of any two of the above compounds by FTIR spectra**

4. **Analysis of food samples using HPLC (Group Experiment)**

*** Course Alignment with SDGs: 4, 3, 12**

Text Book:

LAB MANUAL - Prepared by Faculty, Department of Chemistry, PSGR Krishnammal College for Women

Reference books:

S. No	Authors	Title	Publisher	Year & Edition
1.	Arthur I. Vogel	Elementary Practical Organic Chemistry (Part 2) Qualitative Organic Analysis	Pearson Education	2011 2 Edn.

2.	F.G. Mann & B.C. Saunders	Practical Organic Chemistry	Pearson Education	2009 4 Edn

Pedagogy: The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Demonstration and hands on practical
- Peer-Assisted Learning
- Microscale Practice
- Spectral Integration

Course Designers & Teaching–Learning Strategies

Course Code & Title	**MCE26P1, Organic Chemistry Practical I**
Course Designers	Dr. P. Kanchana Dr. Sowmya Ramkumar

Course Code	Course Title	Hours			Credits
		Total	Practical	Examination	
MCE26P2	Core Practical II: Inorganic Chemistry Practical I	120	114	6	4

Preamble

- Provides hands-on training in classical and modern experimental techniques relevant to inorganic chemistry.
- The course emphasizes semi-micro qualitative analysis of less familiar cations and anions, complexometric titrations using EDTA, and the preparation of coordination compounds.
- Students gain practical exposure to synthesis and purification of inorganic complexes and their spectroscopic characterization using IR techniques.
- The course also involves nanomaterial preparation through the synthesis of CuO nanoparticles and their characterization using a Nano Particle Track Analyzer.
- This practical training strengthens analytical skills, experimental precision, and interpretation of chemical data.

Prerequisite

- Basic knowledge of undergraduate inorganic chemistry, qualitative inorganic analysis, coordination chemistry, and fundamental laboratory techniques including titration and solution preparation.

Course Learning Outcomes (CLOs)

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

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Recall the principles of qualitative analysis, complexometric titration and coordination compound formation relevant to inorganic laboratory experiments.	K1
CLO2	Explain the reactions, separation schemes and analytical principles involved in semi-micro qualitative analysis and EDTA titrations.	K2

CLO3	Perform qualitative analysis, complexometric estimations and synthesis of selected inorganic complexes using standard laboratory procedures.	K3
CLO4	Analyze experimental observations and spectroscopic data to identify ions and interpret structural features of synthesized complexes.	K4
CLO5	Evaluate the accuracy and reliability of analytical results by comparing experimental data with theoretical values.	K5
CLO6	Design and execute experimental procedures for the preparation and characterization of inorganic complexes and nanomaterials.	K6
K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		

Unit-wise CLO Mapping

Experiment No.	**Coverage**	**Mapped CLOs**
1	Semi-micro qualitative analysis	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
2	Complexometric titrations	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
3	Preparation of inorganic coordination complexes Characterization of complexes using IR spectroscopy	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
4	Preparation of CuO nanoparticles and characterization using Nano Particle Track Analyzer	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	3	2	1	1	1	1	1	1	1	1
CLO3	2	3	1	1	1	1	1	1	2	1
CLO4	2	2	3	1	1	1	1	1	1	1
CLO5	1	2	3	1	1	1	1	1	1	1
CLO6	3	2	2	3	2	1	1	2	2	1

Core Practical II: INORGANIC CHEMISTRY PRACTICAL I MCE26P2 (114 Hrs)

1. **Qualitative Analysis**

Qualitative Analysis employing semi micro methods & spot tests of mixtures of common cations& ions of the following less familiar elements - Molybdenum , Thallium, Tungsten, Selenium, Tellurium, Cerium, Thorium, Titanium, Zirconium, Vanadium, Beryllium, Uranium & Lithium.

2. **Titrimetry**

Complexometric titrations using EDTA - Estimations of Magnesium, Nickel & Zinc.

3. **Preparation of Inorganic Complexes**
   i. Tris(thiourea)copper (I)chloride
   ii. Potassium tris(oxalato)ferrate(III)
   iii. Hexammine cobalt (III)chloride
   iv. Ammonium hexachlorostannate(IV)
   v. Tetramminecopper (II)sulphate
4. **Characterization of any two of the above complexes by IR spectra**
5. **Preparation of CuO nanoparticles and its characterization using Nano Particle Track Analyzer (Group Experiment)**

*** Course Alignment with SDGs: 4, 9, 12**

Text Books: LAB MANUAL - Prepared by Faculty, Department of Chemistry, PSGR Krishnammal Collegefor Women

Reference books:

S. No	Authors	Title	Publisher	Year & Edition
1	Arthur I.Vogel	Macro &Semimicro Qualitative Inorganic Analysis	Orient Long man'sLtd	1985 5 Edn
2	G.Palmer	Experimental InorganicChemistry	Cambridge University Press	1964 3 Edn.

Pedagogy: The course will be delivered using a combination of traditional and learner-centered teaching methods, including:

- Demonstration and hands on practical
- Peer-Assisted Learning

- Microscale Practice
- Spectral Integration

Course Designers & Teaching–Learning Strategies

Course Code & Title	**MCE26P2, Inorganic Chemistry Practical I**
Course Designers	Dr. N. Muthulakshmi Andal Dr. G. Subashini

Course Code	Course Title	Hours			Credits
		Total	Practical	Examination	
MCE26P3	**Core Practical III: Physical Chemistry Practical I**	**120**	**114**	**6**	**4**

Preamble

- Perform laboratory experiments related to molecular weight determination, phase equilibria, transition temperature studies, viscosity measurements and electrochemical analysis using potentiometric methods.
- Gain experience in interpreting experimental data and validating physicochemical principles through laboratory observations.
- Develops skills in writing laboratory reports, working together in experiments, and following proper laboratory practices.

Prerequisite

- Basic knowledge of physical chemistry principles, including thermodynamics, phase rule, electrochemistry, chemical equilibrium, and acid–base concepts, along with familiarity with basic laboratory techniques and measurement methods.

Course Learning Outcomes (CLOs)

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

CLO No	Course Learning Outcome	Bloom's Level
CLO1	Recall the fundamental principles underlying molecular weight determination, viscosity, and potentiometric titration techniques.	K1
CLO2	Explain the theoretical principles involved in experiments such as eutectic systems, transition temperature of salt hydrates, electrode potential measurements. and electrochemical measurements.	K2
CLO3	Perform physical chemistry experiments using appropriate laboratory instruments and titration methods to obtain accurate experimental data.	K3
CLO4	Analyze experimental data from viscosity, electrochemical, and phase equilibrium studies to determine physicochemical parameters.	K4
CLO5	Evaluate the accuracy and reliability of experimental results by comparing them with theoretical expectations and standard values.	K5
CLO6	Design an experimental approach to evaluate the purity and molecular association of an organic compound by analyzing its effect on the freezing point depression of a suitable solvent.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit-wise CLO Mapping

Experiment No.	Coverage	Mapped CLOs
1.	Potentiometric titrations:	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6
2.	Non - Potentiometric titrations:	CLO1, CLO2, CLO3, CLO4, CLO5, CLO6

Alignment of CLO with PLO

3 = High, 2 = Medium, 1 = Low

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	1	1	1	1	1	1	1	1	1
CLO2	2	3	1	1	1	1	1	1	2	1
CLO3	2	2	3	1	1	1	1	1	1	1
CLO4	1	1	3	1	1	2	1	1	1	1
CLO5	1	2	2	3	1	2	1	1	1	1
CLO6	3	2	2	3	2	1	1	2	2	1

Core Practical III : PHYSICAL CHEMISTRY PRACTICAL I MCE26P3 (114 Hrs)

1. Molecular weight determination by Rast Micro Method
2. Phase study: Simple Eutectic System & Compound Formation
3. Determination of Transition Temperature of Salt Hydrate
4. Viscosity: Variation of viscosity of liquids with temperature
5. Electromotive Force:
   i) Determination of Standard Potentials (Cu, Ag)
   ii) Determination of pH & pKa values using Hydrogen & Quinhydrone electrodes
6. Potentiometric Titrations:

Acid Base titrations
i)Titration of HCl vs NaOH
ii) Titration of mixture of acids against a strong base
iii)Titration of CH_3COOH vs NaOH
Redox titrations
iv)Titration of Ferrous ammonium sulphate against Potassium dichromate
v) Titration of Potassium iodide against Potassium permanganate
Precipitation titrations
vi)Estimation of KI by titration with $AgNO_3$ using KCl as standard.
vii) Titration of mixture of halides against $AgNO_3$ solution
viii)Determination of solubility product of a sparingly soluble salt (Concentration Cell &Chemical Cell)

*** Course Alignment with SDGs: 4, 9, 12**

Text Books:

LAB MANUAL-Prepared by Faculty, Department of Chemistry, PSGR Krishnammal College for Women

Reference books:

S. No	Authors	Title	Publisher	Year & Edition
1	B. Viswanathan& P.S. Raghavan	Practical Physical Chemistry	Viva Books	2009 & 3 Edn

Pedagogy

- Demonstration Method
- Experimental / Hands-on Learning Method
- Observation Method
- Problem-solving Method
- Collaborative Learning Method
- Discussion Method

- Laboratory Report Writing Method

Course Designers :

Course Code & Title	**MCE26P3 & Core Practical III: PHYSICAL CHEMISTRY PRACTICAL I**
Course Designers	Dr. E. Kayalvizhy Dr S. Jone Kirubavathy Dr. G. Sathya Priyadarshini Dr. Sowmya Ramkumar